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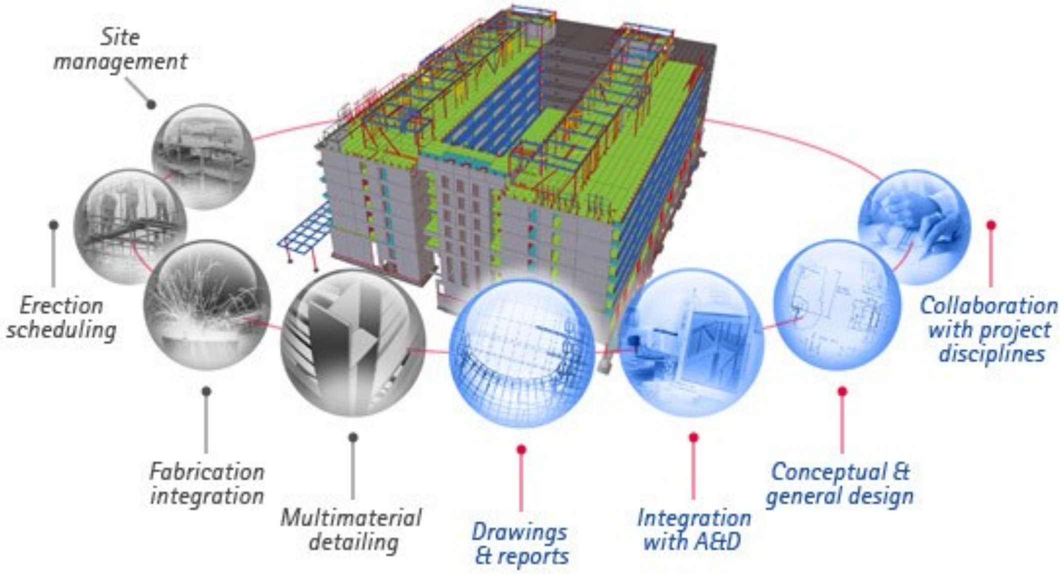

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Translation of Software Requirements

Hanan Elazhary

Abstract—Stakeholders typically speak and express software requirements in their native languages. On the other hand, software engineers typically express software requirements in English to programmers who program using English-like programming languages. Translation of software requirements between the native languages of the stakeholders and English introduces further ambiguities. This calls for a system that simplifies translation of software requirements while minimizing ambiguities. Unfortunately, this problem has been overlooked in the literature. This paper introduces a system designed to facilitate translation of requirements between English and Arabic. The system can also facilitate the analysis of software requirements written in Arabic. This is achieved through enforcing writing software requirements statements using templates. Templates are selected such that they enforce following best practices in writing requirements documents.

Index Terms— Requirements, Software Engineering, Translation

1 Introduction

SOFTWARE requirements engineering is concerned with understanding and specifying the services and constraints of a given software system. It involves software requirements elicitation and specification [1]. Elicitation of software requirements from stakeholders typically results in user requirements, which are natural language statements that describe the high-level goals of a given software system [2]. Analysis of natural language user requirements is an important activity since imprecision in this stage causes errors in later stages. Requirements imprecision is at least an order of magnitude more expensive to correct when undetected until late software engineering stages [3]. Thus, focusing on improving the precision of the elicited user requirements in the first cycle is one of the ambitious aims of software engineering [4]. One of the main causes of imprecision is the ambiguity of natural languages used to express the user requirements [5]. To minimize ambiguity, a number of best practices in writing requirements documents have been proposed by experts [6-9]. These practices include:

- Maintain terminological consistency and clarity by restricting action and actor descriptions to terms that are clearly defined in a glossary.
- Do not use different phrases to refer to the same entity (For example, do not use Order Processing System and Order Entry System to refer to the same system).
- Avoid using phrases, such as “easy to use”, whose meaning is subjective and leads to ambiguity.
- Write each requirement as a single separate sentence.
- Write complete sentences rather than bulleted buzz phrases.
- Write complete active-voice sentences which clearly specify the actor / agent and the action.
- Write requirements sentences in a consistent fashion using a standard set of syntaxes with each syntax-type corresponding to and signaling different kinds of requirements.
- Associate a unique identifier with each requirement.

While these practices are relatively easy to state and understand, it seems fairly difficult for requirements engineers to consistently apply them throughout requirements documents with thousands of requirements. Thus, some tools in the literature have been developed to help users adhere to best practices in writing requirements documentation. This also simplifies the automatic analysis of requirements documents written in natural language and allows generating warning messages when the requirements do not conform to best practices [9].

One of the problems that have been overlooked in the literature is the problem of software requirements translation. Stakeholders typically speak their native languages, while requirements documents are typically written in English and software programs are typically developed in English-like programming languages. The problem is that the translation of software requirements from the native language of stakeholders to English introduces further ambiguities. Whenever errors are discovered in later stages of the software engineering process, suggested modifications of the software requirements result. To negotiate these modifications with the stakeholders, modified requirements need to be translated between English and the native language of the stakeholders back and forth. This can introduce more ambiguities that complicate the problem even more.

To address this problem, we suggest implementing systems that helps users adhere to best practices in writing requirements documents using different natural languages. This simplifies analyzing requirements documents in the natural language of the stakeholders. By specifying the mappings between the different developed systems, we allow translation of software requirements between different natural languages while minimizing ambiguities. In this paper, we introduce the Arabic Requirements Analysis Tool (ARAT) system that has been designed to handle software requirements in Arabic. The reason for selecting the Arabic language is that it is the official language of hundreds of millions of people in the Middle East and North Africa. It is expected that a large number of these targeted users would benefit from ARAT. We also specify mappings between our system and a similar system called Requirements Analysis Tool (RAT) [9]. RAT handles requirements written in English. Mappings simplify translation of natural language requirements between English and Arabic, while minimizing ambiguities.

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The paper is organized as follows: Section 2 describes related research in the literature. Section 3 describes the RAT system and Section 4 describes the ARAT system and how the Arabic requirements are analyzed using it. Section 5 provides examples that illustrate the mappings between the English syntaxes in the RAT system and the Arabic syntaxes in the ARAT system. The examples also illustrate how translation is performed between English and Arabic requirements accordingly while minimizing ambiguities. Finally, Section 6 provides conclusions and directions for future research.

TABLE 1
A SNAPSHOT OF AN ENTITY GLOSSARY

Entity Descriptor	Explanation	Is Agent
order processing system	System for processing orders	Yes
Web server	HTTP Web Server	Yes
finance department user	User from finance department	Yes
chemical containers	Containers that store acids	No
customer standing	The status of the customer	No

TABLE 2
A SNAPSHOT OF AN ACTION GLOSSARY

Action Descriptor	Explanation
process payroll	Action for processing of payroll.
inform administrator	Action for sending e-mail notification to the administrator.
send contracts data	Action for transfer of contract data.
Display	Rendering an item on screen.

2 REALTED WORK

Many tools in the literature have been developed to automatically analyze natural language software requirements. Lami [10] and Hussain et al. [11] developed systems that can automatically detect potential imprecision in natural language software requirements through indicators such as weak verbs. But, these systems don't assist in correcting any imprecision.

Another approach in the literature attempts to avoid the introduction of imprecision while the software requirements are being written by imposing the use of natural language patterns. Some of these have focused on developing natural language patterns for specific domains such as database systems [12], scenarios [13], and embedded systems [5]. General purpose systems include Raven [14], which can analyze use cases. Jain et al. [9] developed the general-purpose RAT system that imposes the use of specific natural language patterns that help users adhere to best practices in writing software requirements in different situations and can provide useful advices.

The REAS system [15] attempts to integrate these two approaches intelligently to exploit their advantages and avoid their disadvantages, but cannot help in the translation of requirements. Thus, the prposed system emulates the RAT system and uses the analogy ti simplify the translation of requirements between Arabic and English while minimizing ambiguities.

3 THE RAT SYSTEM

In this section, we describe the structure of an English requirements document according to the RAT system and discuss how the requirements document is analyzed accordingly.

3.1 User-Defined Glossaries

User-defined glossaries should be created to define valid entities and actions in the requirements document. This helps requirements engineers adhere to one of the best practices in writing requirements documents; that is using entities and actions consistently. As will be explained later in Section 3.3, the terms in the glossaries will also be used as placeholders that help in the analysis of the requirements.

The entity glossary defines all entities in the requirements document. It also specifies whether each entity is an agent that can perform actions or not. Agents and non-agents will be referred to as agents and entities respectively throughout the paper. Snapshots of an entity glossary and an action glossary are shown in Tables 1 and 2 respectively.

3.2 Best Practices Syntaxes

A set of syntaxes has been defined in the RAT system to help requirements engineers adhere to best practices in writing requirements documents as explained in Section 1. These syntaxes are as follows:

(a) The syntax *<Agent Phrase> <"shall" | "must" | "will"> <Action Phrase>* is used to express a requirement that an agent is responsible for carrying out some action. For example: The Web server must inform administrator of failed login attempts.

(b) The syntax *<Agent Phrase> <"shall" | "must" | "will"> "be able to" <Action Phrase>* is used to express a requirement that an agent should have the ability to perform an action. For example: The payroll system shall be able to deduct loan amounts from paychecks.

(c) The syntax *<Agent Phrase> <"shall" | "must" | "will"> <"allow" | "permit"> <Agent Phrase> "to" <Action Phrase>* is used to express a requirement that an agent should provide another agent with the capability to perform an action. For example: The order processing system must permit administrator to view daily transactions.

(d) The syntax *<Agent Phrase> <"shall" | "will" | "may"> <"only" | "not"> <Action Phrase> <"when" | "if"> <condition>* is used to express imposed conditions or constraints on actions performed by agents. For example: The account management system shall only close an account if the current balance is zero.

(e) The syntax *"Only" <Agent Phrase> <"may" | "maybe"> <Action Phrase>* is used to express imposed conditions on agents who may perform an action or to whom an action may be performed. For example: Only the payroll employees may access the payroll database.

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(f) The syntax <*Entity Phrase* | *Agent Phrase*> *"must"* <*"always"* | *"never"* | *"not"*> <*"be"* | *"have"*> <*Value Phrase*> is used to express imposed constraints on attributes or values of attributes of entities or agents. For example: The customer standing must always be gold, silver, or bronze.

(g) The syntax <*Entity Phrase* | *Agent Phrase*> *"is"* <*"defined as"* | *"classified as"*> < *Entity Phrase*> is used to express a definition of an entity or an agent. For example: The total sales value is defined as total item value plus sales tax.

(h) The syntax <*Entity Phrase* | *Agent Phrase*> <*"is"* | *"is not"*> <*Action Phrase*> is used to express policies that should be adhered to. For example: The sales tax is computed on instate shipments.

It is clear that each category of requirements is expressed by a specific syntax type with different keywords. This simplifies understanding the intent of each requirement and its analysis as explained in Section 3.3. It should be noted that these syntaxes can be written in the format of the conditional syntax (d).

3.3 Analyzing Requirements

RAT uses a two phased approach for the analysis of the requirements document: 1) lexical analysis and 2) syntactic analysis.

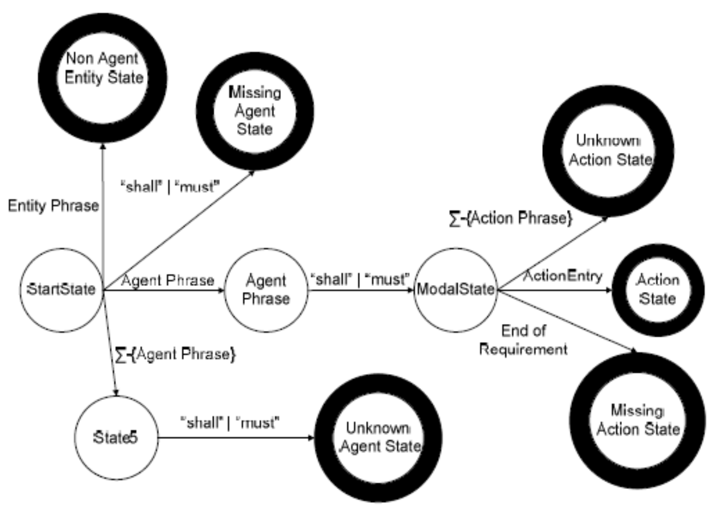

Fig. 1. A state machine for syntax type (a) of the RAT system [9].

3.3.1 Lexical analysis

A lexical analyzer breaks down a given requirement into a set of tokens: agent phrases, entity phrases, action phrases, or modal phrases formed of keywords such as "shall", "will" and "shall be able to". For example, the following statement "The SAP system shall send the vendor data to the order processing system" is tokenized into: the agent phrase "The SAP system", the modal phrase "shall", the action phrase "send", the entity phrase "the vendor data", the unknown phrase "to" and the agent phrase "the order processing system". After tokenization, the requirement is classified into one of the syntax types based on the modal phrase(s). Thus, according to the above modal phrase "shall", the requirement follows syntax type (a).

3.3.2 Syntactic analysis

The syntactic analyzer has a different sate machine to validate each syntax type. The tokenized requirement is run through the corresponding state machine. A requirement is treated as syntactically correct when the state machine successfully transitions from the start state to a valid final state. In the above example, the state machine shown in Figure 1 is used. The token stream for the requirement will end up in "Action State" and so will be treated as a valid requirement.

For every error state, there is a predefined warning message that is displayed to the user. The statement of each warning message explains why the requirement deviates from best practices in writing requirements documents. Table 3 shows the warning messages corresponding to different error states in the above state machine. For example, the statement "shall display error messages in new window" halts in "Missing Agent State" since it lacks an agent phrase in the beginning. The generated warning message is "This requirement lacks an agent before 'shall'. It can be confusing to leave the agent implicit."

TABLE 3
ERROR STATES AND THE CORRESPONDING WARNING MESSAGES

Error State	**Warning Message**
Missing Agent State	*This requirement lacks an agent before '<variable at which error occurs>'. It can be confusing to leave the agent implicit.*
Unknown Action State	*This requirement contains '<variable at which error occurs>' where an action is expected, but '<variable at which fault occurs>' is not in the action glossary.*
Unknown Agent State	*This requirement contains '<variable at which error occurs>' where an agent is expected, but '<variable at which fault occurs>' is not in the entity glossary.*
Non Agent Entity State	*This requirement contains '<variable at which error occurs>' where an agent is expected. '<variable at which error occurs>' is in the entity glossary but is not designated as an agent.*
Missing Action State	*This requirement lacks an action before '<variable at which error occurs>'. It can be confusing to leave the action implicit.*

3.3.3 Early Deployment Results

Eleven real industrial software projects have been used to assess the tool. They used RAT to make changes to the requirements based on the warning messages generated by RAT. This resulted in:

- 10-30% reduction in time required to transform notes taken in interview sessions to well formed requirements.
- 30-50% reduction in time needed to review requirements.
- 5% estimated reduction in overall budget, due to expected reduction in requirements defects and associated reduction in rework.

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4 The ARAT System

The ARAT system is an Arabic version of the RAT system. The advantage of this system is twofold. First, it has similar advantages as the RAT system but with respect to Arabic requirement documents. In other words, it helps requirements engineer adhere to best practices in writing Arabic requirements documents and simplifies the analysis of these documents. Second, due to the analogy between both systems, it allows the translation of software requirements between Arabic and English while resolving many ambiguities. Thus, an Arabic syntax (and a corresponding state machine) in the ARAT system has been designed corresponding to each English syntax (and its corresponding state machine) in the RAT system. While reading the Arabic syntaxes, it should be noted that:

- Arabic statements and thus Arabic syntaxes are written from the right to the left.
- Some syntaxes in RAT are decomposed into two syntaxes in ARAT due to the nature of the Arabic language.
- Some model phrases in RAT are represented by two modal phrases in the corresponding syntax in ARAT due to the nature of the Arabic language. For example “be able to” is represented by "يمكنه أن" and"يمكنها أن" for masculine and feminine respectively.
- The meanings of the Arabic modal phrases in these syntaxes are provided in the modal phrases dictionary shown in Table 4.
- The arrangements of the components of a given syntax in ARAT may be different from that of the corresponding syntax in RAT due to the nature of the Arabic language.

The ARAT Arabic syntaxes (corresponding to the RAT English syntaxes described in Section 3.2) are as follows:

TABLE 4
The Modal Phrases Dictionary

Modal phrases in RAT	Corresponding modal phrases in ARAT
shall | will	سوف
shall | will not	لن
must	يجب أن
must not	لا يجب أن
may | maybe	يمكن أن
may not | may not be	لا يمكن أن
is	
is not	لا
be able to	يمكنه أن | يمكنها أن
allow | permit	يمكن | تمكن
to	أن
only	فقط
when | if	لو | عندما | حين
always	دائما
never	مطلقا لا
be	يكون | تكون
have	يكون له | يكون لها
defined as	تعريفه | تعريفها
classified as	تصنيفه | تصنيفها

(a) <Agent Phrase> <"سوف" | "يجب أن"> <Action Phrase>
(b) <Agent Phrase> <"سوف" | "يجب أن"> <"يمكنه أن" | "يمكنها أن"> <Action Phrase>
(c) <Agent Phrase> <"سوف" | "يجب أن"> <"يمكن" | "تمكن"> <Agent Phrase> "أن" <Action Phrase>.
(d) <Agent Phrase> "فقط" <"سوف" | "يمكن أن"> <Action Phrase> <"لو" | "عندما" | "حين"><condition>
<Agent Phrase> <"لن" | "لا يمكن أن"> <Action Phrase> <"لو" | "عندما" | "حين"><condition>
(e) "فقط" <Agent Phrase> "يمكن أن"<Action Phrase>
(f) <Entity Phrase | Agent Phrase> <"دائما" | "لا" | "مطلقا لا"> "يجب أن" <"يكون" | "تكون" | "يكون له" | "يكون لها"> <Value Phrase>
(g) <Entity Phrase | Agent Phrase> <"تعريفه" | "تعريفها" | "تصنيفه" | "تصنيفها"> <Entity Phrase>
(h) <Entity Phrase | Agent Phrase> <Action Phrase>
<Entity Phrase | Agent Phrase> "لا" <Action Phrase>

As an example of analyzing Arabic requirements in ARAT, consider the following Arabic statement "نظام ساب سوف يرسل بيانات التاجر إلى نظام تدوير الطلبيات". This statement is tokenized into: the agent phrase "نظام ساب", the modal phrase "سوف", the action phrase "يرسل", the entity phrase "بيانات التاجر", the unknown phrase "إلى", and the agent phrase "نظام تدوير الطلبيات". According to the above modal phrase "سوف", the requirement follows syntax type (a). When this token stream is run through the corresponding state machine, it ends up in “Action State” and so is treated as a valid requirement.

In the next section, we provide examples that illustrate the mappings between the English syntaxes in the RAT system and the Arabic syntaxes in the ARAT system. The examples also illustrate how translation is performed between English and Arabic requirements accordingly while resolving many ambiguities.

5 Translation Between Arabic and English Requirements

Translating a given statement between RAT and ARAT systems is done by following the following steps:

- Break down the statement into a set of tokens.
- Specify the corresponding syntax.
- Translate each modal phrase according to the modal phrases dictionary shown in table 4.
- Interpret the unknown phrases and rearrange the statement according to the corresponding goal syntax (RAT syntax if translating from Arabic to English and ARAT syntax if translating from English to Arabic).
- The rest is left to the software engineer to resolve.

This is illustrated by few examples. The first example involves translating Arabic statements to English. Because the reader expects to read mainly English, the rest of the examples will involve translating English statements to Arabic.

5.1 Example 1

Consider the following Arabic statement: "نظام ساب سوف يرسل بيانات التاجر إلى نظام تدوير الطلبيات". This statement is tokenized into: the agent phrase "نظام ساب", the modal phrase

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"سوف", the action phrase "يرسل", the entity phrase "بيانات التاجر", the unknown phrase "إلى", and the agent phrase "نظام تدوير الطلبيات" (remember that the Arabic statements are written from the right to the left). According to the above modal phrase, the requirement follows syntax type (a). The unknown phrases are interpreted as extensions of the action phrase. According to the modal phrases dictionary, this modal phrase is translated into "shall | will". The statement is then rearranged as follows:

- *"نظام ساب" "shall | will" "يرسل" "بيانات التاجر إلى نظام تدوير الطلبيات".*

The software engineer can then translate "نظام ساب" to "The SAP system", "يرسل" to "send", and "بيانات التاجر إلى نظام تدوير الطلبيات" to "the vendor data to the order processing system" without / with minimal ambiguity. Note that the words "shall" and "will" have the same meaning. The translated statement is:

- *"The SAP system shall | will send the vendor data to the order processing system".*

5.2 Example 2

Consider the following English statement: "The Web server must inform administrator of failed login attempts". This statement is tokenized into: the agent phrase "The Web server", the modal phrase "must", the action phrase "inform administrator", the unknown phrase "of", and the entity phrase "failed login attempts". According to the above modal phrase, the requirement follows syntax type (a). The unknown phrases are interpreted as extensions of the action phrase. According to the modal phrases dictionary, the modal phrase "must" is translated into "يجب أن". The statement is then rearranged as follows (remember that the Arabic statements are written from the right to the left):

- *"The Web server" "يجب أن" "inform administrator of failed login attempts"*

The software engineer can then translate "The Web server" to "خادم الويب", "inform administrator of failed login attempts" to "يخبر المسؤول عن محاولات فاشلة لتسجيل الدخول" without / with minimal ambiguity. The translated statement is:

- *"خادم الويب يجب أن يخبر المسؤول عن محاولات فاشلة لتسجيل الدخول"*

5.3 Example 3

Consider the following English statement: "The payroll system shall be able to deduct loan amounts from paychecks". This statement is tokenized into: the agent phrase "The payroll system", the modal phrase "shall", the modal phrase "be able to", the action phrase "deduct loan amounts", the unknown phrase "from", and the entity phrase "paychecks". According to the above modal phrases, the requirement follows syntax type (b). The unknown phrases are interpreted as extensions of the action phrase. According to the modal phrases dictionary, the modal phrase "shall" is translated into "سوف" and the modal phrase "be able to" is translated into "يمكنه أن | يمكنها أن". The statement is then rearranged as follows:

- *"The payroll system" "سوف" "يمكنه أن | يمكنها أن" "deduct loan amounts from paychecks"*

The software engineer can then translate "The payroll system" to "نظام جداول الرواتب" and "deduct loan amounts from paychecks" to "يقتطع مبالغ القروض من شيكات المرتبات" without / with minimal ambiguity. Since "نظام الرواتب" is masculine in Arabic, the software engineer selects "يمكنه أن" rather than "يمكنها أن". The translated statement is:

- *"نظام جداول الرواتب سوف يمكنه أن يقتطع مبالغ القروض من شيكات المرتبات"*

5.4 Example 4

Consider the following English statement: "The order processing system must permit administrator to view daily transactions". This statement is tokenized into: the agent phrase "The order processing system", the modal phrase "must", the modal phrase "permit", and agent phrase "administrator", the modal phrase "to", and the action phrase "view daily transactions". According to the above modal phrases, the requirement follows syntax type (c). According to the modal phrases dictionary, the modal phrase "must" is translated into "يجب أن", the modal phrase "permit" is translated into "يمكن | تمكن", and the modal phrase "to" is translated into "أن". The statement is then rearranged as follows:

- *"The order processing system" "يجب أن" "يمكن | تمكن" "administrator" "أن" "view daily transactions"*

The software engineer can then translate "The order processing system" to "نظام معالجة الطلبات", "administrator" to "المسؤول", and "view daily transactions" to "يرى المعاملات اليومية" without / with minimal ambiguity. Since "المسؤول" is masculine in Arabic, the software engineer selects "يمكن" rather than "تمكن". The translated statement is:

- *"نظام معالجة الطلبات يجب أن يمكن المسؤول أن يرى المعاملات اليومية"*

5.5 Example 5

Consider the following English statement: "The account management system shall only close an account if the current balance is zero". This statement is tokenized into: the agent phrase "The account management system", the modal phrase "shall", the modal phrase "only", the action phrase "close an account", the modal phrase "if", and the unknown phrase "the current balance is zero". According to the above modal phrases, the requirement follows syntax type (d). The unknown phrase is interpreted as a condition. According to the modal phrases dictionary, the modal phrase "shall" is translated into "سوف", the modal phrase "only" is translated into "فقط", and the modal phrase "if" is translated into "لو | عندما | حين". The statement is then rearranged as follows:

- *"The account management system" "فقط" "سوف" "close an account" "لو | عندما | حين" "the current balance is zero"*

The software engineer can then translate "The account management system" to "نظام إدارة الحسابات", "close an account" to "يغلق حساب", and "the current balance is zero" to "الرصيد الحالي صفر" without / with minimal ambiguity. Note that the words "لو", "عندما", and "حين" have the same meaning. The translated statement is:

- *"نظام إدارة الحسابات فقط سوف يغلق حساب لو | عندما | حين الرصيد الحالي صفر"*

5.6 Example 6

Consider the following English statement: "Only the payroll

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employees may access the payroll database". This statement is tokenized into: the modal phrase "only", the agent phrase "the payroll employees", the modal phrase "may", and the action phrase "access the payroll database". According to the above modal phrases, the requirement follows syntax type (e). According to the modal phrases dictionary, the modal phrase "only" is translated into "فقط" and the modal phrase "may" is translated into "يمكن أن". The statement is then rearranged as follows:

- *"فقط" "the payroll employees" "يمكن أن" "access the payroll database"*

The software engineer can then translate "the payroll employees" to "موظفي جداول الرواتب" and "access the payroll database" to "يصلوا إلى قاعدة بيانات جداول الرواتب" without/with minimal ambiguity. The translated statement is:

- *"فقط موظفي جداول الرواتب يمكن أن يصلوا إلى قاعدة بيانات جداول الرواتب"*

5.7 Example 7

Consider the following English statement: "The customer standing must always be gold, silver, or bronze". This statement is tokenized into: the entity phrase "The customer standing", the modal phrase "must", the modal phrase "always", the modal phrase "be", and the unknown phrase "gold, silver, or bronze". According to the above modal phrases, the requirement follows syntax type (f). The unknown phrase is interpreted as a value phrase. According to the modal phrases dictionary, the modal phrase "must" is translated into "يجب أن", the modal phrase "always" is translated into "دائما", and the modal phrase "be" is translated into "يكون | تكون". The statement is then rearranged as follows:

- *"The customer standing" "دائما" "يجب أن" "يكون | تكون" "gold, silver, or bronze"*

The software engineer can then translate "The customer standing" to "موقف العميل" and "gold, silver, or bronze" to "ذهب، فضة، أو برونز" without/with minimal ambiguity. Since "موقف العميل" is masculine in Arabic, the software engineer selects "يكون" rather than "تكون". The translated statement is:

- "موقف العميل دائما يجب أن يكون ذهب، فضة، أو برونز"

5.8 Example 8

Consider the following English statement: "The total sales value is defined as total item value plus sales tax". This statement is tokenized into: the entity phrase "The total sales value", the modal phrase "is", the modal phrase "defined as", and the entity phrase "total item value plus sales tax". According to the above modal phrases, the requirement follows syntax type (g). According to the modal phrases dictionary, the modal phrase "is" is translated into "", and the modal phrase "defined as" is translated into "تعريفه | تعريفها". The statement is then rearranged as follows:

- "The total sales value" "تعريفه | تعريفها" "total item value plus sales tax"

The software engineer can then translate "The total sales value" to "إجمالي قيمة المبيعات" and "total item value plus sales tax" to "إجمالي قيمة البنود وضريبة المبيعات" without/with minimal ambiguity. Since "إجمالي قيمة المبيعات" is masculine in Arabic, the software engineer selects "تعريفه" rather than "تعريفها". The translated statement is:

- "إجمالي قيمة المبيعات تعريفه إجمالي قيمة البنود وضريبة المبيعات"

5.9 Example 9

Consider the following English statement: "The sales tax is computed on instate shipments". This statement is tokenized into: the entity phrase "The sales tax", the modal phrase "is", the action phrase "computed on instate shipments". According to the above modal phrase, the requirement follows syntax type (h). According to the modal phrases dictionary, the modal phrase "is" is translated into "". The statement is then rearranged as follows:

- "The sales tax" "computed on instate shipments"

The software engineer can then translate "The sales tax" to "ضريبة المبيعات" and "computed on instate shipments" to "تحسب على الشحنات المحلية" without/with minimal ambiguity. The translated statement is:

- "ضريبة المبيعات تحسب على الشحنات المحلية"

5.10 Results

From the above examples, it is clear that many ambiguities have been resolved while translating software requirements between English and Arabic. These include specifying the agents, the entities, the actions, who performs each action, and to whom an action is performed. Besides, the intent of each statement is well understood. Few ambiguities are left to the software engineer to resolve, which dramatically simplifies the work of the software engineer.

6 Conclusion

Stakeholders typically speak and express software requirements in their native language. On the other hand, software engineers typically express software requirements in English to programmers who write program using English-like programming languages. This requires translating requirements between the native language of the stakeholders and English back and forth. This introduces further ambiguities, which affects the length of the whole software process. Unfortunately, this problem has been overlooked in the literature. To tackle this problem, this paper introduces the ARAT system. The ARAT system is analogous to the RAT system [9] that uses templates to express English software requirements. As illustrated by many examples, specifying mappings between both systems facilitate translation of requirements between English and Arabic while resolving many ambiguities such as specifying agents and their actions. Since the RAT system uses templates that enforce following best practices in writing requirements documents in English, the ARAT system achieves the same while writing requirements documents in Arabic. Similarly, since the RAT system has been designed to facilitate the analysis of English software requirements, the ARAT system facilitates the analysis of Arabic software requirements. As future work, the tool should be tested against more requirements documents. Observings and suggestions should be taken into consideration in future versions of the system. We encourage

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researchers to develop similar systems in their native languages with the aim of facilitating communication between stakeholders and software engineers using different languages.

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Tuning of FOPID Controller Using Taylor Series Expansion

Ali Akbar Jalali, Shabnam Khosravi

Abstract— In this paper, a direct synthesis approach to fractional order controller design Is investigated. The proposed algorithm makes use of Taylor series of both desired closed-loop and actual closed-loop transfer function which is truncated to the first five terms. FOPID Controller parameters are synthesized in order to match the closed-loop response of the plant to the desired closed-loop response. The standard and stable second-order model is considered for both plant and the desired closed-loop transfer functions. Therefore for a given plant with damping ratio ξ_1 and natural frequency ω_{n_1}. The tuned FOPID controller results in the desired closed-loop response with damping ratio ξ_2 and natural frequency ω_{n_2}. An example is presented that indicates the designed FOPID results in actual closed-loop response very close to desired response rather than PID controller. It is shown that the proposed method performs better than Genetic Algorithm in obtaining the desired response.

Index Terms— FOPID controller, Taylor series expansion, second order model.

1 INTRODUCTION

For many decades, proportional-integral-derivative (PID) controllers have been very popular in industries for process control applications. The popularity and widespread use of PID controllers are attributed primarily to their simplicity and performance characteristics. Owing to the paramount importance of PID controllers, continuous efforts are being made to improve their quality and robustness [1], [2].

An elegant way of enhancing the performance of PID controllers is to use fractional order controllers where the integral and derivative operators have non-integer orders. Podlubny proposed the concept of fractional order control in 1999 [3]. In FOPID controller, despite of the proportional, integral and derivative constants, there are two more adjustable parameters: the power of s in integral and derivative operators, λ, μ respectively. Therefore this type of controllers is generalizations of PIDs and consequently has a wider scope of design, while retaining the advantages of classical ones.

Several methods have been reported for FOPID design. Vinagre, Podlubny, Dorcak, Feliu [4] proposed a frequency domain approach based on expected crossover frequency and phase margin. Petras came up with a method based on the pole distribution of the characteristic equation in the complex plane [5]. In recent years evolutionary algorithms are used for FOPID tuning. YICAO, LIANG, CAO [6], presented optimization of FOPID controller parameters based on Genetic Algorithm. A method based on Particle Swarm Optimization was proposed [7]. In this paper a tuning method for FOPID controller is proposed. Suppose a standard and stable second order plant such that desired response is not available. Tuning FOPID controller by the proposed method results in desired closed-loop response. The standard second order is considered for desired response. It is shown that the proposed method performs better than Genetic Algorithm in obtaining the desired response. The rest of the paper is organized as follows: In section 2 the tuning method for FOPID controller is described. An example is investigated in section 3 and finally Section 4 draws some conclusions.

2 OBTAINING THE TUNING METHOD FOR FOPID CONTROLLER

Consider the block diagram of feedback control system in fig. 1. The objective is design a FOPID controller, $G_c(s)$, such that for a given plant, $G_p(s)$, with standard second order model, the actual closed-loop response results in desired closed-loop response. Desired closed-loop response denoted by $G_d(s)$ and described by standard second order model as follows

$$G_d(s) = \frac{\omega_n^2}{s^2 + 2\xi\omega_n s + \omega_n^2} \quad (1)$$

Where ξ, ω_n are damping ratio and natural frequency of desired response.

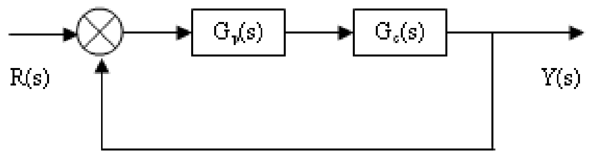

Fig. 1. Block diagram of feedback control system.

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According to fig. 1. the actual closed-loop transfer function is given by

$$G_{Acl}(s)=\frac{G_p(s)G_c(s)}{1+G_p(s)G_c(s)} \tag{2}$$

In (2), transfer function of FOPID controller is given by

$$G_c(s)=k(1+\frac{k_i}{s^{\lambda}}+k_d s^{\mu}) \tag{3}$$

Where proportional, integral, derivative constants are denoted by k_c, k_i, k_d respectively. The orders of integral and derivative actions, λ, μ, include non-integer values as

$$0<\lambda,\mu<2 \tag{4}$$

M. Ramasy and Sundaramoorthy in [8] has used different structure for FOPID controller as

$$G_c(s)=\frac{k_c}{s}\tilde{G}_c(s) \tag{5}$$

Where

$$\tilde{G}_c(s)=(s+\frac{k_i}{s^{\lambda-1}}+k_d s^{\mu+1}) \tag{6}$$

Then for actual closed-loop transfer function in (2), we have

$$G_{Acl}(s)=\frac{k_c G_p(s)\tilde{G}_c(s)}{s+k_c G_p(s)\tilde{G}_c(s)} \tag{7}$$

For designing FOPID controller, it is not possible to set both $G_{Acl}(s)$ and $G_d(s)$ equal directly. For each closed-loop transfer function, there exist an equal expression but in different structure. This equal expression is Taylor series expansion that can be represented for both $G_{Acl}(s)$ and $G_d(s)$ in $s=\alpha$ as follows

$$G_{Acl}(s)=G_{Acl}(\alpha)+(s-\alpha)G'_{Acl}(\alpha)+\frac{(s-\alpha)^2 G''_{Acl}(\alpha)}{2}+...... \tag{8}$$

$$G_d(s)=G_d(\alpha)+(s-\alpha)G'_d(\alpha)+\frac{(s-\alpha)^2 G''_d(\alpha)}{2}+....... \tag{9}$$

In (8), (9), expressions for derivatives of actual closed-loop transfer function involve derivatives of FOPID controller.

$$G'_c(s)=k_c(-k_i\lambda s^{-\lambda-1}+k_d\mu s^{\mu-1}) \tag{10a}$$

$$G''_c(s)=k_c(-k_i\lambda(-\lambda-1)s^{-\lambda-2}+k_d\mu(\mu-1)s^{\mu-2}) \tag{10b}$$

$$G'''_c(s)=k_c(-k_i\lambda(-\lambda-1)(-\lambda-2)s^{-\lambda-3} +k_d\mu(\mu-1)(\mu-2)s^{\mu-3}) \tag{10c}$$

$$G_c^{(4)}(s)=k_c(-k_i\lambda(-\lambda-1)(-\lambda-2)(-\lambda-3)s^{-\lambda-4} +k_d\mu(\mu-1)(\mu-2)(\mu-3)s^{\mu-4}) \tag{10d}$$

$$G_c^{(5)}(s)=k_c(-k_i\lambda(-\lambda-1)(-\lambda-2)(-\lambda-3)(-\lambda-4)s^{-\lambda-5} +k_d\mu(\mu-1)(\mu-2)(\mu-3)(\mu-4)s^{\mu-5}) \tag{10e}$$

However derivatives of FOPID controller are not defined at $s=0$. For convenience and avoiding complexity that causes by non-integer orders of the Laplace variable s, it is proposed to evaluate (8) and (9) at $\alpha=1$.

FOPID controller has five tuning parameters. Therefore five independent equations are needed for tuning FOPID controller.

$$G_{Acl}(1)=G_d(1) \tag{11a}$$

$$G'_{Acl}(1)=G'_d(1) \tag{11b}$$

$$G''_{Acl}(1)=G''_d(1) \tag{11c}$$

$$G'''_{Acl}(1)=G'''_d(1) \tag{11d}$$

$$G_{Acl}^{(4)}(1)=G_d^{(4)}(1) \tag{11e}$$

$$G_{Acl}^{(5)}(1)=G_d^{(5)}(1) \tag{11f}$$

In obtaining design parameters of FOPID controller, the first terms in (8) and (9) are not considered. According to (1) and (7),$G_{Acl}(s), G_d(s)$ are equal in $s=0$. Probably these values are nearly equal in $s=1$. Using (2), the equations in (11) can be written as

$$\frac{G'_c(1)G_p(1)+G_c(1)G'_p(1)}{(1+G_c(1)G_p(1))^2}-G'_d(1)=0 \tag{12a}$$

$$\frac{(G''_c(1)G_p(1)+2G'_c(1)G'_p(1)+G_c(1)G''_p(1))(1+G_c(1)G_p(1))-2(G'_c(1)G_p(1)+G_c(1)G'_p(1))^2}{(1+G_c(1)G_p(1))^3}-G''_d(1)=0 \tag{12b}$$

$$\frac{\begin{gathered}(G'''_c(1)G_p(1)+3G''_c(1)G'_p(1)+3G'_c(1)G''_p(1)+G_c(1)G'''_p(1))(1+G_c(1)G_p(1))^2-6(G'_c(1)G_p(1)+G_c(1)G'_p(1))\\(G''_c(1)G_p(1)+2G'_c(1)G'_p+G_c(1)G''_p)(1+G_c(1)G_p)+6(G'_c(1)G_p(1)+G_c(1)G'_p(1))^3)\end{gathered}}{(1+G_c(1)G_p(1))^4}-G'''_d(1)=0$$

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(12c)

$$\frac{\begin{aligned}&(G_c^{(4)}(1)G_p(1)+4G_c'''(1)G_p'(1)+6G_c''(1)G_p''(1)\\&+4G_c'(1)G_p'''(1)+G_c(1)G_p^{(4)}(1))(1+G_c(1)G_p(1))^3\\&-6(G_c''(1)G_p(1)+2G_c'(1)G_p'(1)+G_c(1)G_p''(1))^2\\&(1+G_c(1)G_p(1))^2-8(G_c'(1)G_p(1)+G_c(1)G_p'(1))\\&(G_c'''(1)G_p(1)+3G_c''(1)G_p'(1)+3G_c'(1)G_p''(1)+\\&G_c(1)G_p'''(1))(1+G_c(1)G_p(1))^2+36(G_c'(1)G_p(1)\\&+G_c(1)G_p'(1))^2(G_c''(1)G_p(1)+2G_c'(1)G_p'(1)+G_c(1)\\&G_p''(1))(1+G_c(1)G_p(1))-24(G_c'(1)G_p(1)+G_c(1)\\&G_p'(1))^4)\end{aligned}}{(1+G_c(1)G_p(1))^5}-G_d^{(4)}(1)=0$$

(12d)

$$\frac{\begin{aligned}&(G_c^{(5)}(1)G_p(1)+5G_c^{(4)}(1)G_p'(1)+10G_c'''(1)G_p''(1)+\\&10G_c''(1)G_p'''(1)+5kG_c'(1)G_p^{(4)}(1)+G_c(1)G_p^{(5)}(1))\\&(1+G_c(1)G_p(1))^4-20(G_c''(1)G_p(1)+2G_c'(1)G_p'(1)\\&+G_c(1)G_p''(1))(G_c'''(1)G_p(1)+3G_c''(1)G_p'(1)+3G_c'(1)\\&G_p''(1)+G_c(1)G_p'''(1))(1+G_c(1)G_p(1))^3+90(G_c''(1)\\&G_p(1)+2G_c'(1)G_p'(1)+G_c(1)G_p''(1))^2(G_c'(1)G_p(1)\\&+G_c(1)G_p'(1))(1+G_c(1)G_p(1))^2-10(G_c'(1)G_p(1)\\&+G_c(1)G_p'(1))(G_c^{(4)}(1)G_p(1)+4G_c'''(1))G_p'(1)+6\\&G_c''(1)G_p''(1)+4G_c'(1)G_p'''(1)+G_c(1)G_p^{(4)}(1))(1+G_c(1)\\&G_p(1))^3+60(G_c'(1)G_p(1)+G_c(1)G_p'(1))^2(G_c'''(1)G_p(1)\\&+3k_cG_c''(1)G_p'(1)+3G_c'(1)\ \mathrm{G}_\mathrm{p}''(1)+G_c(1)G_p'''(1))(1+\\&G_c(1)G_p(1))^2-240(G_c'(1)G_p(1)+G_c(1)G_p'(1))^3(G_c''(1)\\&G_p(1)+2G_c'(1)G_p'(1)+G_c(1)G_p''(1))(1+G_c(1)G_p(1))+\\&120(G_c'(1)G_p(1)+G_c(1)G_p'(1))^5\end{aligned}}{(1+G_c(1)G_p(1))^6}-G_d^{(5)}(1)=0$$

(12e)

Where

$$G_c(1)=k_c(1+k_i+k_d) \tag{13a}$$

$$G_c'(1)=k_c(-k_i\lambda+k_d\mu) \tag{13b}$$

$$G_c''(1)=k_c(-k_i\lambda(-\lambda-1)+k_d\mu(\mu-1)) \tag{13c}$$

$$G_c'''(1)=k_c(-k_i\lambda(-\lambda-1)(-\lambda-2)+k_d\mu(\mu-1)(\mu-2)) \tag{13d}$$

$$\begin{aligned}G_c^{(4)}(1)=k_c(-k_i\lambda(-\lambda-1)(-\lambda-2)(-\lambda-3)+k_d\mu(\mu-1)\\(\mu-2)(\mu-3))\end{aligned} \tag{13e}$$

$$\begin{aligned}G_c^{(5)}(1)=k_c(-k_i\lambda(-\lambda-1)(-\lambda-2)(-\lambda-3)(-\lambda-4)\\+k_d\mu(\mu-1)(\mu-2)(\mu-3)(\mu-4))\end{aligned} \tag{13f}$$

The nonlinear equations in (12) are complicated to obtain design parameters, $k_c, k_i, k_d, \lambda, \mu.$ thus a nonlinear optimization problem must be solved. The fsolve command in optimization toolbox of Matlab is a sufficient tool for solving the set of nonlinear equations. The input arguments of this command are described as fun, x_0 and options. Fsolve starts at an initial value for design parameters, x_0, in order to solve the set of nonlinear equations described in fun. The argument of option determines the type of optimization algorithm which is used in solving the nonlinear equations. The output arguments are the solution of nonlinear equations, x, and the value of objective function at x. Consider the nonlinear equations in (12) as the objective functions. In this case the solution, x, is the design parameters of FOPID controller, $k_c, k_i, k_d, \lambda, \mu.$The optimization algorithm of Levenberg-Marquert and Gauss-Newton are considered. In the next section, the proposed tuning method is illustrated during an example.

3 EXAMPLE

In this section, a process from [9] is considered. The example involves the speed control of a DC motor. Since the most basic requirement of a motor is that it should rotate at the desired speed, the steady-state error of the motor speed should be less than 1%. We want to have settling time of 2s and an overshoot of 4%. A desired closed-loop transfer function that includes all of the design specifications, can be defined as follows

$$G_d(s)=\frac{8.9401}{s^2+4.2398s+8.9401} \tag{14}$$

The transfer function of the process is defined by

$$G_p(s)=0.0999\frac{20.02}{s^2+12s+20.02} \tag{15}$$

Applying the values of $G_p(1), G_p'(1), G_p''(1), G_p'''(1), G_p^{(4)}(1)$ $G_p^{(5)}(1), G_d(1), G_d'(1), G_d''(1), G_d'''(1), G_d^{(4)}(1), G_d^{(5)}(1)$ in (12), five nonlinear equations are obtained. Using the fsolve command in optimization toolbox of Matlab, the fractional order controller is designed as

$$G_c(s)=18.27(1+\frac{1.11}{s^{1.02}}-0.563s^{0.1}) \tag{16}$$

After designing the FOPID controller, the values of nonlinear equations in (12), are $-10^{-4}, -10^{-4}, -10^{-4}, -10^{-4}, 10^{-3}$. It is obvious that the obtained values for design parameters, $k_c, k_i, k_d, \lambda, \mu.$, are very close to roots of nonlinear eq-

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uations in (12). Furthermore the values of both actual and desired closed-loop transfer functions at $s=1$ are nearly equal with difference of 10^{-3}. Thus the first six terms of Taylor series of actual closed-loop transfer function are equal to same order terms for desired one. The accuracy of how much the actual closed-loop response is close to desired response can be concluded from fig. 2. For comparison, the tuned FOPID controller using Genetic Algorithm is considered. Fig. 3 shows that the closed-loop response under FOPID controller, which is tuned by both GA and proposed methods, in comparison to desired response. Data about specifications of desired closed-loop response are collected in Table1.

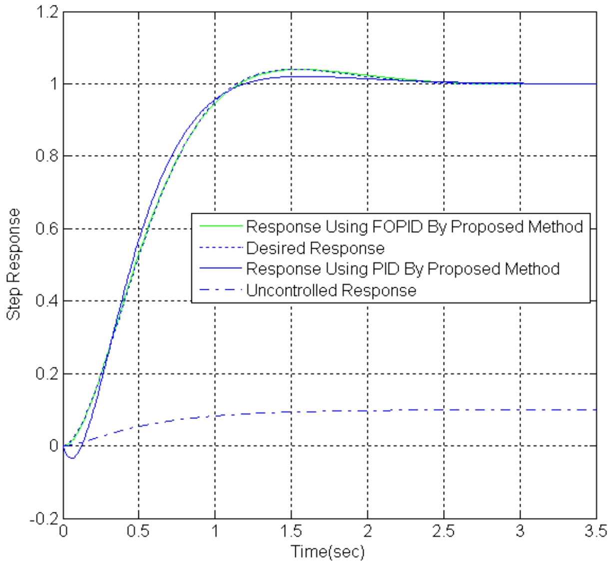


Fig. 2. Step response of closed-loop system using both FOPID and PID controllers, step response of the desired closed-loop system, step response of uncontrolled system.

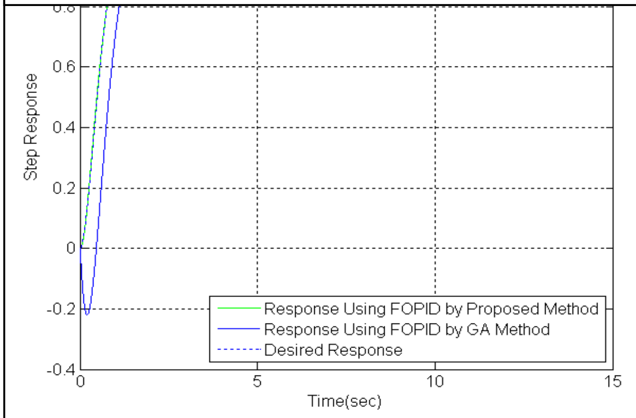


Fig. 3. Step response of closed-loop system using FOPID controller obtained by proposed method and Genetic Algorithm tuning method, step response of the desired closed-loop system.

TABLE 1

SPECIFICATIONS OF DESIRED CLOSED-LOOP RESPONSE

Maximum overshoot	Settling time	Rise time	Steady-state error
4	2	0.9	0

Table. 1. reports the maximum overshoot (in %), settling time and rise time (in second) and steady-state error (in %) for the closed-loop step response. Data about the performance of closed-loop system under FOPID and PID controllers against unit step, are collected in Table 2.

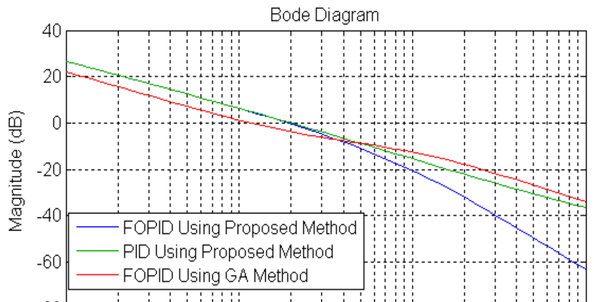
TABLE 2

SUMMERY OF THE PERFORMANCE OF CLOSED-LOOP SYSTEM UNDER FOPID AND PID CONTROLLER AGAINST UNIT STEP

Different controllers	Maximum overshoot	Settling time	Rise time	Steady-state error
FOPID using proposed method	4	2.08	0.9	0
FOPID using GA method	4.5	5.3	1.26	0
PID using proposed method	2	1.08	0.86	0

Fig. 2. compares actual closed-loop response under both PID and FOPID controllers and desired response. In fig. 2. PID and FOPID controllers are tuned by proposed method. Due to Table. 2. the actual closed-loop response under FOPID controller is very close to desired response rather than applying PID controller. For example the specifications of transient response, such as maximum overshoot, rise time, settling time and steady-state error when using FOPID controller, are very close to desired transient specifications. Using PID controller results in a behavior in t=0, which is not appeared when applying FOPID controller. This behavior is because of existing a zero near the origin. Furthermore due to fig.3. and Table. 2 the FOPID controller, which is tuned by proposed method, results in better performance rather than FOPID controller which is tuned by GA method.

Fig. 4. shows the bode diagram of open-loop systems, applying both FOPID and PID controllers.



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According to fig.4. applying FOPID and PID controllers which is tuned by proposed method result in a same phase margin of 66 (deg). However the difference in values of gain margin is significant. The gain margin of 30.7 (dB) and 17(dB) are obtained for FOPID and PID controllers respectively. The FOPID controller which is tuned by Genetic Algorithm results in gain margin and phase margin of 8.2(dB) and 59 (deg) respectively. It can be concluded that better performances can be obtained by using the proposed method.

4 Conclusion

A design method for FOPID controller is proposed. This method is based on Taylor series of both actual and desired closed-loop transfer function. The design parameters of controller are used for matching the same order terms of both desired and actual closed-loop response. FOPID controller has two design parameters, λ, μ, more than PID controller. Thus two more terms in Taylor series are used to match closed-loop response to desired response. This causes increasing accuracy in tracking the desired response rather than using PID controller. Furthermore the FOPID controller which is tuned by proposed method performs better than FOPID controller which is tuned by Genetic Algorithm. It can be concluded that that better performances can be obtained by the proposed method.

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Adaptive Classification of Web Mining Methods and Challenges of Customer Relationship Management Domain

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Abstract — In recent years, World Wide Web has been extended from research society to the most dominant and general way for communication and broadcasting of information. Web mining is responsible to discover the hidden knowledge, rules and patterns from web. Customers always play a key role for the establishment or mean of crisis for any organization. Web mining is going to be involved in every organization for extracting extra information which is not visible for everyone. The most important application of web mining is in the domain of the e-commerce and economy that leads to the detection of most facts and effective factors in the customer relationship management and efficient services to the customers through the behavior and communicating with system. CRM uses data mining (one of the elements of CRM) techniques to interact with customers. It is also used for web mining in web domain.Our Analysis provides a roadmap to guide creation concerning the adaptive classification based on web/data mining methods to solve challenges of CRM. For this, we comparison and analyze the application of web mining process to solution challenges of CRM dimensions.

Index Terms— CRM Challenges, Customer Relationship Management, Web Mining, Data Mining.

1 Introduction

THE e-commerce Rapid development Caused to business advancement in the Internet. The CRM became the main part of the work when e-commerce turned to customer-oriented from product-oriented and products and services were built and personalized according to customer's recommendations. It was done because the internet-based technologies are the best framework for implementation of CRM [1]. One of the goals of CRM is close relationship between customers and vendors, which is the simplest form of e-commerce. CRM uses data mining (one of the elements of CRM) techniques to interact with customers. It is also used for web mining in web domain. Web mining is one of the domains of Data mining. Web mining refers to the techniques that automatically retrieve, extract and evaluate information from documents and web services for knowledge discovery. This article proposes data mining methods in the commerce, understanding challenges and ways to manage customer communications with the related rules and classification provided in this area.

2 CRM Concept

CRM is collection of steps to create, develop, maintain and optimize long-term and valuable relationships between Customers and organizations. Furthermore, it is part of the organization's strategy to identify customers, keep them satisfied and change them in to permanent customers. The main architecture includes several layers [3]. Fig (1)

Operational layer: In this layer some tools are provided for company sales and marketing personnel that can control, manage and improve their contacts with customers, accounting and sales information.

Technologies used in the operational layer are responsible for collecting customer data through their contact points such as connection centers, connection management systems, mails, faxes, sale persons, web and etc. Fig (2)

Data layer: As it is obvious in Figure (1) the collected data from operational part are stored in a repository that is large in size.

Analytical layer: This layer is one of the most important layers that are responsible to obtain, store, process, interpret and report data to the users which use customer's data. This layer provides capabilities for classification of customers to optimize the behavior of company, improve marketing activities and keeping customers. It is done by studying information in information storage. In terms of ICT and e-business development, customers' data are gathered more and more and day by day. Analytical layer capabilities can be used for better management of these data. Operational and analytical layers interact with each other. This means that data of operational layer go through to the analysis layer, then the data are analyzed and the results derived would have direct effect on the operational layer. By analyzing this section, Customers are classified and focusing on particular customers is provided for the organization.

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This layer uses statistical analysis and predictive models for making decision, process improvement and other unperceived benefits. Generally, they have been equipped by two types of technology: Online analytical processing, Data mining [3].
Online analytical processing is a process that uses one or more resources for collecting data. Data analysis and unification are done dynamically in different levels so they can help in finding, mapping and analyzing the customer's patterns based on their past data values.
Application Layer: When data are analyzed, and customers' profiles are created, this layer provides some statistics and analyzes the status of sales, marketing and support and it also measures the amount of satisfaction and loyalty of customers then the customers will be categorized based on this method. For example, we can give responsibility to the system for monitoring all of customer's behaviors and when the amount of customers' purchases exceeds of a certain limit, makes the organization informed to do special works for them, Such as sending email or phone call automatically with the buyer.

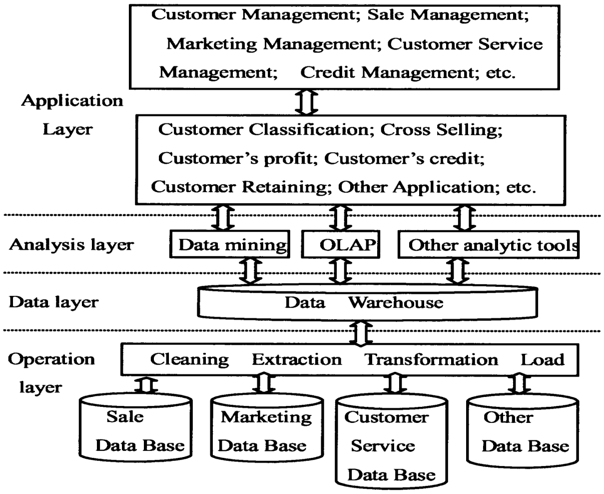

Fig 1: CRM Architecture [3]

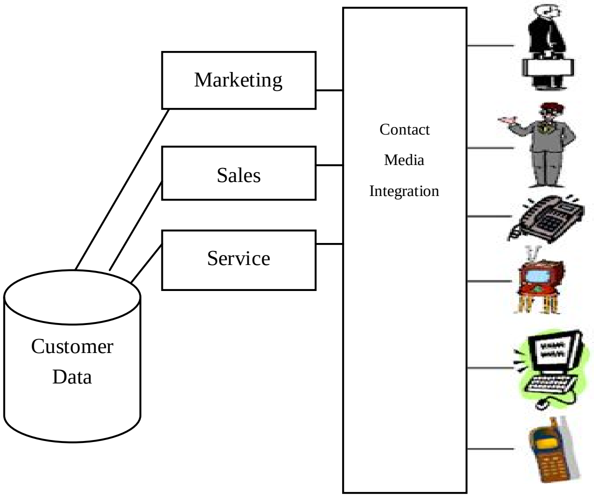

Fig 2: Operation Layer CRM

3 CRM Challenges

Organization before implementing a CRM should be aware of the potential and possible problems, in order to deal with them when it is necessary.
In organizational levels, business should create common activity between different parts that have contacts with customer and all sections related to the CRM in order to be more effective.
This established inter-group relationships with customers, have effect on the role of employee within the organization also this issue can reduce emphasis on participation of the certain sections of the company. Usually this type of policy changes faced with the opposition in the early stages of performances.
One of the important points is that organizations should be maintaining the best employees of sales and service departments; they must develop personal skills of talented employees and reward them. For example, in telephone centers, six months is needed to turn an armature person to an experienced one and six month is needed for an experienced person to become specialized and professional. Employees, who work in the internal sections, should be involved in the discussions related to the customers' needs. Customers' feedbacks should be considered in the process of developing products and services. Because all parts of organization collaborate in order to gain customer satisfaction, they should create a reward system for injecting the necessary motivation to these domains. The main challenges can be divided into four important cases that organization might face with during the implementing of CRM [2, 6, 7]:

3.1 Executive Challenges

- Initial launching Costs: It is considered as one of the challenges of CRM. Organizations may spend large amount of investment on customer management application tools, but some of these tools may have a specific application that can be hard to share them in different parts.
- Integrated application tools: Organizations need some integrated application tools that have been created based on customer's life cycles and related interactions. For example, organizations which need different languages and monetary units for managing customer interactions, cannot implement CRM through traditional technologies and this will be a severe problem, because data types are various and the noise of data is high and inevitable.
- Collaboration of various segments: CRM is an integrated approach and needs assisting of some parts of business that previously were working independently. Data that are collected in one portion should to share their data with be shared within all segments. It is possible that some sections would be unpleased others.

Challenges that should be noticed in this approach are:

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1- Non-obvious results that often require a combination of the analysis layer techniques (data mining), 2- Serious requests for collecting of data before using of analysis layer techniques (data mining), 3- Not being aware that what data are available for mining and what kinds of virtual activities should be done.

3.2 Stategy Challenges

These are parts of inter-organization challenges which provide forces that any decision should be made is based on it and Organization processes are managed from the starting point to the end within the rules of the Organization. The raised Challenges in this regard are: 1- output results must match the realities of the world, 2- good activities mechanism, 3- combination of the old knowledge.

3.3 Technology Challenges

These are one of the key challenges for the realization of policies, processes, people and their interaction with each other. Organizations need an integrated approach to unify the technologies within it. The raised Challenges in this regard are: 1- Reliable considerations don't exist for results of analysis and data because of lack of integrated approach in technologies. 2- Finding data for deeper understanding, which cause high accuracy and cost reduction, for example metric product evaluation.

3.4 Customer Dimention Challenges

These Challenges that relate to the customer loyalty and maintenance are: 1- Deeper models for identifying and developing customer behavior. 2- A framework for evaluating that leads to diagnosing the accuracy of customer understanding.

4 Web Mining For CRM

The research method can be divided into three steps: (1) collecting and cleaning the information, store the information in the data warehouse.

(2) An iterative discovering process by the data mining tools and analysts review of the extracted patterns to generate new set of questions to refine the search. After refine the search, the results of the mining process is be translated to association rules, which stored in the knowledge base.

(3) The patterns are good predictors of purchasing behaviors, the CRM process uses the scores generated by the data mining process to sharpen the focus of targeted customers or prospects, thereby increasing response rates and campaign effectiveness. Fig (3) presents the applicable methods of web mining for CRM [1,9,10].

A. Data Collection Process

Suitable representation, in such a way that it is readable by the mining algorithm in the next step. This process ensures the data set is ready to use for specific mining technique and purpose. In this process, generalization can be done through attribute removal or attribute generalization and aggregation can be done by combines conformed records and add up total amount.

B. Data mining process

The Fig (4) process model for data mining provides an overview of the life cycle of a data mining project. It contains the corresponding phases of a project, their respective tasks, and relationships between these tasks. At this description level, it is not possible to identify all relationships. There possibly exist relationships between all data mining tasks depending on goals, background and interest of the user, and most importantly depending on the data.

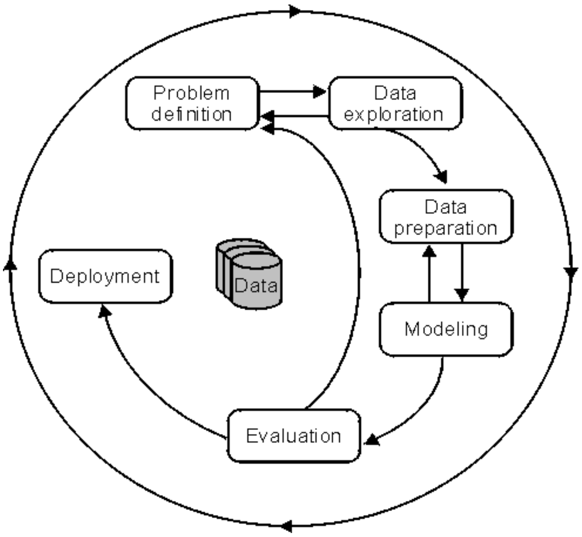

Fig 4: The CRISP-DM process model [8]

C. CRM process

The CRM process is the most influential customer oriented strategy of the decade. Despite its humble origins it has evolved into a relatively complex strategy. The essentials of a CRM program include focus, commitment to CRM goals and above all a desire to be customer focused [8].

Data warehouse, data mining, used to serve the purpose of supporting selection for acquisition, cross-sales, and retention of (real or potential) customers. By running data mining algorithms on customer dataset, data mining can uncover important associations about what products are often purchased together. This knowledge can then be used for product recommendations and product bundling. This knowledge is then used to make a recommendation for a future customer.

4 Conclusion

The most important results obtained from the above techniques are reorganization of data and information for easier access, yielding more effective Efficiency and better data classification in order to obtain best results from them. Web mining and CRM integration has advantages and lots of benefits for companies that need to discover profitability of some customers than other customers.

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Web mining can identify important customers in large databases.
Intelligent CRM system is created based on web mining analysis on important customers that leads to customer's management ,sharing the obtained information from different channels, reforming of communications between different parts, organization and investigation of operational activities and the appropriate understanding of trade. Therefore, customer chooses the connection channel with the company according to his or her own interest to receive the best services .In table (1) Proposed Adaptive Classification Based On Web/Data Mining Methods to Solve Challenges of CRM are shown.

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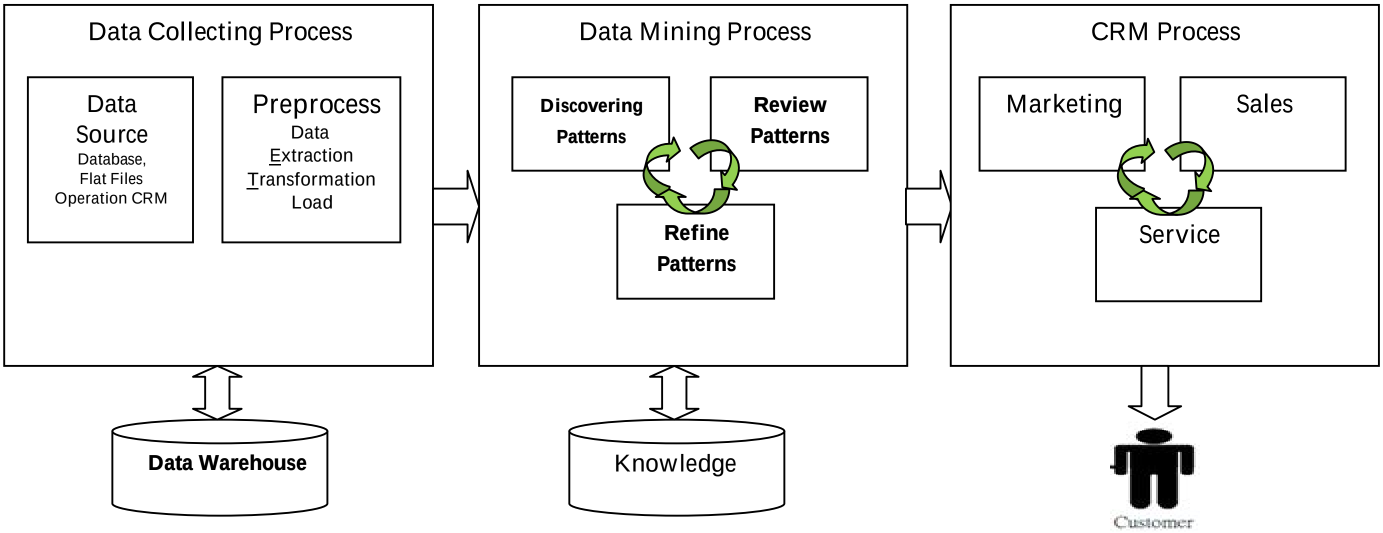

Fig 3: Presents the Applicable Methods of Web Mining for CRM [1]

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Table 1. Proposed Adaptive Classification Based On Web/ Data Mining Methods to Solve Challenges of CRM

Mining	Types of Methods	Main Idea	Dimensions of CRM	CRM Challenges
Data mining	**Association Rules**	Statistical and former algorithms are used for diagnosing the behavior of an event or specific process that identifies the communication between elements in a specified record uses.	Customer Development	Integrated application tools Technology challenges Collaboration of various segments
	Classification	Classification is one of the most common learning models in data mining. It aims at building a model to predict future customer behaviors through classifying Database records into a number of predefined classes based on certain criteria. Common tools used for classification are neural networks, decision trees and if then-else rules.	Customer Identification	Initial launching Costs Strategy challenges Customer Dimensions Challenges
	Clustering	Clustering is the task of segmenting a heterogeneous population into a number of more homogenous clusters. It is different to classification in that clusters are unknown at the time the algorithm starts. In other words, there are no predefined clusters. Common tools for clustering include neural networks and discrimination analysis	Customer Identification	Initial launching Costs Strategy challenges Customer Dimensions Challenges
	Forecasting	Forecasting estimates the future value based on a record's patterns. It deals with continuously valued outcomes. It relates to modeling and the logical relationships of the model at some time in the future. Demand forecast is a typical example of a forecasting model. Common tools for forecasting include neural networks and survival analysis.	Customer Attractions	Integrated application tools Collaboration of various segments
	Regression	Regression is a kind of statistical estimation technique used to map each data object to a real value provide prediction value. Uses of regression include curve fitting, prediction (including forecasting), modeling of causal relationships, and testing scientific hypotheses about relationships between variables. Common tools for regression include linear regression and logistic regression.	Customer Retention	Collaboration of various segments Strategy challenges Customer Dimensions challenges
	Sequence	Sequence discovery is the identification of associations or patterns over time. Its goal is to model the states of the process generating the sequence or to extract and report deviation and trends over time. Common tools for sequence discovery are statistics and set theory.	Customer Retention	Collaboration of various segments Strategy challenges Technology challenges
	Visualization	Visualization refers to the presentation of data so that users can view complex It is used in conjunction with other data mining models to provide a clearer understanding of the discovered patterns or relationships. Examples of visualization model are 3D graphs.	Customer Development	Integrated application tools Technology challenges Collaboration of various segments
Web Mining	**Web Content Mining**	Active methods of Automatic discovery, retrieve, organization, and management of a huge volume of web information and resources. It helps in improving or filtering the search information that is usually based on the information derived from user profile or request so provides more complex queries from a simple keyword for more accuracy.	Customer Identification (Customer's Primary Information)	Initial launching Costs Strategy challenges Customer Dimensions Challenges
	Web Structure Mining	Web is a graph. Its nodes are web pages and hyperlinks create edges that provide the communication between the related pages.	Customer Identification (Customer's Primary Information)	Initial launching Costs Strategy challenges Customer Dimensions Challenges
	Web Usage Mining	It focuses on techniques that can predict user behavior interactively while working with the web pages. Mostly, e-commerce is very important for web based companies and CRM can be an effective advantage of web usage mining.	Customer Attractions, Retention, Development (Customer's Secondary Information)	Integrated application tools Technology challenges Collaboration of various segments Customer Dimensions Challenges

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A Study of Carcinogenic Components Removal in Chemical Industry

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Abstract-The chemical industries are involving with various surfaces coating process which develops pollutions like Carcinogenic components. In industry and environment inhalation of high doses have the potential to induce lung tumors in human and animals. The process of Carcinogenic components removal is a major real time problem in environmental toxicology in chemical processing industry. The standard analysis method determines and calculates the constituent of hexavalent chromium and trivalent chromium compounds in carcinogenic fumes. The research identifies that the presence of Carcinogenic components leads to the low generations of gastric juice, epithelial lining fluids to the human beings and animals. The segregation and analysis of Carcinogenic components was attracted several researcher for the past three decades. This paper discusses with Biological, Chemical and Mechanical analysis methods of identifying Carcinogenic components present in the effluent of the chemical industry in the form of sludge.

Index Terms— Environmental Production Agency, Hexavalent chromium, Scrubber, Trivalent chromium

1 INTRODUCTION

AN experiment was conducted by Abbasi and Soni(1984) thirty adult channel fish exposed to waterborne hexavalent chromium concentration of 50 to 100ppm and hardness of 3ppm resulted in alterations in swimming and balancing behaviors including loss of balance erratic and rapid twisting. Further research was proposed by James R Kastner et al (2002) for the determination of chromium compounds using Polarography.He embraced EPA method which is also named as ion chromatography to determine the dissolved hexavalent chromium ($CrO_4$2-) in ambient water .This method was developed by integrating analytical procedures.The promulgation of odour was controlled and determined using mass spectrometry and wet scrubber including the reducing agents [7].

John C.Chang et al (2003) inquiers Ontario Hydro analysis technique coupled with FGD scrubber in laboratory scale inorder to remove the effulent by 70% using [10]. More over Hyeon – Yeong Kim et al (2004) conducted experiment for Sprague Dawley rat, 90 day repeated dose inhalation toxicity study was carried out resulted in 0.5-5μm decrease of activity,nasal hemorrhage.Later Chih-Cheng Wu et al(2004) absorbed the effects of hexavalent chromium in municipal and hazardous waste and he adopted packed tower scrubber for the elimination[3]. Present investigation is aims at reduction in high percentage of trivalent chromium and hexavalent chromium accompanies with chemical using packed scrubber and spray technology at the exit.

2 THEORITICAL MODELS

Theoritical model was first adopted by S.Sakar et al (2007) for dust particle collection.In this model there are various paramaters which is used to calculate the percentage of the hexavalent chromium removal [15]. It includes two major factors to be found, they are collection efficiency of the particle and the mass balance of the liquid drop.

.

2.1 Collection Efficiency

Dust collection efficiency is frequently expressed in terms of penetration which was adopted by Lim K.S et al (2006). Penetration is defined as the fraction of particles that passes through the scrubber uncollected.

Penetration is the opposite of the fraction of particles collected and is expressed as

$$Pt = 1 - \eta \qquad - (1)$$

Wet scrubbers usually have an efficiency curve that fits the relationship of

$$\eta = 1 - e^{-f\ system} \qquad - (2)$$

By substituting for efficiency, penetration can be expressed as:

$$Pt = 1 - \eta$$
$$= 1-(1-e^{-f\ system})$$
$$Pt=e^{-fsystem} \qquad - (3)$$

The major equation to be included is Souder's–Brown equation. They are as follows

2.2 The Souder's–Brown equation

Trond Austrheim.et al., (2008) used the expression for sizing of gas scrubbers [16].This was the expression developed and given below as

$$K= (\sqrt{4gd_d}) / (\sqrt{3C_d}) \qquad - (4)$$

Equation (4) involves an empirically quantified factor known as the Souder's–Brown value, the K-value, or the Gas Load Factor. The basis of the Souder's–Brown expression is a force balance resolved in the vertical direction on a spherical droplet in an upward flowing gas in a gravity field.

When the droplet is held stationary,

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$Fr=0.5C_dA_d\rho_gU^2_{g,set}=G_d=(\pi/6)d_d^2g(\rho_l-\rho_g)$ - (5)

In practice Cd varies with the droplet Reynolds number,

$R_e=\rho_gU_{g,set}d_d/\mu$ - (6)

Except for high values of Re, where Newton's law states that it is constant and about equal to 0.43.

At low Re, the well-known relation of Stokes states that

$C_d=24/R_e$ - (7)

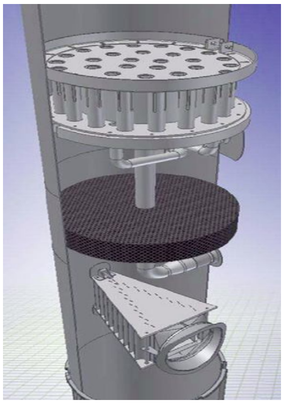

Fig. 1 Upward flowing spherical droplet

Svrcek and Monnery said that decreasing the K-value with 25% for 85 bars pressure. They said while designing a column we have to avoid the upwards velocity entrains droplets and the recommended K-value is K < 0.1 m/s for low-pressure applications often a safety margin of 50% is added for vessels without internals. Yarong Li,et al., (2002) said that for increasing pressures the critical K-value has been seen to decline. Increasing pressure in oil/gas applications is often accompanied by a decrease in interfacial tension and thereby a decrease in the droplet sizes [16].

2.3 Mass balance of liquid drops

Sarkar.S.et al., (2007) considered the schematic of a horizontal co-current gas–liquid scrubber (Fig 2). In this scrubber air stream containing a trace amount of trivalent chromium. This trivalent chromium enters horizontally at the left face (x = 0) with a velocity Ugas along with a spray of water droplets whose number concentration at the inlet is Nin. Trivalent chromium and hexavalent chromium was removed from the gas stream by absorption of droplets as both travels through the chamber from left to right. They assumed that individual drop moves horizontally with a velocity equal to U_{gas} and falls vertically at its terminal settling velocity U_{ter}.

They assumed that mixed flow in chamber has mixing in the vertical direction while no mixing in the horizontal direction. Consider the slice or control volume of thickness ▲x. There will be a certain height h along the vertical direction in this slice below which all drops will reach the floor of the chamber all such drops will be collected [15].

$▲t= (h/U_{ter}) = (▲x/U_{gas})$ - (8)

$\frac{dN}{N} = -\frac{U_{ter}}{HU_{gas}}dx$ - (9)

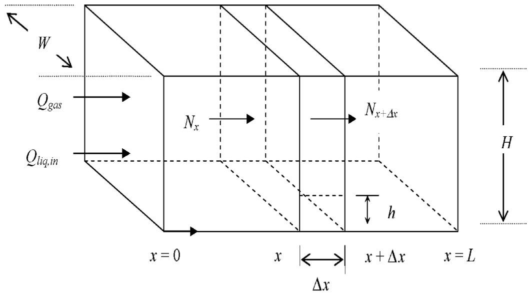

Fig. 2 Horizontal co-current gas–liquid scrubber

Integrating Eq. from the inlet to any location x gives

$N=N_{in}\exp\left(\frac{-U_{ter}x}{HU_{gas}}\right)$ - (10)

N_{in}, N_x, and $N_{x+▲x}$ be the number concentration of water drops at the inlet (x = 0) and at locations x and x +▲x.

$\Phi= \frac{N_{in}-N_{out}}{N_{in}} = 1-\exp\left(-\frac{U_{ter}x}{HU_{gas}}\right)$ - (11)

3 EXPERIMENTAL METHODS

Experimental methods have lots of categories. The major three main categories of experimental methods are Biological, Chemical and Mechanical methods. Each category has sub category based on the instruments and experiments.

3.1 Biological Technology

Graciela Rojas, Jorge Silva, Jaime A. et al., (2005) experimented using Flame atomic absorption spectrometry and colorimetric to determine Chromium in solution along with diphenylcarbazide. Cross-inked chitosan is efficient in removing hexavalent chromium from aqueous solutions and at the same time less efficient in eliminating trivalent chromium owing to protonated active sites interacting mainly with metallic anions at acidic pH. He absorbed that the maximum adsorption capacity achieved in this experiment, as high as 215

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mg/g, is among the highest reported elsewhere [5].

Further Jinwook Chung,et al., (2010) adopted hydrogen based membrane biofilm reactor along with reducing bacteriafor reduction of hexavalent and trivalent chromium.Reduction occurred rapidly under normal membrane biofilm reactor denitrifying condition and Reduction is optimum near 7pH. The results show that the hydrogen based membrane biofilm reactor is a treatment technology for treating hexavalent chromium in wastewater.For effective hexavalent chromium removal, the critical operational parameters for maximizing reduction hexavalent chromium are hydrogen concentration, nitrate concentration and pH [9].Later Trond Austrheim.et al., (2008) Trametes Versicolor Polyporus fungi .The Absorption capacity of this trametes versicolor polyporus fungi was 125.0 mg/g. The maximum uptake of hexavalent chromium ions was occurred at pH 4.By increasing the amount of the biosorbent which increase the percentage of metal ions removal [16].

Surfactant cetyltrimethylammonium bromide was used as an adsorbent by Sadaoui.Z.et al., (2009) to remove the hexavalent chromium from wastewaters.The adsorption performances of cetyltrimethylammonium bromide was studied.The adsorption capacity of hexavalent chromium was increased with initial metal concentration and in a lesser extent with solution pH. However, it decreases with initial cetyltrimethylammonium bromide mass and with concentration of other ions present in the solution.The maximum capacities of metal adsorption as calculated as 17.89 mgg^{-1} and 13.85 mgg^{-1} using Langmuir adsorption isotherm at 45^0C [13] .

Alok Prasad Das,Susmita Mishra, (2010) implemented Microbial remediation Peptone Yeast Exatract and Brevibacterium Casei for hexavalent chromium removal.These bacterium detoxify the chromate present in contaminated wastes of industries and minings. This Brevibacterium Casei can effectively degrade hexavalent chromium upto 99% in 12hr at neutral pH and temperature of 30% [1].

Futher Activated sludge with powdered Activated carbon technique was adopted by Ferro Orozco A.M. et al., (2010) [4] .They observed that the hexavalent chromium removal in the combined activated sludge with powdered activated carbon system in comparison is high than individual Activated sludge treatments.Chromate removal was improved by increasing powdered activated carbon concentrations in both PAC and activated sludge with powdered activated carbon systems.

3.2 Chemical Technology:

Ramajeevan Ganeshjeevan,et al., (2003) investicates hexavalent chromium detection in the presence of a high load of colourants using an on-line dialysis technique for ion chromatography.This method has been developed to remove water-soluble anionic dyes and particulate colourants and other substances to facilitate hexavalent chromium quantification. They found that this method has a detection limit of 5 mg/ l, recovery rate of 100% and analysis time less than 20 min [11].

Later Venkata Subbaiah.M.et al., (2006) inquiries coupled plasma mass spectrometry along with dynamic reaction cell with ammonia for detection. This method is used for determining ultra-trace levels of hexavalent chromium in ambient air. The method involves a 24-h sampling of air into potassium hydroxide solution, followed by silica gel column separation of hexavalent chromium, then preconcentration by complexation and solvent extraction. The hexavalent chromium complex was dissolved in nitric acid. The resultant chromium ions were determined by inductively coupled plasma mass spectrometry using a dynamic reaction cell with ammonia 9.3% of trivalent chromium converted to hexavalent chromium within 6 hrs [17].

Complex matrices such as crude oil and sludge was adopted by Safavi.A,Maleki.N., (2006). They implemented sensitive method for determination of chromium ion (VI) in complex matrices such as crude oil and sludge was presented based on the decreasing effect of hexavalent chromium on cathodic adsorptive stripping peak height of Cu–adenine complex. Under the optimum experimental conditions, a linear decrease of the peak current of Cu–adenine was observed, when the chromium (VI) concentration was increased from 5 μgL^{-1} to 120μgL^{-1}. Trivalent chromium at concentrations10–100fold excess of hexavalent chromium [14].

Turkish brown coals (Ilgın, Beys_ehir, and Ermenek) have been established for treating chromium by Gulsin Arslan, Erol Pehlivan, (2007). This method is simple, effective and economical means of wastewater treatment. The mechanism of hexavalent chromium ion binding to brown coals may include ion exchange, surface adsorption, chemisorption, complexation, and adsorption–complexation. Maximum adsorption capacity of 11.2 mM of hexavalent chromium /g for Ilgın, 12.4 mM of Hexavalent chromium /g for Beys_ehir, 7.4 mM of hexavalent chromium /g for Ermenek and 6.8 mM of Hexavalent chromium /g for activated carbon was achieved at pH of 3.0[6].

Tri-chamber bath system, titanium plated ruthenium anode,nafion quaternary cation has been adopted by JIANG Xiaojun et al., (2009) . This technique has higher current efficiency 34.7% and no health damage to the operators [8].

3.3 Mechanical Technology

Mass spectrometry analysis and wet scrubber has been adopted for carcenogenic component removal by

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James R.Kastner and K.C.Das, (2002).Emission rate of Sulfur compounds is reduced nearly 90 % [7].

Wet Scrubber Simulator System and Ontario Hydro Analysis were used as technique for examination by John C.S Chang,S.Behrooz Ghorishi , (2003). The model can be used to predict Hg^0 increase across wet FGD scrubbers when the Hg^{2+} reduction and Hg^0 emission in the scrubber is dominated by the mechanism. Pilot- and full-scale tests are needed to validate the results from this current work which was conducted under simulated bench-scale conditions. This reduce S (IV) concentration enhances Hg^0 and Hg^{2+} emission [10].

Amornpon Chandsuphan et al., (2003) explorize oxidizing agent along with packed bed wet scrubberwas meant for treating the chemicals. 99.10% of carcenogenic components were removed. Surfactants with packed tower scrubber reduce $C_{10}E_4$ (Naphthalene) nearly 60%. By using Pilot Scale Packed Bed scrubber along with oxidant 99.5%H2S was removed [2].

Residence time distribution approach has been used by Sarkar.S.et al., (2007) for developing a theoretical model for predicting the SO_2 removal efficiency in a horizontal co-current gas–liquid scrubber by water spray. Experimental investigation shows that a very high percentage removal of SO_2 can be achieved from air–SO_2 mixture without using any additives or pre-treatment. Removal of sulfur compound efficiency lies in the range of 60-97% [15].

4 LIST OF SYMBOLS

TABLE1

Symbol	Quantity
Pt	Penetration
η	Collection efficiency
e	Exponential function
f_{system}	Function of the scrubbing system variables
C_d	Drag coefficient
K	Gas Load Factor
g	Gravity field
d_d	Droplet diameter
A_d	Projected area of the droplet,(Πd_d^2 /4)
d_d	Droplet diameter
ρ_i and ρ_g	Densities of the gas and liquid
$U_{g,set}$	Terminal velocity relative to the gas
F_r	Flow force
G_d	Gravity force
N_{out}	Number concentration of liquid drops at the outlet (x = L) of the scrubber

5 Conclusion

Various biological, chemical and mechanical method list different percentages of hexavalent chromium and trivalent chromium removal, among these Microbial remediation and Brevibacterium Casei removes hexavalent chromium upto 99% in 12hr.This is the maximum percentages of chemical removal as examined among the biological techonolgy upto now,Maximum adsorption capacity of 11.2 mM of hexavalent chromium /g for Ilgın , 12.4 mM of hexavalent chromium /g for Beys_ehir , 7.4 mM of hexavalent chromium /g for Ermenek and 6.8 mM of hexavalent chromium /g has been observed by Gulsin Arslan.Among the chemical technology this Turkish brown coals produces maximum removal of chemicals. 99.10% of mercury is removed in the mechanical technoly using packed bed wet scrubber. The future work concentrates in the increase of trivalent and hexavalent chromium removal percentage.

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Effects of Socio-Demographic Covariates on Blood Glucose Level of the Diabetic Patients: A Multiple Classification Analysis (MCA)

Md. Behzad Noor, Dr. Mir Mohammad Azad, Dr. J.A.M. Shoquilur Rahman

Abstract— This study has been undertaken to determine the socio-demographic related covariates affecting blood glucose level of the diabetic patients as well as to identify the extent of influences of the variables by the implied factors on blood glucose level. Data have been collected from two diabetic diagnostic centers in Rajshahi City. The result implies that insulin intake, blood pressure, tablet intake and mental suppression of the diabetic patients have the intense influence on blood glucose level. The proportion of variance explained (adjusted) by the respective variables are β^2 = 0.422, 0.122 and 0.120 respectively. So, the diabetic patients are supposed to maintain their medication, control their blood pressure, become free from mental suppression, overall, giving up the sedentary life style. They should maintain a regulatory life to keep themselves away from having high blood glucose level.

Index Terms— Glucose Level of Diabetic Patients.

1 Introduction

GLUCOSE is a main source of energy for the cells that make up our muscles and other tissues. Blood glucose tests measure how well our body processes sugar (glucose). A normal fasting blood glucose result is lower than 100 milligrams of glucose per deciliter of blood (mg/dl) [1]. Hyperglycemia, or high blood glucose levels, is the hallmark of diabetic and it is linked to the development of long-term diabetic complications. Healthy people without diabetic typically have blood glucose levels of 65-110 mg/dl and 120-140 mg/dl one to two hours after eating [2, 3].Type-I diabetes is an autoimmune disease. An autoimmune disease results when the body's system for fighting infection (the immune system) turns against a part of the body. In diabetes, the immune system attacks and destroys the insulin-producing beta cells in the pancreas. The pancreas then produces little or no insulin. A person who has type-I diabetes must take insulin daily to live.

In type-II diabetic, the pancreas is usually producing enough insulin, but for unknown reasons the body cannot use the insulin effectively, a condition called insulin resistance. After several years, insulin production decreases. The result is the same as for type-I diabetes - glucose builds up in the blood and the body cannot make efficient use of its main source of fuel [4]. Worldwide, type-II diabetes has soared to epidemic proportions and is at the forefront of current public and community health intervention in both Western and developing countries. Obesity, consanguinity, blood pressure, total cholesterol, HDL-cholesterol and triglyceries are more prevalent in diabetic patients [5]. It is estimated that 135 million people worldwide have diagnosed diabetes in 1995, and this number is expected to rise to at least 300 million by 2025 [6]. The prevalence data on diabetes were available from seven countries in the Region. The sources of information were surveys covering relatively small population groups. For the purpose of projection to the countries with no representative data, the data from the seven countries were used. it was estimated that the Region had about 40.9 million cases of diabetes [7]. For this estimation, the weighted average prevalence of the countries with available data was used. Two other approaches were also used.

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Table 1: Estimated prevalence of diabetes mellitus in SEAR, 1998

Country	Population ('000)	Estimated cases of diabetes mellitus
Bangladesh	**124,000**	**2,700,000**
DPR Korea	23,700	16,497
India	982,200	28,702,100
Indonesia	209,000	4,639,000
Maldives	282	7,000
Sri Lanka	18,700	1,500,000
Thailand	61,000	1,380,000
Total of above countries	1,418,882	38,944,597
Estimated cases from countries with no representative data *	70,250	1,928,178
Estimated total cases in the Region	1,489,132	40,872,775

Source: Based on prevalence estimate derived from the above seven countries.

First, as the data showed that two countries in the Region have either high (Sri Lanka) or very low (DPR Korea) prevalence, a revised estimate was made excluding these two countries, which came to 40.8 million. Secondly, the Indian prevalence estimate for the three countries from where data was not available, was used as it was felt that culturally and socio- demographically, India was the closest to these countries. This gave an estimate of 41.0 million cases [7].

In the Diabetes Atlas 2000, published by the International Diabetes Federation (IDF), it was estimated that in 2000 (report of IDF includes India, Bangladesh, Mauritius and Sri Lanka in the SEA Region of IDF) an estimated 35 million cases of diabetes would be prevalent [7]. The differences are in the year of estimate and the countries included. If we take only India, Bangladesh and Sri Lanka (WHO/SEAR countries included in the IDF report), then the comparison of the two estimates is shown in Table 2 below. Though the total estimate appears to be similar, the country specific estimates show a variation [7].

Table 2: Comparison of estimates of prevalence of diabetes mellitus of derived by IDF and the present report

Country	IDF	WHO SEARO
Bangladesh	1,759,700	2,700,000
India	32,674,400	28,702,100
Sri Lanka	335,400	1,250,000

Source: Diabetes Atlas 2000, International Diabetes Federation

The ten Member Countries of WHO's South-East Asia Region (Bangladesh, Bhutan, DPR Korea, India, Indonesia, Maldives, Myanmar, Nepal, Sri Lanka and Thailand) are undergoing significant social, economic and demographic changes. Most of the noncommunicable diseases (NCDs) are a part of the degenerative diseases group and have higher prevalence in the older population. In addition, many of the lifestyle risk factors for NCDs like improper nutrition, sedentary life, alcohol and tobacco use are showing an upward trend in these countries. This has led to the emergence of NCDs as important causes of morbidity and mortality in the Region. In 1998 alone, NCDs are estimated to have contributed almost 60% of deaths in the world and accounted for 43% of the global burden of disease. Based on current trends, by 2020, these diseases are expected to account for 73% of deaths and 60% of the disease burden [7].

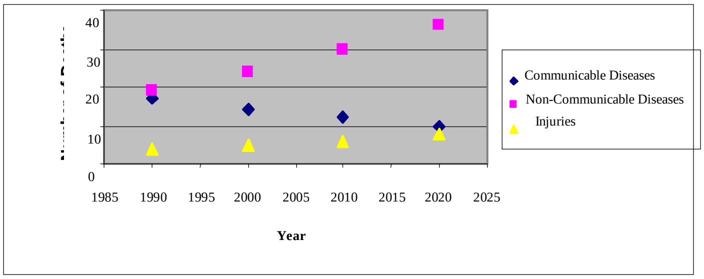

Fig. 1: Projected trends in the number of deaths by broad cause group in developing regions

The development of type-II diabetes is the result of a complex interaction between genetic and environmental factors and has been researched extensively in the scientific and medical literature [8]. The most common form of diabetic is type-II diabetic and this type of diabetic is most often associated with older age, obesity, physical inactivity, and ethnicities [9]. Obesity is a well-known risk factor for cardiovascular disease, including systemic hypertension, heart failure those in turn affect the blood glucose level. Obesity is a well-known risk factor for cardiovascular disease, including systemic hypertension, heart failure those in turn affect the blood glucose level [10].

Investigating the prevalence of type-II Diabetic Mellitus (DM), impaired glucose tolerance and the factors affecting blood glucoselevel, it has been found that the sex, hyperlipoidemia, hypertriglyceredemia and hypertension as independent factors for the abnormalities in glucose tolerance; whereas, BMI and per day insulin and tablet intake affect blood glucoselevel for the both sexes and for both tablet or insulin users [11]. It has also been revealed that aging, overweight and a sedentary lifestyle are the important determinants in the prevalence of the diabetic during this transition period in Vietnam [12]. For non-insulin-dependent diabetic mellitus (NIDDM), impaired glucose tolerance (IGT) and

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hyper tension in rural community of Bangladesh, increased age has been considered as an important risk factor for all disorder related to diabetic whereas BMI associated risk have been significant with NIDDM and hypertension [13,14].

The main aim of this paper is to assess different covariates affecting blood glucose level as well as to intensify their effect on blood glucose level through other implied factors.

2 DATA SOURCE

Out of 84 diagnostic and pathologies [15], there are only two well recognized diabetic diagnostic centers named "Rajshahi Diabetic Association and Diagnostic Center" at Laxmipur and "Diabetic Welfare Center, Talaimary, Rajshahi" in Rajshahi city. Theses two diabetic centers have been considered as our study areas. There are 5345 registered diabetic patients at both the diabetic diagnostic centers; out of them 3772 registered patients are in Rajshahi Diabetic Association and Diagnostic Center and 1573 in Diabetic Welfare Center. We serially numbered all those registered diabetic patients from the two centers' respective registered book and thereafter we selected 1069 diabetic patients through the process of linear systematic sampling procedure using the formula $N=nk$, where N=5348, n=1069 and k=5 [16]. Among 1069 patients there are 504 males and 565 females of whom 454 are tablet users and 615 insulin users.

3 ANALYTICAL METHODOLOGY

Multiple Classification Analysis (MCA) requires one dependent variable and two or more independent variables. The dependent variable can be either a continuous or a categorical variable, but all the independent variables must be categorical. MCA can equally handle the nominal and ordinal variables and can also deal with linear and non-linear relationships of predictor variables with dependent variables. Mathematically, the model can be expressed by the following equation:

$$Y_{ijk} = \bar{y} + a_i + b_j + c_k + \text{- - - - - - - -} + e_{ijk}\,.$$

Where,

Y_{ijk} is the value or score of an individual who falls in the i th category of the factor A, j th category of the factor B and k th category of the factor C.

$\bar{y}$ is the grand mean of Y.

a_i is the effect due to the i th category of the factor A, which is equal to the difference between y and the mean of its category of factor A.

b_j is the effect due to j th category of the factor B, which is equal to the difference between $\bar{y}$ and the mean of its category of factor B.

c_k is the effect due to the k th category of the factor C, which is equal to the difference between y and the mean of its category of factor C.

e_{ijk} is the error term related with Y_{ijk} score of the individals.

The coefficients, which are estimated by solving the normal equation systems, are called the adjusted or net effect of the predictors. These effects measure those of the predictor alone after taking into account the effects of all other predictors. The unadjusted, eta-square (η2) coefficient is a correlation ratio, which explains how well the predictor variable explains the variation in the dependent variables. Similarly, the beta-square (β2) coefficient indicates the proportion of variation explained by the other predictor variables.

3.1 Variables Considered for the Analysis

The multiple classification analysis is undertaken first to evaluate the contribution of socio- demographic and the health related characteristics such as age, respondents' education, occupation, Body Mass Index (BMI), calorie intake, injection intake, obesity, patients' mental suppression, smoking habit and walking habit on the blood glucose level. In this case blood glucose level is taken to be the dependent variable and socio- demographic and health related variables as explanatory variables. All the socio- demographic variables are the categorical variables. The categories of the selected variables have been disclosed in the following table:

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		0 = Don't Take *1 =Take*

Table 3: Variables and their Covariates used in the Multiple Classification Analysis

<table>
<tr><th colspan="2">Variable</th><th rowspan="2">Covariates</th></tr>
<tr><th>Dependent</th><th>Independent</th></tr>
<tr><td>Y = Blood Glucose Level</td><td>X₁ = Age of the Respondents

X₂ = Body Mass Index

X₃ = Calorie Intake

X₄ = Educational Qualification

X₅ = Occupation

X₆ = Sugar level increased in relation to suppression

X₇ = Injection Intake

X₈ = Blood Pressure

X₉ = Walking Distance Covered

X₁₀ = Tablet Intake</td><td>0 = Early Age
1 = Middle Age
2 = Older Age

1 = Under Weight
2 = Over Weight
3= Obesity

0 = Don't Take
1 = Medium Intake
2= High Intake

1 = Illiterate
2 = Primary Level of Education
3=Secondary Level of Education
4= H.S.C Level of Education
5=Graduation Level of Education
6= Post Graduation Level of Education

0 = Non- Professional
2 = Professional

0 = N0
1 = Yes

0 = Don't take
1 = Take

0 = Normal
1 = High
2 = Low
0= Don't Walk
2 = Walk</td></tr>
</table>

4 Influential Determinants of the Blood Glucose Level

There are a variety of socio-demographic and health related factors that influence blood glucose level. To examine the differential patterns of mean level of the blood glucose among the patients, the well known Multiple Classification Analysis (MCA) has been employed. Table 2 shows the mean level of blood glucose of both unadjusted and adjusted by different socio- demographic and diabetes related characteristics with the values of $\eta 2$ and β^2 produced from multiple classification analysis.

As we can found from Table 2 that the mean level of blood glucose (Adjusted) for the early, middle and the older aged persons are 13.16, 12.39 and 12.83 respectively [Table 2]. At the early age due to have a sedentary life style blood glucose level remains uncontrolled, which might lead some sort of vulnerability to the young diabetic patients. Again, the mean level of blood glucose has been found to be a bit higher for the older aged people than that of the middle aged people. This refers that with the increase of the age patients' blood glucose is increased. This finding is supported by other studies, where the prevalence of the type-II diabetes in urban slum of Dhaka, Bangladesh have been determined and it has been found that increasing age, sex, literacy and waist to hip ratio for men as significant risk factors for increasing the blood glucose level [17].

Many researchers have found BMI as one of the most influential factors affecting blood glucose level. Some other studies shows that the risk factors for increasing blood glucose level are age, BMI and parity which are all positively associated with the prevalence of the type-II diabetes [18]. From our study we have noticed that over weighted and obese people's mean blood glucose level (Adjusted) are much higher (14.55 and 14.99 respectively) [Table 2] than that of the respondents with the normal weight (11.48) [Table 2].

Calorie intake per day is another important factor that often termed as the decider of the blood glucose level for the diabetes patients. Here, we could notice that the patients who used to follow the chart of medium and the high calorie have much lower mean level of blood glucose (12.52 and 13.32 respectively) [Table 2] than of those who don't follow any calorie chart referred by the physician from the diabetes

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book (15.54) [Table 2].

The respondents with the post graduation level of education are found with a lowest mean glucose level (11.15) [Table 2] than of the other educational category. This result focuses that with the advanced educational background a people comes to know with various knowledge regarding diabetes through various accessories through accessing with the latest news and views about the various invariable knowledge of the diabetes. So, education has its own part to play in developing the knowledge and awareness about diabetes.

The mean glucose level (Adjusted) for the respondents with the professional background is 12.59 [Table 2] which is a bit higher than those of the respondents who are non-professional (12.56) [Table 2]. This might happen due to the matter of less physical work and more mental suppression on the professional respondents who are more used to be involved with various types of official jobs where the maximum part of the day have to be spent without doing any physical work as a result the weight gaining was ongoing that increase the blood glucose level. Type-II diabetes and the impaired fasting glucose (IFG) in the rural area of the Bangladesh had been investigated by the Sayeed and group and found that the prevalence of the diabetes and IFG in the rural population was increased, where, older ages, highest obesity and reduced physical activities proved significant risk factors for the diabetes and IFG [19].

Tension and the mental suppression play the pivotal role in increasing blood glucose level. From Table 2 we notice that the respondents whose blood glucose level increase at the time of being tensed are found to have the maximum mean blood glucose level (Adjusted) (13.0) [Table 2] comparing to those whose blood glucose level is not influenced by the mental suppression (12.04) [Table 2]. Scientifically as we know that excessive tension or mental agony cause the pancreas to exert more insulin through urine that in turn cause the deficit of insulin which influence blood glucose level [19].

The respondents who are used to take tablet and insulin to control their blood glucose level are noticed to have more adjusted mean glucose level (14.82 for the insulin intake and 14.30 for the tablet intake) [Table 2] than of those who don't control their blood glucose level through either of these process (10.65 and 10.63 for the tablet and insulin users respectively) [Table 2]. Here, more mean glucose level has been noticed for those who used to have the insulin as their medication of controlling diabetes.

Among 1,000 respondents the mean adjusted blood glucose level is high for the patients who have the high blood pressure (15.07) [Table 2] comparing to the mean adjusted blood glucose level to those of the respondents with normal blood pressure (10.55) [Table 2]. Here, from our study it has been found that the mean adjusted blood glucose level of the respondents who have regular walking habit is depicted as much lower (11.67) [Table 2] than of those who don't have any habit to walk at a regular basis (13.08) [Table 2].

4.1 Intensity of effects of the various implied factors on blood glucose level

In this section an attempt has been made to observe the extent of influences of the variables on blood glucose level. Table 3 produces the results of zero order correlation coefficients of blood glucose level with various socio- demographic and health related characteristics. These variables have to affect blood glucose level through one or more proximate determinants.

Table 2 shows that respondents' habit of taking insulin has a significant contribution on blood glucose level which has been noticed to have a positive association with blood glucose level. The correlation coefficient is found to be $r = 0.343$ [Table 3]. Among the included variables respondents' insulin intake has the strongest influence on blood glucose level. The proportion of variance explained (unadjusted) by insulin intake is $\eta^2 = 0.335$ [Table 2] and the proportion of variance explained (adjusted) by this variable is $\beta^2 = 0.422$ [Table 2]. The indirect effect of insulin intake through calorie intake, BMI, and walking distance on the blood glucose level are 0.010, 0.032 and 0.005 respectively.

Blood pressure of the respondents has a significant contribution on blood glucose level. Blood pressure has a positive significant association ($r = 0.046$) with blood glucose level [Table 3]. Among the included variables, blood pressure has the second strongest influence on blood glucose level. The proportion of variance explained (unadjusted) by blood pressure was $\eta^2 = 0.117$ [Table 2] and the proportion of variance explained (adjusted) by this variable is $\beta^2 = 0.122$ [Table 2]. The effect of blood pressure on blood glucose level through mental suppression, calories intake and the walking habit of the respondents is 0.003, 0.007, 0.00012 and 0.0046 respectively.

Mental tension has a positive significant association ($r = 0.083$) with blood glucose level [Table 3]. The strength of explaining variability (unadjusted) is $\eta^2 = 0.083$ [Table 2] and the strength of explaining variability (adjusted) is $\beta^2 = 0.119$ [Table 2] which is the third most influential factors affected

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the blood glucose level. The indirect effect of mental suppression of the respondents suffering from the diabetes on blood glucose level through body mass index is 0.013 [Table 2] and through education and age are 0.013 and 0.0009 respectively on the blood glucose level.

Daily tablet intake of the patients also has a significant contribution on blood glucose level. The tablet intake of the respondents has the negative significant association (r= -0.332) [Table 3] with blood glucose level. The proportion of variance explained (unadjusted) by tablet intake of the respondents is $\eta 2$= 0.124 and the proportion of variance explained (adjusted) by this variable is $\beta 2$ = 0.324 [Table 2]. Tablet intake by the diabetes patients affects blood glucose level through body mass index, blood pressure, calories intake and walking habit of the respondents with the value of 0.0096, 0.0043, 0.0026 and .0026 respectively.

Calorie intake of the respondents has a vital role to control the blood glucose level and has shown a considerable positive association with blood glucose level. The proportion of variance explained by the calorie intake is (unadjusted) $\eta 2$= 0.054 and the proportion of variance explained (adjusted) by this variable is $\beta 2$ = 0.048 [Table 2].

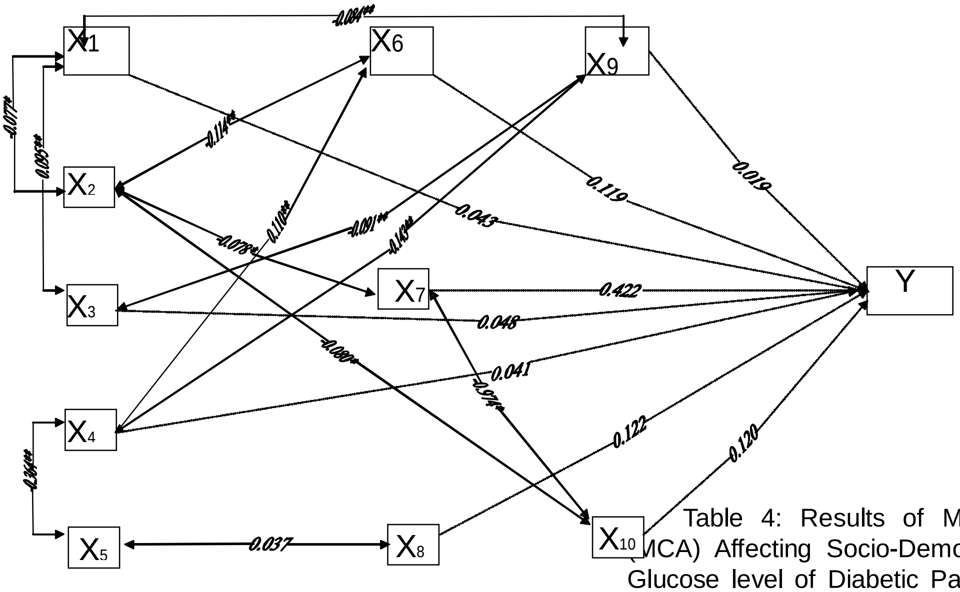

Fig.1: Decomposing and synthesizing the relative influences of different variables on blood glucose level of the diabetic patients.

As there is no mechanical method for building a causal model (Srinivsan, 1981), it primarily depends on the substantive reasoning of the cause effect relationship. With these statistics, this part attempts to decompose and synthesize relative influence of the variables on blood glucose level. The model shows that there is a positive significant correlation between education and occupation, r = 0.364 [Table 3]. In addition, it can be mentioned that the educational qualification has the positive and significant association with the mental suppression, as we found from other study that the educated people are more likely to have high level of mental suppression [19]. Again, from the Table 3 we observe that education has the positive association (r=0.048) [Table 3] with the calorie intake and through the calorie intake education affect the blood glucose level that is the indirect effect of the education through calorie intake was 0.0019.

Walking habit of the respondents had four posterior factors: age, calorie intake, occupation and BMI. The extent of correlation between walking habit and age is -0.084 [Table 3]. The result implies that as age increases the walking habit is reduced. For instance, in spite of having the desire, due to the physical inability an aged population couldn't be able to walk at a regular basis for a long distance. So walking habit also affects blood glucose level through age with the indirect effect of 0.0015.

Table 4: Results of Multiple Classification Analysis (MCA) Affecting Socio-Demographic Covariates on Blood Glucose level of Diabetic Patients in Rajshai City, Bangladesh.

Characteristics	Unadjusted	Adjusted	η2	β2
Age				
Early Age	13.32	13.16		
Middle Age	12.36	12.39	0.055	0.043
Older Age	12.92	12.83		

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Body Mass Index (BMI)				
Under Weight	13.08	13.17	0.039	0.016
Normal Weight	11.08	11.48		
Over Weight	14.44	14.55		
Obesity	14.71	14.98		
Calorie Intake				
1. Don't follow the calorie Chart	15.14	15.54	0.054	0.048
2. Follow the Medium Calorie Chart	12.49	12.52		
3. Follow the High Calorie Chart	13.80	13.32		
Educational Qualification				
1. Illiterate	12.44	12.49	0.061	0.041
2. Primary Level of Education	12.48	12.47		
3. Secondary Level of Education Higher.	12.73	12.65		
4. Secondary Level of Education	12.21	12.77		
5. Graduate Level of Education	13.21	12.99		
6. Post Graduate Level of Education	11.01	11.15		
Occupation				
Professional	12.56	12.59	0.007	0.004
NonProfessional	12.48	12.56		
Sugar Level increased with Mental Suppression				
No	12.04	11.99	0.083	0.119
Yes	12.96	13.00		
Insulin Intake				
Don't take	10.63	10.13	0.335	0.422
Take	14.35	14.82		
Blood Pressure				
Normal	10.03	10.55	0.117	0.122
High	14.88	15.07		
Low	11.88	12.04		
Walking Habit				
Don't have regular Walking habit	12.89	13.08	0.022	0.019
Having regular Walking habit	11.43	11.67		
Tablet Intake				
Don't take	10.65	10.89	0.324	0.120
Take	14.14	14.30		
Grand Mean	12.55			
Proportion of Variance Explained	0.367			

The correlation between walking habit and calorie intake shows an insignificant association (r= -0.091) [Table 3]. This implies that the respondents who are used to take high calorie are not used to walk at a regular basis that leads them to the obesity which in turn affects the blood glucose level [20]. So it is clear that walking habit also affects blood glucose level through calorie intake and this time the indirect effect through calorie intake is 0.0017. The more professional persónnel have to occupy their most of the time doing many official works that don't allow them to walk at a sufficient rate of time and distance. So walking habit also affects blood glucose level through occupation as well. The association between the walking habits and occupation is 0.143 [Table 3] and has the significant association. The indirect effect of walking habit through occupation is 0.0027. The correlation between the walking habit and the BMI is-0.016 [Table 3] that reveals that the respondents who have the less regular habit of walking are more likely to have more BMI that produce the risk of gripping by the diabetes [21]. Here, in this case the negative effect of the walking habit through BMI is 0.0003. According to some other study, diabetes is associated with the age, BMI, blood pressure, HDL, cholesterol, education levels, and the family history [21].

Table 5. Zero order correlation coefficient of Socio-Demographic variables on the blood glucose level.

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
Y	1	0.024	0.014**	0.056	0.013	0.066	0.083**	0.343**	0.046**	-0.023	0.332**
X_1		1	0.077*	0.095**	0.046	0.011	0.008	0.013	0.010	-0.084**	0.008
X_2			1	0.044	0.046	0.024	0.114**	0.078**	0.062	0.016	0.080**
X_3				1	0.048	0.048	0.027	0.024	0.001	-0.091**	-0.022
X_4					1	0.364**	0.110**	0.030	0.037	0.026	0.022
X_5						1	0.21**	0.011	0.037	0.143**	0.036
X_6							1	0.075	0.025	-0.037	0.002
X_7								1	0.033	-0.012	0.974**
X_8									1	-0.038	0.036
X_9										1	-0.022
X_{10}											1

In our study the correlation between the age and blood glucose level is 0.004 [Table 3] that implies that as age increase the blood glucose level is more likely to increase. Again age of the respondents has three posterior factors: BMI, calorie intake and the walking distance. The correlation between age and BMI of the patients is observed to be significant (r = 0.077) [Table 3] which implies that with the

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increase of age the BMI decrease. So age affects blood glucose level through BMI. The indirect effect of age through BMI was 0.035. Age also affects blood glucose level through calorie intake and walking distance. We have found that there is a significant and positive association between the age and calorie intake (r= 0.095) [Table 3], that refers that with the increase of age patients of our study take more calorie and in previous we have detected that with the increase of age the patients are less used to walk at a regular basis, so, more calorie consumption and less walking habit always create a huge risk to the prevalence of obesity that is the most influencing and effective factor in the prevalence of diabetes [22]. The effect of the age through calorie intake was 0.0036.

Again, the correlation between BMI and mental pressure and BMI and blood pressure are 0.114 and 0.062 respectively [Table 3], where, the association between the BMI and mental suppression has the significant association. This result implies that with the increase of BMI both the mental suppression and blood pressure both are increased. Here, the negative effect of the BMI and the blood pressure on the blood glucose level are 0.0018 and 0.0009 respectively.

Education and mental suppression have a significant positive association (r=0.110) [Table 3]. This refers that with the advanced educational background people become more likely to grippe by the tension which is one of the most effective factor in the prevalence of the diabetes. Other study has reported as BMI associated risk of the diabetes was significant with NIDDM and hypertension [22]. The education has the negative effect on the blood glucose level through mental tension and BMI of 0.00451 and 0.0018 respectively.

CONCLUSION

Insulin and Tablet intake and Blood pressure of the patients are most important influential factors that affect blood glucose level. As we can observe that mental tension has a positive and significant association with blood glucose level. we also have find that the early aged patients' mean blood glucose (Adjusted) is much higher than that of the older aged people and the patients who don't follow the calorie chart at all have the highest mean blood glucose level than of those who follow the medium and high calorie chart from their diabetes book. Multiple Classification Analysis (MCA) results deserve considerations from the viewpoint of policy implication. So, we could say that the early and middle aged population should be more and more conscious about controlling their weight and the older aged patients should maintain their blood glucose through dieting and doing physical work as well and also they should take care of their calorie intake to keep themselves in safer zone.

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Optimization of Power Consumption in Wireless Sensor Networks

Surendra bilouhan, Prof.Roopam Gupta

Abstract—In this paper, we consider the problem of discovery of information in a densely deployed Wireless Sensor Network (WSN), where the initiator of search is unaware of the location of target information. We propose a protocol: Increasing Ray Search (IRS), an energy efficient and scalable search protocol. The priority of IRS is energy efficiency and sacrifices latency. The basic principle of this protocol is to route the search packet along a set of trajectories called rays that maximizes the likelihood of discovering the target information by consuming least amount of energy. The rays are organized such that if the search packet travels along all these rays, then the entire terrain area will be covered by its transmissions while minimizing the overlap of these transmissions. In this way, only a subset of total sensor nodes transmits the search packet to cover the entire terrain area while others listen. We believe that query resolution based on the principles of area coverage provides a new dimension for conquering the scale of WSN. We compare IRS with existing query resolution techniques for unknown target location such as Round Robin Search. We show by simulation that, performance improvement in total number of transmitted bytes, energy consumption, and latency with terrain size

Index Terms—Wireless sensor networks, energy efficiency, scalability, CSMA, Sensor Sim , SIR, Low-power optimization , transmission strategy.

1. Introduction

A sensor network is a group of specialized transducers with a communications infrastructure intended to monitor and record conditions at diverse locations. Commonly monitored parameters are temperature, humidity, pressure, wind direction and speed, illumination intensity, vibration intensity, sound intensity, power-line voltage, chemical concentrations, pollutant levels and vital body functions.

A sensor network consists of multiple detection stations called sensor nodes, each of which is small, lightweight and portable. Every sensor node is equipped with a transducer, microcomputer, transceiver and power source. The transducer generates electrical signals based on sensed physical effects and phenomena. The microcomputer processes and stores the sensor output. The transceiver, which can be hard-wired or wireless, receives commands from a central computer and transmits data to that computer. The power for each sensor node is derived from the electric utility or from a battery. This paper provides an analytical model for the study of energy consumption in multihop wireless embedded and sensor networks where nodes are extremely power constrained. Low-power optimization techniques developed for conventional ad hoc networks are not sufficient as they do not properly address particular features of embedded and sensor networks. It is not enough to reduce overall energy consumption, it is also important to maximize the lifetime of the entire network, that is, maintain full network connectivity for as long as possible. This paper considers different multihop scenarios to compute the energy per bit, efficiency and energy consumed by individual nodes and the network as a whole. The analysis uses a detailed model for the energy consumed by the radio at each node. Multihop topologies with equidistant and optimal node spacing are studied. Numerical computations illustrate the effects of packet routing, and explore the effects of coding and medium access control. These results show that always using a simple multihop message relay strategy is not always the best procedure.

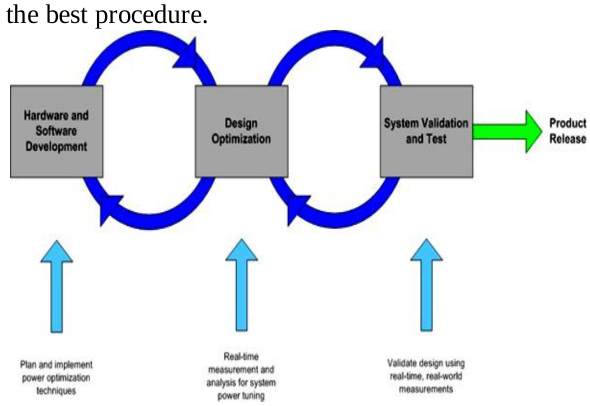

Fig1.Life cycle of sensor network

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2.BACKGROUND

Recent advances in sensor technology (in terms of size, power consumption, wireless communication and manufacturing costs) have enabled the prospect of deploying large quantities of sensor nodes to form Wireless Sensor Networks (WSN). These networks are created by distributing large quantities of usually small, inexpensive sensor nodes over a geographical region of interest with a view to collect data relating to one or more variables. These nodes are primarily equipped with the means to sense, process and communicate data to other nodes and ultimately to a remote user(s). WSN nodes can also have mobility capabilities which enable them to move around and roam the region of interest to harvest information. Figure 1 shows a typical sensor node hardware architecture. Sensor nodes may cooperate with their neighbors (within communication range) to form an ad-hoc Network. WSN topologies are generally dynamic and decentralized. Figure 2 gives a general overview of a WSN.

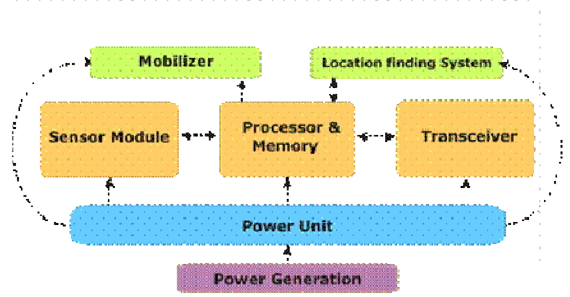

Fig2.Execution phase of sensor signal

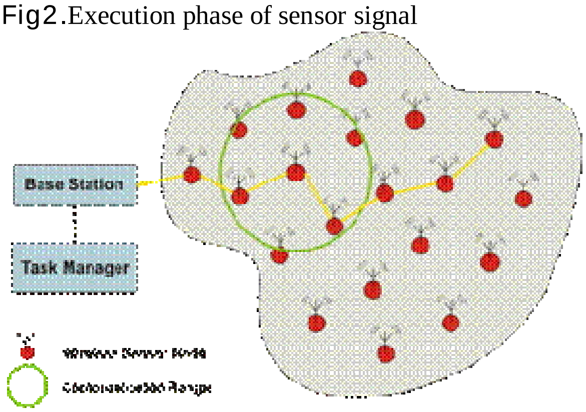

Fig3.wireless area consist of various sensor nodes.

BACKGROUND AND RELATED WORK

Understanding the performance and behavior of sensor networks requires simulation tools that can scale to very large numbers of nodes. Traditional network simulation environments, such as ns2 [6], are effective for understanding the behavior of network protocols, but generally do not capture the operation of endpoint nodes in detail. Also, while ns2 provides implementations of the 802.11 MAC/PHY layers, many sensor networks employ nonstandard

wireless protocols that are not implemented in ns2. A number of instruction-level simulators for sensor network nodes have been developed, including At emu [11] and Simulavr [20]. These systems provide a very detailed trace of node execution, although only At emu provides a simulation of multiple nodes in a networked environment. The overhead required to simulate sensor nodes at the instruction level considerably limits scalability. Other sensor network simulationenvironments include PROWLER [21], TOSSF [19] (based on SWAN [14]), Sensor Sim [17], and SENS [23]. Each of these systems provides differing levels of scalability and realism, depending on the goals for the simulation environment. In some cases, the goal is to work at a very abstract level, while in others, the goal is to accurately simulate the behavior of sensor nodes. Few of these simulation environments have considered power consumption. Sensor- Sim [17] and SENS [23] incorporate simple power usage and battery models, but they do not appear to have been validated against actual hardware and real applications [18]. Also, SensorSim does not appear to be publically available.

Several power simulation tools have also been developed for energy profiling in the embedded systems community.

Performance Metrics Used

•**Number of transmitted bytes**: Average number of bytes transmitted by all the nodes in the network for finding the target information. As the message formats are not uniform across protocols, we measured the number of bytes transmitted instead of the number of messages transmitted.

•**Number of transmitted and received bytes:**Average number of transmitted and received bytes by all the nodes in the network for finding the target information.

•**Energy consumed:** The total energy consumed by all the nodes in the network for finding the target information.

•**Latency:** Time taken to find the target information, i.e., the time difference between, the time at which the search is initiated by the sink node by transmitting the search packet, and the time at which the search packet is received by the target node.

•**Probability of finding the target information**:Probability of finding the target information is a measure of the success probability of

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the search protocols. It is also a measure of non determinism of the search protocols.

4.Method of Reducing Power Consumption(WSN)

A method for reducing power consumption in a wireless sensor network is provided. An optimized path destined for a sink node is set using a common channel in which first and second nodes use a CSMA scheme. A first channel is set and transmission/reception slots for packet transmission/reception arc allocated in the first channel. A packet is transmitted to the second node through a first transmission slot using a TDMA scheme. When a packet is not received from the second node through a first reception slot within a first set amount of time, the first reception slot is allowed to transition to an inactive state. The first node is one of the sink node, at least one parent node, and at least one child node of the parent node, and the second node is one of child nodes of the first node.

3.Sampling energy consumption in wireless sensor networks

Knowing available energy in each part of a wireless sensor networks (WSN) is undoubtedly essential information. A simple approach to achieve this would be for sensor nodes to periodically report to the sink node on their available energy. This approach is expensive however in terms of energy consumption. In this work we apply several sampling techniques for obtaining such information in WSNs. The results show our samples are representative and the energy map may be satisfactorily built using information from a single subgroup of nodes hence leading to important energy savings

Software components embedded in wireless sensors are generally elaborated taking into account the limited available resources. Operating systems dedicated to the Wireless Sensor Networks (WSN) were thus developed. However, this design method can induce major problems if resource management policies associated to each software component are very different or opposite. The aim is to develop a global method in order to manage the energy consumption of the WSN.

The first goal of this post-doc is to develop an energetic model of wireless sensor in order to virtually test various policies of management. If some generic models exist at the level of the energy consumption of the communication medium, models dedicated to the energy consumption of the memory and the processor are not or poorly addressed in the literature. Some complete models already exist but are only dedicated to a specific hardware architecture of wireless sensor. It highlights the need of a model that can be applied to various wireless sensors. This model will be used in a WSN platform jointly developed by the Cemagref and the LIMOS laboratory of Clermont-Ferrand.

The second objective is to establish optimal action policies for a given sensor. Thus, a wireless sensor can be seen as a system that we would try to optimize the use of its resources such as energy, memory and computing power. The application of the viability theory to the energy management problem will be also studied during this year. The viability theory consists in maintaining a system in a space of constraints (for example, to maintain a frequency of sending between a minimal value and a maximum value). To do that, a control is defined on which one can act and, which allows us to maintain this system into a space of constraints. Thus the management of a wireless sensor can be done thanks to the use of control techniques such as viability. Some recommendations or policies applicable to a wireless sensor would be defined in order to achieve a lifetime long enough while performing assigned tasks. Some simulations will be done before an implementation into a real system. Finally, this work will be extended to the case of the whole WSN at the end of the post-doc.Salary: nearly 2000 euros per month.

An Energy-Efficient Routing Method of Wireless Sensor Networks

In wireless sensor networks(WSNs), as sensor nodes are characterized by having specific requirements such as limited energy availability, low memory and reduced processing power, energy efficiency is a key issue in designing the network routing. In the existing clustering-based routing protocols for the WSNs, the cluster-heads are usually selected randomly and do a lot of work, which may cause unbalanced energy consumption and thus short network lifetime. Based on this approach, the paper proposes a method that a cluster-head distributes energy load evenly among its members based on their energy usage by chain. With the chain, in a cluster, different cycle. The new method balances the nodes' power depletion. Simulation results show that it has better power management performance and can prolong the lifetime of the network.

4.OPTIMIZATION OF ENERGY CONSUMPTION IN WIRELESS SENSOR NETWORKS

Multiple antenna systems are capable of providing high data rate transmissions in a fading environment without the need of increasing the signal bandwidth. This suggests the question whether they can be used to reduce the energy consumption inwireless networks. Before addressing this problem, we must first understand the problem of minimizing transmit powerssubject to some SIR requirements. In fact, note that for a fixed transmit time *TA*, a fixed number

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of antennas *N* and fixed beam formers U(*k*),V(*k*) at each transmitter-receiver pair, the problem of energy minimization subject to the SIR requirements is equivalent to minimizing transmit powers subject to the same SIR requirements.

5.CONCLUSIONS

In wireless networks, a widely studied approach is to minimize transmit powers subject to some QoS constraints. However, minimizing the transmit powers is not equivalent to minimizing the energy consumption. In this paper we addressed the problem of minimizing the overall energy consumption in wireless networks including the energy consumption for hardware. Therefore, we first pointed out some basic properties of the optimal power allocation. In order to give some insights, we then discussed the general energy minimization problem that depends on system parameters as the number of antennas *N*, on the transmission strategy represented by beam formers and number of parallel data streams and on transmit powers. Due to the fact that the general problem is quite complex we focused on a restricted problem. Considering the relation between transmission time and transmit power, we optimized both jointly to find an energy-optimal power-time tradeoff. More precisely, we proposed an algorithm that determines the energy-optimal number of data streams per link for a certain SIR requirement. To gain further insights into the energy minimization problem, it has to be considered for assumptions that may be more general or give another perspective on the problem. Further, note that the notion of energy minimization is not restricted to sensor networks. Thus, in future work the optimization problemmay also include other aims and constraints.

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A Robust H∞ Speed Tracking Controller for Underwater Vehicles via Particle Swarm Optimization

Mohammad Pourmahmood Aghababa, Mohammd Esmaeel Akbari

Abstract— This paper presents an H_∞ controller designing method for robust speed tracking of underwater vehicles, using Particle Swarm Optimization (PSO). Nonlinearity mapping of the underwater vehicles model to a nominal linear model, by employing a linear controller for a nonlinear model, is one of the main contributions of this paper. For reaching the linear H_∞ controller, the nonlinear models linearized around an operating point. Both nonlinear and linearized models are discussed. A brief explanation of H_∞ synthesis is given. Also frequency dependent weighting functions are used for penalizing tracking errors, setpoint commands and measured outputs noises using PSO. Obtained controller is reduced order to achieve a lower order controller. After simulating the reduced order H_∞ controller it is embedded into the nonlinear model. By nonlinear simulations, robustness and efficient performance of the H_∞ controller is shown. Control efforts of actuators revealed no saturation, therefore it is feasible to implement.

Index Terms— H_∞ controller, underwater vehicles, particle swarm optimization, robustness.

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1 Introduction

In the past two decades, underwater vehicles have become an intense area of oceanic researches because of their emerging applications, such as scientific inspection of deep sea, exploitation of underwater resources, long range survey, oceanographic mapping, underwater pipelines tracking and so on. Developing a control system that can achieve the aforementioned goal is challenging for a variety of reasons such as: the nonlinearity of the dynamics, the multivariable character of the vehicle with coupling among different channels, the consistent amount of uncertainty due to the lack of precise knowledge of hydrodynamic drag coefficients and evaluation of external disturbance due to environmental interaction.

Several control techniques have been proposed in literature to deal with uncertainty. Sliding mode controller for trajectory control of underwater vehicles, neglecting the cross coupling terms, is proposed in [2]. Multivariable sliding mode control for diving, steering and speed control of underwater vehicles with decoupled design is used in [3].

An H_∞ autopilot for subzero II that had two sub-controllers, the longitudinal controller for the forward speed and depth, and the lateral controller for the heading angle is presented in [4]. A reduced order H_∞ control that had three SISO decoupled controllers for the forward speed, heading angle and depth control was applied to subzero III in [5]. A time delay control law for robust trajectory control of underwater vehicles is proposed in [6].

In this paper, designing of an H_∞ controller for robust speed tracking is the major purpose. Position control cannot be performed without suitable speed tracking. Here, both linear and angular speeds are considered to be controlled. Using Particle Swarm Optimization (PSO), weighting functions, that capture the disturbance characteristics and performance requirements are selected to take advantage of H_∞ design algorithm.

For designing the speed controller, the nonlinear model is linearzed around an operating point. Afterwards, parameters changing mapped to the linear model as uncertainties. Weighted noises are also added to measured outputs. Then weighting functions for setpoint commands and tracking errors are obtained. It is assumed that all states can be measured by sensors, so that the state estimator is not necessary. After designing the H_∞ controller and order reduction, it is embedded to full nonlinear model. Tracking robustness and efficiency of the proposed controller is shown by nonlinear simulation. The required control efforts of thrusters are possible to realize.

The proposed method has the following characteristics: a) the problem of speed tracking is considered as a new work, b) designed controller is MIMO (Multi Input-Multi Output) without neglecting the cross coupling terms, c) the H_∞ controller is designed by using PSO, and d) the linear controller robustness is shown when it is embedded to the nonlinear model.

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The rest of this paper is preceded as follows. Section 2 presents the nonlinear and linearized motion equations of underwater vehicles. In Section 3, a general scheme of H_∞ control synthesis is firstly explained. Then, the main procedure of PSO method is given. In Section 4, an H_∞ controller is designed for speed tracking aim of the underwater vehicles and numerical simulations are performed. Finally, some conclusions are given in section 5.

2 Motion Equations and Dynamics of Underwater Vehicles

2.1 The Nonlinear Model of Underwater Vehicles

Throughout the marine robotics literature a vehicle's six degrees of freedom dynamic equations are expressed as [1]:

$$M\dot{v}+C(v)v+D(v)v+g(\eta)=\tau \tag{1}$$

$$\dot{\eta}=J(\eta)v \quad J(\eta)=diag\{J_1(\eta),J_2(\eta)\} \tag{2}$$

where s(.)=sin(.), c(.)=cos(.), t(.)=tan(.), η is the position and orientation of the vehicle in the Earth fixed frame, $\in R^{6\times1}$, v is linear and angular velocity of the vehicle in the body fixed frame, $\in R^{6\times1}$, M is the inertia matrix including added mass, $\in R^{6\times6}$, C(v) is a matrix consisting Coriolis and centripetal terms, $\in R^{6\times6}$, D(v) is a matrix consisting damping or drag terms, $\in R^{6\times6}$, $g(\eta)$ is the vector of restoring forces and moments due to gravity and buoyancy, $\in R^{6\times1}$, and τ is the vector of forces and moments of propulsion, $\in R^{6\times1}$.The matrix $J(\eta)$ converts velocity in a body fixed frame, v, to velocity in an earth fixed frame, $\dot{\eta}$, as shown in Fig. 1. In fact $J_1(\eta)$ and $J_2(\eta)$ convert linear and angular velocities in a body fixed frame, v, to velocities in an earth fixed frame, $\dot{\eta}$, respectively. A detailed derivation of these nonlinear equations of motion can be found in [1]. Below a small summary of the modeled phenomena is given.

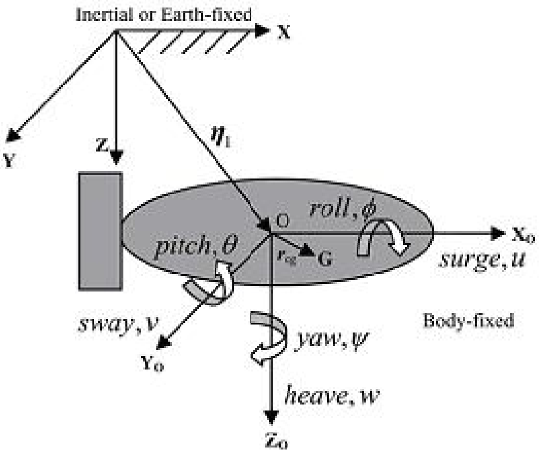

Fig. 1. Inertial and body coordinate frames

1) Mass and Inertia, M: In matrix M, two inertial components are accounted for [1],

$M=M_{RB}+M_A$, $M=M^T$, $M>0$ (3)

The rigid body inertial matrix, M_{RB}, represents the mass and inertia terms due to the mass and other physical characteristics of the craft. However in a dense medium such as water, a considerable contribution to the mass originates from the medium. This so called added mass is accounted for by the matrix M_A.

2) Coriolis and Centripetal forces, C(v): For matrix C(x), a similar discourse can be held. Both the coriolis and centripetal forces are forces that are proportional to mass and inertia. Hence, the matrix consists of two matrices:

$$C(v)=C_{RB}(v)+C_A(v) \quad C_{RB}=-C_{RB}^T \tag{4}$$

where C_{RB} represents forces and moments due to the mass and physical characteristics of the craft, C_A(x) incorporates the terms originating from the added mass.

3) Damping terms, D(v): In the damping matrix, D(x), four terms are combined [1]:

$D(x)=D_p+D_s(x)+D_w+D_M(x)$ (5)

where D_p is the potential damping, $D_s(x)$ is linear and quadratic skin friction, D_w is wave drift damping and $D_M(x)$ is damping due to vortex shedding.

Potential damping is introduced due to forces on the body when the latter is forced to oscillate. Skin friction effects can be shown to constitute both a linear and a quadratic term. Wave drift damping only plays a major role at the surface where it can be interpreted as added resistance due to incoming waves. Damping due to vortex shedding is a result of the non-conservative nature of a moving system in water with respect to energy. The viscous damping force due to this phenomenon is a function of the relative velocity of the craft, its physical characteristics and the density and viscosity of the water.

4) Gravitation and Buoyancy, $g(\eta)$: This term models the restoring forces which result from gravitation and buoyancy.

5) Thruster model, τ: Usually, propellers are used as propulsion devices for underwater vehicles. The load torque Q from the propeller, and the thrust force T, are then usually written as [1]:

$$Q=\rho D^5 K_Q(J_\circ)|n|n\ ,\ T=\rho D^4 K_T(J_0)|n|n \tag{6}$$

where n is rotational velocity of the thruster, ρ is the mass density of water, D is the diameter of the propeller, K_Q and K_T are the torque and the thrust coefficients of the propeller, and J_0 is the advance ratio.

In this paper, the thrusters are assumed to be driven by DC motors. DC motors are usually controlled by velocity feedback. It is assumed that six propellers are erected in six freedom degrees. Therefore, n_i will be the physical input related to thruster number i. It can be also shown that an algebraic relation exists between the thrust of propeller i and the physical input. Therefore, the thrust will be chosen as input in the model $u_i = T_i$.

2.2 The Linearzed Model for Underwater Vehicles

The nonlinear speed system of the underwater vehicles can be described in state space form by defining a six dimensional state vector x=(u, v, w, p, q, r) as follows.

$$\dot{x}=f(x)+Bu,\ u=\tau \tag{7}$$

$$f(x)=M^{-1}(-C(x)-D(x)-g(\eta)),\ B=-M^{-1} \tag{8}$$

For a linear controller design, it is necessary to extract the linearzed model from the nonlinear model around a representative operating point. In this paper, the nominal value of rotational speed of the propellers is considered 100 rpm. Using this assumption, the operating point is

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obtained:

x_0=(1, 1, 1, 1, 1, 1) (9)

The linearized model is:

$$\Delta\dot{x} = A\Delta x + B\Delta u,\ \ \Delta y = C\Delta x$$

$$x = [u, v, w, p, q, r]^T,\ u = [\tau_1, \tau_2, \tau_3, \tau_4, \tau_5, \tau_6]$$

$$y = [u, v, w, p, q, r]^T \qquad (10)$$

where A and B are 6× 6 matrices and C is a 6×1 vector, τ_i i=1, 2, ..., 6 are the propeller forces, explained in the previous section. [u, v, w] and [p, q, r] are the linear and angular speeds of the underwater vehicle in a body fixed coordinate system, respectively.

The step response of linearized model is shown in Fig. 2. As seen in this figure, the step response is not tracked and system modes are not decoupled.

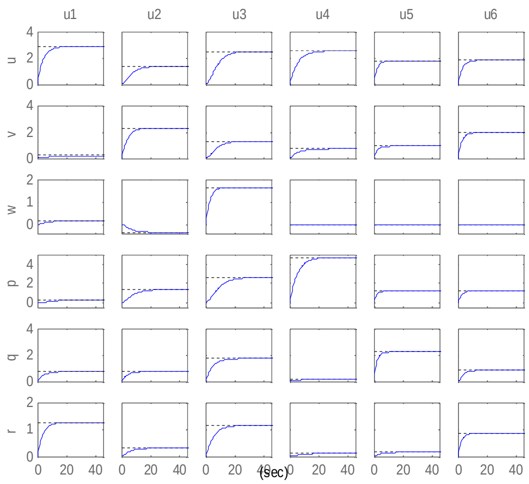

Fig. 2. Step response of open loop linear model

3 Methodologies

3.1 H∞ Synthesis Approach

Figure 3 shows a tracking problem, with disturbance rejection, measurement noise, and control input signal limitations. K is a controller to be designed, G is the system, as nonlinearity uncertainties modeled, to be controlled and W_{noise}, W_{cmd} and W_{perf} are weighting functions for sensor noises, setpoint commands and tracking errors, respectively. A reasonable design objective would be to design K to keep tracking errors and control input signal small for all reasonable reference commands, sensor noises, and external force disturbances.

Hence, a natural performance objective is the closed loop gain from exogenous influences (reference commands, sensor noise, and external force disturbances) to regulated variables (tracking errors and control input signal). Specifically, let T denote the closed loop mapping from the outside influences to the regulated variables. Good performance is associated with T being small. The mathematical objective of H∞ control is to make the closed loop MIMO transfer function T_{ed} to satisfy $||T_{ed}||_\infty<1$. The weighting functions are used to scale the input/output transfer functions such that when $||T_{ed}||_\infty <$ 1, the relationship between e and d is suitable.

Without lack of generality, a mathematical overview of H∞ synthesis is as follows. Figure 4 shows a standard feedback system, where w is the input vector of exogenous signals, e is the output vector of errors to be reduced, y is the vector of measurements that are available for feedback and u is the vector of external force signals. Let T_{ew} denote the closed loop transfer matrix from w to e. The H∞ synthesis problem is to find, among all controllers that yield a stable closed loop system, a controller K that minimizes the infinity norm $||T_{ed}||_\infty$. Throughout this paper we assume that all states are available for measurement, that is, y equals the internal state of the generalized plant P.

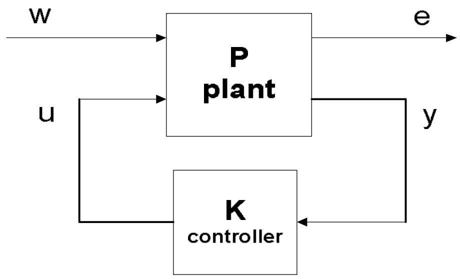

Fig. 4. Standard feedback configuration

Suppose that a state space realization for P can be written as

$$\dot{x} = C_1 x + B_1 w + B_2 u \qquad (11)$$

$$e = C_1 x + D_{12} u,\ y = x \qquad (12)$$

and assume that (A, B_2) is stabilizable, D_{12} has independent columns and the system with input u and output e has no zeros on the imaginary axis.

Theorem. Suppose $\gamma > 0$ is a given positive number. Let $H(\gamma) = \begin{bmatrix} H_{11} & H_{12} \\ H_{21} & H_{22} \end{bmatrix}$ denote the Hamiltonian matrix with entries

$H_{11}=A-B_2(D_{12}^TD_{12})^{-1}D_{12}^TC_1$

$H_{12}=\gamma^{-2}B_1B_1^T-B_2(D_{12}^TD_{12})^{-1}B_2^T$

$H_{21}=-C_1^T(I-D_{12}(D_{12}^TD_{12})^{-1}D_{12}^T)C_1$

$H_{22}=-A^T+C_1^TD_{12}(D_{12}^TD_{12})^{-1}B_2^T$ (13)

Then, there exists a stabilizing controller K such that $||T_{ed}||_\infty < \gamma$ if and only if: i) $H(\gamma)$ has no eigenvalues on the imaginary axis and there exist a basis for the spectral subspace X-$H(\gamma)$ of $H(\gamma)$ of the form [X_1^T, X_2^T] where X_1 and X_2 are square matrices of appropriate di-

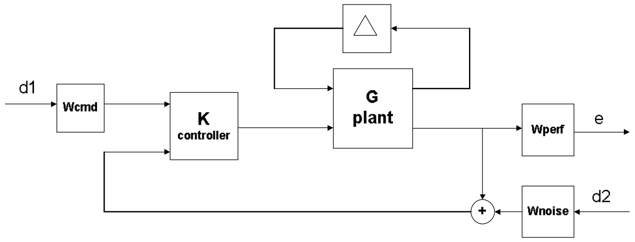

Fig. 3. Generalized Performance Block Diagram

mensions and X_1 is invertible. ii) $X(\gamma)=X_2X_1^{-1}$ is positive

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semi definite. In this case, one such controller is K(s) = F, where

$F=-(D_{12}^T D_{12})^{-1}[D_{12}^T C_1+B_2^T X(\gamma)]$ (14)

Existence and computation of $X(\gamma)$ is a standard matrix algebra problem that can be solved using a standard technique for solving Riccati equations based on the real Schur decomposition [9].

3.2 Particle Swarm Optimization

A particle swarm optimizer is a population based stochastic optimization algorithm modeled after the simulation of the social behavior of bird flocks. PSO is similar to genetic algorithm (GA) in the sense that both approaches are population-based and each individual has a fitness function. Furthermore, the adjustments of the individuals in PSO are relatively similar to the arithmetic crossover operator used in GA. However, PSO is influenced by the simulation of social behavior rather than the survival of the fittest. Another major difference is that, in PSO each individual benefits from its history whereas no such mechanism exists in GA. In a PSO system, a swarm of individuals (called particles) fly through the search space. Each particle represents a candidate solution to the optimization problem. The position of a particle is influenced by the best position visited by itself (i.e. its own experience) and the position of the best particle in its neighborhood. When the neighborhood of a particle is the entire swarm, the best position in the neighborhood is referred to as the global best particle and the resulting algorithm is referred to as a gbest PSO. When smaller neighborhoods are used, the algorithm is generally referred to as a lbest PSO. The performance of each particle (i.e. how much close the particle is to the global optimum) is measured using a fitness function that varies depending on the optimization problem.

The global optimizing model proposed by Shi and Eberhart [7] is as follows:

$$v_{i+1} = w \times v_i + RAND \times c_1 \times (P_{best} - x_i) + rand \times c_2 \times (G_{best} - x_i) \quad (15)$$

$$x_{i+1} = x_i + v_{i+1} \quad (16)$$

where v_i is the velocity of particle i, x_i is the particle position, w is the inertial weight. c_1 and c_2 are the positive constant parameters, Rand and rand are the random functions in the range [0,1], Pbest is the best position of the i^{th} particle and Gbest is the best position among all particles in the swarm.

The inertia weight term, w, serves as a memory of previous velocities. The inertia weight controls the impact of the previous velocity: a large inertia weight favors exploration, while a small inertia weight favors exploitation [7]. As such, global search starts with a large weight and then decreases with time to favor local search over global search [7].

It is noted that the second term in equation (15) represents cognition, or the private thinking of the particle when comparing its current position to its own best. The third term in equation (15), on the other hand, represents the social collaboration among the particles, which compares a particle's current position to that of the best particle [8]. Also, to control the change of particles' velocities, upper and lower bounds for velocity change is limited to a user-specified value of Vmax. Once the new position of a particle is calculated using equation (16), the particle, then, flies towards it [7]. As such, the main parameters used in the PSO technique are: the population size (number of birds); number of generation cycles; the maximum change of a particle velocity Vmax and w.

Generally, the basic PSO procedure works as follows: the process is initialized with a group of random particles (solutions). The i^{th} particle is represented by its position as a point in search space. Throughout the process, each particle moves about the cost surface with a velocity. Then the particles update their velocities and positions based on the best solutions. This process continues until stop condition(s) is satisfied (e.g. a sufficiently good solution has been found or the maximum number of iterations has been reached).

4 H_∞ CONTROLLER DESIGNING PROCEDURE

4.1 Weight Selection and Building Model Uncertainty

To take advantage of H_∞ design algorithm, we formulate the design as a closed loop gain minimization problem. So we select weighting functions that capture the disturbance characteristics and performance requirements to help normalize the corresponding frequency dependent gain constraints.

W_{cmd} is included in H_∞ control problems that require tracking of a reference command. W_{cmd} shapes the normalized reference command signals into the reference signals that we expect to occur. It describes the magnitude and the frequency dependence of the reference commands generated by the normalized reference signal. Reference commands for underwater vehicles linear and angular speeds are usually flat. This means that underwater vehicle speed does not change frequently and has no high oscillations. Therefore, W_{cmd}, is selected equal to

$$W_{cmd} = \frac{A}{s+B} \quad (17)$$

where A and B are two constants that are determined using PSO.

W_{perf} weights the difference between the response of the closed loop system and the ideal model. Often we might want accurate matching of the ideal model at low frequencies and require less accurate matching at higher frequencies, in which case W_{perf} is flat at low frequencies, rolls off at first or second order, and flattens out at a small, nonzero value at high frequencies. Therefore, the error weights penalize setpoint tracking errors on u, v, w, p, q and r. Hence, W_{perf} is considered as follows, for all of

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them.

$$W_{perf} = \frac{C}{s+D} + E \quad (18)$$

as A and B; C, D and E are three constants that are found using PSO.

W_{noise} represents frequency domain models of sensor noise. Each sensor measurement feedback to the controller has some noise, which is often higher in one frequency range than another. The weighting function for the sensors would be small at low frequencies, gradually increase in magnitude as a first order or second order system, and level out at high frequencies. Then a high pass filter is selected for weighting functions of measured states.

$$W_{noise} = \frac{Fs}{s+G} \quad (19)$$

where F and G constants are found by PSO.

To complete the uncertainty model, changing of the underwater vehicle speeds due to vehicle parameters changing, that can be produced by hydrodynamic drag coefficients and propellers rotational speeds and external disturbance, should be considered in controller designing procedure. In this paper it performed by evaluating the underwater vehicle nonlinear behavior, when the mentioned vehicle parameters are changed reasonably, and mapping it to the linear model. Therefore, we will build an uncertainty model that matches our estimate of uncertainty in the physical system as closely as possible. Because the amount of the model uncertainty or variability typically depends on frequency, our uncertainty model involves frequency-dependent weighting functions to normalize modeling errors across frequency. The following frequency dependent weighting function for both linear and angular speeds is chosen.

$$W_{uncertainty} = \frac{Hs+I}{s+J} \quad (20)$$

where H, I and J constants are computed by PSO.

4.2 H∞ Controller Design and Simulation results

Now that all plant components, as illustrated in Figure 3, are described and nonlinearity uncertainties and the weighting functions are constructed. We can design a desired H∞ controller. By using *sysic* function of MATLAB Robust Control Toolbox, the weighted uncertain model is built. Nonlinearity uncertainties are modeled by using *ultidyn* function.

The weighting functions unknown parameters are computed using PSO. Therefore, minimizing a cost function, determining the vector P=[A, B, C, D, E, F, G, H, I, J] is the main purpose. For doing this, a performance index as a cost function- that should be minimized- must be selected. The performance criterion is defined based on some typical desired output specifications in the time domain such as overshoot M_p, rise time T_r, settling time T_s, and steady-state error E_{ss}. Therefore, in this paper, a time domain performance criterion defined by

$$\min_{K_{Q,R}} F(P) = \sum_{i=1}^{6}\sum_{j=1}^{6}\Big[\left(1-e^{-\alpha}\right)\times\left(T_{sij}+T_{rij}\right) + e^{-\alpha}\left(M_{pij}+E_{ssij}\right)\Big] \quad (21)$$

is used for evaluating the H∞ controller performance.

where M_{pij} is the maximum overshoot, T_{sij} is the settling time, T_{rij} is the rise time and E_{sij} is the integral absolute error of step response (i, j=1, 2, …, 6). Note that desired steady state of diagonal modes of the system (i.e. i=j) is 1 while for non-diagonal modes (i.e. i≠j) it is desired to be 0.

$\alpha \in [0,4]$ is the weighting factor. The optimum selection of α depends on the designer's requirement and the characteristics of the plant under control. We can set α to be smaller than 0.7 to reduce the overshoot and steady-state error. On the other hand, we can set α to be larger than 0.7 to reduce the rise time and settling time. If α is set to 0.7, then all performance criteria (i.e. overshoot, rise time, settling time, and steady-state error) will have the same worth.

The minimization process is performed using PSO algorithm. Step response of the plant is used to compute four performance criteria M_p, E_{ss}, T_r and T_s in the time domain. At first, the lower and upper bounds of the parameters are specified. Then a population of particles and a velocity vector are initialized, randomly in the specified range. Each particle represents a solution (i.e. weighting functions parameters P) that its performance criterion should be evaluated. This work is performed by computing M_p, E_{ss}, T_r, and T_s using the step response of the plant, iteratively. Then, by using the four computed parameters, the performance criterion is evaluated for each particle according. Then using equations (15) and (16) the next likely better particles (solutions) are determined. This process is repeated until a stopping condition is satisfied. In this stage, the particle corresponding to G_{best} is the optimal vector P. The optimal P is obtained as P=[0.15, 1.23, 98.47, 0.95, 0.11, 0.2, 1.51, 5.73, 1.29, 10.33].

After constructing the weights and the weighted plant, we have recast the control problem as a closed loop gain minimization. A gain minimizing controller for the uncertain plant can be computed by using *hinfsyn* function. By using this function, the desired H∞ controller (K in Figure 3) is obtained. The obtained controller has 12 inputs (plant noisy outputs and weighted setpoint commands), 6 outputs for control forces of the plant, and 18 states, with nominal performance $\gamma_{\min} = 0.65$. For model order reduction, *modred* and *balreal* commands are used. Small Henkel singular values indicate that the associated states are weakly coupled. With discarding these negligible Henkel singular values, the controller order is reduced to 11. Figure 5 shows the reduced order H∞ controller behavior (step response), when it is engaged with the linear plant. As illustrated in this figure, the H∞ controller can control the vehicle to track the desired speeds, efficiently.

To assess the behavior of the designed H∞ controller, it is embedded to the full nonlinear model of the underwa-

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ter vehicle as described in section 2.1 to form a closed loop system. Simulations are implemented in MATLAB Simulink. By the step response, the speed tracking quality is examined. Figure 6 shows the robust behavior of the designed controller against the nonlinearity of the nonlinear model. As shown in this figure, when a step is simultaneously commanded to the actuators, the proposed H∞

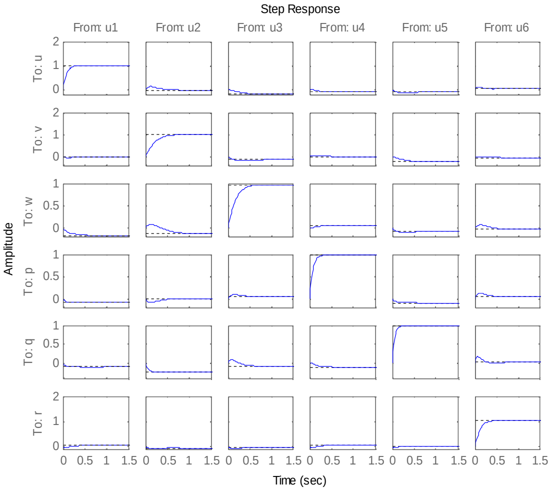

Fig. 5. Step response of linear model with reduced order H∞ controller

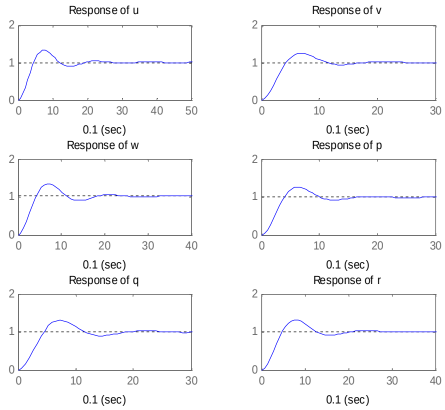

Fig. 6. Step response of the reduced order H∞ controller integrated in the nonlinear model

controller can follow the signal with small errors. Furthermore, steady state and amplitude errors are desirably

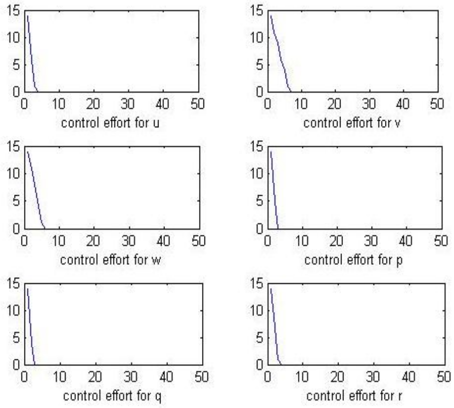

Fig. 7. Control efforts of the H∞ controller embedded into the linear plant, (time unit is 0.1s)

small. This means that the designed controller can behave robustly against to the nonlinearities.

Figures 7 and 8 show the control efforts of the H∞ controller with the linearized and the nonlinear models, respectively. As illustrated in the figures, the control effort of actuators reveals no saturation and so it is feasible to implement.

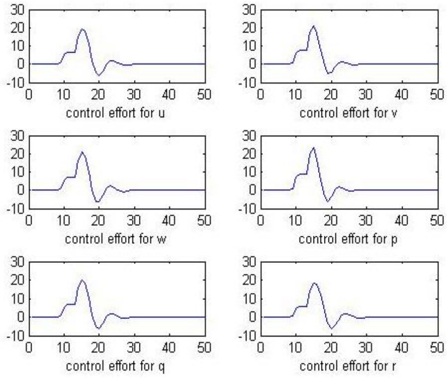

Fig. 8. Control efforts of the H∞ controller embedded into the nonlinear plant, (time unit is 0.1s)

5 Conclusions

A robust H∞ controller for underwater vehicles speed tracking is introduced, in this paper. Nonlinearity of nonlinear model is mapped onto the nominal linear model as uncertainties. Using frequency dependent weighting functions that are determined by PSO, tracking errors and noise errors are eliminated, robustly. The designed controller order is reduced. Using nonlinear simulations, robust behavior of the proposed controller is shown. The actuator control efforts were at the suitable rang for implementation. The future work can focus on control of underwater vehicles using nonlinear methods hybrid with intelligent techniques.

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Crank-Nicolson Scheme for Numerical Solutions of Two-dimensional Coupled Burgers' Equations

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Abstract— The two-dimensional Burgers' equation is a mathematical model to describe various kinds of phenomena such as turbulence and viscous fluid. In this paper, Crank-Nicolson finite-difference method is used to handle such problem. The proposed scheme forms a system of nonlinear algebraic difference equations to be solved at each time step. To linearize the non-linear system of equations, Newton's method is used. The obtained linear system is then solved by Gauss elimination with partial pivoting. The proposed scheme is unconditionally stable and second order accurate in both space and time. Numerical results are compared with those of exact solutions and other available results for different values of Reynolds number. The proposed method can be easily implemented for solving nonlinear problems evolving in several branches of engineering and science.

Index Terms — Burgers' equations; Crank-Nicolson scheme; finite- difference; Newton's method; Reynolds number.

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1 INTRODUCTION

THE nonlinear coupled Burgers' equation is a special form of incompressible Navier-Stokes equation without having pressure term and continuity equation. Burgers' equation is an important partial differential equation from fluid dynamics, and is widely used for various physical applications, such as modeling of gas dynamics and traffic flow, shock waves [1], investigating the shallow water waves[2,3], in examining the chemical reaction-diffusion model of Brusselator[4] etc. It is also used to test several numerical algorithms. The first attempt to solve Burgers' equation analytically was given by Bateman [5], who derived the steady solution for a simple one-dimensional Burgers' equation, which was used by J.M. Burger in [6] to model turbulence. In the past several years, numerical solution to one-dimensional Burgers' equation and system of multidimensional Burgers' equations have attracted a lot of attention and which has resulted in various finite-difference, finite-element and boundary element methods. Finite difference methods can be classified in two broad categories, i.e. explicit and implicit. Chabak and Sharma [7] have executed the solution of two dimensional coupled wave eqution explicitly.

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An implicit approach has been utilized for solving two dimensional coupled Burgers' equations. Since in this paper the focus is numerical solutions of the two-dimensional Burgers' equations, a detailed survey of the numerical schemes for solving the one-dimensional Burgers' equation is not necessary. Interested readers can refer to [8-14] for more details.

Consider two-dimensional coupled nonlinear Burgers' equations

$$\frac{\partial u}{\partial t}+u\frac{\partial u}{\partial x}+v\frac{\partial u}{\partial y}-\frac{1}{\mathrm{Re}}\left(\frac{\partial^2 u}{\partial x^2}+\frac{\partial^2 u}{\partial y^2}\right)=0, \qquad (1)$$

$$\frac{\partial v}{\partial t}+u\frac{\partial v}{\partial x}+v\frac{\partial v}{\partial y}-\frac{1}{\mathrm{Re}}\left(\frac{\partial^2 v}{\partial x^2}+\frac{\partial^2 v}{\partial y^2}\right)=0, \qquad (2)$$

subject to the initial conditions

$$u(x,y,0)=\psi_1(x,y);\ (x,y)\in\Omega,$$
$$v(x,y,0)=\psi_2(x,y);\ (x,y)\in\Omega,$$

and boundary conditions

$$u(x,y,t)=\xi(x,y,t);\ (x,y)\in\partial\Omega,\ t>0,$$
$$v(x,y,t)=\zeta(x,y,t);\ (x,y)\in\partial\Omega,\ t>0,$$

Where $\Omega=\{(x,y): a\le x\le b,\ c\le y\le d\}$ and $\partial\Omega$ is its boundary; $u(x,y,t)$ and $v(x,y,t)$ are the velocity components to be determined, ψ_1,ψ_2, ξ and ζ are known functions and Re is the Reynolds number.

The analytic solution of eqns. (1) and (2) was proposed by

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Fletcher using the Hopf-Cole transformation [15]. The numerical solutions of this system of equations have been solved by many researchers. Jain and Holla [16] developed two algorithms based on cubic spline method. Fletcher [17] has discussed the comparison of a number of different numerical approaches.Wubs and Goede [18] have applied an explicit–implicit method. Goyon [19] used several multilevel schemes with ADI. Recently A. R. Bahadır [20] has applied a fully implicit method.
In this paper, Crank-Nicolson finite-difference scheme is used for solving two-dimensional coupled nonlinear Burgers' equations. Two numerical examples have been carried out and their results are presented to illustrate the efficiency of the proposed method.

2 The Solution procedure

The computational domain Ω is discretized with uniform grid. Denote the discrete approximation of $u(x,y,t)$ and $v(x,y,t)$ at the grid point $(i\Delta x, j\Delta y, n\Delta t)$ by $u_{i,j}^{n}$ and $v_{i,j}^{n}$ respectively $(i=0,1,2......,n_x;\ j=0,1,2.....,n_y;\ n=0,1,2......)$, where $\Delta x = 1/n_x$ is the grid size in x-direction, $\Delta y = 1/n_y$ is the grid size in y-direction, and k represents the increment in time.
Crank-Nicolson finite-difference approximation to (1) is given by

$$\frac{u_{i,j}^{n+1}-u_{i,j}^{n}}{\Delta t}+\frac{1}{2}[\ u_{i,j}^{n+1}(\frac{u_{i+1,j}^{n+1}-u_{i-1,j}^{n+1}}{2\Delta x})+u_{i,j}^{n}(\frac{u_{i+1,j}^{n}-u_{i-1,j}^{n}}{2\Delta x})\ ]$$
$$+\frac{1}{2}[\ \mathrm{v}_{i,j}^{n+1}(\frac{u_{i,j+1}^{n+1}-u_{i,j-1}^{n+1}}{2\Delta y})+v_{i,j}^{n}(\frac{u_{i,j+1}^{n}-u_{i,j-1}^{n}}{2\Delta y})\ ]$$
$$-\frac{1}{\mathrm{Re}}[\frac{1}{2}\{(\frac{u_{i+1,j}^{n+1}-2u_{i,j}^{n+1}+u_{i-1,j}^{n+1}}{(\Delta x)^2})+(\frac{u_{i+1,j}^{n}-2u_{i,j}^{n}+u_{i-1,j}^{n}}{(\Delta x)^2})\}$$
$$+\frac{1}{2}\{(\frac{u_{i,j+1}^{n+1}-2u_{i,j}^{n+1}+u_{i,j-1}^{n+1}}{(\Delta y)^2})+(\frac{u_{i,j+1}^{n}-2u_{i,j}^{n}+u_{i,j-1}^{n}}{(\Delta y)^2})\}]=0$$

Similarly, Crank-Nicolson approximation to (2) is given by

$$\frac{v_{i,j}^{n+1}-v_{i,j}^{n}}{\Delta t}+\frac{1}{2}[\ u_{i,j}^{n+1}(\frac{v_{i+1,j}^{n+1}-v_{i-1,j}^{n+1}}{2\Delta x})+u_{i,j}^{n}(\frac{v_{i+1,j}^{n}-v_{i-1,j}^{n}}{2\Delta x})\ ]$$
$$+\frac{1}{2}[\ \mathrm{v}_{i,j}^{n+1}(\frac{v_{i,j+1}^{n+1}-v_{i,j-1}^{n+1}}{2\Delta y})+v_{i,j}^{n}(\frac{v_{i,j+1}^{n}-v_{i,j-1}^{n}}{2\Delta y})\ ]$$
$$-\frac{1}{\mathrm{Re}}[\frac{1}{2}\{(\frac{v_{i+1,j}^{n+1}-2v_{i,j}^{n+1}+v_{i-1,j}^{n+1}}{(\Delta x)^2})+(\frac{v_{i+1,j}^{n}-2v_{i,j}^{n}+v_{i-1,j}^{n}}{(\Delta x)^2})\}$$
$$+\frac{1}{2}\{(\frac{v_{i,j+1}^{n+1}-2v_{i,j}^{n+1}+v_{i,j-1}^{n+1}}{(\Delta y)^2})+(\frac{v_{i,j+1}^{n}-2v_{i,j}^{n}+v_{i,j-1}^{n}}{(\Delta y)^2})\}]=0$$

Consider the above nonlinear system of equations in the form

$$\Theta(w) = 0, \qquad (3)$$

Where,

$$\Theta = (g_1, g_2, ..., g_{2n})^t,$$
$$w = (u_1^{n+1}, v_1^{n+1}, u_2^{n+1}, v_2^{n+1}, ..., u_n^{n+1}, v_n^{n+1}),$$

and $n = n_x - 1 = n_y - 1$. Newton's method when it is applied to (3) results in the following steps:

1. set $w^{(0)}$, an initial approximation.
2. while for $k = 0,1,.......$ until convergence do:
   - solve $J(w^{(k)})\Delta w^{(k)} = -\Theta(w^{(k)})$,
   - set $w^{(k+1)} = w^{(k)} + \Delta w^{(k)}$,

Where $J(w^{(k)})$ is the Jacobian matrix and $\Delta w^{(k)}$ is the correction vector. It is a $n\times n$ square matrix whose elements are blocks of size 2×2. Newton's iteration at each time-step is stopped when $\|\Theta(w^{(k)})\|_\infty \le 10^{-5}$.
By using Taylor's series expansion one can easily see that the present scheme has accuracy of order $\mathrm{O}((\Delta t)^2+(\Delta x)^2+(\Delta y)^2)$.

3 Numerical Examples and Discussion

3.1 Problem 1

The exact solutions of Burgers' equations (1) and (2) can be generated by using the Hopf–Cole transformation [13] which are:

$$u(x,y,t) = \frac{3}{4} - \frac{1}{4[1+\exp(\ (-4x+4y-t)\mathrm{Re}/32\ )]},$$
$$v(x,y,t) = \frac{3}{4} + \frac{1}{4[1+\exp(\ (-4x+4y-t)\mathrm{Re}/32\ )]},$$

Here the computational domain is taken as a square domain $\Omega = \{(x,y): 0 \le x \le 1, 0 \le y \le 1\}$. The initial and boundary conditions for $u(x,y,t)$ and $v(x,y,t)$ are taken from the analytical solutions. The numerical computations are performed using uniform grid, with a mesh width $\Delta x = \Delta y = 0.05$. From Tables 1-10, it is clear that the results from the present study are in good agreement with the exact solution for different values of Reynolds number. From Tables 1-10, it is also clear that that the present scheme is unconditionally stable as it is accurate for any time step-size. Perspective views of u and v for $\mathrm{Re}=500$ at $t=0.5$ with $\Delta t = 0.001$ are given in Figs. 1 and 2.

3.2 Problem 2.

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Here the computational domain is taken as $\Omega = \{(x, y): 0 \le x \le 0.5, 0 \le y \le 0.5\}$ and Burgers' equations (1) and (2) are taken with the initial conditions,

$$\left.\begin{aligned} u(x,y,0) &= \sin(\pi x) + \cos(\pi y) \\ v(x,y,0) &= x + y \end{aligned}\right\} \; 0 \le x \le 0.5, \; 0 \le y \le 0.5,$$

and boundary conditions,

$$\left.\begin{aligned} u(0,y,t) &= \cos(\pi y), \quad u(0.5,y,t) = 1 + \cos(\pi y) \\ v(0,y,t) &= y, \qquad\quad v(0.5,y,t) = 0.5 + y \end{aligned}\right\} \; 0 \le y \le 0.5, \; t \ge 0,$$

$$\left.\begin{aligned} u(x,0,t) &= 1 + \sin(\pi x), \quad u(x,0.5,t) = \sin(\pi x) \\ v(x,0,t) &= x, \qquad\qquad v(x,0.5,t) = x + 0.5 \end{aligned}\right\} \; 0 \le x \le 0.5, \; t \ge 0,$$

The numerical computations are performed using 20×20 grids and $\Delta t = 0.0001$. The steady state solutions for $\mathrm{Re} = 50$ and $\mathrm{Re} = 500$ are obtained at $t = 0.625$. Perspective views of u and v for $\mathrm{Re} = 50$ at $\Delta t = 0.0001$ are given in Fig.s 3 and 4. The results given in Tables 11- 14 demonstrate that the proposed scheme achieves similar results given by [16,20].

Table 1
The numerical results for u in comparison with the exact solution at $t = 0.5$ and $t = 2$ with $\Delta t = 0.0001$, and $\mathrm{Re} = 10$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	0.61525	0.61525	0.58716	0.58716
(0.5, 0.1)	0.58540	0.58540	0.56129	0.56127
(0.9, 0.1)	0.56062	0.55984	0.54330	0.54113
(0.3, 0.3)	0.61526	0.61525	0.58718	0.58716
(0.7, 0.3)	0.58555	0.58540	0.56188	0.56127
(0.1, 0.5)	0.64628	0.64628	0.61721	0.61720
(0.5, 0.5)	0.61529	0.61525	0.58738	0.58716
(0.9, 0.5)	0.58707	0.58540	0.56654	0.56127
(0.3, 0.7)	0.64638	0.64628	0.61771	0.61720
(0.7, 0.7)	0.61562	0.61525	0.58900	0.58716
(0.1, 0.9)	0.67557	0.67481	0.65097	0.64817
(0.5, 0.9)	0.64773	0.64628	0.62264	0.61720
(0.9, 0. 9)	0.61802	0.61525	0.59642	0.58716

Table 2
The numerical results for v in comparion with the exact solution at $t = 0.5$ and $t = 2$ with $\Delta t = 0.0001$, and $\mathrm{Re} = 10$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	0.88475	0.88475	0.91284	0.91284
(0.5, 0.1)	0.91460	0.91460	0.93871	0.93873
(0.9, 0.1)	0.93938	0.94016	0.95670	0.95887
(0.3, 0.3)	0.88474	0.88475	0.91283	0.91284
(0.7, 0.3)	0.91445	0.91460	0.93812	0.93873
(0.1, 0.5)	0.85372	0.85373	0.88279	0.88280
(0.5, 0.5)	0.88471	0.88475	0.91262	0.91284
(0.9, 0.5)	0.91293	0.91460	0.93346	0.93873
(0.3, 0.7)	0.85362	0.85373	0.88229	0.88280
(0.7, 0.7)	0.88437	0.88475	0.91101	0.91284
(0.1, 0.9)	0.82443	0.82519	0.84903	0.85183
(0.5, 0.9)	0.85227	0.85373	0.87736	0.88280
(0.9, 0.9)	0.88198	0.88475	0.90358	0.91284

Table 3
The numerical results for u in comparison with the exact solution at $t = 0.5$ and $t = 2$ with $\Delta t = 0.0001$, and $\mathrm{Re} = 100$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	0.54300	0.54332	0.500470	0.50048
(0.5, 0.1)	0.50034	0.50035	0.500003	0.50000
(0.9, 0.1)	0.50000	0.50000	0.500000	0.50000
(0.3, 0.3)	0.54269	0.54332	0.500441	0.50048
(0.7, 0.3)	0.50032	0.50035	0.500003	0.50000
(0.1, 0.5)	0.74215	0.74221	0.555151	0.55568
(0.5, 0.5)	0.54250	0.54332	0.500415	0.50048
(0.9, 0.5)	0.50030	0.50035	0.500014	0.50000
(0.3, 0.7)	0.74212	0.74221	0.554811	0.55568
(0.7, 0.7)	0.54246	0.54332	0.500683	0.50048
(0.1, 0.9)	0.74995	0.74995	0.744215	0.74426
(0.5, 0.9)	0.74213	0.74221	0.559802	0.55568
(0.9, 0.9)	0.54640	0.54332	0.513409	0.50048

Table 4
The numerical results for v in comparison with the exact solution at $t = 0.5$ and $t = 2$ with $\Delta t = 0.0001$, and $\mathrm{Re} = 100$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	0.95700	0.95668	0.99953	0.99952
(0.5, 0.1)	0.99966	0.99965	1.00000	1.00000
(0.9, 0.1)	1.00000	1.00000	1.00000	1.00000
(0.3, 0.3)	0.95731	0.95668	0.99956	0.99952
(0.7, 0.3)	0.99968	0.99965	1.00000	1.00000
(0.1, 0.5)	0.75785	0.75779	0.94485	0.94433
(0.5, 0.5)	0.95750	0.95668	0.99959	0.99952
(0.9, 0.5)	0.99970	0.99965	0.99999	1.00000
(0.3, 0.7)	0.75789	0.75779	0.94519	0.94433
(0.7, 0.7)	0.95754	0.95668	0.99932	0.99952
(0.1, 0.9)	0.75006	0.75005	0.75579	0.75574
(0.5, 0.9)	0.75787	0.75779	0.94020	0.94433
(0.9, 0.9)	0.95360	0.95668	0.98659	0.99952

Table 5
The numerical results for u in comparison with the exact solution at $t = 0.5$ and $t = 2$ with $\Delta t = 0.0001$, and $\mathrm{Re} = 500$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	0.48732	0.50010	0.49725	0.50000
(0.5, 0.1)	0.50002	0.50000	0.50024	0.50000
(0.9, 0.1)	0.50000	0.50000	0.49932	0.50000
(0.3, 0.3)	0.49531	0.50010	0.50687	0.50000
(0.7, 0.3)	0.50001	0.50000	0.49929	0.50000
(0.1, 0.5)	0.74990	0.75000	0.43945	0.50048
(0.5, 0.5)	0.49438	0.50010	0.49958	0.50000

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(0.9, 0.5)	0.49977	0.50000	0.51378	0.50000
(0.3, 0.7)	0.75001	0.75000	0.41654	0.50048
(0.7, 0.7)	0.49323	0.50010	0.51054	0.50000
(0.1, 0.9)	0.75000	0.75000	0.75003	0.75000
(0.5, 0.9)	0.75001	0.75000	0.42895	0.50048
(0.9, 0.9)	0.47390	0.50010	0.56293	0.50000

Table 6
The numerical results for v in comparison with the exact solution at $t=0.5$ and $t=2$ with $\Delta t = 0.0001$, and $\mathrm{Re} = 500$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	1.01268	0.99990	1.00276	1.00000
(0.5, 0.1)	0.99999	1.00000	0.99975	1.00000
(0.9, 0.1)	1.00000	1.00000	1.00068	1.00000
(0.3, 0.3)	1.00469	0.99990	0.99313	1.00000
(0.7, 0.3)	0.99999	1.00000	1.00072	1.00000
(0.1, 0.5)	0.75010	0.75000	1.06055	0.99952
(0.5, 0.5)	1.00562	0.99990	1.00041	1.00000
(0.9, 0.5)	1.00023	1.00000	0.98622	1.00000
(0.3, 0.7)	0.74999	0.75000	1.08346	0.99952
(0.7, 0.7)	1.00677	0.99990	0.98946	1.00000
(0.1, 0.9)	0.75000	0.75000	0.74997	0.75000
(0.5, 0.9)	0.74999	0.75000	1.07105	0.99952
(0.9, 0.9)	1.02610	0.99990	0.93707	1.00000

Table 7
The numerical values for u in comparison with the exact solution at $t=0.5$ and $t=2$ with $\Delta t = 0.001$, and $\mathrm{Re} = 500$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	0.48732	0.50010	0.49725	0.50000
(0.5, 0.1)	0.50002	0.50000	0.50025	0.50000
(0.9, 0.1)	0.50000	0.50000	0.49932	0.50000
(0.3, 0.3)	0.49531	0.50010	0.50687	0.50000
(0.7, 0.3)	0.50001	0.50000	0.49929	0.50000
(0.1, 0.5)	0.74990	0.75000	0.43945	0.50048
(0.5, 0.5)	0.49438	0.50010	0.49959	0.50000
(0.9, 0.5)	0.49977	0.50000	0.51376	0.50000
(0.3, 0.7)	0.75001	0.75000	0.41654	0.50048
(0.7, 0.7)	0.49324	0.50010	0.51050	0.50000
(0.1, 0.9)	0.75000	0.75000	0.75003	0.75000
(0.5, 0.9)	0.75001	0.75000	0.42895	0.50048
(0.9, 0.9)	0.47380	0.50010	0.56293	0.50000

Table 8
The numerical values for v in comparison with the exact solution at $t=0.5$ and $t=2$ with $\Delta t = 0.001$, and $\mathrm{Re} = 500$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	1.01286	0.99990	1.00276	1.00000
(0.5, 0.1)	1.00000	1.00000	0.99976	1.00000
(0.9, 0.1)	1.00000	1.00000	1.00068	1.00000
(0.3, 0.3)	1.00481	0.99990	0.99313	1.00000
(0.7, 0.3)	0.99999	1.00000	1.00072	1.00000
(0.1, 0.5)	0.75010	0.75000	1.06055	0.99952
(0.5, 0.5)	1.00571	0.99990	1.00041	1.00000
(0.9, 0.5)	1.00022	1.00000	0.98624	1.00000
(0.3, 0.7)	0.74999	0.75000	1.08346	0.99952
(0.7, 0.7)	1.00676	0.99990	0.98950	1.00000
(0.1, 0.9)	0.75000	0.75000	0.74997	0.75000
(0.5, 0.9)	0.74999	0.75000	1.07105	0.99952
(0.9, 0.9)	1.02620	0.99990	0.93707	1.00000

Table 9
The numerical values for u in comparison with the exact solution at $t=0.5$ and $t=2$ with $\Delta t = 0.01$, and $\mathrm{Re} = 500$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	0.48714	0.50010	0.49729	0.50000
(0.5, 0.1)	0.50002	0.50000	0.50024	0.50000
(0.9, 0.1)	0.50000	0.50000	0.49934	0.50000
(0.3, 0.3)	0.49519	0.50010	0.50690	0.50000
(0.7, 0.3)	0.50001	0.50000	0.49928	0.50000
(0.1, 0.5)	0.74990	0.75000	0.43939	0.50048
(0.5, 0.5)	0.49429	0.50010	0.49951	0.50000
(0.9, 0.5)	0.49978	0.50000	0.51355	0.50000
(0.3, 0.7)	0.75001	0.75000	0.41647	0.50048
(0.7, 0.7)	0.49325	0.50010	0.51008	0.50000
(0.1, 0.9)	0.75000	0.75000	0.75004	0.75000
(0.5, 0.9)	0.75001	0.75000	0.42909	0.50048
(0.9, 0.9)	0.47275	0.50010	0.56275	0.50000

Table 10
The numerical values for v in comparison with the exact solution at $t=0.5$ and $t=2$ with $\Delta t = 0.01$, and $\mathrm{Re} = 500$.

(x, y)	t=0.5		t=2	
	Numerical	**Exact**	**Numerical**	**Exact**
(0.1, 0.1)	1.01286	0.99990	1.00271	1.00000
(0.5, 0.1)	0.99999	1.00000	0.99976	1.00000
(0.9, 0.1)	1.00000	1.00000	1.00066	1.00000
(0.3, 0.3)	1.00481	0.99990	0.99310	1.00000
(0.7, 0.3)	0.99999	1.00000	1.00072	1.00000
(0.1, 0.5)	0.75010	0.75000	1.06061	0.99952
(0.5, 0.5)	1.00571	0.99990	1.00049	1.00000
(0.9, 0.5)	1.00022	1.00000	0.98646	1.00000
(0.3, 0.7)	0.74999	0.75000	1.08353	0.99952
(0.7, 0.7)	1.00676	0.99990	0.98992	1.00000
(0.1, 0.9)	0.75000	0.75000	0.74996	0.75000
(0.5, 0.9)	0.74999	0.75000	1.07091	0.99952
(0.9, 0.9)	1.02725	0.99990	0.93725	1.00000

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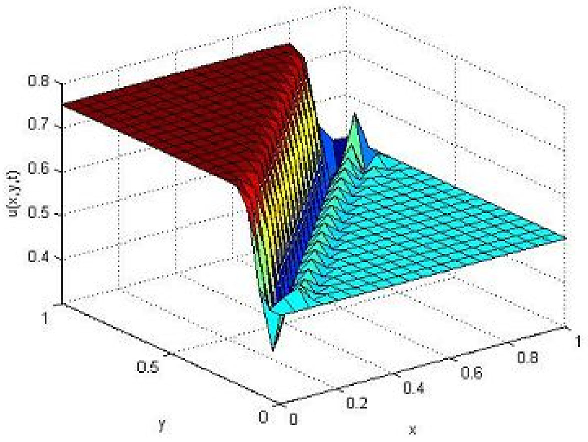

Fig.1.The numerical value of u for $\mathrm{Re} = 500$ at time level $t = 0.5$ with $\Delta t = 0.001$.

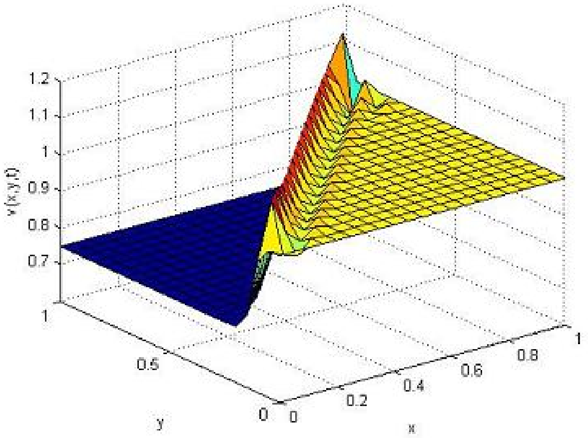

Fig.2.The numerical value of v for $\mathrm{Re} = 500$ at time level $t = 0.5$ with $\Delta t = 0.001$.

Table 11
Comparison of computed values of u for $\mathrm{Re} = 50$ at $t = 0.625$.

(x, y)	Computed values of u		
	Present work	A.R.Bahadir	Jain and Holla
	N=20	N=20	N=20
(0.1, 0.1)	0.97146	0.96688	0.97258
(0.3, 0.1)	1.15280	1.14827	1.16214
(0.2, 0.2)	0.86307	0.85911	0.86281
(0.4, 0.2)	0.97981	0.97637	0.96483
(0.1, 0.3)	0.66316	0.66019	0.66318
(0.3, 0.3)	0.77230	0.76932	0.77030
(0.2, 0.4)	0.58180	0.57966	0.58070
(0.4, 0.4)	0.75856	0.75678	0.74435

Table 12
Comparison of computed values of v for Re =50 at $t = 0.625$

(x, y)	Computed values of v		
	Present work	A.R.Bahadir	Jain and Holla
	N=20	N=20	N=20
(0.1, 0.1)	0.09869	0.09824	0.09773
(0.3, 0.1)	0.14158	0.14112	0.14039
(0.2, 0.2)	0.16754	0.16681	0.16660
(0.4, 0.2)	0.17110	0.17065	0.17397
(0.1, 0.3)	0.26378	0.26261	0.26294
(0.3, 0.3)	0.22654	0.22576	0.22463
(0.2, 0.4)	0.32851	0.32745	0.32402
(0.4, 0.4)	0.32500	0.32441	0.31822

Table 13
Comparison of computed values of u for Re =500 at $t = 0.625$.

(x, y)	Computed values of u		
	Present work	A.R.Bahadir	Jain and Holla
	N=20	N=20	N=20
(0.15, 0.1)	0.96870	0.96650	0.95691
(0.3, 0.1)	1.03200	1.02970	0.95616
(0.1, 0.2)	0.86178	0.84449	0.84257
(0.2, 0.2)	0.87814	0.87631	0.86399
(0.1, 0.3)	0.67920	0.67809	0.67667
(0.3, 0.3)	0.79947	0.79792	0.76876
(0.15, 0.4)	0.66036	0.54601	0.54408
(0.2, 0.4)	0.58959	0.58874	0.58778

Table 14
Comparison of computed values of v for $\mathrm{Re} = 500$ at $t = 0.625$.

(x, y)	Computed values of v		
	Present work	A.R.Bahadir	Jain and Holla
	N=20	N=20	N=20
(0.15, 0.1)	0.09043	0.09020	0.10177
(0.3, 0.1)	0.10728	0.10690	0.13287
(0.1, 0.2)	0.17295	0.17972	0.18503
(0.2, 0.2)	0.16816	0.16777	0.18169
(0.1, 0.3)	0.26268	0.26222	0.26560
(0.3, 0.3)	0.23550	0.23497	0.25142
(0.15, 0.4)	0.29019	0.31753	0.32084
(0.2, 0.4)	0.30419	0.30371	0.30927

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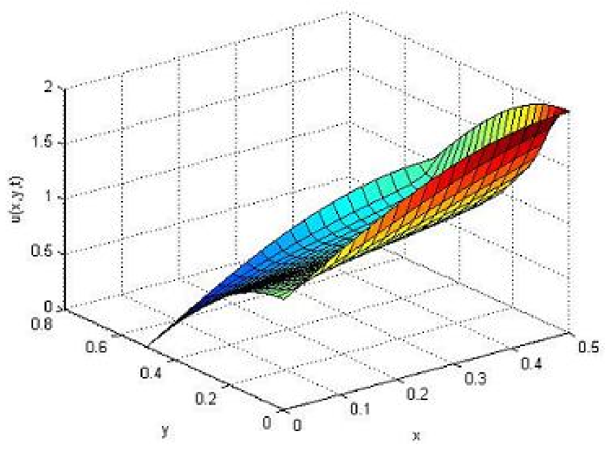

Fig.3.The computed value of u for $\mathrm{Re}=50$ at time level $t=0.625$.

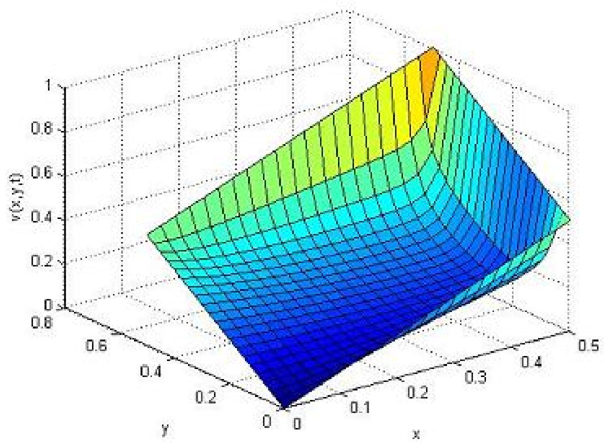

Fig.4.The computed value of v for $\mathrm{Re}=50$ at time level $t=0.625$.

4 Conclusion

Crank-Nicolson finite-difference method for two-dimensional coupled nonlinear viscous Burgers' equations has been presented.The advantage of the proposed method is that it is second order accurate in space and time. The efficiency and numerical accuracy of the present scheme are validated through two numerical examples. The test examples show that the present scheme is unconditionally stable as there is no constraint on time step-size. Numerical results are compared well with those from the exact solutions and previous available results.

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Implementation of Adaptive Modulation and Coding Technique using

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Abstract—Different order modulations combined with different coding schemes, allow sending more bits per symbol, thus achieving higher throughputs and better spectral efficiencies. However, it must also be noted that when using a modulation technique such as 64-QAM with less overhead bits, better signal-to-noise ratios (SNRs) are needed to overcome any Intersymbol Interference (ISI) and maintain a certain bit error ratio (BER). The use of adaptive modulation allows wireless technologies to yielding higher throughputs while also covering long distances. The aim of this paper is to implement an Adaptive Modulation and Coding (AMC) features of the WiMAX and LTE access layer using SDR technologies in Matlab. This papper focusing on the physical layer design (i.e. Modulation), here the various used modulation type will be implemented in a single Matlab function that can be called with the appropriate coefficients. A comparison with the hardware approaches will be made in terms of SNR vs. BER relation.

Index Terms—. Adaptive Modulation and Coding (AMC), Cognitive Radio (CR), LTE, Software Defined Radio (SDR), WiMAX.

1 Introduction

The growth in the use of the information networks lead to the need for new communication networks with higher data rates. The telecommunication industry is also changing, with a demand for a greater range of services, such as video conferences, or applications with multimedia contents. The increased reliance on computer networking and the Internet has resulted in a wider demand for connectivity to be provided "any where, any time", leading to a rise in the requirements for higher capacity and high reliability broadband wireless access Broadband wireless Access (BWA) telecommunication systems.

BWA intensively focused in the last few years. Thus, various new technologies with high transmission abilities have been designed. The BWA has become the best way to meet escalating business demand for rapid Internet connection and integrated "triple play" services. That is the very base of the HSPA, WiMAX, and LTE concept: a wireless transmission infrastructure that allows a fast deployment as well as low maintenance costs.

The emergent demand of all types of services, not only voice and data but also multimedia services, aims for the design of increasingly more intelligent and agile communication systems, capable of providing spectrally efficient and flexible data rate access. These systems are able to adapt and adjust the transmission parameters based on the link quality, improving the spectrum efficiency of the system, and reaching, in this way, the capacity limits of the underlying wireless channel.

Link adaptation techniques, often referred to as adaptive modulation and coding (AMC), are a good way for reaching the cited requirements. They are designed to track the channel variations, thus changing the modulation and coding scheme to yield a higher throughput by transmitting with high information rates under favorable channel conditions and reducing the information rate in response to channel degradation.

2 BWA Development Roadmap

2.1 Preface

The current WiMAX revision is based upon IEEE802.16e-2005, approved in December 2005. It is a supplement to the IEEE802.16-2004. [1] Thus, IEEE 802.16e-2005 improves by:

– Adding support for mobility
– Scaling of the Fast Fourier transform (FFT) to the channel bandwidth in order to keep the carrier spacing constant across different channel bandwidths (typically 1.25 MHz, 5 MHz, 10 MHz or 20 MHz
– Advanced antenna diversity schemes, and hybrid automatic repeat-request (HARQ)
– Adaptive Antenna Systems (AAS) and MIMO technology
– Denser sub-channelization, thereby improving indoor penetration
– Introducing Turbo Coding and Low-Density Parity Check (LDPC)
– Introducing downlink sub-channelization, allowing administrators to trade coverage for capacity or vice versa
– Adding an extra QoS class for real time applications

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In the other hand, Long Term Evolution (LTE) is the latest standard in the 3rd Generation Partnership Project (3GPP), mobile network technology tree that produced the GSM/EDGE and UMTS/HSPA network technologies.[1][2]

The LTE specification provides downlink peak rates of at least 100 Mbps, an uplink of at least 50 Mbps and RAN round-trip times of less than 10 ms. LTE supports scalable carrier bandwidths, from 1.4 MHz to 20 MHz and supports both frequency division duplexing (FDD) and time division duplexing (TDD).

The main advantages with LTE are high throughput, low latency, plug and play, FDD and TDD in the same platform, an improved end-user experience and a simple architecture resulting in low operating costs. LTE will also support seamless passing to cell towers with older network technology such as GSM, cdmaOne, UMTS, and CDMA2000. The next step for LTE evolution is LTE Advanced and is currently being standardized in 3GPP Release 10. [3]

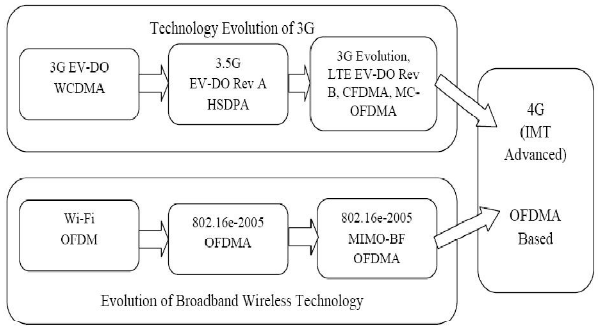

Fig. 1. BWA System Development.

The most important similarity between LTE and WiMAX is orthogonal frequency division multiplex (OFDM) signaling. Both technologies also employ Viterbi and turbo accelerators for forward error correction. From a chip designer's perspective, that makes the extensive reuse of gates highly likely if one had to support both schemes in the same chip or chip-set. From a software defined radio (SDR) perspective, the opportunity is even more enticing. Flexibility, gate reuse and programmability seem to be the answers to the WiMAX-LTE multimode challenge.

2.2 Hypothesis of AMC

In traditional communication systems, the transmission is designed for the "worst case" channel scenario thus, coping with the channel variations and still delivering an error rate below a specific limit. Adaptive transmission schemes, however, are designed to track the channel quality by adapting the channel throughput to the actual channel state. These techniques take advantage of the time-varying nature of the wireless channel to vary the transmitted power level, symbol rate, coding scheme, constellation size, or any combination of these parameters, with the purpose of improving the link average spectral efficiency (bits/s/Hz).

3 System Design

3.1 Preface

Most BWA support variety of modulation and coding schemes and allows for the scheme to change on a burst-by-burst basis per link, depending on channel conditions. Current systems contains separate hardware channel for each Modulation/Coding scheme. The more intelligent approach is to design single soft defined circuit for BPSK, QPSK, 16QAM, and 64QAM based on SDR then design a cognitive engine (CE) to determine which profile to load and operate. Following is a list of the various modulation and coding schemes supported by WiMAX and LTE.

Both WiMAX and LTE support a variety of modulation and coding schemes and allows for the scheme to change on a burst-by-burst basis per link, depending on channel conditions. Using the channel quality feedback indicator, the mobile can provide the base station with feedback on the downlink channel quality. For the uplink, the base station can estimate the channel quality, based on the received signal quality.

For example, when a user gets closer to a cell site, the number of channels will increase and the modulation can also change to increase bandwidth. At longer ranges, modulations like QPSK (which offer robust links but lower bandwidth) can give way at shorter ranges to 64 QAM (which are more sensitive links, but offer much higher bandwidth). Each subscriber is linked to a number of subchannels that obviate multi-path interference. The upshot

TABLE 1

MODULATION/CODING SCHEMES SUPPORTED BY WIMAX [1]

Modulation	RS Code	Note
BPSK	(12,12,0)	12 data in, 12 data out
QPSK	(32,24,4)	4 erroneous bytes
QPSK	(40,36,2)	2 erroneous bytes
16QAM	(64,48,8)	8 erroneous bytes
16QAM	(80,72,4)	4 erroneous bytes
64QAM	(108,96,6)	6 erroneous bytes
64QAM	(120,108,6)	6 erroneous bytes

is that cells should be much less sensitive to overload and cell size shrinkage during the load than before. Ideally, customers at any range should receive solid QoS without drops that 3G technology may experience.

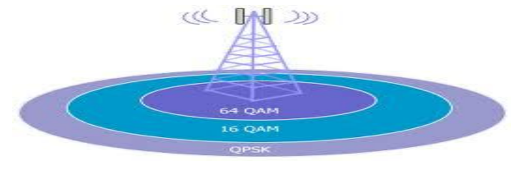

Fig. 2. AMC Cell

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3.2 System Architecture

3.2.1 Basic Wimax

The model for the WiMAX is build from the standard documents [1, 2] as follow;

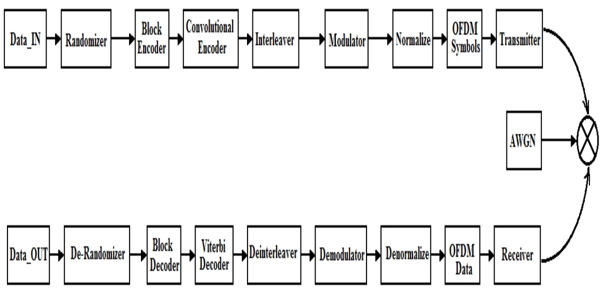

Fig. 3. BWA System Components

3.2.2 Cognitive Engin

When the basic system successfully built and tested, a cognitive engine (CE) must develop to automatically direct the SDR to load and execute the appropriate profile. The CE refer to predefined polices, while continuously sensing the channel situation. Then, perform its logic to pick up the suitable configuration to execute it in the SDR system.

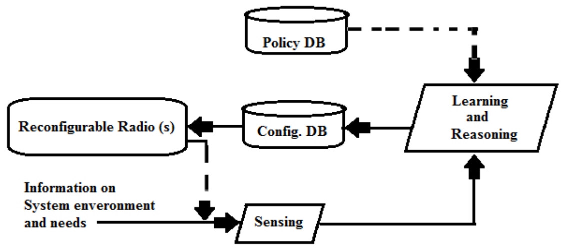

Fig. 4. Cognitive Mechanism

4 ADAPTIVE COMMUNICATION SYSTEM

4.1 AMC Architecture

The function of AMC is based on SDR-CR combination. The receiver evaluate received packets (i.e. SNR or BER) to estimate the Channel Quality Indictor (CQI) module, then feedback the transmitter to reconfigure itself for the next packet send.

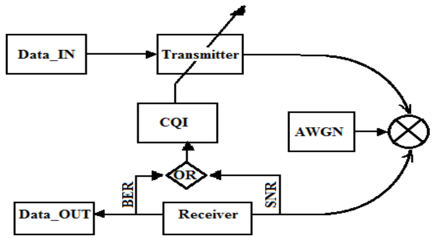

Fig. 5. Adaptive System

4.2 AMC System Performance

The performance of AMC highly depends on the accurate channel estimation at the receiver and the reliable feedback path between that estimator and the transmitter on which the receiver reports channel state information (CSI). In order to assure a high-quality implementation the next steps must be followed:

4.2.1 Channel Quality Estimation

The transmitter requires an estimate of the expected channel conditions for the next transmission interval. Since this knowledge can only be gained by prediction from past channel quality estimations, the adaptive system can only operate efficiently in an environment with relatively slowly-varying channel conditions. Therefore, the delay between the quality estimation and the actual transmission in relation to the maximal Doppler frequency of the channel is crucial for the system implementation since poor system performance will result if the channel estimate is obsolete at the time of transmission.

4.2.2 Parameter adaptation

The choice of the appropriate modulation and coding mode to be used in the next transmission is made by the transmitter, based on the prediction of the channel conditions for the next time interval. An SNR threshold such that it guarantees a BER below the target BER (BER0), is defined by the system for each scheme whenever the SNR is above the SNR threshold.

4.2.3 Feedback Mechanism

Once the receiver has estimated the channel SNR, converted it into BER information for each mode candidate, and, based on a target BER, selected the mode that yields the largest throughput while remaining within the BER target bounds, it has to feed back the selected mode to the transmitter in order that the adaptation can be performed.

However, the challenge associated with adaptive modulation and coding is that the mobile channel is time-varying, and thus, the feedback of the channel information becomes a limiting factor. Therefore, the assumption of a slowly-varying as well as a reliable feedback channel is necessary in order to achieve an accurate performance of the AMC scheme. In this way, no delay or transmission error can occur in the feedback channel so that no discrepancy between the predicted and the actual SNR of the next frame appears. Moreover, the receiver must also be informed of which demodulator and decoding parameters to employ for the next received packet.

5 SIMULATION RESULTS

5.1 Functionality

A single function the can give different modulation order from BPSK to M-QAM (M= 2n, where n = 2,4,6,...) implemented in Matlab. The function called with the modulation order and the SNR in dB as input, then its plot the constella-

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tion and calculates the BER.

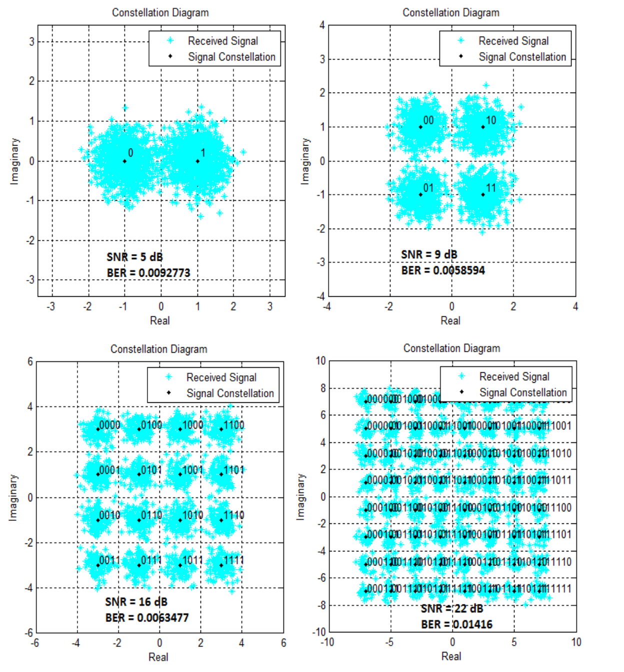

Fig. 4. AMC Constalation Diagrams

5.2 BER vs. SNR

BER is the number of error bits occurs within one second in transmitted signal. BER defined mathematically as follow;

$$\text{BER} = \frac{\text{Number of Bits with Error}}{\text{Total Number of Bits Transmited}} \quad (1)$$

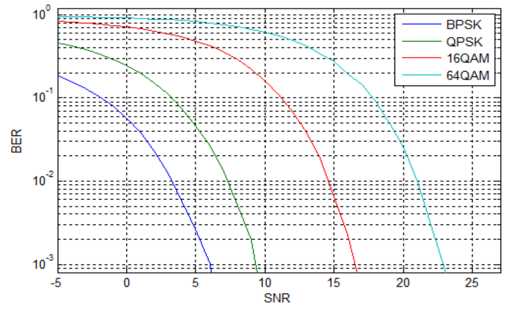

Fig. 4. Simulation BER vs. SNR

When the transmitter and receiver's medium are good in a particular time and Signal-to-Noise Ratio is high, and then Bit Error rate is very low. In our thesis simulation we generated random signal when noise occurs after that we got the value of Bit error rate.

$$\text{SNR} = \frac{\text{Signal Power}}{\text{Noise Power}} = \left(\frac{\text{Signal Amplitude}}{\text{Noise Amplitude}}\right)^2 \quad (2)$$

6 CONCLUSION

The function implemented in this paper demonstrates the ability of converge AMC concepts in a single Matlab file. Tests show that all measured can be compared with the hardware model in terms of functionality and system performance. This component can be reused against a defined standard, IEEE 802.1 6e, LTE, or other BWA. The second part of the paper (Part II) will implement other system component related to coding both for source and channel. In the future this model can be expanded to include the components of the upper layers and a complete end to end BWA system could be built.

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A QoS Based Web Service Selection Through Delegation

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Abstract- Service selection is essential for fulfilling the requirements of service requestors. In the service oriented environment, Quality of Services (QoS) is one of the utmost concerns for consumers during service selection. Existing web service standards do not undertake the QoS issue efficiently and the load balancing is not performed to the maximum degree. In this paper we propose a new architecture called the Delegation Web Service (DWS) for selecting the web service more efficiently and with maximum load balancing. The load balancing is achieved by grouping the web services of similar type from the registry by the DWS for each consumer's request and it is predestinated to each monitored web service. The monitoring of QoS parameters such as response time, efficiency, round trip time are done using the Web Service Distributed Management (WSDM) standard, since it has the better method and specifications.

Index Terms: Delegation Web Service, load balancing, Quality of Services, response time, Service selection, Service oriented architecture, WSDM

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1. INTRODUCTION

A Web service is a programmable Web application that is universally accessible through standard Internet protocols [1], such as Simple Object Access Protocol (SOAP). Web service technology is becoming more and more popular in many practical application domains, such as electronic commerce, flow management, application integration, etc. It presents a promising solution for solving platform interoperability problems encountered by the application system integrators.

With the ever increasing number of functional similar web services being made available on the Internet, how to distinguish the best Web service from others becomes an urgent problem to be solved. Web Service Selection is a key component in service-oriented architecture [2].

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The selection of web service is usually based on the functional requirements of the consumer but those web services may not able to provide the quality the consumer expects.

Consumer requirements may include not only functional aspects of very depends on the ability to describe and to match QoS offers and demands, in addition to functional capabilities [3], [4], [5], [6].The web services has to provide a good quality of service to the consumer. The Web Service Selection based on QoS parameters become the challenging task in current trend. Quality of Service is an aggregated metric for describing characteristics of systems in areas, such as networks and distributed systems. According to Liu Sha [7], QoS based web service selection mechanisms plays an essential role in service-oriented architectures, because most of the applications want to use services that accurately meet their requirements.

To overcome the above mentioned drawbacks of previous works, a new approach has been proposed which offers a better solution for implementing web service load balancing. It also reduces the complexity of the work in selecting a particular web service and provide less components compared to the previous selector approaches. In this proposed work, each similar type of web service has one Delegation Web Service and it is predestinated thereby we can

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solve the problem of load balancing. It also simplifies the architecture as well as the Delegation Web Service's interface. Moreover in this paper the manageability of resources can be performed efficiently. The standard called WSDM has been provided for the resource monitoring. WSDM includes Management using Web Services (MUWS) and Management of Web Services (MOWS). The MUWS and MOWS of the WSDM standards are used to monitor the QoS of each of those similar web services consumed by the Delegation Web Service. The availability of the web service has been checked by using Web Service Ping operation which is called as a diagnostic tool. With help of these standards the accuracy of the web service can be maintained greatly.

The remainder of this paper is outlined as follows: In section 2 we briefly present the framework to monitor the QoS parameters and also the processing states of the request , in Section 3 we present the related researches, in Section 4 we describe the Delegation Web Service (DWS) architecture's concepts and the selection process steps, in Section 5 the selection algorithm based on strategy pattern is discussed, in section 6 the process to balance the load is discussed, in section 7 the implementation and its results is discussed and Section 8 concludes the paper and presents the future work.

2. BACKGROUND

2.1 WSDM Framework

2.1.1 Framework Description

The WSDM standard specifies how the manageability of a resource is made available to manageability consumers via web services. Endpoints that support access to manageable resources are called manageability endpoints. The implementation behind manageability endpoints must be capable of retrieving and manipulating the information related to a manageable resource.

The focus of the WSDM architecture is the manageable resource. The manageable resource must be represented as a Web service. In other words, management information regarding the resource must be accessible through a web service endpoint**.** To provide access to a resource, this endpoint must be able to be referenced by an endpoint-reference (EPR). The EPR provides the target location to which a manageability consumer directs messages. The manageable resource may also direct notifications of significant events to a manageability consumer, provided the consumer has subscribed to receive notifications. Thus, WSDM covers three modes of interaction between a manageable resource and a manageability consumer. These modes of interaction are as follows:

- A manageability consumer can retrieve management information about the manageable resource. For example, the consumer can retrieve the current operating status of the manageable resource or the current state of the process running on the manageable resource.
- A manageability consumer may affect the state of some manageable resource by changing its management information.
- A manageable resource may inform, or notify, a manageability consumer of a significant event. This mode of interaction requires the manageability consumer to subscribe to receive events on a desired topic.

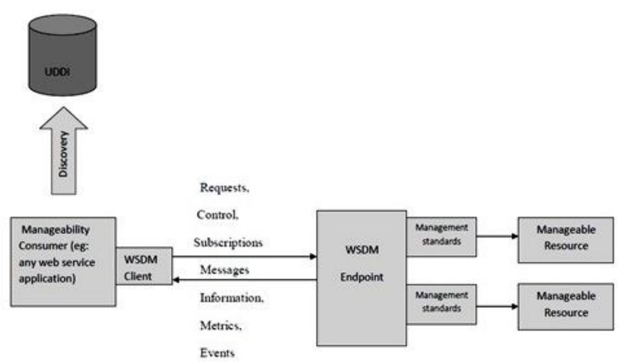

Fig. 1: WSDM Framework

2.2 WSDM SPECIFICATIONS

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WSDM consists of two specifications: Management of Web Service (MOWS) and Management using Web Service (MUWS).

WSDM-MUWS

MUWS enables management of distributed information technology (IT) resources using Web services. Many distributed IT resources use different management interfaces. By leveraging Web service technology, MUWS enables easier and more efficient management of IT resources. This is accomplished by providing a flexible, common framework for manageability interfaces that leverage key features of web services protocols. Universal management and interoperability across the many and various types of distributed IT resources can be achieved using MUWS.

The types of management capabilities exposed by MUWS are the management capabilities generally expected in systems that manage distributed IT resources. Examples of manageability functions that can be performed via MUWS include:

- monitoring the quality of a service
- enforcing a service level agreement
- controlling a task
- managing a resource lifecycle

WSDM-MOWS

MOWS provide mechanisms and methodologies that enable manageable web services applications to interoperate across enterprise and organizational boundaries. It is used to publish Web Service’s QoS parameters. WSDM's Management of Web Services specification extends MUWS to define how to specifically manage a resource that is a web service. Web services, like other resources, have identity, metrics, configuration, and other capabilities to enable management. For web services the compose-ability characteristic is especially interesting because it allows the business function of a service

and the management function for a service to be composed together into a single service.

2.3 REQUEST PROCESSING STATES

A web service endpoint accepts and processes messages targeted at it requests. Every request goes through a number of states (e.g. received, processing, completed or failed) as defined by the [WSLC] and extended here.

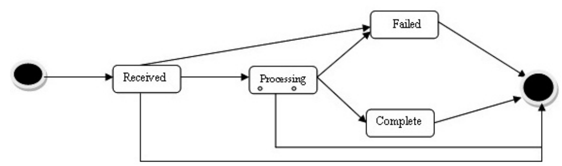

Fig. 2: Request processing states

Following is a list of elements corresponding to the top-level states of the request processing state model (Fig 2).

Request Received State

This element corresponds to the Received top-level state which means that the web service endpoint has accepted a request to perform one of the service's functional responsibilities. This state represents the earliest point at which the manageability provider knows that the request was dispatched to the web service endpoint being managed.

Request Processing State

This element corresponds to the Processing top-level state which means that the web service endpoint is doing some internal processing/execution to fulfill the requested function. This state represents the earliest point at which the application module or business logic begins processing the request. For example, if the application server queues the request before dispatching it to the business logic, the time difference between “request received” and “processing” will include the duration the request was queued.

Request Completed State

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This element corresponds to the Completed top-level state which means that the web service endpoint successfully completed requested function returning results to the requester.

Request Failed State

This element corresponds to the failed top-level state which means that the web service endpoint encountered an error and didn't complete the requested function, returning error/fault to the requester.

The RequestProcessingStateType XML Schema type is declared as follows.

```
<xs:complexType
name=”RequestProcessingStateType”>
<xs:complexContent>
<xs:extension base=”muws:StateType”/>
</xs:complexContent>
</xs:complexType>
```

An instance of the request processing state information represented in XML may appear as shown in the following example

```
<my:RequestProcessingStateInformationElement
xsi:type=”mows:RequestProcessingStateType”>
<my-soap:SerializationState>
<mows:RequestProcessingState/>
</my-soap:SerializationState>
</my:RequestProcessingStateInformationElement>
```

3. RELATED WORKS

According to Liu Sha [7], the Web service selection is usually driven only by functional requirements, which can’t guarantee the real-time validity of the web services selected. So he proposed a QoS based Web Services Selection Model (WSSM-Q) to provide QoS support for service publishing and selection. In the model, the QoS of web services is managed, including defining the QoS model, collecting the QoS information, computing and maintaining the QoS data. Upon the QoS management, the web services that match the requirements of consumers are ranked for selection according to the overall QoS utility. In [8], Web service architecture employs an extended UDDI registry to support service selection based on QoS, but only the certification approach is used to verify QoS and no information is provided about the QoS specification.

According to Diego Zuquim Guimarães Garcia and Maria Beatriz Felgar de Toledo [9], an extended web service architecture can be used to support QoS management. In this approach, QoS information derived from policies based on WS-Policy is encapsulated inside QoS Policy structures stored in UDDI registries. Each element of a QoS Policy structure can be associated with a Technical Model (tModel) structure, which allows specification, standardization and reuse of QoS-related concepts. Furthermore, the extension allows the use of brokers to facilitate service selection according to functional and non-functional requirements, and monitors to verify QoS attributes. According to S.Ran [10], a component called certifier and a new extension of UDDI is modeled. The certifier’s role is to verify service provider’s QoS claims and the new UDDI registry is a repository of registered web services with lookup facilities. The new registry differs from the current UDDI model by having information about the functional description of the web service as well as its associated quality of service registered in the repository. Lookup could be made by functional description of the desired web service, with the required quality of service attributes as lookup constraints. The new role in this model is the Web service QoS certifier that does not exist in the original UDDI model. The certifier verifies the claims of quality of service for a web service before its registration.

Y.Lee [11] introduces WSQMS (Web Service quality Management System) to measure QoS of web services. It further introduces WSQDL (Web Service Quality Description Language). It advocates the use of the QoS enhanced UDDI for web service selection. Tao Yu et al. [12] design the service selection algorithms to meet the end-to-end QoS constraints. Their works are not focused on the trustworthiness of QoS criteria of a service. Although the global quality constraints can be satisfied, service selection may not be locally optimized. Therefore, good component service

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often fails to exert its potential and embody its personality. The work was proposed in the reference [13], which presented a model of reputation-enhanced QoS-based web service discovery that combines an augmented UDDI registry to publish the QoS information and a reputation manager to assign reputation scores to services. However, it only described abstract service matchmaking, ranking and selection algorithm. The references [14], [15] introduces WS QoS (Web Service QoS), a framework for QoS based selection and monitoring of web services. It advocates the use of a Web Service Broker for QoS based web service selection. Frameworks to support QoS verification with the goal of guarantying quality levels are described in [16], [17], [18].

The works discussed above may have certain limitations and involves complexity in monitoring the QoS parameters efficiently and also the load balancing may not be provided to maximum degree. So a new approach has been proposed to overcome the limitations of the existing works.

4. DELEGATION WEB SERVICE ACHITECTURE

4.1 Concept

The new approach that is the Delegation Web Service as selector architecture is predestinated to implement web service load balancing. In this approach a Delegation Web Service for each web service type is made, as this simplifies the architecture as well as the Delegation Web Service's interface. However, one Delegation Web Service can also be used for multiple web service types. The Delegation Web Service does not implement any functional parts. It delegates the functional request to corresponding web services. This DWS is used to perform the load balancing factor in an efficient way by grouping all the similar web services requested by the consumer into its register module and there by assigning the priority value to all the grouped web services and it will use the particular web service with the highest priority value. In case if that particular service gets overloaded then immediately it will use the next service in the prioritized order from the register module of DWS. Moreover it will consume functional as well as non-functional parts from the used web services. Non-functional parts will include MOWS and web service Ping, as well as MUWS from multiple MUWS web services. The Delegation Web Service will then decide which web service it delegates to. The decision is based on the consumer's functional requirements and the non-functional requirement that is the QoS preferences.

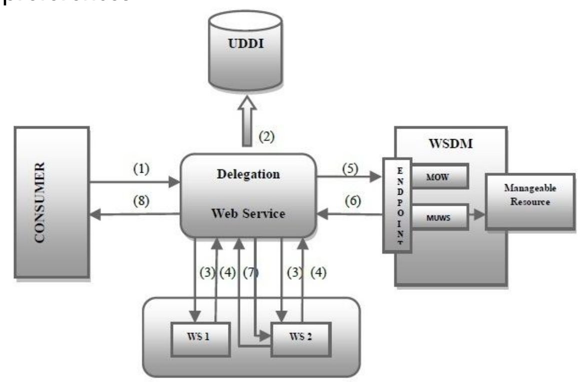

Fig. 3: Proposed Architecture

4.2 Selection Process Steps

Following are the steps to select the best Web Service using the Delegation Web Service:

(1) In step 1 the consumer requests the Delegation Web Service (DWS) for the best web service by giving the functional requirements along with the QoS preference.
(2) In step 2 the DWS look for similar web services according to the functional requirements of the consumer from the UDDI registry.
(3) In step 3 the DWS send the request to publish the QoS parameters of each web services.
(4) In step 4 the web services publish their QoS parameters to DWS.
(5) In step 5 DWS request the WSDM to monitor the QoS parameters of the consumer's preference of each web services by using the selection algorithm which is described below.
(6) In step 6 the WSDM response with the QoS metrics value and report the best Web Service.

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(7) In step 7 the request will be sent to the best web service that has been reported by the WSDM and that particular Web Service will then respond to the DWS.
(8) In step 8 the best web service meeting the requirement and the QoS preference will be sent to the consumer.

5. SELECTION ALGORITHM

Input: Web Services ($W_{I}, W_{I+1}\ldots\ldots W_n$) with QoS constraints

Output: Best performing Web Service W_k satisfying QoS constraints

Begin

DecisionContext → Best Web Service

//check for service identification

If W_i !□ S_L<Service List>

AddService(W_i) to S_L // adding service to the service list S_L

Assign W_i = {EPR, IP, EPRMUWS} // assigning endpoint reference, IP and the MUWS EPR to the added Web Service

While (ServiceList != empty) do

ServcieList→null throw

List is Empty Else

getstrategy(QoS) //Getting the QoS parameter to be monitored with the constraint

DecisionStrategy(QoS for all W_k (S_L)) // QoS monitoring of the Web Services in the list

Compare (Result (QoS (W_k (S_L)))) // To compare all the web services result of the QoS from the list

Select (W_k(S_L)) // Selecting the best Web Service

Return Best WebService(W_k) // returning the best web services satisfying the QoS constraints

End

pattern to select the best Web Service by monitoring the QoS parameters specified by the user. The strategy pattern based selection algorithm yields easy to implement algorithms and to use multiple diverse selection algorithms. The decision context of the algorithm is to return the best web service to the Delegation Web Service. At first it checks for the service identification to see that particular service belongs to the service list if not it will added to the service list. Then the end point reference will be assigned to it and also the corresponding MUWS address to which it should get monitored.

After that get the QoS parameters to be monitored for all the similar web services which have been sent by the Delegation Web Service and those corresponding parameters will be then monitored. Then the result of the monitored parameters of all the web services in the list will be compared and the decision will be made to select the best web service. After the decision the result will be sent to the decision context and then it will be responded to the Delegation Web Service. Multiple algorithms can be defined for the same QoS parameter depending on the constraints.

6. MANAGEMENT OF BALANCING THE LOAD

In the proposed work the load balancing factor is concerned greatly. For every consumer request the DWS look into the registry and group all the similar web services meeting the functional requirements. In this approach for each type of web services a Delegation Web Service is provided and also it is predestinated in sending the request to the web services to implement web service load balancing to maximum. Each web service will be provided with some threshold value and by reaching above the value will make the service to get overloaded. Since for each type a DWS is provided it is easy to balance the load when it gets overloaded by making the next subsequent monitored web service to be available.

From the consumer the functional requirement needed will be requested to DWS along with the QoS preferences. Then the DWS identifies the type of service based on the functional requirement requested by the consumer and will look into the registry by specifying the name of the service. The Find module of the UDDI registry will display all the services of the similar type. The DWS will then

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group all the similar web services into its registry module. Then each of these similar types of web services will be monitored and assigned the priority value so that the DWS will be able to predestinate the request of the consumer's to the web service. This mechanism provides the maximum degree of load balancing compared to the other approaches.

7. IMPLEMENTATION AND EXPERIEMENTS

The proposed system is implemented using the Eclipse IDE and Apache Tomcat server as the service deploying platform. Apache Muse a java based implementation is used to implement the WSDM standards. In the Apache Muse framework first create a WSDL specifying the Delegation Web Service interface and then create DelegationAsSelectorResource.rmd. Secondly add the Operation getBestWS, for returning the Address of the web service with the best QoS. The DelegationAsSelector.wsdl needs to contain all functional operations, of the web service it delegates to. The code is then imported to the Eclipse and then being tested with the TestServlet to be run on the server as shown in the Fig 4.

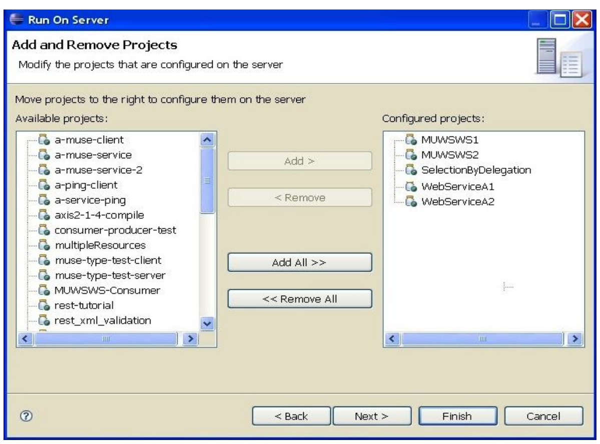

Fig. 4: Testing of the services using the Test Servlet

Then the result of the best web service for different QoS parameters in the service list based on the proposed selection algorithm will be displayed as shown in the Fig. 5

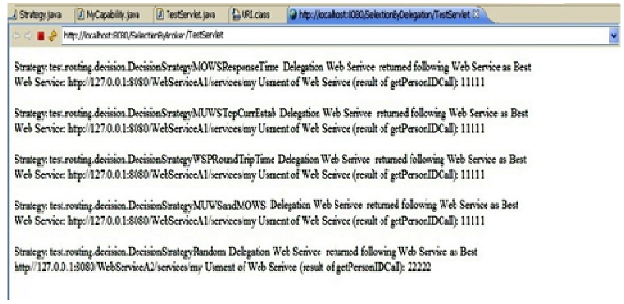

Fig. 5: Result of the Best Web Service in the Service List

For inquiry and publishing of the service UDDI browser and jUDDI registry is used. The jUDDI is the java implementation of the UDDI registry. The module publishes the service in the UDDI registry with the WSDL file and extracts the QoS information of the service. The service can be published and inquired by specifying the URL into the registry information module as shown in the Fig. 6

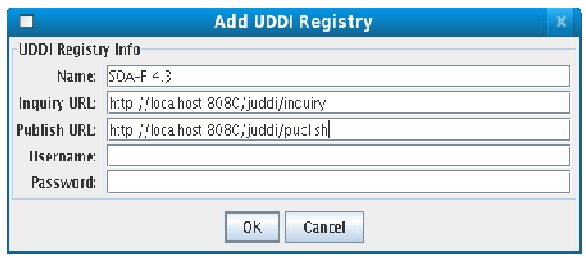

Fig. 6: The info window for publish/inquiry of service

After the service has been published it can be inquired at any time for the functional implementation of the service. The customer queries the Find module for services with functional and QoS requirements. The Delegation Web Service gets functional matched services from the registry and then requests those web services for the QoS attributes of each Web services and then it will be monitored by the WSDM framework. The Find module of the registry provides the search with three options as shown in the Fig. 7

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Fig. 7: The Find window to search any published services

The previous work [7] is taken for experiment and compared with the proposed work. Both the works have been experimented in their own form of selection process. Then the experimental result of both the works is calculated by evaluating the parameters such as responsiveness of the web service selection per request and efficiency. These parameters are defined as follows:

Efficiency: Refers to the overall quality of the service selection and the load balancing factor**.**

Responsiveness: Defines the time taken to response for each consumer's request/ second

The comparison graph of efficiency for the proposed architecture and the previous work [7] is shown below (Fig. 8) in which for example the consumer 1 gets the efficiency of 94.5 percent with the proposed work whereas the same consumer gets the efficiency with 92.54 percent. The Fig. 9 shows the responsiveness of the web service selection by the selector to the consumer's request.

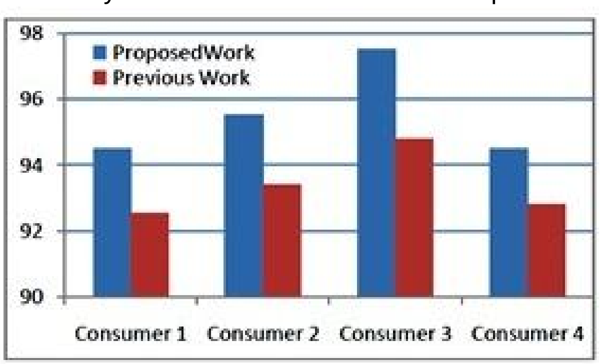

Fig. 8: Efficiency of the web service using proposed and previous techniques

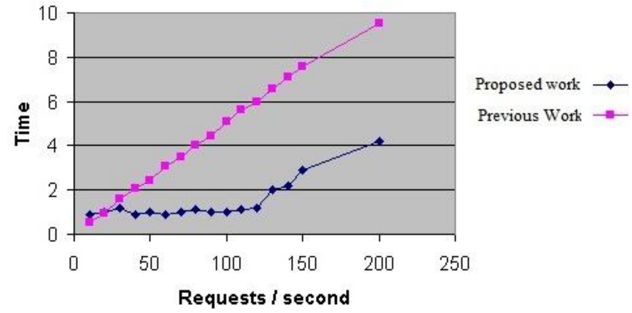

Fig. 9: Responsiveness of web service selection to customer's request

8. CONCLUSION

Web Service Selection based on QoS value is an important research area. The selection of web service are usually based on the functional requirements of the consumer but those web services are not able to provide the accuracy in their services The decision should always be based on QoS parameters important to the specific consumer. The proposed Delegation Web Service as selector architecture hides the web services and also it is predestinated to implement web service load balancing. For each type of Web Services a Delegation Web Service is provided for better load balancing. The QoS monitoring is done efficiently by using the WSDM and the best web service is selected based on the selection algorithm being proposed. Future and upcoming work is to include more QoS parameters to get monitored by the WSDM and to have one Delegation Web Services for multiple web services types.

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Iatrogenic effects of Orthodontic treatment – Review on white spot lesions

Sangamesh B., Amitabh Kallury

Abstract— Demineralization is an inevitable side effect associated with fixed appliance orthodontic treatment, especially associated with poor oral hygiene. Fixed orthodontic appliances create several retentive areas for the accumulation of bacterial plaque. The acidic byproducts of these bacteria are responsible for the subsequent enamel demineralization and formation of white spot lesions (WSL), causing caries therefore leading to poor esthetics, patient dissatisfaction and legal complications. This highlights the need for assessing the saliva, oral hygiene status and caries rate before beginning of treatment and initiating preventive measures. Orthodontists must take up active responsibility to educate the patients about the importance of maintaining good dietary compliance and excellent oral hygiene regime. Depending on the oral environment, WSL can develop into cavities, stay stable for a long time, or heal to a certain extent. Thus, the prevention of WSL is crucial to prevent tooth decay as well as minimize tooth discoloration that could compromise the treatment results.

Index Terms— Iatrogenic effects, White spot lesion, Incidence, Orthodontic Treatment, Duration, Oral hygiene, Etiology, Prevention, Fixed Appliances, Demineralization.

1 Introduction

White spot lesion (WSL) is a common iatrogenic effect seen in patients undergoing orthodontic treatment with fixed appliances **(Fig.1)**.[1,2] Individuals with malocclusions often have many plaque retention sites due to the irregularities of their teeth **(Fig.2)**. Orthodontic treatment with fixed appliances and complex loop designs further increases the risk for development of WSL due to the creation of additional retention sites on surfaces generally not susceptible to caries.[2] Hence a strong co-relation exists between oral hygiene and caries incidence in orthodontic patients as compared to in non orthodontic individuals.[3] Despite intensive efforts to educate patients about effective oral hygiene procedures, WSL associated with fixed orthodontic appliances remains a significant clinical problem **(Fig.3)**. This clinical problem has increased since the advent of directly bonded orthodontic brackets.[4] Appearance of these spots after the completion of orthodontic treatment can lead to patient dissatisfaction and legal complication.[5] The formation of WSL after completion of orthodontic therapy is discouraging to a speciality whose goal is to improve esthetics in the dento-facial region. Orthodontists should be proactive and take active responsibility to prevent the development of WSL by educating their patients about the importance of maintaining an excellent dietary compliance and oral hygiene regime. Oral hygiene regime must include topical fluoride agents such as fluoridated toothpaste, fluoride-containing mouth rinse, gel and varnish to prevent or minimize the formation of WSL during orthodontic treatment.[6]

DEFINITION

The term white spot lesion was defined as 'the first sign of a caries lesion on enamel that can be detected with the naked eye'.[7]

The WSL has also been defined as 'subsurface enamel porosity from carious demineralization' that presents itself as 'a milky white opacity when located on smooth surfaces'.[8]

CLASSIFICATION OF WHITE LESIONS ON ENAMEL

White discolorations of enamel can be classified as dental fluorosis, opacities, or WSL.[6] A set of criteria has been developed to differentiate between fluorosis and opacities.[9] Fluorosis **(Fig.4)** is a white/yellowish lesion that is not well defined, blends with normal enamel, and has symmetrical distribution in the mouth. Nonfluoride opacities have a more defined shape, are well differentiated from surrounding enamel, often located in the middle of the tooth, and randomly distributed **(Fig.5)**.

INCIDENCE

Orthodontic patients have significantly more WSL than non-orthodontic patients and these WSL may present esthetic problems years after treatment.[3,10] A recent review of literature[11] showed variations ranging from 2% to 97%, for WSL prevalence associated with orthodontic treatment[3,10,12-17]. This high prevalence is attributed to the difficulties in performing oral hygiene procedures on bonded dental arches along with long-time accumulation and easier retention of bacterial plaque on tooth surfaces around fixed orthodontic appliances.[15,18] The variation in WSL prevalence among studies could be attributed to differences in the number of teeth ex-

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amined, the methods and the standardizations in examinations, the location of the study sample (cultural differences), time era of the study, age at the start of treatment, treatment duration, and materials (banding vs bonding).[19] In general, the prevalence of WSL in patients after orthodontic treatment varies from 15% to 85%[13], with most studies reporting 50% to 70%.[10,15-17,20-22] It is reported that any tooth in the mouth can be affected by the process with the common ones being maxillary lateral incisors, maxillary canines, and mandibular premolars.[15] The incidence was highest in the labio-gingival area of the maxillary lateral incisors **(Fig.6)** and lowest in the maxillary posterior segment. The reported incidence and prevalence of WSL between males and females have been found to be inconclusive.[10,11,14] No significant differences between the right and left sides of the maxilla and mandible were noted.[10,14]

MECHANISM OF FORMATION OF WSL

WSL can occur on any tooth surface in the oral cavity where the plaque is allowed to develop and remain for a period of time **(Fig.7)**. The naturally occurring self cleansing mechanisms of the oral musculature and saliva are limited by the irregular surface of brackets, bands, and wires.[23] The composition of the bacterial flora of the plaque shows a rapid shift following the placement of orthodontic appliances. Patients undergoing treatment with fixed orthodontic appliances have a rapid increase in the volume of dental plaque (with a lower pH) than that in non-orthodontic patients.[24,25] The levels of acidogenic bacteria, especially Streptococcus mutans and lactobacillus, are significantly elevated.[26] Both *S.* mutans and lactobacilli are often associated with caries development. Streptococcus mutans colonize over the retentive areas of orthodontic appliances and surrounding enamel surfaces. Lactobacillus is responsible for the progression of the carious lesion. Their presence in large numbers is indicative of the necessary condition for dental caries to exist.[27] However, the association between caries and bacteria is not straightforward. The prediction of caries development based on bacterial counts is uncertain and of minor clinical significance.[28] S. mutans and lactobacilli produce organic acids in the presence of fermentable carbohydrates and this is responsible for lowering the pH. Sucrose plays an important role in plaque formation inducing the formation of a cariogenic plaque.[29] There is a direct relationship between plaque pH and total plaque fluoride. Total plaque fluoride levels are low in areas of low pH. The lowest pH (as low as 4) during resting and fermenting conditions was observed in the plaque of the bonded upper incisors.[30] After bonding, resting pH is lowered. In the patient with good oral hygiene, fluoride is able to prevent lesions to develop by increasing remineralization and inhibiting demineralization. With poor oral hygiene, plaque builds up around the appliance and the resting pH may reach the limit of the fluoride effect at pH 4.5. During an acid attack, caries and even erosions develop.[29] Carious decalcification occurs when the pH drops below the threshold for remineralization and creates an alteration in the appearance of the enamel surface which is visualized as WSL.[25,31] Such lesions have been clinically noticed within a short span of 4 weeks[2]**.** If these are not treated, they progress to a cavitated carious lesion.[32] WSL makes the affected area softer than the surrounding sound enamel, making the tooth more prone to caries[33]. There is about 10% reduction in the mineral content of enamel in these incipient carious lesions. This leads to their increased abrasion in vivo.[34] This makes the affected teeth more susceptible to enamel loss while debonding.[35] Fast developing white spots may remineralize almost completely within a few weeks of the removal of the cariogenic challenge. However, lesions that develop slowly take a longer period to remineralize.[36] Micro-leakage around orthodontic brackets can be another cause for the formation of WSL**(Fig.8).** [37] The teeth expand and contract when they are heated and cooled by the ingestion of hot or cold foods[38]. The linear thermal coefficient of expansion of enamel, ceramic / metal brackets and the adhesive systems do not match.[39] This repeated expansion and contraction at different coefficients results in fluids being sucked in and pushed out at the margins of the bracket. In comparison with ceramic brackets, the metal brackets are associated with more micro-leakage **(Fig.9)**.[40] Metal brackets contract and expand more than ceramic brackets, enamel, or the adhesive systems, producing microgaps between the bracket and the adhesive system causing leakage of oral fluids and bacteria beneath the brackets, leading to the formation of WSL.[41]

RISK FACTORS FOR WSL

Formation of WSL is primarily due to the subsurface demineralization resulting in porosities and a change in the optical properties. If the surface of porous enamel remains intact, there is a possibility of arrest / remineralization of the lesion due to the buffering action of the saliva. If the pH of plaque remains low for a prolonged period of time, the environment becomes conducive for long periods of demineralization with short periods of remineralization, resulting if frank carious lesions. Risk factors for the development of incipient caries during orthodontic treatment are young age (preadolescents), number of poor oral hygiene citations during treatment, unfavorable clinical outcome score, white ethnic group, and inadequate oral hygiene at the initial pretreatment examination.[42]

Factors such as the patient's medical history, dental history, medication history, diet; salivary flow rate, levels of calcium, phosphate, and bicarbonate in saliva, fluoride levels and genetic susceptibility also play an important role.[23,43,44] There is a poor correlation between length of treatment time and the incidence of number of white spot formations.[14]

PREVENTION OF WSL

Studies have shown that decalcification is a significant risk during fixed orthodontic treatment.[3,10,14,1745] Current evidence suggests that topical fluoride treatment (TFT) is beneficial in preventing the development of WSL during orthodontic treatment.[46] When topical fluoride is applied on the tooth surface (enamel / dentin), a calcium fluoride-like material (CaF2) builds up in plaque, or in incipient lesions which acts as a reservoir and releases fluoride ions when the pH is lowered during a caries attack.[47] Implementing a good oral hygiene regimen including proper tooth brushing with a fluoridated dentifrice is the most important prophylactic

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measure to prevent the occurrence of WSL in orthodontic patients. Fluoride concentrations of less than 0.05% are beneficial in reduction of the carious lesions.[48] Evidence suggests that reduced demineralization and enhanced remineralization can occur with a toothpaste containing 5000ppm fluoride.[49,50]

When fluoride ions are incorporated into the surface of enamel, it forms a fluoroapatite crystal structure that has lower solubility in the oral environment compared with hydroxyapatite. Fluoroapatite helps in reducing tooth decay by remineralization of small decalcified areas and reduction in the formation of new lesions.[51] In addition, stannous fluoride may have a plaque-inhibiting effect by interfering with the adsorption of plaque bacteria to the enamel surface.[52,53] Atoms of tin in stannous products block the passage of sucrose into bacterial cells and thus inhibit acid production. The use of a fluoridated antiplaque dentifrice may reduce enamel demineralization around brackets more than the use of a fluoridated dentifrice alone.[54] Enamel dissolution occurs rapidly around orthodontic brackets even during regular use of a fluoride dentifrice[31]. Thus, supplemental sources of fluoride are suggested.

Fluoridated mouth rinses containing 0.05% sodium fluoride used daily have been shown to significantly reduce lesion formation beneath bands. Chemical agents such as chlorhexidine or benzydamine used in the form of mouth rinses or oral sprays are useful adjuncts in plaque and inflammation control.[55] These mouth rinses have been combined with antibacterial agents such as chlorhexidene, triclosan, or zinc to improve their cariostatic effect.[33] When patients have been noncompliant with other oral hygiene regimens, chlorhexidine mouthwashes might be beneficial in preventing white spot caries lesions as an intensive, short-term regimen. Chlorhexidine mouthwash used as a complement to fluoride therapy has demonstrated demineralization-inhibiting tendencies in patients with fixed orthodontic appliances.[56] The main goal of antimicrobial therapy is to achieve a shift from an ecologically unfavorable to an ecologically favorable biofilm.[57] Patients are instructed to use chlorhexidine rinse (available in nonalcohol formulations for patients with xerostomia or saliva dysfunction) for 30 seconds once a day, preferably before bedtime, because saliva flow diminishes overnight and the concentration of the drug in the oral cavity remains high until morning.[58] A 14-day regimen is usually recommended.[58] While these products provide the patient with increased caries protection, patient compliance is mandatory. A fluoride mouth rinse will work best if it is used regularly by the patient. Studies have showed that less than 15% of orthodontic patients rinsed daily as instructed but patients who were more compliant had fewer WSL.[15]

An in-office application of a high concentration of fluoride in the form of a varnish can be beneficial for the less compliant patients. It eliminates the need for patient cooperation that is required with fluoride rinses. The American Dental Association's Council on Scientific Affairs recommends application of 'in-office fluoride varnish at six-month intervals for moderate and high-risk patients'. Although varnish application is associated with the temporary discoloration of the teeth and gingival tissue, it has been reported that the application of a fluoride varnish resulted in a 44.3% reduction in enamel demineralization in orthodontic patients.[59] Acid-resistant coatings of calcium fluoride or titanium fluoride on the enamel surface and the use of fluoride in combination with different antimicrobials have been suggested to improve the cariostatic effect of fluoride at low pH.[60] Varnish forms of the other antibacterial solutions such as benzydamine, triclosan, and xylitol could be helpful for suppressing levels of oral mutans or the other microbes for long periods, when used before the placement of fixed orthodontic appliances. In contrast to one-time topical application in high doses, a long-term, low-dose fluoride availability might increase the caries-resistant fluorapatite concentration in enamel, helping the prevention and reduction of demineralization.[48,51]

Unfortunately, preventive and chemoprophylactic products, such as high-fluoride toothpaste or gel, fluoride varnish, and chlorhexidine rinse, gel, or varnish, are rarely prescribed by orthodontists. It was reported that 95% of orthodontists provide oral hygiene instructions, while only 52% prescribe fluoride mouth rinse[61].

Xylitol, a polyol (a type of carbohydrate) that does not act as a metabolizing substrate for Streptococcus mutans, can be used as a low-calorie sugar substitute to prevent caries.[62] Xylitol has been used as a caries preventive agent in form of gum and mints. It is noncariogenic and appears to have antimicrobial properties that help to inhibit S mutans attachment to the teeth. The salivary pH remains stable as there is no metabolism by bacteria, and the environment does not favor acidogenic bacteria.[63] Additionally, the consumption of chewing gum and mints has been demonstrated to result in increased production of stimulated saliva containing more calcium and phosphate ionic concentrations when compared with non-stimulated saliva.[63] The systematic use of xylitol chewing gum can significantly reduce the risk of caries compared with gums that contain sorbitol and sucrose.[64] Chewing xylitol gum thrice a day for 5 minutes has shown positive results.[65] However, long-term clinical trials with a standardized methodology are needed. Moderate and high-risk adult patients are recommended to chew 2 pieces of xylitol gum for 10minutes at least, 3 to 5 times a day.[66] Therapeutically, 6gm/day of xylitol is recommended for adults.[67] However, xylitol can cause diarrhea if the recommended doses are exceeded.[63]

Enamel demineralization might be prevented by the application of products containing casein phosphopeptides-amorphous calcium phosphate (CPP-ACP). CPP-ACP is a nanocluster that binds calcium and phosphate ions in an amorphous form. CPP-ACP has been shown to adhere to the bacterial wall of microorganisms and tooth surfaces.[68,69] When an intraoral acid attack occurs, the calcium and phosphate ions are released to produce a supersaturated concentration of ions in the saliva, which then precipitates a calcium-phosphate compound onto the exposed tooth surface.[69] However, there is insufficient clinical trial evidence to make a recommendation regarding its long-term effectiveness.[63]

The prolonged duration of orthodontic treatment places the patient at an increased caries risk. This risk can be

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minimized by a continuous fluoride release from the bonding system around the bracket base. The introduction of fluoride-releasing adhesive systems, resin composites, and glass ionomer cements for bracket bonding offered a means of fluoride delivery adjacent to bracket-enamel interface independent of patient cooperation. However, the ability of these materials to reduce decalcification clinically remains equivocal.[70] Glass ionomer cements(GIC) do not provide complete caries protection under loose bands or in areas of missing/dissolved cement.[71] However the shear bond strength (SBS) of GIC was not adequate for bonding brackets. In an attempt to increase the bond strength of GIC's, resin particles were added to their formulation to create resin modified Glass Ionomer (RMGI) bonding systems. These adhesives release fluoride like conventional GIC's and can also be used successfully to bond orthodontic brackets because of their relatively higher SBS.[72-83] Additionally, in vivo studies have shown no significant differences in bracket failure rates between the RMGI's and composite adhesives.[84] Because of the recent improvements in the fluoride-releasing capabilities and the SBS of RMGI, it has been suggested that these adhesives should be used more widely in bonding orthodontic brackets in the future.[85] However a recent study concluded that it is impossible to make recommendations on the use of fluoride-containing orthodontic adhesives during fixed orthodontic treatment.[86] The authors found sufficient evidence to suggest that GIC is more effective than composite resin in preventing white spot formation, but further research is required to determine the effectiveness of the various fluoride-containing orthodontic adhesives.

A fluoride releasing antibacterial bonding agent has been developed by combining the physical advantages of dental adhesive technology and antibacterial effect. The antibacterial activity of 12-methacryloyloxydodecyl-pyridinium bromide (MDPB) incorporated in the antibacterial adhesive systems demonstrated inhibition of caries formation, especially along the enamel margins.[87] Incorporating MDPB into self-etching primer and adhesive resin has demonstrated in vitro antibacterial activity, bonding ability, cytotoxicity, and pulpal response. It was confirmed that MDPB-containing primer has got antibacterial effects in vivo when used in animal models.[88,89]

Other fluoride-release mechanisms like fluoride- releasing elastic ligature and power chains have been tried. Research has shown that fluoride-releasing elastomeric ligatures were effective in reducing plaque accumulation and decalcification around the brackets.[16,90,91] However, later investigations reported that fluoride-releasing elastomeric ligatures did not reduce the amount disclosed plaque around the brackets.[92] Research has shown that the fluoride release was high in the first week but decreased significantly in the subsequent weeks.[93]

Finally, use of argon laser to cure composite resins has demonstrated its ability to alter the enamel, rendering it less susceptible to demineralization. It was also shown that combining laser irradiation with fluoride treatment can have a synergistic effect on acid resistance preventing formation of WSL and dental caries.[94] Research has shown that exposing the teeth to an argon laser for 60 seconds at the time of appliance placement reduced lesion depth by 91.4% and lesion area by 94.6% when compared with untreated control teeth.[95]

Clinical Significance

The authors recommend the following measures to prevent WSL in orthodontic patients:

1. Educate and motivate the patients at every visit to maintain optimal oral hygiene around the appliances to obtain the full effect of fluoride.[29]
2. Daily brushing with fluoride toothpaste (1500ppm or more) twice a day.[56] Use of interdental brushes to remove plaque around the brackets.
3. Daily use of a fluoride mouth rinse (0.05% NaF).[29,31,55]
4. Performing oral prophylaxis (scaling) and reinforcing instructions at each appointment in non-compliant patients.
5. Use of chlorhexidine mouth rinse at night for 2 weeks in patients with poor oral hygiene.
6. Use of topical fluoride in the form of solutions, varnishes, or gels around the brackets of non-compliant/ high risk patients at 6 months interval.
7. Cementing the bands with good quality GIC.

Conclusion

WSL on the enamel surface adjacent to fixed orthodontic appliances is an important and prevalent iatrogenic effect of orthodontic therapy. The components of the appliance and the bonding materials create stagnation areas for plaque accumulation and bacterial colonization. The subsequent acid production by the acidogenic bacteria leads to enamel decalcification. The orthodontist must educate the patient regarding the importance of maintaining good oral hygiene and dietary regime. Fluoride is the most important agent to prevent decalcification and restrict lesions from progressing. Oral hygiene regime must include topical fluoride agents such as fluoridated toothpaste, fluoride-containing mouth rinse, gel and varnish to prevent or minimize the formation of WSL during orthodontic treatment.

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A Study of Effects of Disease Caused Death in A Simple Epidemic Model

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Abstract- This paper is concerned with various effects of disease caused death on the host population in an epidemic model of SIR type. Various effects of disease caused death on the host population are studied in this epidemic model. The basic problem discussed in this paper is to be describing the spread of an infection caused death within a population. It is further assumed that there is no substantial development of immunity and that removed infectious are in effect cured of disease. The rate of natural birth and death is assumed to be balanced.

Key Word - Mathematical modeling, Population size , Birth- rate , Death- rate & Infection rate.

INTORDUCTION

Anderson and May [7] studied the effects of disease caused death on the population size in model for a disease which spreads through direct infection within a population whose size is allowed to very in time. Two important new phenomena a was revealed by their study.

A threshold for the population size exists that determines whether the population can sustain an epidemic; fatal diseases are found to have a regulating effect on the growth of the population. Many subsequent works have fallowed this line of research [5]. Another characteristic of this body of research is that the emphasis is on the interplay between the net intrinsic growth rate r and the rate of disease caused death α : it $r > \alpha$ then the disease it likely to become endemic. To explain this phenomenon, potential mechanisms to endemicity other then a large intrinsic growth rate r need to be studied. In recent study, we discovered that a long incubation period incorporated into a SIR model may provide an explanation for concurrence of high pathogenicity and long life span of infectiousness. We took different approach to study of epidemic models by assuming that the population a small intrinsic growth rate r so that disease caused mortality rate
α is relatively large. This approach has following advantage.

1. If greatly reduces the technicality in mathematical analysis, One may start with the case r = 0 and then consider the case of small positive r.
2. If enables us to isolate those effects on the population that directly related to the disease e.g. we discovered our essential difference between a model that incorporates an incubation period and one that does not. Even in a simple model that does not contain an incubation period, this new approach leads to the discovery of several interesting details not found in literature.
3. By keeping the mathematical technicalities at its minimum, this approach may allow our models more accessible to field epidemiologist and hence encourage of application of mathematics in epidemiological studies.

In the present work we demonstrate our approach through a very simple model. We assume that the disease spreads through direct contact among the hosts, the disease has no incubation period as considered in most of previous works [2,4] and that the intrinsic growth rate of host population is zero i.e r = 0 so that in absence of disease, the population size remains constant. The mathematical analysis of model is very elementary, and it provides epidemiologically interesting details about an epidemic. Also, we demonstrate that the kind of phenomenon one many observe in the case of a small positive intrinsic growth is essentially the some as we obtained here. In particular, this seems to suggest that, an SIR model is essentially a model for an epidemic; it does not provide an epidemiologically relevant mechanism for disease endimicity.
For other studies on epidemological models with varying population size closely related to the one we consider her, see Greenhalgh [1] and Mena- Lorca and Hethcote [6] and references there on. Other models with varying population and disease- caused death have been studies by Brauer [2], Bremerman and Thieme [3], Gao and Hethcote [4], and Hethcote [6], and Pugliese [7].

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FORMULATION OF MATHEMATICAL MODEL :

The population is partitioned into classes of susceptible, infectious and immune individuals, with population N(t) is

$$n(t) = x(t) + y(t) + z(t) \qquad (1)$$

Let us consider the per capital birth rate is a constant 'b' and all newborns are susceptible. The per capital natural death rate assumed to be 'b' so that total population remains constant in absence of disease. Suppose the disease spreads through direct contact between susceptible and infections individuals. We assume that the transmission coefficient per unit time by β x(t)y(t). This is equivalent to assuming that the contact rate between individual is β n(t), proportional to n (t).

The disease is assumed to causes death to infected individuals, with a death rate constant α . Let the average infectious period for an infectious individual be $\frac{1}{\gamma}$ so that transfer from infectious class to immune class is at a constant rate γ . It is also assumed that the disease confers permanent immunity so that no transfer from infectious class to immune class exists. Since vaccination is one of the major means of control and prevention of many viral infections, the effect of a vaccination strategy is also considered. All susceptible individuals are vaccinated at a constant per capita rate 'p'. Based on these modeling hypotheses, the following set of differential equations is derived.

$$\begin{aligned} x' &= bn - \beta xy - bx - px \\ y' &= \beta xy - (b + r + \alpha) y \\ z' &= ry - bz + px \qquad (2) \end{aligned}$$

and

$$n(t) = x(t) + y(t) + z(t)$$

The model (2) was one of many model proposed and studied in [1], in which only a local analysis is carried out. It is also related to a model studied in [5] which does not consider vaccination.

Adding the equations in (2) gives

$$x' + y' + z' = bn - \beta xy - bx - px + \beta xy - (b + r + \alpha) y + ry - bz + px$$

$$n' = bn - \beta xy - bx - px + \beta xy - by - ry - \alpha y + ry - bz + px$$

$$n' = -\alpha y \qquad (3)$$

which implies that total population always decreases.

Observing that the variable z does not appear in first two equations in (1) we may simply study the following system

$$\begin{aligned} x' &= bn - \beta xy - bx - px \\ y' &= \beta xy - (b + r + \alpha) y \qquad (4) \\ n' &= -\alpha y \end{aligned}$$

and determine the variable z from

$$z(t) = n(t) - x(t) - y(t)$$

The feasible region for (4) is

$$G = \{(x, y, n) \in R \quad x + y \le n \}$$

It can be checked that G is positively invariant under the dynamics of (4) which, together with the fact that the right hand side of (4) is analytic in (x, y, n), shows that the model is well posed.

EQUILIBRIUM POINT:

Setting the right hand side of (4) equal to zero, we obtain the set of equilibrium Eo

$$Eo = \{ (x, y, n) \in G \quad y = 0, x = b/b+p\ n\} \qquad (5)$$

LOCAL STABILITIES:

To study the local stability of each equilibrium,

$$P^* = (bn^*/b+p, 0, n^*) \in Eo,$$

we linearize the vector field of (4) at P*. The corresponding Jacobian matrix is

$$J(P^*) = \begin{bmatrix} -b-p & -\beta bn^*/b+p & b \\ 0 & \beta bn^*/b+p - b - r - \alpha & 0 \\ 0 & -\alpha & 0 \end{bmatrix}$$

whose characteristic equation is $[J - \lambda I] = 0$

$$\begin{vmatrix} b - p - \lambda & \beta bn^*/ b+p & b \\ 0 & \beta bn^*/ b+p - b - r - \alpha - \lambda & 0 \\ 0 & -\alpha & 0 - \lambda \end{vmatrix} = 0$$

Or $(-b-p-\lambda)\ (\beta bn^*/b+p - b - r - \alpha-\lambda)\ (-\lambda) = 0$

whose eigen values are

$$\lambda_1 = -b - p$$

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$\lambda_2 = \beta bn^*/b+p - b - r - \alpha$
$\lambda_3 = 0$ (6)

with corresponding eigen vetors
$v_1 = (1, 0, 0)$
$v_2 = (a_1, a_2, a_3)$
$v_3 = (b, 0, b+p)$ (7)

where
$a_1 = (b- \beta bn^* a_2 / b +p) / (\beta bn^*/b+p - p - r - \alpha)$
$a_2 = \beta bn^*/\alpha\ (b+p) - (b + r + \alpha) / \alpha$ (8)
set
$n = (b +p) (b + r +\alpha) / \beta b$ (9)

The local stability of $P^* = (x^*, y^*, n^*)$ is determined by the sings of λ_i's. These are two cases arises:

CASE I :

1. $P^* \in E_0$ and $n^* \neq n$, then P^* always has a 1-dimensional manifold
given by E_0.

2. If $n^* > n$, then P^* has a 1- dimensional stable and 1-dimensional
unstable manifold.

3. If $n^* < n$, then P^* has a 2- dimensional stable manifold.

CASE II :

If $P^* \in E_0$and $n^*= n$ then we observe that subspace $y=0$ is invariant with respect to (6.2.4) and so is the line defined by $y=0$ and $n= n^*$ for each $n^*>0$. In each of these lines P^* is the global attractor in the line $y=0$, $n = n^*$.

RESULT:
The parameter
$n = (b +p) (b + r +\alpha) / \beta b \equiv (b + p) x / b$
is the threshold for the total population to sustain an epidemic. Where the total population n(t) is much below this value so that x < x , any outbreak of infection, no matter its initial momentum y(0), will sustain itself and immediately decreases and continues to decrease monotonically with time until it dies out. On other hand, if the population above this threshold value, disease will sustain itself for certain time, reach its maximum extent while killing many of the infection and reducing the total population below the threshold n, and start to decline and eventually die out.
If we set, each solution x(t) , y(t), n(t) to (4)

$y\,(max) = max\ y(t)$

Then y (max) is achieved where $y'(t) = 0$, so
$x\,(t) = (b + r + \alpha) / \beta = x$

where no vaccination is applied, namely P = 0 then x = n. This is the loss from the infected class divided by the rate of transmission of disease caused death. α increases. Once again this implies that a faster killing disease has less change to cause a large scale epidemic.
If y (max) increases as transmission coefficient β increases. This implies that diseases with greater transmission rate cause larger scale epidemics.
If p increases. y (max) decreases and it takes less time for y(t) to achieve its minimum, the faster the susceptible are removed to the immune class, the less virulent the disease becomes.
. Also x can used as an indicator as to whether the epidemic has reached its maximum extent. After the number of susceptible has decreased below x , the disease will start to die down and eventually die out. If y (max) decreases when the rate

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Autonomous Room Air Cooler Using Fuzzy Logic Control System

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Abstract— This research paper describes the design and implementation of an autonomous room air cooler using fuzzy rule based control system. The rule base receives two crisp input values from temperature and humidity sensors, divides the universe of discourse into regions with each region containing two fuzzy variables, fires the rules, and gives the output singleton values corresponding to each output variable. Three defuzzifiers are used to control the actuators; cooler fan, water pump and room exhaust fan. The results obtained from the simulation were found correct according to the design model. This research work will increase the capability of fuzzy logic control systems in process automation with potential benefits. MATLAB-simulation is used to achieve the designed goal.

Index Terms— Fuzzy Logic Control, Inference Engine, MATLAB simulation and Rule Selection.

1 INTRODUCTION

MODERN processing systems are heavily dependent on automatic control systems. The control automation has become essential for machines and processes to run successfully for the achievement of consistent operation, better quality, reduced operating costs, and greater safety.

The control system design, development and implementation need the specification of plants, machines or processes to be controlled. A control system consists of controller and plant, and requires an actuator to interface the plant and controller. The behaviour and performance of a control system depend on the interaction of all the elements. The dynamical control systems design, modeling and simulation in local and distributed environment need to express the behaviour of quantitative control system of multi-input and multi-output variables control environment to establish the relation between actions and consequences of the control strategies [1].

Computational Intelligence (CI) is a field of intelligent information processing related with different branches of computer sciences and engineering. The fuzzy systems are one paradigm of CI. The contemporary technologies in the area of control and autonomous processing are benefited using fuzzy sets [2].

The user based processing capability is an important aspect of fuzzy systems taken into account in any design consideration of human centric computing systems. The human centricity plays a vital role in the areas of intelligent data analysis and system modeling [3]. The elements of fuzzy sets belong to varying degrees of membership or belongingness. Fuzzy sets offer an important and unique feature of information granules. A membership function quantifies different degrees of membership. The higher the degree of membership A (x), the stronger is the level of belongingness of this element to A. Fuzzy sets provide an ultimate mechanism of communication between humans and computing environment [4].

The fuzzy logic and fuzzy set theory deal with non-probabilistic uncertainties issues. The fuzzy control system is based on the theory of fuzzy sets and fuzzy logic [5]. Previously a large number of fuzzy inference systems and defuzzification techniques were reported. These systems/techniques with less computational overhead are useful to obtain crisp output. The crisp output values are based on linguistic rules applied in inference engine and defuzzification techniques [6]-[7].

The efficient industrial control with new techniques of fuzzy algorithm based on active rule selection mechanism to achieve less sampling time ranging from milliseconds in pressure control, and higher sampling time in case of temperature control of larger installations of industrial furnaces has been proposed [8].

The development of an air condition control system based on fuzzy logic with two inputs and one output using temperature and humidity sensors for feedback control, and three control elements for heating, cooling, and humidity, and formulated fuzzy rules for temperature and humidity has been achieved. To control the room temperature, the controller reads the room temperature after every sampling period [9].

This proposed design work of Autonomous Room Cooling System is the application of fuzzy logic control system consisting of two input variables: Temperature and Humidity, and three output variables: Cooler fan speed, Water pump speed and Exhaust fan speed, used in a processing plant of room cooler to maintain the

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required cooling environment. The basic structure of the proposed model is described in Section 2. Section 3 gives the simplified design algorithm of fuzzy logic for room air cooler system. Section 4 describes the simulation results of this system. Conclusion and future work is given in Section 5.

2 BASIC STRUCTURE OF THE PROPOSED MODEL

The basic structure of the proposed model of autonomous water room cooler consists of room air cooler with fuzzy logic control system. The room cooler mounted in a room has cooler fan, a water pump to spread water on its boundary walls of grass roots or wooden shreds. A room exhaust fan, humidity and temperature sensors used to monitor the environment of room are mounted in the room. The sensors with amplification and voltage adjustment unit are connected with the two fuzzifiers of the fuzzy logic control system. Three outputs of defuzzifiers: cooler fan speed control, water pump speed control and room exhaust fan speed control are connected through actuators.

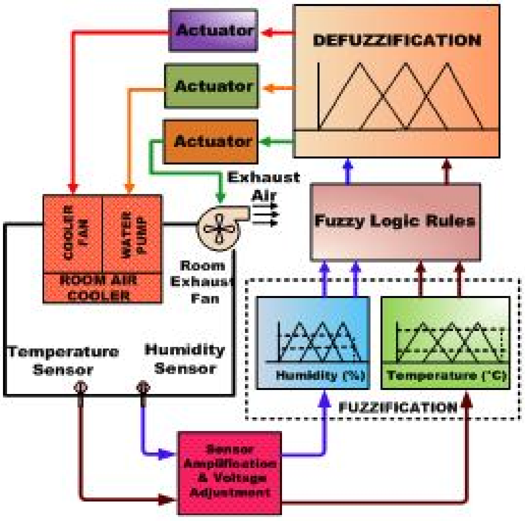

Fig.1. Block diagram of Autonomous Room Air Cooler System

3 SIMPLIFIED DESIGN ALGORITHM OF FUZZY LOGIC FOR ROOM AIR COOLER SYSTEM

This simplified design algorithm is used to design the fuzzifier, inference engine, rule base and defuzzifier for the autonomous room air cooling system according to the control strategy of the processing plant to achieve the quantity and quality of the desire needs to maintain the room environment.

This design work uses five triangular membership functions equally determined over a scale range of 0°C to 40°C for the temperature input and 0% to 100% relative humidity inputs. The five fuzzy membership functions for temperature input are termed as: cold 0-10°C, cool 0-20°C, normal 10-30°C, warm 20-40°C, and hot 30-40°C. As for humidity input, the five fuzzy membership functions are: dry 0%-25%, not too dry 0%-50%, moist 25%-75%, not too wet 50%-100%, and wet range 75%-100%.This fuzzy logic model aims to determine the amplitude of the voltage signal 0-5v to be sent to the three actuators for: Cooler fan speed, water pump speed and room exhaust fan speed to maintain a constant and desired environment. Here no time constrain is applied. Three outputs of this proposed system are: Cooler fan speed, water pump speed and room exhaust fan speed. Each output variable consists of five membership functions: Stop 0-5, Low 0-50, Medium 40-60, Fast 50-90 and Very Fast 90-100.

3.1 Fuzzifier

The set points of fuzzifiers use the data of two input variables, "Temperature" and, "Humidity". Their occupied region description, membership functions and range are given in TABLE 1 and TABLE 2.

TABLE 1
MEMBERSHIP FUNCTIONS AND RANGES OF INPUT VARIABLE TEMPERATURE

Membership Function (MF)	Ranges	Region Occupied
Cold	0-10	1
Cool	0-20	1-2
Normal	10-30	2-3
Warm	20-40	3-4
Hot	30-40	4

TABLE 2
MEMBERSHIP FUNCTIONS AND RANGES OF INPUT VARIABLE HUMIDITY

Membership Function (MF)	Ranges	Region Occupied
Dry	0-25	1
Not Too Dry	0-50	1-2
Moist	25-75	2-3
Not Too Wet	50-100	3-4
Wet	75-100	4

For each input variable, five membership functions are used as shown in Fig. 2 and in Fig. 3.

The five membership functions, "Cold", "Cool", "Normal", "Warm", "Hot" are used to show the various ranges of input fuzzy variable "TEMPERATURE" in a plot consisting of four regions as shown in Fig. 2.

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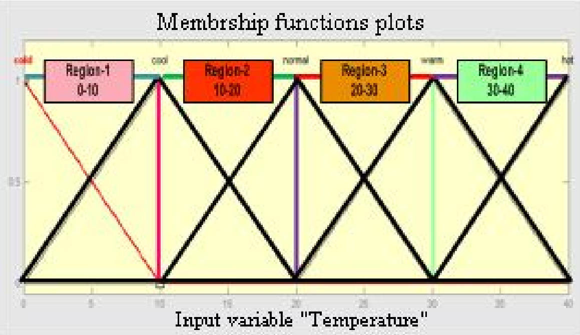

Fig.2. Plot of membership functions for input variable, "TEMPERATURE"

The five membership functions, "Dry", "Not Too Dry", "Moist", "Not Too Wet", "Wet" are used to show the various ranges of input fuzzy variable "HUMIDITY" in a plot also consisting of four regions as shown in Fig. 3

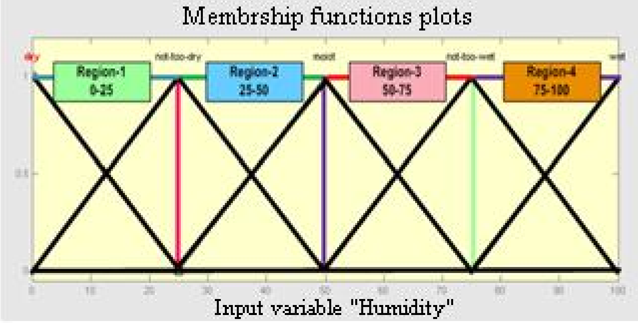

Fig.3. Plot of membership functions for input variable, "HUMIDITY"

The linguistic values are the mapping values of the fuzzy input variables with the membership functions occupied in the regions [10]. As we are using two variables, therefore four linguistic values are shown in Fig.4. The mapping of input fuzzy variables with the functions in four regions is listed in TABLE 3.

TABLE 3
LINGUISTIC VALUES OF FUZZIFIERS OUTPUTS IN ALL REGIONS

Input Variables	Linguistic Fuzzifiers Outputs	Region 1	Region 2	Region 3	Region 4
Temperature	f_1	$f_1[1]$	$f_1[2]$	$f_1[3]$	$f_1[4]$
	f_2	$f_1[2]$	$f_1[3]$	$f_1[4]$	$f_1[5]$
Humidity	f_3	$f_2[1]$	$f_2[2]$	$f_2[3]$	$f_2[4]$
	f_4	$f_2[2]$	$f_2[3]$	$f_2[4]$	$f_2[5]$

TABLE 4
RULE MAPPING FOR REGIONS OCCUPIED

Case No.	Regions Occupied: Temperature Input variable 1	Regions Occupied: Humidity Input variable 2	Rules: $f_n[m]$= Membership value, where n=No. of input variable, m=No. of membership func-
1	1	1	$R_1 = f_1 \wedge f_3 = f_1[1] \wedge f_2[1]$ $R_2 = f_1 \wedge f_4 = f_1[1] \wedge f_2[2]$ $R_3 = f_2 \wedge f_3 = f_1[2] \wedge f_2[1]$ $R_4 = f_2 \wedge f_4 = f_1[2] \wedge f_2[2]$
2	1	2	$R_1 = f_1 \wedge f_3 = f_1[1] \wedge f_2[2]$ $R_2 = f_1 \wedge f_4 = f_1[1] \wedge f_2[3]$ $R_3 = f_2 \wedge f_3 = f_1[2] \wedge f_2[2]$ $R_4 = f_2 \wedge f_4 = f_1[2] \wedge f_2[3]$
3	1	3	$R_1 = f_1 \wedge f_3 = f_1[1] \wedge f_2[3]$ $R_2 = f_1 \wedge f_4 = f_1[1] \wedge f_2[4]$ $R_3 = f_2 \wedge f_3 = f_1[2] \wedge f_2[3]$ $R_4 = f_2 \wedge f_4 = f_1[2] \wedge f_2[4]$
4	1	4	$R_1 = f_1 \wedge f_3 = f_1[1] \wedge f_2[4]$ $R_2 = f_1 \wedge f_4 = f_1[1] \wedge f_2[5]$ $R_3 = f_2 \wedge f_3 = f_1[2] \wedge f_2[4]$ $R_4 = f_2 \wedge f_4 = f_1[2] \wedge f_2[5]$
5	2	1	$R_1 = f_1 \wedge f_3 = f_1[2] \wedge f_2[1]$ $R_2 = f_1 \wedge f_4 = f_1[2] \wedge f_2[2]$ $R_3 = f_2 \wedge f_3 = f_1[3] \wedge f_2[1]$ $R_4 = f_2 \wedge f_4 = f_1[3] \wedge f_2[2]$
6	2	2	$R_1 = f_1 \wedge f_3 = f_1[2] \wedge f_2[2]$ $R_2 = f_1 \wedge f_4 = f_1[2] \wedge f_2[3]$ $R_3 = f_2 \wedge f_3 = f_1[3] \wedge f_2[2]$ $R_4 = f_2 \wedge f_4 = f_1[3] \wedge f_2[3]$
7	2	3	$R_1 = f_1 \wedge f_3 = f_1[2] \wedge f_2[3]$ $R_2 = f_1 \wedge f_4 = f_1[2] \wedge f_2[4]$ $R_3 = f_2 \wedge f_3 = f_1[3] \wedge f_2[3]$ $R_4 = f_2 \wedge f_4 = f_1[3] \wedge f_2[4]$
8	2	4	$R_1 = f_1 \wedge f_3 = f_1[2] \wedge f_2[4]$ $R_2 = f_1 \wedge f_4 = f_1[2] \wedge f_2[5]$ $R_3 = f_2 \wedge f_3 = f_1[3] \wedge f_2[4]$ $R_4 = f_2 \wedge f_4 = f_1[3] \wedge f_2[5]$
9	3	1	$R_1 = f_1 \wedge f_3 = f_1[3] \wedge f_2[1]$ $R_2 = f_1 \wedge f_4 = f_1[3] \wedge f_2[2]$ $R_3 = f_2 \wedge f_3 = f_1[4] \wedge f_2[1]$ $R_4 = f_2 \wedge f_4 = f_1[4] \wedge f_2[2]$
10.	3	2	$R_1 = f_1 \wedge f_3 = f_1[3] \wedge f_2[2]$ $R_2 = f_1 \wedge f_4 = f_1[3] \wedge f_2[3]$ $R_3 = f_2 \wedge f_3 = f_1[4] \wedge f_2[2]$ $R_4 = f_2 \wedge f_4 = f_1[4] \wedge f_2[3]$
11.	3	3	$R_1 = f_1 \wedge f_3 = f_1[3] \wedge f_2[3]$ $R_2 = f_1 \wedge f_4 = f_1[3] \wedge f_2[4]$ $R_3 = f_2 \wedge f_3 = f_1[4] \wedge f_2[3]$ $R_4 = f_2 \wedge f_4 = f_1[4] \wedge f_2[4]$
12.	3	4	$R_1 = f_1 \wedge f_3 = f_1[3] \wedge f_2[4]$ $R_2 = f_1 \wedge f_4 = f_1[3] \wedge f_2[5]$ $R_3 = f_2 \wedge f_3 = f_1[4] \wedge f_2[4]$ $R_4 = f_2 \wedge f_4 = f_1[4] \wedge f_2[5]$
13.	4	1	$R_1 = f_1 \wedge f_3 = f_1[4] \wedge f_2[1]$ $R_2 = f_1 \wedge f_4 = f_1[4] \wedge f_2[2]$ $R_3 = f_2 \wedge f_3 = f_1[5] \wedge f_2[1]$ $R_4 = f_2 \wedge f_4 = f_1[5] \wedge f_2[2]$

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Case No.	Regions Occupied		Rules
	Temperature Input variable 1	Humidity Input variable 2	$f_n[m]$= Membership value, where n=No. of input variable, m=No. of membership func-
14.	4	2	$R_1 = f_1 \wedge f_3 = f_1[4] \wedge f_2[2]$ $R_2 = f_1 \wedge f_4 = f_1[4] \wedge f_2[3]$ $R_3 = f_2 \wedge f_3 = f_1[5] \wedge f_2[2]$ $R_4 = f_2 \wedge f_4 = f_1[5] \wedge f_2[3]$
15.	4	3	$R_1 = f_1 \wedge f_3 = f_1[4] \wedge f_2[3]$ $R_2 = f_1 \wedge f_4 = f_1[4] \wedge f_2[4]$ $R_3 = f_2 \wedge f_3 = f_1[5] \wedge f_2[3]$ $R_4 = f_2 \wedge f_4 = f_1[5] \wedge f_2[4]$
16.	4	4	$R_1 = f_1 \wedge f_3 = f_1[4] \wedge f_2[4]$ $R_2 = f_1 \wedge f_4 = f_1[4] \wedge f_2[5]$ $R_3 = f_2 \wedge f_3 = f_1[5] \wedge f_2[4]$ $R_4 = f_2 \wedge f_4 = f_1[5] \wedge f_2[5]$

Fuzzifier converts the input crisp value into the linguistic fuzzy values. The output of fuzzifier gives the linguistic values of fuzzy set. For the two input variables, two fuzzifiers are used which are shown in Table 5.

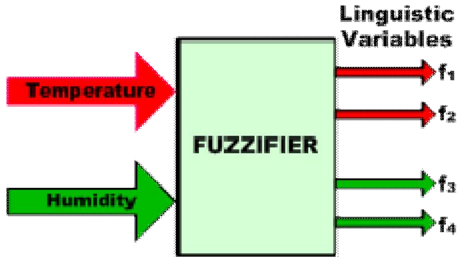

Fig.4 Fuzzifier Block

Each fuzzifier consists of : a multiplier: which converts the input voltage range 0-5volt into the crisp value 0-40 for temperature by multiplying the input with 10, and the crisp value 0-100 for humidity by multiplying the input with 25, comparators; used to decide the region occupied by the input variable value, subtractors; used to find the difference of crisp value from the end value of each region, multiplexer; using the address information from the region selection and inputs from the four subtractors, multiplex the four values because this system is designed for the four predefined regions, divider; used to divide the difference value in each selected region by 10 to find the mapping value of membership function with the input variable value of temperature in that region, and to find the mapping value of membership function for input variable value of humidity, divide the difference value in each selected region by 25, a second fuzzy set subtractor; used to find the active value of the second fuzzy set by subtracting the first active fuzzy set value from 1. The general internal hardware structural scheme of a fuzzifier for four regions is shown in Fig. 5 & Fig. 6 and the results of fuzzification are shown in TABLE 5 for mathematical analysis [11].

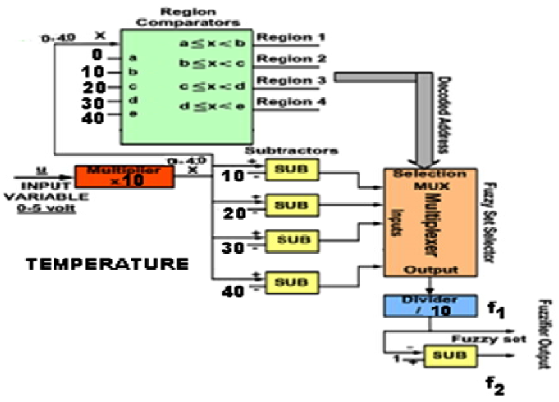

Fig. 5 Internal Hardware Structural Scheme for Four Regions "TEMPERATURE"

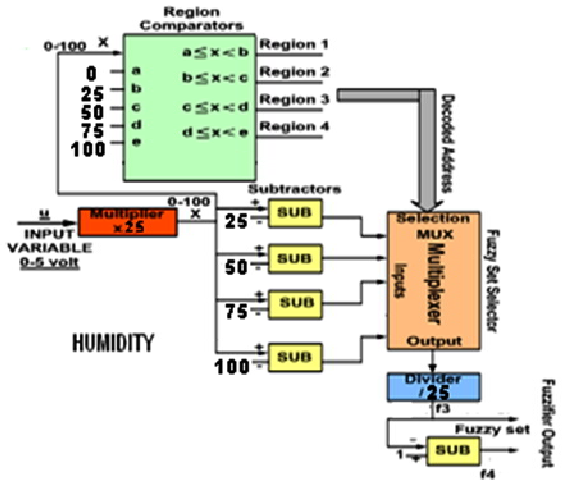

Fig. 6 Internal Hardware Structural Scheme for Four Regions "HUMIDITY"

TABLE 5
RESULTS OF FUZZIFICATION

Input Variables	Input Voltage (u)	Values	Region Selection	Fuzzy Set Calculation
Temperature	2.8 volts	x= 10u=28	$20 \le x < 30$ Region-3	$f_1=(30-28)/10=0.2$ $f_2=1-f_1=1-0.2=0.8$
Humidity	1.6 volts	x= 25u=40	$25 \le x < 50$ Region-2	$f_3=(50-40)/25=0.4$ $f_4=1-f_3=1-0.4=0.6$

3.2 Inference Engine

The inference engine consists of four AND operators, these are not the logical ANDs but select minimum value input for the output. This inference engine accepts four inputs from fuzzifier and applies the min-max composition to obtain the output R values. The min-max inference

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method uses min-AND operation between the four inputs. Fig. 7 shows this type of inference process.

Number of active rules = m^n, where m = maximum number of overlapped fuzzy sets and n = number of inputs. For this design, m = 5 and n = 2, so the total number of active rules are 25. The total number of rules is equal to the product of number of functions accompanied by the input variables in their working range [12]. The two input variables described here consisted of five membership functions. Thus, 5 x 5 = 25 rules were required which are shown in TABLE 6.

TABLE 6
TOTAL NUMBER OF RULES

INPUTS		OUTPUTS		
Temperature (°C)	**Humidity %**	**Speed of Cooler Fan**	**Speed of Water Pump**	**Speed of Room Exhaust Fan**
Cold	Dry	Stop	Low	Stop
Cold	Not Too Dry	Stop	Low	Slow
Cold	Moist	Stop	Low	Slow
Cold	Not Too Wet	Stop	Low	Slow
Cold	Wet	Low	Stop	Medium
Cool	Dry	Stop	Medium	Stop
Cool	Not Too Dry	Stop	Low	Slow
Cool	Moist	Stop	Low	Medium
Cool	Not Too Wet	Low	Low	Medium
Cool	Wet	Low	Stop	Medium
Normal	Dry	Low	Medium	Stop
Normal	**Not Too Dry**	**Low**	**Medium**	**Slow**
Normal	**Moist**	**Medium**	**Medium**	**Slow**
Normal	Not Too Wet	Medium	Low	Medium
Normal	Wet	High	Stop	Fast
Warm	Dry	High	High	Stop
Warm	**Not Too Dry**	**High**	**High**	**Slow**
Warm	**Moist**	**High**	**High**	**Medium**
Warm	Not Too Wet	High	Medium	Slow
Warm	Wet	Very High	Low	Stop
Hot	Dry	High	Very High	Stop
Hot	Not Too Dry	Very High	Very High	Slow
Hot	Moist	Very High	High	Medium
Hot	Not Too Wet	Very High	Medium	Medium
Hot	Wet	Very High	Low	Fast

In this case only 4 rules are required for the particular values of two variables because each value of two variables in a region corresponds to mapping of two functions. The corresponding mapping values of $f_1[3]$, $f_1[4]$, $f_2[2]$, $f_2[3]$ were used to establish the 4 rules. Here $f_1[3]$ means the corresponding mapping value of membership function "Normal" of temperature in region-3 and the similar definitions are for the others [13].

$R_1 = f_1 \wedge f_3 = f_1[3] \wedge f_2[2] = 0.2 \wedge 0.4 = 0.2$
$R_2 = f_1 \wedge f_4 = f_1[3] \wedge f_2[3] = 0.2 \wedge 0.6 = 0.2$
$R_3 = f_2 \wedge f_3 = f_1[4] \wedge f_2[2] = 0.8 \wedge 0.4 = 0.4$
$R_4 = f_2 \wedge f_4 = f_1[4] \wedge f_2[3] = 0.8 \wedge 0.6 = 0.6$

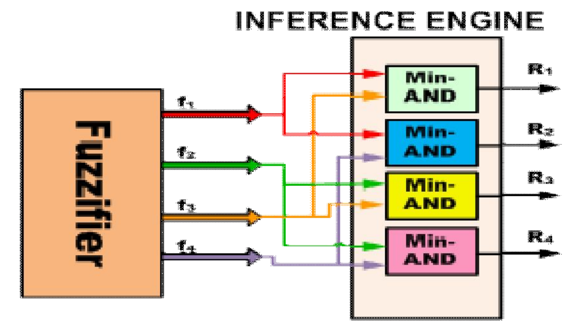

Fig. 7 Block Diagram of Inference Engine

3.3. Rule Selector

The rule selector receives two crisp values of temperature and humidity. It gives singleton values of output functions under algorithm rules applied on design model.

For two variables, four rules are needed to find the corresponding singleton values S_1, S_2, S_3 and S_4 for each variable according to these rules are listed in Table 7.

TABLE 7
ILLUSTRATION OF RULES APPLIED MODEL

Rule No.	INPUTS		SINGLETON VALUES OF OUTPUTS			Singleton Values
	Temperature	Humidity	Speed of Cooler Fan	Speed of Water Pump	Speed of Room Exhaust Fan	
1.	Normal	Not Too Dry	Low = 0.25	Medium=0.50	Slow=0.25	S_1
2.	Normal	Moist	Medium = 0.50	Medium=0.50	Slow=0.25	S_2
3.	Warm	Not Too Dry	High = 0.70	High=0.70	Slow=0.25	S_3
4.	Warm	Moist	High = 0.70	High=0.70	Medium=0.50	S_4

The rule base accepts two crisp input values, distributes the universe of discourse into regions with each region containing two fuzzy variables, fires the rules, and gives the output singleton values corresponding to each output variable. Fig. 8 shows the main block diagram of the Rule Base.

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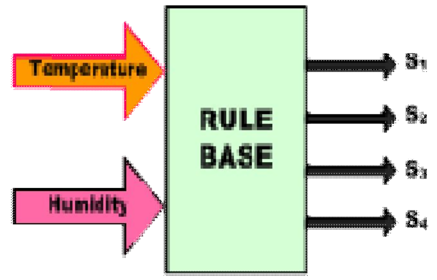

Fig. 8 Rule Base

3.4 Deffuzifier

In this system, three defuzzifiers control the actuators; speed of cooler fan, speed of water pump, speed of room exhaust fan. The membership functions of the three output variables are shown in Fig. 9 to Fig. 11, and the detail of each plot is given in TABLE 8.

TABLE 8
OUTPUT VARIABLES MEMBERSHIP FUNCTIONS

MFs	Range	Speed of Cooler Fan	Speed of Water Pump	Speed of Room Exhaust Fan
MF1	0-5	Stop	Stop	Stop
MF2	0-50	Low	Low	Slow
MF3	40-60	Medium	Medium	Medium
MF4	50-90	High	High	Fast
MF5	70-100	Very High	Very High	Very Fast

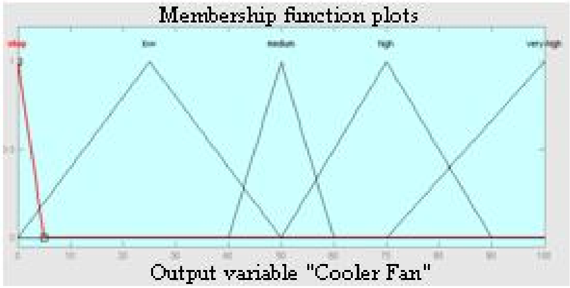

Fig. 9 Plot of Membership Functions for Output Variable, “Cooler Fan Speed”

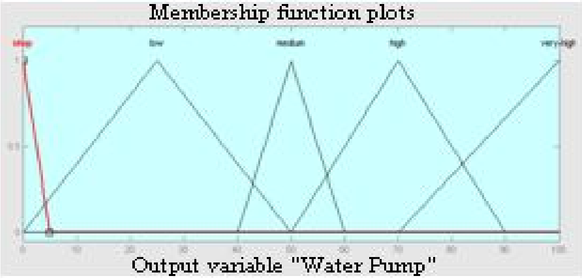

Fig.10. Plot of Membership Functions for Output Variable, “Water Pump Speed”

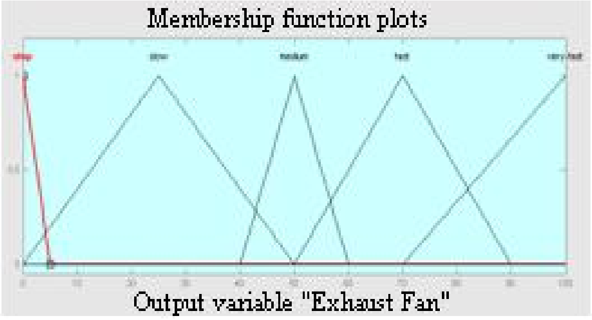

Fig.11. Plot of Membership Functions for Output Variable,

The defuzzification process provides the crisp value outputs after estimating its inputs [14]. In this system 8 inputs are given to each of three defuzzifiers. Four values of R_1, R_2, R_3, R_4 from the outputs of inference engine and four values S_1, S_2, S_3, S_4 from the rule selector are shown in Fig. 10. Each defuzzifier estimates the crisp value output according to the center of average (C.O.A) method using the mathematical expression, $_i * \mathbf{R_i} / \ \mathbf{R_i}$, where i = 1 to 4. Each output variable membership function plot consists of five functions with the same range values for simplification.

Fig.12 shows the design arrangement of a defuzzifier. One defuzzifier consists of : one adder for $\mathbf{R_i}$, four multipliers for the product of $S_i * R_i$, one adder for $_i * \mathbf{R_i}$, and one divider for $_i * \mathbf{R_i} / \ \mathbf{R_i}$. Finally a defuzzifier gives the estimated crisp value output.

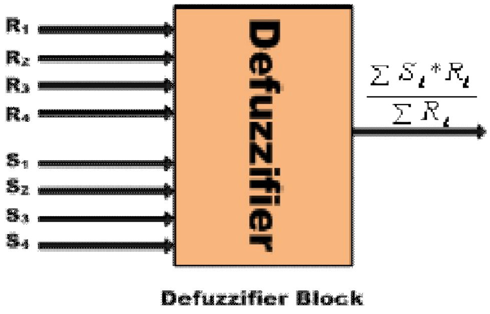

Fig.12 Defuzzifier Block

4. RESULTS AND DISCUSSION

The designed values for three outputs; cooler fan speed, water pump speed and room exhaust fan speed are given in the Tables 9-11. According to the results of inference engine

$\mathbf{R_i}$ = $R_1+R_2+R_3+R_4$ = 0.2+0.2+0.4+0.6 = 1.4

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TABLE 9
DESIGNED VALUE FOR COOLER FAN SPEED

i	S_i	R_i	$S_i * R_i$
1	0.25	0.2	0.05
2	0.50	0.2	0.10
3	0.70	0.4	0.28
4	0.70	0.6	0.42

$\Sigma S_i * R_i$ = 0.85 and $\Sigma S_i * R_i / \Sigma R_i$ =0.85 / 1.4=0.6071
= 60.71% of Cooler Fan Speed

TABLE 10
DESIGNED VALUE FOR WATER PUMP SPEED

i	S_i	R_i	$S_i * R_i$
1	0.50	0.2	0.10
2	0.50	0.2	0.10
3	0.70	0.4	0.28
4	0.70	0.6	0.42

$\Sigma S_i * R_i$ = 0.90 and $\Sigma S_i * R_i / \Sigma R_i$ = 0.90 / 1.4 = 0.6428

=64.28 % of Water Pump Speed

TABLE 11
DESIGNED VALUE FOR EXHAUST FAN SPEED

i	S_i	R_i	$S_i * R_i$
1	0.25	0.2	0.05
2	0.25	0.2	0.05
3	0.25	0.4	0.10
4	0.50	0.6	0.30

$\Sigma S_i * R_i$ = 0.50 and $\Sigma S_i * R_i / \Sigma R_i$ = 0.50 / 1.4= 0.3571
= 35.71 % of Exhaust Fan Speed.

Using mathematical expression $\Sigma S_i * R_i / \Sigma R_i$ the crisp values for output variables were determined and the results were found according to the MATLAB simulation as shown in Fig.13. These results are compared in TABLE 13 and found correct according to the design model. MATLAB simulation was adapted according to the arrangement of membership functions for four rules as given in TABLE 12.

TABLE 12
ARRANGEMENT OF MEMBERSHIP FUNCTIONS FOR SIMULATION

Rule No.	INPUTS		OUTPUTS		
	Temperature	Humidity	Speed of Cooler Fan	Speed of Water Pump	Speed of Room Exhaust Fan
1	Normal	Not Too Dry	Low	Medium	Slow
2	Normal	Moist	Medium	Medium	Slow
3	Warm	Not Too Dry	High	High	Slow
4	Warm	Moist	High	High	Medium

In Fig. 13 the same values of input variables, Temperature = 28, and Humidity = 40 are shown. Various values of input and output variables match the dependency scheme of the system design. The simulated values were checked using MATLAB-Rule viewer as shown in Fig. 13.

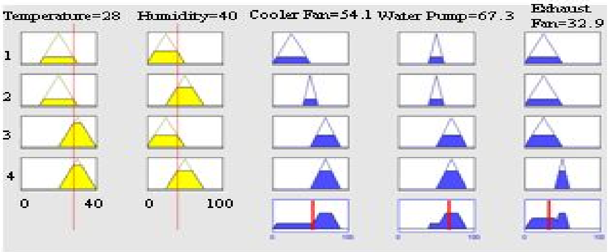

Fig.13. MATLAB-Rule Viewer

The correctness of results shows the validity of the simplified design work for processing system using fuzzy control system.

TABLE 13
COMPARISON OF SIMULATED AND CALCULATED RESULT

Result	Speed of Cooler Fan	Speed of Water Pump	Speed of Room Exhaust Fan
Design Values	60.7	64.28	35.71
MATLAB Simulation	54.1	67.3	32.9
% error	10.8	4.6	7.8

4.1. Simulation Graphs Discussion

This system was simulated for the given range of input variables. The given value of: Temperature = 28 lies in region 3 of the range 20-30 and Humidity = 40 lies in region 2 of the range 25-50. The four rules were applied for MATLAB simulation according to this range scheme. In this design model, the speed of cooler fan depends upon the selected value of temperature sensor, water pump and exhaust fan speeds depend on the value of humidity. The simulated and calculated results are according to the reliance scheme.

Fig. 14 shows that the cooler fan speed is directly proportional to temperature and it does not depend upon the humidity. Fig. 15 represents that the water pump speed is inversely proportional to humidity and it does not depend upon the temperature. Fig. 16 shows that the exhaust fan speed is directly proportional to humidity.

5. CONCLUSION AND FUTURE WORK

Design model of autonomous room air cooler fuzzy logic processing control system provided the results effectively in agreement with the simulation results during the testing of various parts of the control system. The algorithmic design approach makes the system efficient and absolutely under control. This work builds up the control management without the complexity in a processing plant of room cooler to sustain the required cooling environment. The utility of the proposed system in such processing plants is being carried out and in future it will help to design the advanced control system for the various industrial applications in environment monitoring and management systems using state of the art FPGAs based Microelectronics Chips.

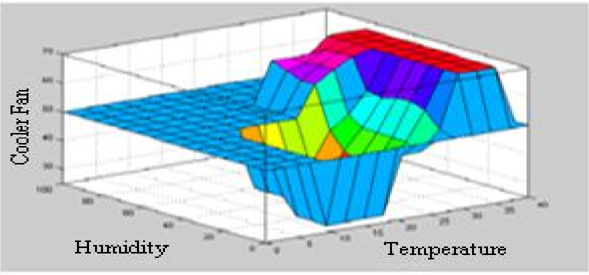

Fig.14 Plot between Temperature-Humidity & Cooler Fan Speed

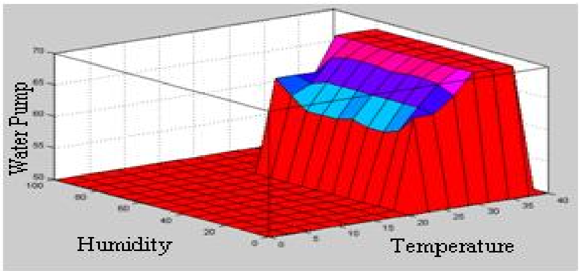

Fig.15. Plot between Temperature-Humidity & Water Pump Speed

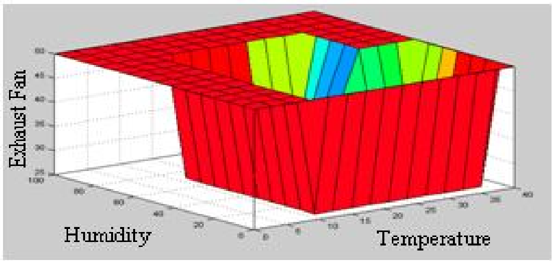

Fig.16. Plot between Temperature-Humidity & Room Exhaust Fan Speed

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Handwritten Character Recognition using Neural Network

Chirag I Patel, Ripal Patel, Palak Patel

Abstract— Objective is this paper is recognize the characters in a given scanned documents and study the effects of changing the Models of ANN.Today Neural Networks are mostly used for Pattern Recognition task. The paper describes the behaviors of different Models of Neural Network used in OCR. OCR is widespread use of Neural Network. We have considered parameters like number of Hidden Layer, size of Hidden Layer and epochs. We have used Multilayer Feed Forward network with Back propagation. In Preprocessing we have applied some basic algorithms for segmentation of characters, normalizing of characters and De-skewing. We have used different Models of Neural Network and applied the test set on each to find the accuracy of the respective Neural Network.

Index Terms— Optical Character Recognition, Artificial Nueral Network, Backpropogation Network, Skew Detection.

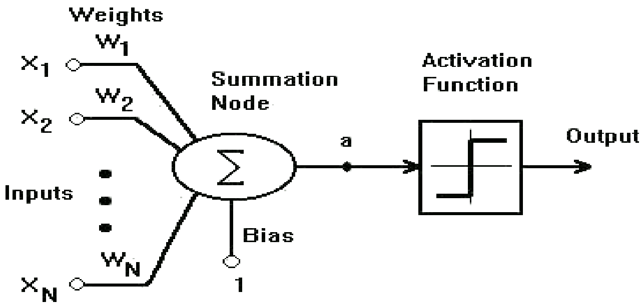
1 Introduction

Such software's are useful when we want to convert our Hard copies into soft copies. Such software's reduces almost 80% of the conversion work while still some verification is always required.

Optical character recognition, usually abbreviated to OCR, involves computer software designed to translate images of typewritten text (usually captured by a scanner) into machine-editable text, or to translate pictures of characters into a standard encoding scheme representing them in (ASCII or Unicode). OCR began as a field of research in artificial intelligence and machine vision. Though academic research in the field continues, the focus on OCR has shifted to implementation of proven techniques [4].

2 Artificial Nueral Network

Pattern recognition is extremely difficult to automate. Animals recognize various objects and make sense out of large amount of visual information, apparently requiring very little effort. Simulating the task performed by animals to recognize to the extent allowed by physical limitations will be enormously profitable for the system. This necessitates study and simulation of Artificial Neural Network. In Neural Network, each node perform some simple computation and each connection conveys a signal from one node to another labeled by a number called the "connection strength" or weight indicating the extent to



$$a = W_1X_1 + W_2X_2 + \dots + W_NX_N + \text{Bias}$$

$$\text{output} = \text{Threshold}(a)$$

$$\text{where} \quad \text{Threshold}(a) = \begin{cases} -1, & \text{for all } a \le 0 \\ 1, & \text{for all } a > 0 \end{cases}$$

Fig. 1 A simple Neuron

which signal is amplified or diminished by the connection.

Different choices for weight results in different functions are being evaluated by the network. If in a given network whose weight are initial random and given that we know the task to be accomplished by the network , a learning algorithm must be used to determine the values of the weight that will achieve the desired task. Learning Algorithm qualifies the computing system to be called Artificial Neural Network. The node function was predetermined to apply specific function on inputs imposing a fundamental limitation on the capabilities of the network.

Typical pattern recognition systems are designed using two pass. The first pass is a feature extractor that finds features within the data which are specific to the task being solved (e.g. finding bars of pixels within an image for character recognition). The second pass is the classifier, which is more general purpose and can be trained using a neural network and sample data sets. Clearly, the feature extractor typically requires the most design effort, since it usually must be hand-crafted based on what the applica-

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tion is trying to achieve.

One of the main contributions of neural networks to pattern recognition has been to provide an alternative to this design: properly designed multi-layer networks can learn complex mappings in high-dimensional spaces without requiring complicated hand-crafted feature extractors. Thus, rather than building complex feature detection algorithms, this paper focuses on implementing a standard backpropagation neural network. It also encapsulates the Preprocessing that is required for effective.

2.1 Backpropogation

Backpropagation was created by generalizing the Widrow-Hoff learning rule to multiple-layer networks and nonlinear differentiable transfer functions. Input vectors and the corresponding target vectors are used to train a network until it can approximate a function, associate input vectors with specific output vectors, or classify input vectors in an appropriate way as defined by you. Networks with biases, a sigmoid layer, and a linear output layer are capable of approximating any function with a finite number of discontinuities.

3 Analysis

By analyzing the OCR we have found some parameter which affects the accuracy of OCR system [1][5]. The parameters listed in these papers are skewing, slanting, thickening, cursive handwriting, joint characters. If all these parameters are taken care in the preprocessing phase then overall accuracy of the Neural Network would increase.

4 Design and Implementation

Initially we are making the Algorithm of Character Extraction. We are using MATLAB as tool for implementing the algorithm. Then we design neural network, we need to have a Neural Network that would give the optimum results [2]. There is no specific way of finding the correct model of Neural Network. It could only be found by trial and error method. Take different models of Neural Network, train it and note the output accuracy.
There are basically two main phases in our Paper:
Preprocessing and Character Recognition .

In first phase we have are preprocessing the given scanned document for separating the Characters from it and normalizing each characters. Initially we specify an input image file, which is opened for reading and preprocessing. The image would be in RGB format (usually) so we convert it into binary format. To do this, it converts the input image to grayscale format (if it is not already an intensity image), and then uses threshold to convert this grayscale image to binary i.e all the pixels above certain threshold as 1 and below it as 0.

Firstly we needed a method to extract a given character from the document. For this purpose we modified the graphics 8-way connected algorithm (which we call as EdgeDetection).

5 Preprocessing

5.1 Character Extraction Algorithm

1. Create a TraverseList :- List of pixels which have been already traversed. This list is initially empty.
2. Scan row Pixel-by-Pixel.
3. Whenever we get a black pixel check whether the pixel is already in the traverse list, if it is simply ignore and move on else apply Edgedetection Algorithm.
4. Add the List of Pixels returned by Edgedetection Algorithm to TraverseList.
5. Continue the steps 2 - 5 for all rows

5.2 Edge Detection Algorithm

The Edge Detection Algorithm has a list called traverse list. It is the list of pixel already traversed by the algorithm.

EdgeDetection(x,y,TraverseList);

1) Add the current pixel to TraverseList. The current position of pixel is (x,y).

2) NewTraverseList= TraverseList + current position (x,y).

```
If  pixel at (x-1,y-1) then
Check if it is not in TraverseList.
Edgedetection(x-1,y-1,NewTraverseList);
endif

If  pixel at (x-1,y) then
Check if it is not in TraverseList.
Edgedetection(x-1,y,NewTraverseList);
endif

If  pixel at (x-1,y) then
Check if it is not in TraverseList.
Edgedetection(x-1,y+1,NewTraverseList);
endif

If  pixel at (x,y-1) then
Check if it is not in TraverseList.
Edgedetection(x,y-1,NewTraverseList);
Endif

If  pixel at (x,y+1) then
Check if it is not in TraverseList.
Edgedetection(x,y+1,NewTraverseList);
endif
```

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If pixel at (x+1,y-1) then
Check if it is not in TraverseList.
Edgedetection(x+1,y-1,NewTraverseList);
endif

If pixel at (x+1,y) then
Check if it is not in TraverseList.
Edgedetection(x+1,y,NewTraverseList);
endif

If pixel at (x+1,y+1) then
Check if it is not in TraverseList.
Edgedetection(x+1,y+1,NewTraverseList);
endif

3) return;

The EdgeDetection algorithm terminates when it has covered all the pixels of the character as every pixel's position would be in TraverseList so any further call to EdgeDetection is prevented.

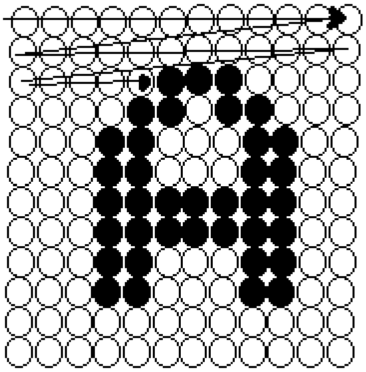
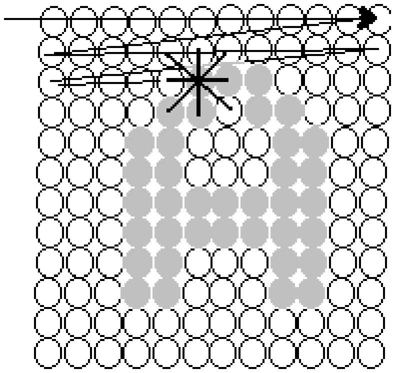


Fig 4(a) shows the traversing each scan lines.



4(b) shows the respective calls made to the all 8-neighbouring pixels.

The Edge detection is called when we hit a pixel (i.e. encounter a pixel with value 1). As per the algorithm the current position is entered in TraverseList and recursive calls are made to all 8 - neighboring pixels. Before the calls are made it is ensured that the corresponding neighboring pixels is having value 1 and is not already encountered before i.e. it should not be in the TraverseList.

5.3 Normalizing

Now as we have extracted the character we need to normalize the size of the characters. There are large variations in the sizes of each Character hence we need a method to normalize the size.

We have found a simple method to implement the normalizing. To understand this method considers an example that we have extracted a character of size 7 X 8. We want to convert it to size of 10 X 10. So we make a matrix of 70 X 80 by duplicating rows and columns. Now we divide this 70 X 80 into sub Matrix of 7 X 8. We extract each sub matrix and calculate the no. of ones in that sub matrix. If the no. of one's is greater than half the size of sub matrix we assign 1 to corresponding position in normalized matrix. Hence the output would be a 10 X 10 matrix.

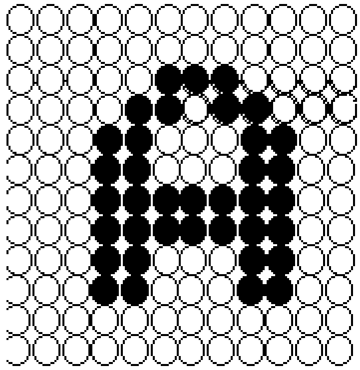


Fig 5(a) shows original representation of the character.

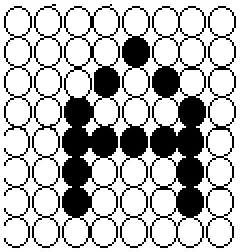


Fig 5(b) shows the Normalized Character representation after Normalizing.

The Fig 5(a) is shows a representation of character of 12 X 12 size. Using the above algorithm it is converted into a character of 8 X 8 as shown in the Fig 5(b).

5.4 Skew Detection

The Characters are often found to be skewed. This would impose problems on the efficient character recognition [3]. So to correct the effect of this skewedness we need counter rotate the image by an angle θ.

We use a very simple but effective technique for Skew Correction. We use "Line Fitting" i.e. Linear Regression to find the angle θ. Consider the Skewed character as a graph i.e. all the pixels that have value 1 are considered to be data points. Then we perform linear regression using the equation Y = M*X +C. Using the formulas for regres-

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sion we calculate M= (nΣxiyi - ΣxiΣyi) / (nΣxi2-(Σxi)2). This angle is equivalent to the skewed angle so by rotating the image by opposite of this angle will remove the skew ness. This is a very crude way of removing skew ness there are other highly efficient ways of removing skew ness. But for Characters that have very low Skew angles this gets the thing done.

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Fig 6(a) Skewed Image Fig 6(b) Corrected Image.

6 NUERAL NETWORK DESIGN

For training and simulating purposes we have scanned certain documents. We have 2 types of documents train documents and test documents. The train documents are the images of the documents which we want to use for training. Similarly test documents are the images of documents which we want to use for test. According to the characters in the documents we train the neural network and apply the test documents.

We have different Models of Neural Network. Hence we record certain parameters like training time, accuracy etc. to find the effectiveness of the Neural Network.

We have selected an image size of 10 X 10 as an input to the Neural Network. Hence we have taken a neural network that has 100 inputs. We are performing the test on only Capital characters so the outputs of the Neural Networks are 26. The no. of nodes of input layer are 100 and the no. of node of output layer are 26. The no. of hidden layer and the size of hidden layer vary.

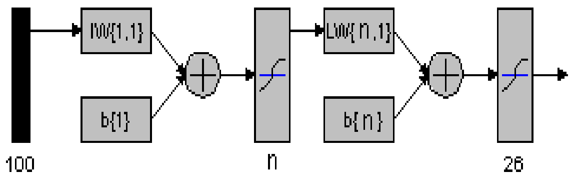

Fig 7. The general Model of ANN used.

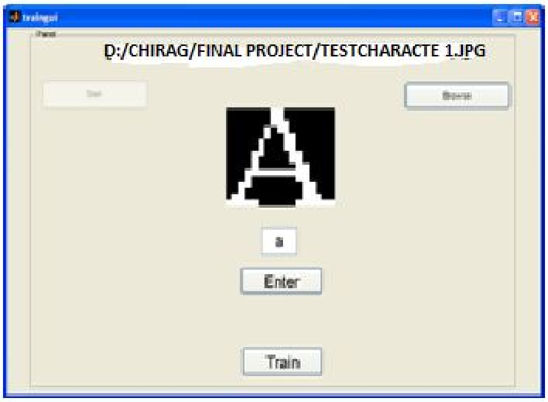

Fig 8. Ttraining automated character extraction

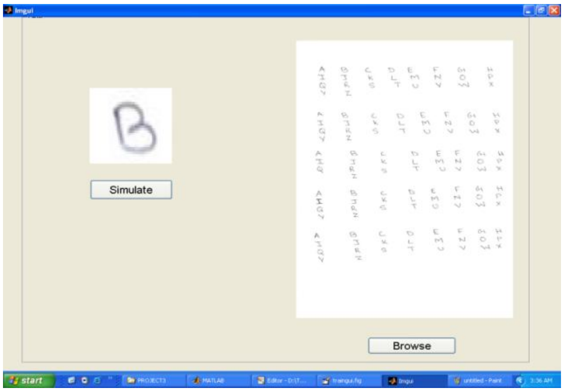

Fig 9 recognition

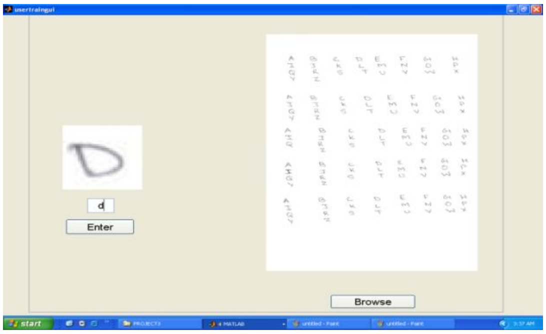

Fig 10 Training – User defined Character Extraction.

7 TEST AND RESULTS ANALYSIS

7.1 Test

This section shows some implementation results. The

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training variables involved in the tests were: the number of cycles, the size of the hidden layer, and the number of hidden layer. The dataset consisted of A-Z typed characters of different size and type. Thus the input layer consisted of 100 neurons, and the output layer 26 neurons (one for each character). Ideally, we'd like our training and testing data to consist of thousands of samples, but this not feasible since this data was created from scratch.

Table 1. Model 1

Epochs	Number of Hidden Layer	Configuration (No. of nodes in HL)	(%)
300	1	26	20
600	1	26	65
1000	1	26	82
300	1	52	25
600	1	52	69
1000	1	52	88
300	1	78	27
600	1	78	71
1000	1	78	91

Table 2. Model 2

Epochs	Number of Hidden Layer	Configuration (No. of nodes in HL)	(%)
300	2	26-52	23
600	2	26-52	67
1000	2	26-52	81
300	2	52-78	40
600	2	52-78	78
1000	2	52-78	96
300	2	26-78	27
600	2	26-78	77
1000	2	26-78	89

Table 3. Model 3

Epochs	Number of Hidden Layer	Configuration (No. of nodes in HL)	Accuracy (%)
300	3	26-52-26	31
600	3	26-52-26	65
1000	3	26-52-26	82
300	3	26-52-78	29
600	3	26-52-78	74
1000	3	26-52-78	92
300	3	78-26-78	27
600	3	78-26-78	71
1000	3	78-26-78	91

Table 4. Model 4

Epochs	Number of Hidden Layer	Configur (No. of nodes in HL)	Accurac (%)
300	3	26-52-26	31
600	3	26-52-26	65
1000	3	26-52-26	82
300	3	26-52-78	29
600	3	26-52-78	74
1000	3	26-52-78	92
300	3	78-26-78	27
600	3	78-26-78	71
1000	3	78-26-78	91

Table 5. Model 5

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Epochs	Number of Hidden Layer	Configur (No. of nodes in HL)	Accura (%)
300	4	26-52-78-104	35
600	4	26-52-78-104	79
1000	4	26-52-78-104	96
300	4	26-52-78-26	30
600	4	26-52-78-26	61
1000	4	26-52-78-26	86
300	4	78-26-52-104	43
600	4	78-26-52-104	82
1000	4	78-26-52-104	98
300	4	78-26-78-52	31
600	4	78-26-78-52	88
1000	4	78-26-78-52	94

Table 6. Model 6

Epochs	Number of Hidden Layer	Configur (No. of nodes in HL)	Accura (%)
300	4	26-52-78-104	35
600	4	26-52-78-104	79
1000	4	26-52-78-104	96
300	4	26-52-78-26	30
600	4	26-52-78-26	61
1000	4	26-52-78-26	86
300	4	78-26-52-104	43
600	4	78-26-52-104	82
1000	4	78-26-52-104	98
300	4	78-26-78-52	31
600	4	78-26-78-52	88
1000	4	78-26-78-52	94

We have used sigmoid transfer function in all the layers. We have used same dataset for training all the different Models while testing character set was changed.

7.2 Result Analysis

From the results, the following observations are made:

- A small number of nodes in the hidden layer (eg. 26) lower the accuracy.
- A large number of neurons in the hidden layer help in increasing the accuracy; however there is probably some upper limit to this which is dependent on the data being used. Additionally, high neuron counts in the hidden layers increase training time significantly.
- As number of hidden layer increases the accuracy increases initially and then saturates at certain rate probably due to the data used in training.
- Mostly Accuracy is increased by increasing the number of cycles.
- Accuracy could also be increased by increasing the training set.

7.3 Additional Formatting and Style Resources

Additional information on formatting and style issues can be obtained in the IJSER Style Guide, which is posted online at: http://www.ijser.org/. Click on the appropriate topic under the Special Sections link.

8 Conclusion

The backpropagation neural network discussed and implemented in this paper can also be used for almost any general image recognition applications such as face detection and fingerprint detection. The implementation of the fully connected backpropagation network gave reasonable results toward recognizing characters.

The most notable is the fact that it cannot handle major variations in translation, rotation, or scale. While a few pre-processing steps can be implemented in order to account for these variances, as we did. In general they are difficult to solve completely.

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A New Approach for Data Encryption Using Genetic Algorithms and Brain Mu Waves

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Abstract: In today's computer world security, integrity, confidentiality of the organization's data is the most important issue. This paper deals with the confidentiality of the data that organization manages and works with. This paper proposes a new approach to data security using the concept of genetic algorithm and brain mu waves with pseudorandom binary sequence to encrypt and decrypt the data. The feature of such an approach includes high data security and high feasibility for practical implementation.

Index Terms—Mu waves, Genetic algorithms, Pseudorandom binary sequence, Encryption, Crossover operator, Data security, Confidentiality.

INTRODUCTION

Recently, due to the big data losses from illegal data access, data security has become an important issue for public, private and defense organizations. In order to protect this valuable data or information from unauthorized readers and illegal modifications and reproductions various types of cryptographic techniques are used.

There are two basic types of cryptographic techniques [1],[2]: symmetric and asymmetric cryptography. In symmetric cryptography, same key is used for encryption and decryption. While in asymmetric cryptography, two different keys are used, one for encryption called public key and another for decryption called private key.

Symmetric key algorithms are typically fast and are suitable for processing large stream of data. Some of the popular and efficient symmetric algorithms include Twofish, Serpent, AES, Blowfish and IDEA etc. There are other encryption algorithms which are proposed. Genetic algorithms [4] are among such techniques.

Generally, genetic algorithms contain three basic operators: reproduction, crossover and mutation [5].

Reproductions and crossover together gives the genetic algorithms most of their power.

This paper proposes a new approach for encrypting large volume of organization data and highly secret personal data or information. First, an 8 character long string is interpreted from the mu waves generated by the brain. Second, a pseudo random binary sequence is generated from the string obtained after processing above string. Third, the first character string and the pseudorandom sequence is applied to crossover operator which will output two keys which then are concatenated to get a final 512 bit key.

This key is then used to encrypt and decrypt data.

The rest of the paper is organized as follows. In section 2, the proposed method is introduced. Section 3 gives the analysis of proposed method. Section 4 concludes the paper.

1. THE PROPOSED METHOD

The proposed method block diagram is shown in fig 1. It consists of key generation logic, encryption and decryption modules, which are explained in following subsections.

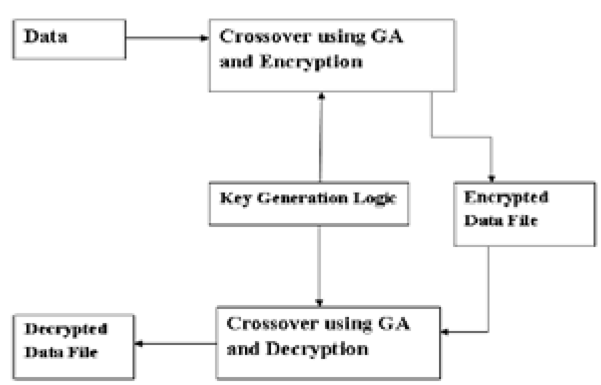

Fig 1.The Block Diagram of Proposed Method

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1.1 The Key Generation Logic

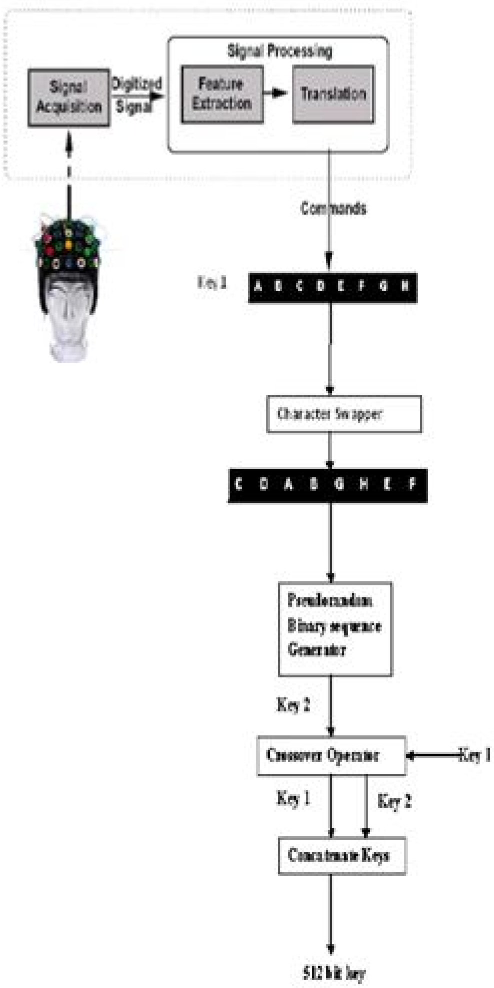

Fig 2.Block Diagram for Key Generation Process

Fig 2 shows the model of key generation logic. It consists of sensory input detection unit which is responsible for detecting the mu waves of the pass though of user (pass thought is the thinking which is used as a key in latter processing.) and interpreting appropriate characters that the user is thinking about to press. This involves signal acquisition, feature extraction, and finally translation.

The other modules involved in this are character swapper, pseudorandom binary sequence generator and crossover operator. The pseudorandom binary sequence generator is explained in following subsections.

2.1.1 Character Swapper

There are mainly two function performed by this unit. First is, separating the characters according their position i.e., odd or even. Then each two consecutive odd/even positioned characters are swapped with their next character.

2.1.2 Pseudorandom Binary Sequence Generator

Fig 3 shows a general model of PRBSG [3]. It is a non linear forward feedback shift register with a feedback function f and non linear function g.

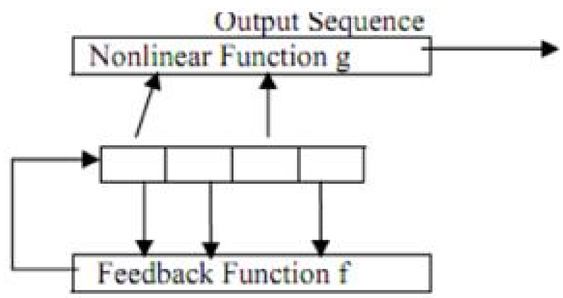

Fig 3.A General Model Of 4 bit NLFFSR

When register is loaded with a non-zero value, a pseudo random sequence with very good randomness and statistical properties is generated.

The only signal required for the operation of this module clock pulse. The balance, run and correlation properties of the sequence generated make it more useful for generating the private key.

2.1.3 Crossover Operator

Crossover in simple words is a process in which two strings are mixed such that they match their desirable qualities in a random fashion.

Crossover operator proceeds in three steps as given below:

1. Two new strings are selected.

2. A random location from strings is selected.

3. The portions of strings on right side are swapped together.

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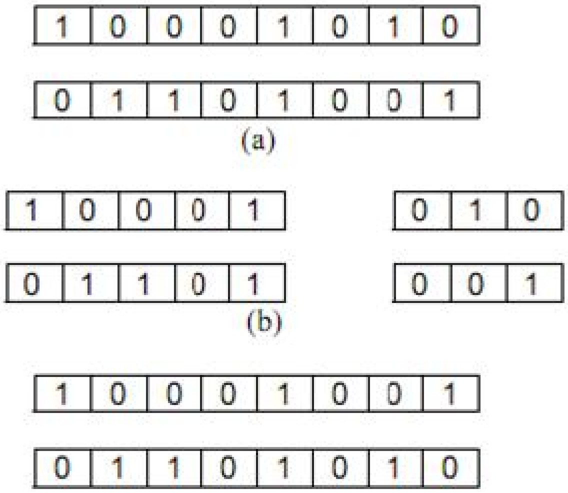

Fig 4. Illustration of crossover operator

2.1.4 Key Generation Process

The key generation algorithm used here produces a very strong key which is very difficult to guess even with exhaustive search. The process of key generation is as given below:

1. Scan the pass thought. Take the string generated after sensing, filtering and processing Mu waves. This is key1.

2. Pass this string to the character swapper.

3. Pass the non zero output of character swapper to the pseudo random binary sequence generator.

4. The output of PRBSG is key2.

5. Both key1 and key2 are 256 bit long.

6. Apply both these keys to crossover operator.

7. Finally, concatenate the two strings generated at

after crossover operation.

This whole process is depicted in fig 2.

2.2 The Encryption Process

The encryption process emulates the operation of key generator and crossover operator. The encryption process comprises of following steps:

1. Generate the key using the key generator logic as Kn.

2. Take mode 8 of the key generated to get decimal value ranging from 0 to 7.

3. Kn =mod (Kn, 8)

4. Initialize i=0

5. Take two consecutive bytes of the data file as A1 and A2

6. Crossover the two consecutive bytes of the data file as B1 and B 2 Using the number Ki.

7. Encrypt data as C1 and C2 .This is done as follows:

Xi=Ki XOR Ki << 4

Xi+1=ki+1 XOR ki+1 <<4

C1=Bi XOR X1

C2=B2 XOR Xi+1

And i=i+2

Repeat steps 4 to 6 until end of the file.

2.3 The Decryption Process

The steps for encryption are just reversal of the encryption. First extract the key1 from sensory output, then obtain key2 through character swapper, generate PRBS and then the key, apply the process using crossover operator decrypt the data.

3. PERFORMANCE ANALYSIS

It should be checked that, if a data is encrypted by the proposed technique whether it can be easily decrypted or not. Since there are M combinations to encrypt 2 consecutive data bytes, thus the number of possible encryption results is M (N/2), where N is the total number of bytes in data to be encrypted and M is the length of one data byte.

The speed of the algorithm is good.

But, the initial key generation process takes some time which may decrease the throughput of the algorithm and may increase the execution time by some seconds.

4. CONCLUSION

This paper proposes a new approach for data security. It uses the concept of brain Mu waves, genetic algorithms and pseudorandom binary sequence. This methodology of scurrying the confidential data is highly safe and reliable. So, without the secret thought of the person i.e., the key no one will be able to extract the data. Since, the

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pass thought is unpredictable is unpredictable it is very difficult to decrypt correctly without knowing the initial pass thought. The proposed method is very sensitive to the changes in pass thought. In the future work, we plan to implement a system implementing this methodology and provide security to highly confidential and secret data in defense and other institutions.

ACKNOWLEDGMENT

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Use of Natural Compounds from Plant Sources as AchE Inhibitors for the Treatment of Early Stage Alzheimer's disease-An Insilico Approach

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Abstract— Traditionally, drugs were discovered by testing compounds manufactured in time consuming multi-step processes against a battery of in vivo biological screens. Promising compounds were then further studied in development, where their pharmacokinetic properties, metabolism and potential toxicity were investigated. Here we present a study on herbal lead compounds and their potential binding affinity to the effectors molecules of major disease like Alzheimer's disease. Clinical studies demonstrate a positive correlation between the extent of Acetyl cholinesterase enzyme and Alzheimer's disease. Therefore, identification of effective, well-tolerated acetyl cholinesterase represents a rational chemo preventive strategy. This study has investigated the effects of naturally occurring nonprotein compounds polygala and Jatrorrhizine that inhibits acetylcholinesterase enzyme. The results reveal that these compounds use less energy to bind to acetylcholinesterase enzyme and inhibit its activity. Their high ligand binding affinity to acetylcholinesterase enzyme introduce the prospect for their use in chemopreventive applications in addition they are freely available natural compounds that can be safely used to prevent Alzheimer's Disease.

Index Terms— Alzheiemr's Disease, Acetylcholinesterase, Binding Affinity, Jatrorrhizine, Clinical Studies, Docking, Rational, Toxicity

1 INTRODUCTION

Alzheimer's disease, most common form of dementia is incurable, degenerative, and terminal disease mostly diagnosed in people over 65 years of age. The disease advances with symptoms include confusion, irritability and aggression, mood swings, language breakdown, long-term memory loss, and the general withdrawal of the sufferer as their senses decline. Gradually, bodily functions are lost, ultimately leading to death. In advanced stages of the disease, all memory and mental functioning may be lost. The condition predominantly affects the cerebral cortex and hippocampus, which lose mass and shrink (atrophy) as the disease advances. These changes, occurring in the association area of the cerebral cortex, the hippocampus and the middle and temporal lobes, are accompanied by decreased concentrations of the neurotransmitter acetylcholine.Acetylcholinesterase is also known as AChE. An acetyl cholinesterase inhibitor or anti-cholinesterase is a chemical that inhibits the cholinesterase enzyme from breaking down acetylcholine, increasing both the level and duration of action of the neurotransmitter acetylcholine.

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2 METHODOLOGY

Some small molecules were taken as targeting agent which are responsible for inhibiting biological process in AD. The investigation drug Galantamine was used as a reference drug in the studies.
2W9I was taken as targeting protein and structure for the same was taken from PDB.
Then Initial screening is done by Lipinski's rule of 5. The accepted compounds that were showing better interaction with the target protein and their energy were minimized using Marvin's Sketch.
Then the selected conformations are saved in three formats:

1. SDF Format
2. PDB Format
3. MOL. Format

Then docking is done between the protein and small molecules with QUANTUM. The best three results

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obtained were analysed under HEX and ARGUS. IC50 value is taken by QUANTUM.Then graphs are plotted by seeing the values.

After this, ADME TOX analysis was performed. In this analysis ADME features were showing interaction
With 2W9I in both Argus and Quantum analysis were predicted under ADME test for toxicity prediction.

TABLE 1
Natural compounds and Their Quantum results

S.no	**Name of compound**	**Gbind**	**Rms**
1.	Dichlorfop	-17.66	69.85
2.	Naringenin	-20.45	72.55
3.	Caffeine	-13.02	80.61
4.	Cla	-20.00	66.34
5.	Toluidine red	-12.08	69.48
6.	Polygala	-22.82	73.28
7.	Jatrorrhizine	-25.95	96.90
8.	Sterigmatocystin	-22.54	73.39
9.	Testosterone	-20.03	74.21
10.	Vitamin b6	-21.39	72.23

TABLE 2
Drugs and Their Quantum results

S.no	**Name of drug**	**Gbind**	**Rms**
1.	Cinacalcet	-15.58	95.83
2.	Penicillamine	-16.18	90.59
3.	Selegeline	-21.29	90.18
4.	Amantadine	-23.79	94.72

AMES test is considering for initial screening of the molecule based on their ability to induce mutation.
AMES test is used for determining if a chemical is mutagen. The molecules which showing ability to induce mutation were rejected in toxicity based screening.

Using ADME TOX analysis it was found that **Jatrorrhizine** was showing lower AMES test values than reference molecules. Further health effects of these molecules in blood, cardiovascular system, gastrointestinal system, kidney, liver and lungs were predicted. LD 50 values also were predicted for selecting reliable molecule for ADME analysis.
After ADME analysis,a graph was plotted on ADME-TOX values.

After all analysis, one compound **Jatrorrhizine** was the best molecule.
This molecule is considered as better ligands for 2W9I based on interaction, Pharmacokinetics, and pharmacodynamic features and can be used for Chemotherapeutic use.

3 BIOCHEMISTRY OF ALZHEIMER'S

The biochemistry of Alzheimer's disease (AD), one of the most common causes of adult dementia, is as yet not well understood. It has been identified as a protein misfolding disease due to the accumulation of abnormally folded amyloid betaprotein in the brains of AD patients. Amyloid beta, also written Aβ, is a short peptide that is an abnormal proteolyticbyproduct of the transmembrane protein amyloid precursor protein (APP), whose function is unclear but thought to be involved in neuronal development. The presenilins are components of proteolytic complex involved in APP processing and degradation. Amyloid beta monomers are soluble and contain short regions of beta sheet and polyproline II helix secondary structures in solution, though they are largely alpha helical in membranes; however, at sufficiently high concentration, they undergo a dramatic conformational change to form a beta sheet-rich tertiary structure that aggregates to form amyloid fibrils. These fibrils deposit outside neurons in dense formations known as senile plaques or neuritic plaques, in less dense aggregates as diffuse plaques, and sometimes in the walls of small blood vessels in the brain in a process called amyloid angiopathy orcongophilic angiopathy.
AD is also considered a tauopathy due to abnormal aggregation of the tau protein, a microtubule-associated proteinexpressed in neurons that normally acts to stabilize microtubules in the cell cytoskeleton. Like most microtubule-associated proteins, tau is normally regulated by phosphorylation; however, in AD patients, hyperphosphorylated tau accumulates as paired helical filaments that in turn aggregate into masses inside nerve cell bodies known as neurofibrillary tangles and as dystrophic neurites associated with amyloid plaques. Although little is known about the process of filament assembly, it has recently been shown that a depletion of a prolyl isomerase protein in the parvulin family accelerates the accumulation of abnormal tau.

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4 Disease Mechanism

Although the gross histological features of AD in the brain are well characterized, three major hypotheses have been advanced regarding the primary cause. The oldest hypothesis suggests that deficiency in cholinergic signaling initiates the progression of the disease. Two alternative misfolding hypotheses instead suggest that either tau protein or amyloid beta initiates the cascade. While researchers have not identified a clear causative pathway originating from any of the three molecular hypotheses to explain the gross anatomical changes observed in advanced AD, variants of the amyloid beta hypothesis of molecular initiation have become dominant among the three possibilities.

4.1 The mechanism of action of acetylcholinestarase

Cholinergic nerve transmission is terminated by the enzyme acetylcholinesterase (AchE). AchE is found both on the post-synaptic membrane of cholinergic synapses and in other tissues eg red blood cells. Acetylcholine (Ach) binds to AchE and is hydrolysed to acetate and choline. This inactivates the Ach and the nerve impulse is halted. AchE inhibitors (eg rivastigmine) prevent the hydrolysis of Ach, which increases the concentration of Ach in the synaptic cleft; AchE inhibitors are widely used in the treatment of Alzheimer's disease.

5 Results and Analysis

Alzheimer's disease, the most common form of dementia, is a progressive disorder characterized by widespread loss of brain cells called neurons, beta-amyloid deposits in the cerebral blood vessels, development of plaques and the presence of neurofibrillary tangles. Alzheimer's disease (AD) is an irreversible, progressive disorder in which brain cells(neurons) deteriorate, resulting in the loss of cognitive functions, primarily memory, judgment and reasoning, movement coordination, and pattern recognition. There is a very high genetic cause for Alzheimer's disease. In addition to genetics as a cause of Alzheimer's disease, many environmental factors including diet are to be considered. Older adults who smoke have an elevated risk of developing Alzheimer's disease. Nerve signals travel across synapses with the help of chemicals known as "neurotransmitters," including one called acetylcholine. Nerve cell destruction causes a reduction in acetylcholine, leading to impaired transmission of nerve signals and poor communication between nerve cells called neurons. In addition to acetylcholine, the brain of Alzheimer's disease patients have areas of abnormal protein called "plaques" and "tangles," the names reflecting what these abnormalities in the brain look like under the microscope. The underlying cause of Alzheimer's – what actually triggers the changes in the brain – is still not fully known but could partly be due oxidation and damage to nerve cells over time. It is likely that no single factor is responsible, but rather that it is due to a variety of factors, which may differ from person to person.

People whose parents or brothers and sisters develop the disease appear to be at greater risk of developing it themselves, so there may be a genetic component. However, no straightforward pattern of inheritance has been found. It is known that head injury is a risk factor, and also that Alzheimer's disease often affects people with Down's syndrome. Some researchers have suggested that people who exercise their brains (for example, doing crosswords and other mental agility exercises) are less likely to develop the disease. And Omega 3 fatty acids, contained in oily fish such as mackerel and salmon may, also help to prevent dementia. Australian scientists say they have identified a toxin that may play a key role as a potential cause of Alzheimer's disease. The toxin, called quinolinic acid, kills nerve cells in the brain, leading to dysfunction and death. Quinolinic acid may not be the main cause of Alzheimer's disease, but it plays a key role in its progression. Researchers have shown that a common anesthetic gas can cause fragments of a normal brain protein called amyloid-beta to clump together, which is thought to be the main problem underlying Alzheimer's disease. Intravenous anesthetics have less of an effect, the team reports in the journal Biochemistry.

Anesthetics used in long surgery, such as inhaled anesthetics isoflurane and halothane, may be another cause of Alzheimer's disease. Scientists conducted a series of lab experiments using nuclear magnetic resonance to investigate the reaction of amyloid-beta peptides to the inhaled anesthetic isoflurane and the intravenous anesthetics propofol and thiopental. They found that the peptides aggregated together after 10 to 30 hours' exposure to isoflurane, depending on the concentration of the gas and the size of the protein fragments. The effect was seen with propofol after exposure for 48 hours, but no clumping was seen with thiopental. Biochemistry, January 23, 2007.

Having frequent colds or flu or other infections increases the risk for this neurological deterioration due to increased overall inflammation in the body and brain.

There are certain natural and synthetic AchE inhibitors which will prevent the cause of AD by blocking the Biochemical pathway .Some number of natural compounds which are Inhibiting Ache were taken.

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Docking of these molecules was performed under QUANTUM 3.3.0.
It was found that the natural compound Polygala, Sterigmatocystin and Jatrorrhizine were showing reliable pharmacokinetics and pharmacodynamics features than the commercial drugs. Hence they were taken out for work.
After analysing the graphs, it was found that Bulbocapnie was the best Acetylcholinesterase Inhibitor.
This molecule is considered as better ligands for Acetylcholinesterase based on ligand-receptor interaction,
Jatrorrhizine is a protoberberine alkaloid isolated from *Enantia chlorantha* (Annonaceae) and other species. Synonyms that may be encountered include jateorrhizine, neprotin, jatrochizine, jatrorhizine, or yatrorizine. It has been reported to have anti inflammatory effect, and to improve blood flow and mitotic activity in thioacetamide-traumatized rat livers. It was found to have antimicrobial and antifungal activity. It binds and noncompetitively inhibits monoamine oxidase (IC_{50} 4 micromolar for MAO-A and 62 for MAO-B). It interferes with multidrug resistance by cancer cells *in vitro* when exposed to a chemotherapeutic agent. Large doses (50-100 mg/kg) reduced blood sugar levels in mice by increasing aerobic glycolysis.

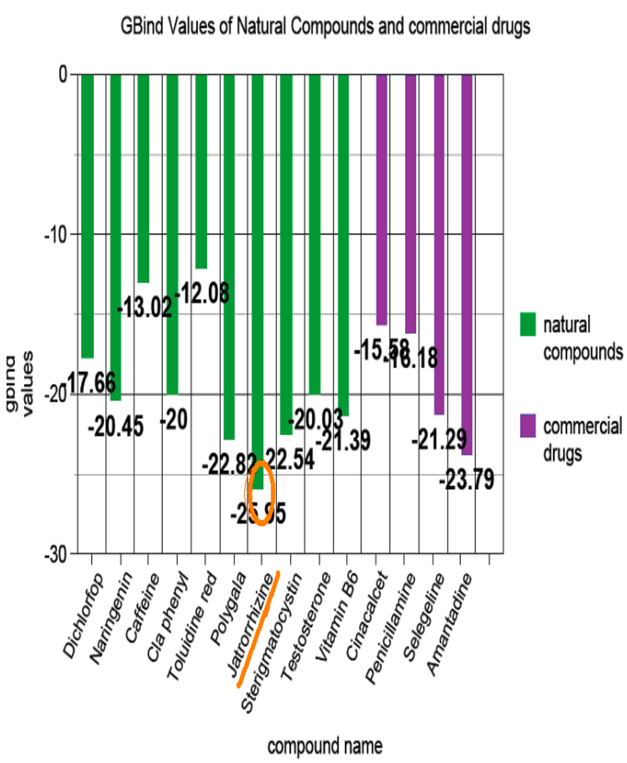

Fig. 1: Graph showing QUANTUM Results of natural compounds and commercial drugs. Greens are for natural compounds and red is for commercial drugs.

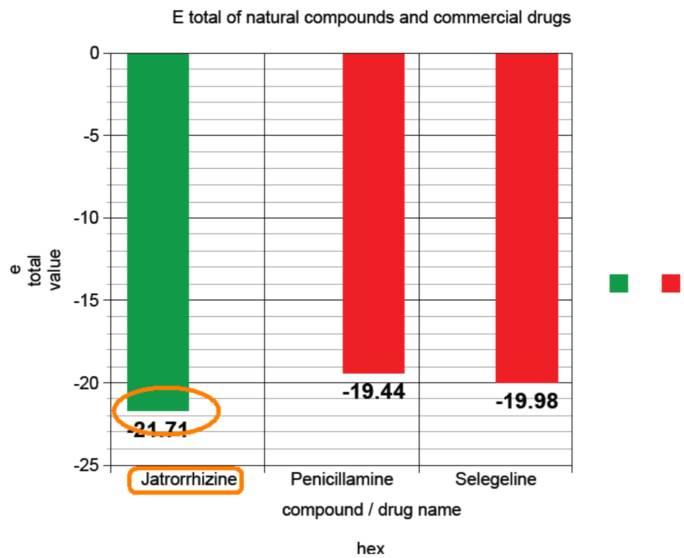

Fig.2: Graph showing Hex results of best two natural compounds and best two commercial drugs based on quantum. Greens are for natural compounds and red is for commercial drugs.

6 Conclusion

Alzheimer's disease, the most common form of dementia, is a progressive disorder characterized by widespread loss of brain cells called neurons, beta-amyloid deposits in the cerebral blood vessels, development of plaques and the presence of neurofibrillary tangles. Alzheimer's disease (AD) is an irreversible, progressive disorder in which brain cells (neurons) deteriorate, resulting in the loss of cognitive functions, primarily memory, judgment and reasoning, movement coordination, and pattern recognition.There are certain natural and synthetic AchE inhibitors which will prevent the cause of AD by blocking the Biochemical pathway .Some number of natural compounds which are Inhibiting Ache were taken.Docking of these molecules was performed under QUANTUM. It was found that the natural compound POLYGALA, STERIGMATOCYSTIN AND JATRORRHIZINE was showing reliable pharmacokinetics and pharmacodynamics features than the commercial drugs. Hence they were taken out for work.

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Further, it was found that among three natural compounds JATRORRHIZINE is the best natural compound and better than commercial drugs and hence can be taken as AD chemopreventive agent and it can be effective inhibitors for AchE in AD pathway.

ACKNOWLEDGMENT

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Hybrid Mechanical Charger

Ayush R Jain, Chinmay V Harmalkar

Abstract— Mobile phone is our means to remain connected. While the phones have progressively got more powerful processors (clocking 1GHz), huge amounts of memory and large touch screen interfaces, their power requirement has increased correspondingly. Unfortunately, battery technology has not been growing at a comparable pace. Hence, there is a need to frequently charge the batteries. While travelling people face a common problem of charging electronic appliances like mobile, mp3 player, camera, etc. Solution to this problem is Hybrid Mechanical Charger, extracts energy from some reliable renewable source. Hence in order to achieve this, Hybrid Mechanical Charger uses mechanical energy from both windmill and hand crank. To compensate the difference in rpm a gear shifting mechanism is used.

Keywords— Gear box, Generator, Handcrank, Windmill

1 Introduction

Existing battery chargers depend on the electricity supply. During travelling, avalibility of electricity supply is a problem. Hybrid Mechanical Charger is developed to solve this problem. Mechanical chargers have been previously developed but they either have hand crank or windmill mechanism to provide mechanical energy to the generator. These Mechanical chargers are not reliable and hence they are not prevalent. Hybrid Mechanical Charger harnesses energy by both mechanisms - handcrank and windmill using a single generator. This is achieved by using gear shifting mechanism. Hybrid Mechanical Charger increases the relaiblity for charging of electronic appliances.

2 Design

2.1 Generator

Generator is used to convert mechanical energy to electrical energy. Generator used is a permanent magnet geared dc motor. The stator consists of two magnets aligned with opposite poles facing each other and the rotor consists of three coils. When the shaft of the motor rotates, there is a relative motion between the permanent magnets and the coils which generates ac current in the coil. The flux associated with the coil is radial in nature. Commutator is used as a mechanical rectifier to convert AC current to DC current. The output of generator is 12v at 435rpm. The generator consists of a base motor and a gear box. The base motor rpm is quite large and to reduce the rpm it consists of a gear box. The gearbox consists of various gears such last gear is attached to the shaft. Gear 3 is mounted on gear 2 and gear 5 is mounted on gear 4. Gear 1 is attached to the shaft of the base motor. (Refer to table 1)

TABLE 1
Gear Box Assembly

Gear No	No of Teeth
Base Motor Shaft Gear	9
Gear no 2	28
Gear no 3	8
Gear no 4	26
Gear no 5	14
Final Shaft Gear	20

2.2 Windmill and Handcrank

Mechanical Enregy is required to produce electricity from generator, for which windmill and hand crank are used. The windmill has got three blades of length 117mm, which are attached to a hub of radius 23mm. Three blades are used to maintain proper rpm by reducing the effect of turbulence. It is a horizontal axis windmill which works on Bernoulli's principle which says that "as the velocity of the fluid increases, the pressure exerted by that fluid decreases". The shape of the windmill blade is aerofoil which is the main cause of the lift force which drives the windmill. Linear velocity at every point on blade is different because as radius changes at different point the linear velocity also changes.

$$v = r\omega \qquad (1)$$

v: linear velocity
r: Radius of windmill
ω: Angular velocity

At the tip the linear velocity is maximum. Therefore the drag force at the tip will be maximum which will give rise to shearing force. It can cause damage to the blade. To reduce the shearing force the area of the tip is reduced by making the tip narrow.

2.3 Gear Shifting Mechanism

The windmill rotates at 400-500 rpm which gives 9-10 V.

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The hand crank can be rotated with maximum of 120-150 rpm. When hand crank is used, the rpm of the shaft is reduced and generator provides less power. To increases the rpm of the generator, an additional spur gear of 40mm diameter is used which is mounted on another shaft. This additional gear will internally increase the rpm by 1:4 ratio because 40mm gear is connected to the final gear of the geanerator (10mm).

2.4 Gearbox design

The Gearbox consists of two aluminum plates constituting the top and the bottom surface. The bottom surface (fig 2) has got a hole for generator and two holes for fitting the bearing. The top surface (fig 1) has got a hole so that the shaft of the generator can come out and two holes for bearing. Both the surfaces have got a linear track so that the other shaft with 40mm gear can linearly move through it. Bearings are used to reduce friction and it also locks the shaft at proper position.

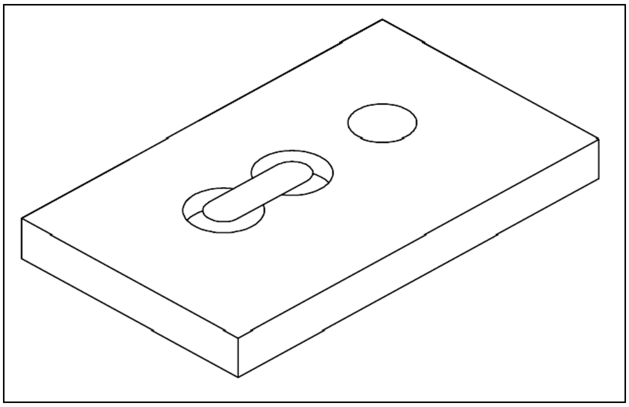


Fig 1. Top surface of the gearbox

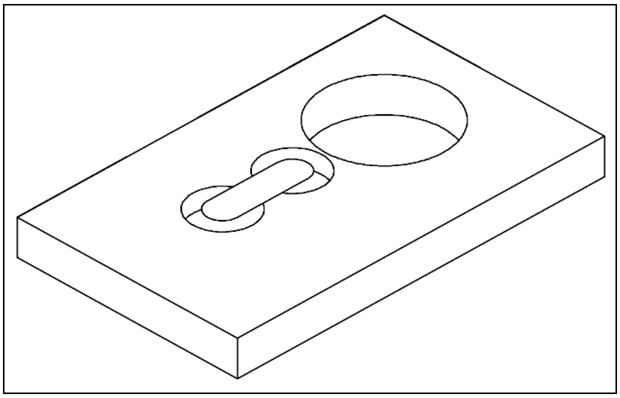


Fig 2. Bottom surface of the gearbox

3 ANALYSIS AND CALCULATIONS

TABLE 2
Motor Parameters

Motor Parameters	Symbol	Value
Rated Motor Voltage	V	12 v
Current at rated voltage	I	60mA
Rated RPM	R	435
Idle Current	I_o	22mA
Internal Resistance	R_i	11 Ω

Various motor parameters have been calculated and listed in table 2

$P_i = VI$ (2)

P_i : *Input electrical power*

$P_i = 0.72\ W$

$P_o = P_i - loss$

P_o : *Output power*

Loss includes both copper losses, mechanical loss which includes losses due to friction and winding.
Copper loss will cause drop in voltage across the winding of the motor which is denoted by V_{cu}.

$V_{cu} = I\,R_i$ (3)

$V_{cu} = 0.66V$

No load idle current I_o is considered as the reason for mechanical loss in motor.

$P_o = P_i - (V - V_{cu})\,(I - I_o)$ (4)

$P_o = 0.43W$

$\eta = P_o/P_i$ (5)

η: *Efficiency of electric motor*

$\eta = 60\%$

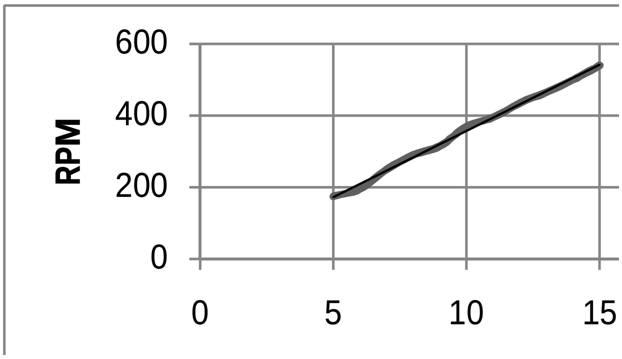
$K_v = RPM\ /\ (V-V_{cu})$ (6)

K_v : *RPM Constant*

$K_v = 38.36$

$\eta_{max} = 74\%$

η_{max}: *Maximum Efficiency*



Fsig 3. Voltage vs RPM characterictics

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Voltage is linearly related to the speed of rotations (rpm) as seen in fig 3.As the speed of rotation is increased more is the output voltage obtained. The black line shows the ideal characteristics.

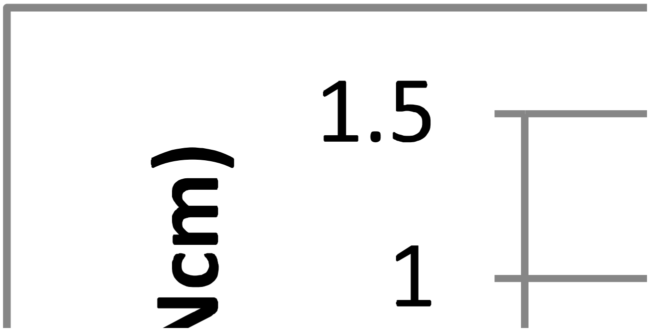

Fig 4 Current vs Torque characteristics

Torque and Current are linearly related to each other as seen in fig 4. The black line shows the ideal characteristics.

4 Comparison of Standard Nokia Charger and Hybrid Mechanical Charger

Standard Nokia mobile charger-

No load condition –
V_{out} *- 7.25V*
V_{out} *: Output voltage of the charger*

With load (mobile connected for charging)-

V_{out} *- 4V*
I_{out} *- 200 - 300mA*
I_{out} *: Output current*

Hybrid Mechanical Charger-

Minimum rpm required – 45
V_{out} *– 3.9V*
I_{out} *- 150 - 250mA*

Generator characteristics-
V_{gen} *-5.5V*
V_{gen} *: Output voltage of the generator*

5 Future Inovation

5.1 Axial Flux generator

The existing generator is a radial flux motor which consists of a drum shaped base motor and a motor gearbox which occupies a lot of space. Axial Flux Generators are disc shaped flat and have got high power density, can accommodate more no of poles.These generator have strong magnetic field due to neodymium-iron-boron magnets. The stator is made of thin coils or it is a printed circuited armature.

5.2 Worm wheel gear shift arrangement

Worm wheel gear shifting arrangement will occupy very less space and gear shifting mechanism will become simple. A worm gear will be mounted on the shaft of the Axial Flux Generator which will be in touch with 20mm worm wheel which will result in a gear ratio of 1:10. Vertcical gear shift can be done which will consume very less space.

5.3 Ultracapacitor

It can have a 1 Farad ultracapacitor which can store energy in the form of charge. In emergency situations rather than using mechanical source of energy we can just discharge the capacitor and use the energy. 2500µFarads can provide energy of 1 rotation so 1 Farad can provide energy for 400 rotations.

6 Conclusion

A Hybrid Mechanical Charger was successfully implemeted on a Nokia phone. Charging of a mobile phone was done by both handcrank and windmill mechanism. It was found that the rate of charging from Hybrid Mechanical Charger is equivalent to the normal charger .

Acknowledgment

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A Novel Real-time Intelligent Tele Cardiology System Using Wireless Technology to Detect Cardiac Abnormalities

S. Kohila, K. Gowri

Abstract - This study presents a novel wireless, ambulatory, real-time, and auto alarm intelligent telecardiology system to improve healthcare for cardiovascular disease, which is one of the most prevalent and costly health problems in the world. This system consists of a lightweight and power-saving wireless ECG device equipped with a built-in automatic warning expert system. A temperature sensor is fixed to the user's body, which senses temperature in the body, and delivers it to the ECG device. This device is connected to a microcontroller and ubiquitous real-time display platform. The acquired ECG signals which are transmitted to the microcontroller is then, processed by the expert system in order to detect the abnormality. An alert signal is sent to the remote database server, which can be accessed by an Internet browser, once an abnormal ECG is detected. The current version of the expert system can identify five types of abnormal cardiac rhythms in real-time, including sinus tachycardia, sinus bradycardia, wide QRS complex, atrial fibrillation (AF), and cardiac asystole, which is very important for both the subjects who are being monitored and the healthcare personnel tracking cardiac-rhythm disorders. The proposed system also activates an emergency medical alarm system when problems occur. We believe that in the future a business-card-like ECG device, accompanied with a Personal Computer, can make universal cardiac protection service possible.

Keywords - Atrial fibrillation (AF), ECG, Temperature Sensor, Expert Systems, Personal Computer, Wireless.

1 INTRODUCTION

1.1 General Introduction

CARDIO Vascular disease (CVD) is one of the most prevalent and serious health problems in the world. An Estimated 17.5 million people died from CVD in 2005, representing 30% of all deaths worldwide. Based on current trends, over 20 million people will die from CVD by 2015. In 2000, 56% of CVD deaths occurred before the age of 75. However, CVD is becoming more common in younger people, with most of the people affected now aged between 34 and 65 years [1]. In addition to the fatal cases, at least 20 million people experience nonfatal heart attacks and strokes every year; many requiring continuing costly medical care. Developed countries around the world continue to experience significant problems in providing healthcare services, which are as follows:

1) The increasing proportion of elderly, whose lifestyle changes are increasing the demand for chronic disease Healthcare services;

2) Demand for increased accessibility to hospitals and mobile healthcare services, as well as in-home care [2];

3) Financial constraints in efficiently improving personalized and quality-oriented healthcare though the current trend of centralizing specialized clinics can certainly reduce clinical costs, decentralized healthcare allow the alternatives of in-hospital and out-hospital care, and even further, home healthcare [3]. Rapid developments in information and communication technologies have made it possible to overcome the challenges mentioned earlier and to provide a changing society with an improved quality of life and medical services.

1.2 Sinus Tachycardia

Sinus tachycardia (also colloquially known as sinus tach or sinus tachy) is a heart rhythm with elevated rate of impulses originating from the sinoatrial node, defined as a rate greater than 100 beats/min in an average adult. The normal heart rate in the average adult ranges from 60–100 beats/min. Note that the normal heart rate varies with age, with infants having normal heart rate of 110–150 bpm to the elderly, who have slower normals. Tachycardia is often asymptomatic. If the heart rate is too high, cardiac output may fall due to the markedly reduced ventricular filling time. Rapid rates, though they may be compensating for ischemia elsewhere, increase myocardial oxygen demand and reduce coronary blood flow, thus precipitating an ischemia heart or valvular disease.

1.3 Sinus Bradycardia

Sinus bradycardia is a heart rhythm that originates from the sinus node and has a rate of under 60 beats per minute. The decreased heart rate can cause a decreased cardiac output resulting in symptoms such as lightheadedness, dizziness, hypotension, vertigo, and syncope. The slow heart rate may also lead to atrial, junctional, or ventricular ectopic rhythms. Sinus Bradycardia is not necessarily problematic. People who regularly practice sports may have sinus bradycardia, because their trained hearts can pump enough blood in each

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contraction to allow a low resting heart rate. Sinus Bradycardia can aid in the sport of Free diving, which includes any of various aquatic activities that share the practice of breath-hold underwater diving, Bradycardia aids in this process due to drop in blood rate pulse. These adaptations enable the human body to endure depth and lack of oxygen far beyond what would be possible without the mammalian diving reflex. Sinus bradycardia is a sinus rhythm of less than 60 bpm. It is a common condition found in both healthy individuals and those who are considered well conditioned athletes. Studies have found that 50 - 85 percent of conditioned athletes have benign sinus bradycardia, as compared to 23 percent of the general population studied. Trained athletes or young healthy individuals may also have a slow resting heart rate.

1.4 Wide QRS Complex

A widened QRS (≥120 msec) occurs when ventricular activation is abnormally slow, either because the arrhythmia originates outside of the normal conduction system (e.g., ventricular tachycardia), or because of abnormalities within the His-Purkinje system (e.g., supraventricular tachycardia with aberrancy).

1.5 Atrial Fibrillation

Atrial fibrillation (AF) is the most common cardiac arrhythmia, affecting nearly 1% of the population. Its prevalence increases with age; although relatively infrequent in those under 40 years old, it occurs in up to 5% of those over 80. Most people with a normal sinus rhythm have a resting heart rate of between 60 and 100 beats per minute. In AF patients, the atria contract rapidly and irregularly at rates between 400 to 800 beat per minute. Fortunately, the atrioventricular node compensates for this activity; only about one or two out of three atrial beats pass to the ventricles [4]. A typical ECG in AF shows a rapid irregular tachycardia in which recognizable P waves are sometimes absent. The ventricular rate in patients with untreated AF is generally 110 to 180 beats per minute. However, slower ventricular rates may occur in elderly patients with untreated AF. Data from the Framingham study demonstrates that chronic heart failure is associated with a 4.5-fold increase in risk of AF in men and a 5.9-fold increase in women. Apart from the epidemiological data, most evidence on the prevalence of AF in heart failure patients stems from analysis of a number of clinical trials conducted within the last 10–15 years on populations with heart failure. AF might have no detectable CVD. Hemodynamic impairment and thromboembolic events related to AF patients included in these trials were selected for different purposes, which are reflected in the varying prevalence of AF. In addition, AF often associated with structural heart disease, causes significant morbidity, mortality, and healthcare cost in a substantial proportion of patients, thus making it a major global healthcare challenge. In this study, we attempted to develop an intelligent expert system with a built-in abnormal ECG-detection mechanism in the telecardiology healthcare service to facilitate diagnosis and management of patients with AF and other rhythm disorders [6]. Simplicity, reliability, and universality are the main concepts behind this service. Therefore, this study constructs a ubiquitous and intelligent telecardiology healthcare network consisting of a miniature wireless ECG device embedded with an alert expert system for the early detection of cardiac disorders.

1.6 Cardiac Asystole

Asystole is a state of no cardiac electrical activity; hence no contractions of the myocardium and no cardiac output or blood flow. Asystole is one of the conditions required for a medical practitioner to certify death. While the heart is asystolic, there is no blood flow to the brain unless CPR or internal cardiac massage is performed, and even then it is a small amount. After many emergency treatments have been applied but the heart is still unresponsive, it is time to consider pronouncing the patient dead. Even in the rare case that a rhythm reappears, if asystole has persisted for fifteen minutes or more the brain will have been deprived of oxygen long enough to cause brain death.

2 OVERALL SYSTEM

The system proposed in this study uses a Three-lead wireless ECG device, a microcontroller expert system, and a Web-based monitoring platform to meet these objectives. A small, three-lead ECG device is first set up using electrodes, affixed to areas on the user's body. A temperature sensor is fixed to the users body, which senses temperature in the body and deliver it to the ECG device. This lightweight ECG can be connected to portable devices, such as a notebook or mobile phone, using ZigBee Module. The programming application installed on a microcontroller in ECG Device can then initiate data recording and data transmission. Successive data are transmitted to a portable device and processed in a period of 6 s by an expert system. The lead signal, coordinated with the direction of cardiac conduction pathway is extracted for signal analysis. As long as an abnormal ECG signal was detected, the system automatically transmitted data over a Wi-Fi/3G/2G networks to a remote data server (see Fig 1). At the same time, the system will send out an alert message to a nursing station in the cardiovascular ward for further examination. If necessary, the emergency ward or other departments can also access this data through an intranet. With the convenience of the world-wide Web protocol, anyone, including physicians, nurses, and family members, can access the data server and monitor real-time ECG plots using a Web browser, such as Internet Explorer (IE). For patients admitted to a cardiovascular ward or intensive care unit (ICU), the proposed cardio-healthcare system provides greater freedom of movement than products currently on the market [7]. Paring lightweight wireless ECG devices with mobile phones offers continuous and reliable patient monitoring. A warning system is also activated when unstable ECGs appear.

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Whenever the person moves his body temperature rises due the work done, and the degree of increase is based on the amount of work done. Also if a person got any fever his heart beat may increase which may be misrecognized as an abnormal heart condition on an average the heart beat increase for an average of 7-8beats for every single degree increase in temperature. Here in the proposed work the constraint has been considered and the problem has been faced better. In the proposed system Zigbee module is used, which is fully secured and provide full duplex transmission. This will enhance the

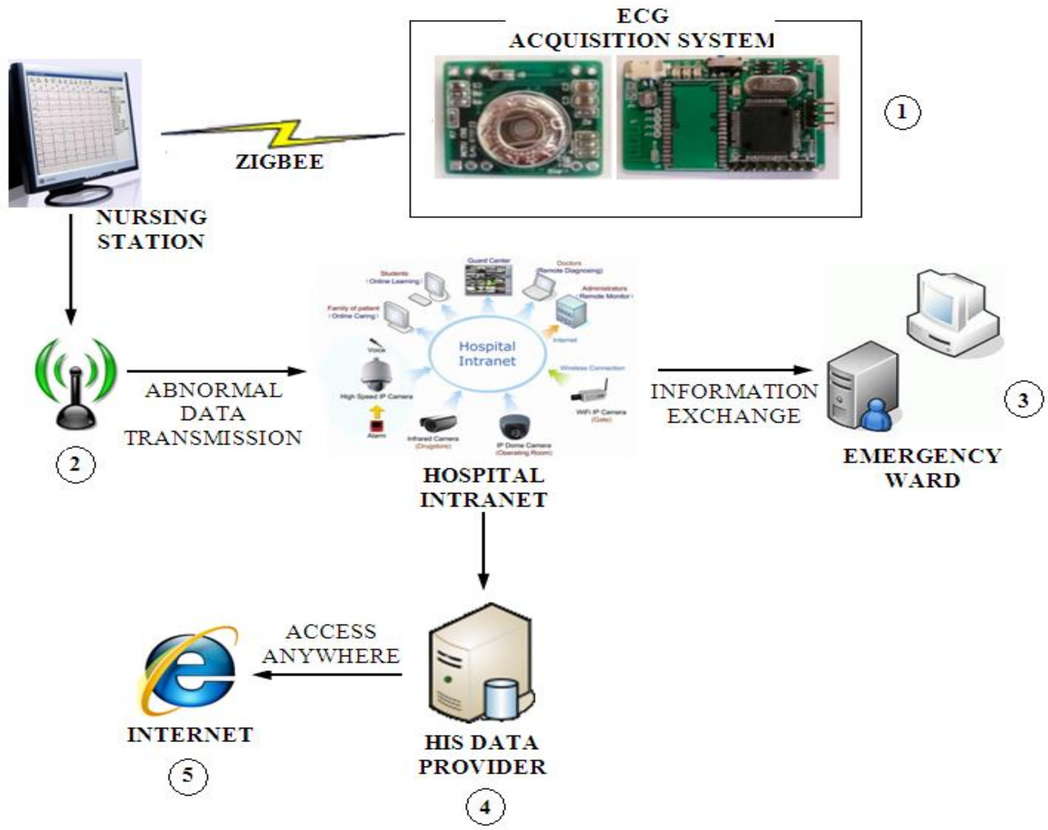

Fig 1: Flowchart of proposed system.The System uses a 5 lead ECG acquisition device ,the Abnormality detection Algorithm in the device detect the abnormal ECG signal and a Web-based monitoring window allowing access to the data server and plot in real time by using an IE browser. Step①: The Signal are acquired by the ECG Electrodes Step②: The Abnormality in signal is detected and transferred to the hospital intranet, Step③:The information from intranet is moved to the emergency ward database, Step④: The information from the intranet is also moved to the hospital intranet server, Step⑤: The abnormality information can be accessed by anyone through web service.

way of wireless communication used in the system. ZigBee targets the application domain of low power, low duty cycle and low data rate requirement devices.

3 ECG DEVICE WITH WIRELESS UNIT

The Hardware Circuit Designed Using all the Required parts (5 ECG electrode, Pre Amplifier, Band Pass Filter, Amplifier, PIC Microcontroller, ADC, Zigbee Module) [8]. The proposed three-lead ECG device contains two main parts: The Analog unit and The Digital unit (see Fig 2).

3.1 Analog Unit

The DAQ unit integrates an analog preamplifier, filter, and an AD converter (ADC) into a small (20 × 18 mm2), lightweight, and battery-powered DAQ system. The ECG signal is sampled at 512 Hz with 12-bit resolution, amplified by 100 times, and band pass filtered between 1 to 150 Hz. To reduce the number of wires for high-density recordings, the

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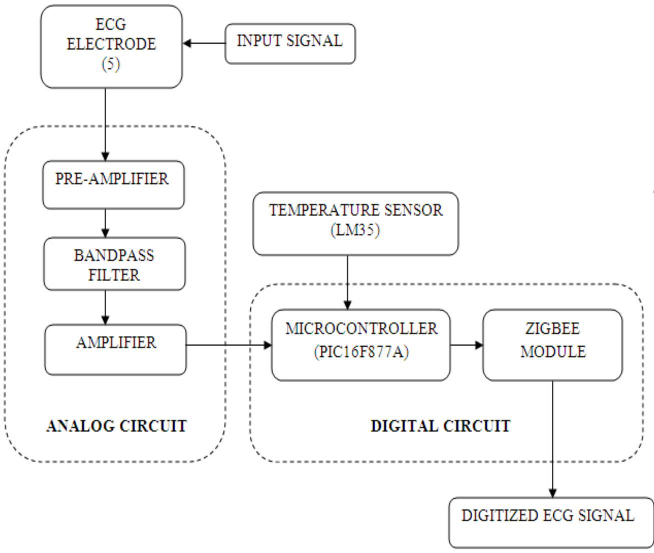

Fig 2: Block Diagram of ECG Device

power clocks, and measured signals are daisy-chained from one node to another with bit-serial output. Therefore, adjacent nodes (electrodes) are connected together to 1) share the power, reference voltage, and ADC clocks and 2) daisy chain the digital signal outputs.

3.2 Digital Unit

The Digital unit consists of a wireless module and a microcontroller. This unit uses a Zigbee module to send the acquired ECG signals to a Zigbee Enabled PC, serving as a real-time signal processing unit. All modules included one wireless-transmission unit and three DAQs, the theoretical maximum running time is estimated at about 33 h when using an 1100 mA·h Li-ion battery with continuous acquisition and transmission of the physiological signal to the expert system[9].

4 QRS WAVE DETECTION ALGORITHM

The ECG signals are amplified and recorded with a sampling rate of 512 Hz and band pass filtered between 1 and 150 Hz. Artifacts were removed before R peak detection. A 50 Hz notch filter is used to eliminate the power line interference, producing high-frequency, noise-free, and smooth data. Two segments of the baseline signal are extracted to compute mean and standard deviation (SD). Besides, the QRS detector requires the first and second-order derivative of the preprocessed ECG signal.

The latter gives spikes at the fiducial points. There are also false spikes, but their relative magnitudes are lower than those of the spikes at the fiducial points. Accordingly, the R peak is clipped by higher magnitude negative peaks and high positive peaks in the first derivative plot. The procedure of defining the QRS complex onset is as follows: after 256 ms of flat segment in the ECG, the first sample, where the slope becomes steeper (high positive peaks) than the higher slope threshold, is defined as the QRS onset. The lower slope threshold is used to detect the higher magnitude negative peaks. Both thresholds are updated to search for missing beats. After identifying the QRS onset, the R peak is labeled by searching for the maximal value of the ECG samples in the 36 ms following the QRS onset. When R peak is determined, the QRS detector searches forward and backward to identify the two most negative points on the ECG plot and labels them as the Q wave peak and the S wave peak, respectively. The black curve means the normal ECG signal which contains three waves. The dotted line shows the first deviation of the normal ECG signal (see Fig 3). Results show that full squares wave peak

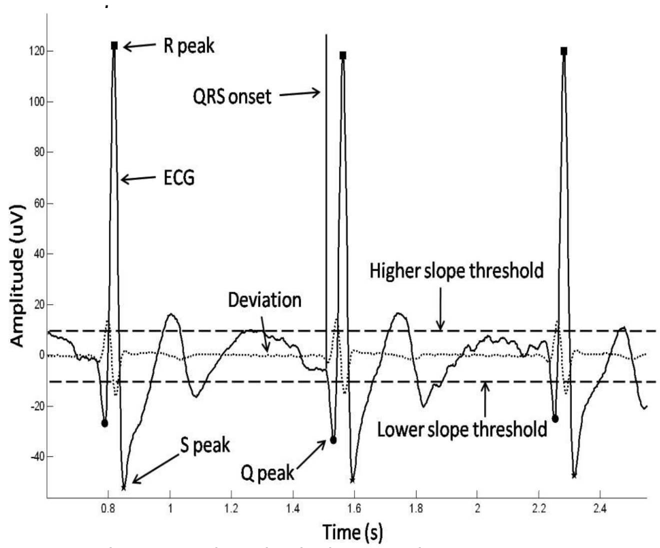

Fig 3: QRS detection in the normal ECG waves.

mark the R wave peaks, full circles mark the Q s, and full star mark the S wave peak. QRS onset is defined by the vertical line.The QRS complex duration is set from QRS onset time to 20 ms after the S wave peak

5 ABNORMAL ECG DETECTION

After defining the QRS complex and the Q, R, and S wave peak, we then sought to detect common and important rhythm disorders, including sinus tachycardia, sinus bradycardia, cardiac systole, AF, and wide QRS complex. Sinus tachycardia is detected by the condition of the heart rate >100 beats per minute. An asystole indicates the situation of no heart rate. Wide QRS complex occurred as the duration of QRS

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complex was greater than or equal to 120 ms. C. AF Detection Since an irregular rhythm of the QRS complexes is the major feature of AF, the R–R interval (RRI), defined as the interval of neighboring QRS complexes, is an ideal parameter to identify AF. This study uses two different algorithms for AF detection.

5.1 Algorithm I for Abnormal ECG Detection:

Step 1: Detection of R waves and marking of R peaks.

Step 2: Calculation of RRI (the duration of adjoined R peaks).

Step 3: Calculation of the variation of consecutive RRI (ΔRRI).

Step 4: Activation of the alarm system when ΔRRI>150 ms occurs twice within each 6 s of computation.

5.2 Algorithm II for Abnormal ECG Detection

Step1: Detection of *R* waves and marking of *R* peaks.

Step2: Calculation of RRI (the duration of adjoined *R* peaks).

*Step*3: Counting the number of peaks to calculate the number of beats in each 6s.

*Step*4: Check whether temperature ranges between 33-37^0 continue the process, else go to Step 8

Step5: Calculation of the variation of consecutive RRI(ΔRRI).

Step6: Calculation of the SD of RRI (RRIstd) in each 6-s recording.

Step7: Activation of the alarm system when ΔRRI>150 ms occurs twice and RRIstd > 60 ms within 6 s of computation.

Step8: Measuring the heartbeat, up to 180bpm is considerable during very high fever.

Theoretically, Algorithm I is more accurate in detecting an irregular ventricular rhythm, though in detecting frequent pre mature beats during uncommon, it is difficult to differentiate the Atrial Fibrillation from Premature Beats. To overcome this problem, we formulated Algorithm II, which uses a cut-off value of RRIstd>60 ms for AF detection. This condition shows that whenever the standard Deviation of RRI exceeds 60ms the system will produce an alert signal. The cut-off value of 60 ms was based on comparing 50 normal subjects' and 50 patients having cardiac abnormality' Also Algorithm II will produce an accurate detection considering the temperature of the patient Fig. 4 shows statistical results of the differences between normal and AF patients regarding ΔRRI and RRIstd. Accordingly, the threshold level of ΔRRI and RRIstd were given as 150 and 60 ms, respectively.

6 RESULTS AND DISCUSSIONS

In order to analyze the performance of the abnormality detection algorithm, the device is fixed to 10 patients who underwent treatment at General Hospital.Analysis and Performance Calculation was performed according to the recommendations of the American National Standard for ambulatory ECG analyzers (ANSI/AAMI EC38–1994) [11]. A true positive (TP) shows that the algorithm successfully detected abnormality for abnormal subject during every 6 s of computation. On the other hand, a false negative (FN) shows a failed detection of abnormality for an abnormal patient. Finally, false positive (FP) represents a false detection of abnormality, whereas true negative (TN) means normal subjects have no abnormality detection. Accuracy, sensitivity and positive predictive values were used for further analysis. The recorded data were shown in Tables 1 and 2 for normal and abnormal patients under testing for different algorithms. The subjects tested for abnormalities were of age group greater than 50. Table 1 shows the abnormality detection in subjects using Algorithm I.

TABLE 1
Abnormality Detection in Subjects Using Algorithm I

Subject/ Condition (N=10)	Positive Test	Negative Test	Total
Abnormal patients	187	8	195
Normal patients	5	0	5
Total no. of tests			200

TABLE 2
Abnormality Detection in Subjects Using Algorithm II

Subject/ Condition (N=10)	Positive Test	Negative Test	Total
Abnormal patients	192	5	197
Normal patients	3	0	3

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Total no. of tests	200

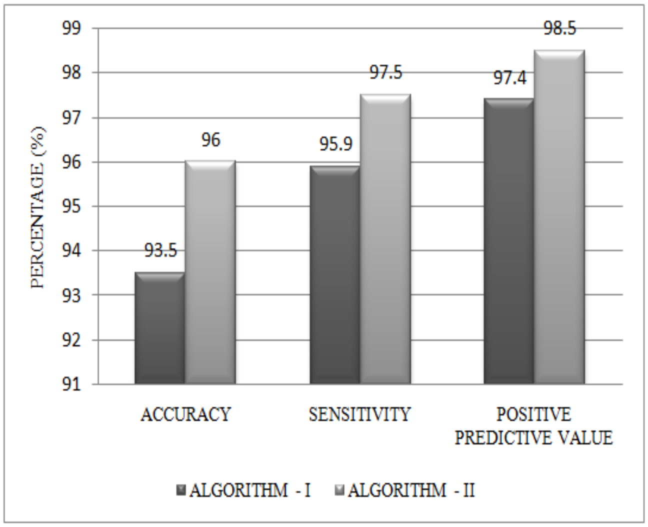

Fig 5: Analysis of Average Performance between two Algorithms.

Totally 10 subjects were tested and each were tested 20 times, hence there will be totally 200 tests undergone. Each test was recorded for duration of 6 sec. Hence the total duration for each subject will be 2 min. This algorithm shows 100% for normal subjects and with little difference in case of abnormal subjects. Similarly, Table 2 shows the abnormality detection in subjects using Algorithm II. While considering Algorithm I the average accuracy was 93.5%, its sensitivity performance is 95.9%, and the positive predictive value is 97.4% (see Fig 5). The same 10 patients were also tested using Algorithm II, in which abnormality is detected only when three conditions were met. i.e.,

(i) ΔRRI>150 ms occurs twice
(ii) RRIstd > 60 ms within 6 s of computation and
(iii) Considering body temperature.

The average accuracy, sensitivity, and positive predictive performance were 96%, 97.5%, and 98.5% (see Fig 5) respectively. Comparing the performance of both Algorithms I and II, the performance in Algorithm II was much better. These results showed that combining the three conditions as the detection criteria in Algorithm II, will improve the abnormality detection performance, especially in terms of accuracy and sensitivity performance. Among a total of 10 patients, Algorithm II displays the stable and high impact results across subjects. The results suggest that our system can provide a reliable abnormality detection function in telecardiology healthcare services.

7 CONCLUSION

AF, the most common sustained cardiac arrhythmia, causes significant mortality and morbidity, and remains a major healthcare challenge [11]. Early detection is very important for providing appropriate therapeutic interventions and managing disease related complications, such as congestive heart failure and stroke. This study demonstrates that the proposed intelligent telecardiology system is capable of accurately detecting AF episodes and instantaneously alerting both the user and the healthcare personnel, facilitating early medical intervention. Furthermore, this intelligent telecardiology system is superior to conventional healthcare devices because it integrates all the key elements in one system. The following list describes the most important features of the proposed system

1) *Wireless*: Communications between devices are all wireless (Zigbee), reducing wire stock usage and allowing convenient operation.
2) *Ambulatory*: The miniature ECG device is very lightweight, can easily be applied to the body, and can operate for a considerable length of time. The system can be run anywhere with a notebook or mobile phone, eliminating the problems of limited power or restricted areas.
3) *Real time*: ECG signals can be transmitted to nearby mobile devices instantly and there is only a few seconds lag when the signals are transmitted to a remote database server, depending on network capacity.
4) *Self-alarm*: The built-in expert system automatically detects abnormal ECG signals and alerts both the user and healthcare personnel using a Internet, or by sending a message to a remote database server installed in the hospital computer system and the emergency service system.

This novel system cannot only be used for inpatients and outpatients, but also provides a long-lasting health monitor to normal people. Patients wearing the lightweight three-limb lead wireless ECG device can hardly feel its presence, but still enjoy a sense of protection.

However, there are several limitations for the expert system. First, Abnormality detection is based on the RRI variation, when the user has frequent atrial or ventricular premature beats, which can be misdiagnosed as AF. Second, in patients with Cardiac Abnormality and markedly impaired AV nodal conduction, RRI variations may become too small for the system to diagnose Abnormality accurately. Lastly, there is still considerable motion noise during the recording, which might impair diagnostic accuracy. In conclusion, this novel intelligent telecardiology system

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is capable of early Abnormality detection, and represents a successful first step toward improving efficiency and quality of care in CVD. Further researches aimed at improving both hardware and software designs are necessary to enhance the efficiency and accuracy in future models of this system.

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A Novel Dynamic Key Management Scheme Based On Hamming Distance for Wireless Sensor Networks

R.Divya , T.Thirumurugan

Abstract - Numerous key management schemes have been proposed for sensor networks. The objective of key management is to dynamically establish and maintain secure channels among communicating nodes. Many schemes, referred to as static schemes, have adopted the principle of key predistribution with the underlying assumption of a relatively static short-lived network (node replenishments are rare, and keys outlive the network). An emerging class of schemes, dynamic key management schemes, assumes long-lived networks with more frequent addition of new nodes, thus requiring network rekeying for sustained security and survivability. This paper proposes a dynamic key management scheme by combining the advantages of simple cryptography and random key distribution schemes. When the hamming distance between the two nodes is found high, the unique key is changed instead of changing the set of keys and the communication takes place by using any one of the set of key x-oring with the new unique key. The security and performance of the proposed algorithm is compared with the existing dynamic key management scheme based on Exclusion Basis System and prove that the proposed scheme performs better when compared to existing scheme by considering the number of nodes colluded with time. The result obtained by simulation also shows that the proposed scheme provides security solution and performs better than the existing scheme.

Index Terms - WSN's, dynamic key management, collusion, hamming distance, security.

1. INTRODUCTION

THE envisioned growth in utilizing sensor networks in a wide variety of sensitive applications ranging from healthcare to warfare is stimulating numerous efforts to secure these networks. Sensor networks comprise a large number of tiny sensor nodes that collect and (partially) process data from the surrounding environment. The data is then communicated, using wireless links, to aggregation and forwarding nodes (or gateways) that may further process the data and communicate it to the outside world through one or more base stations (or command nodes). Base stations are the entry points to the network where user requests begin and network responses are received. Typically, gateways and base stations are higher-end nodes. It is to be noted, however, that various sensor, gateway, and base station functions can be performed by the same or different nodes. The sensitivity of collected data makes encryption keys essential to secure sensor networks.

1.1 Key Management

The term key may refer to a simple key (e.g., 128-bit string) or a more complex key construct (e.g., a symmetric bivariate key polynomial).A large number of keys need to be managed in order to encrypt and authenticate sensitive data exchanged. The objective of key management is to dynamically establish and maintain secure channels among communicating parties.

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Typically, key management schemes use administrative keys (key encryption keys) for the secure and efficient (re-)distribution and, at times, generation of the secure channel communication keys (data encryption keys) to the communicating parties. Communication keys may be pair-wise keys used to secure a communication channel between two nodes that are in direct or indirect communications, or they may be group keys shared by multiple nodes. Network keys (both administrative and communication keys) may need to be changed (re-keyed) to maintain secrecy and resilience to attacks, failures, or network topology changes. Numerous key management schemes have been proposed for sensor networks. Most existing schemes build on the seminal random key pre-distribution scheme introduced by Eschenauer and Gligor [1]. Subsequent extensions to that scheme include using deployment knowledge [2] and key polynomials [3] to enhance scalability and resilience to attacks. These set of schemes is referred as static key management schemes since they do not update the administrative keys post network deployment.

An example of dynamic keying schemes is proposed by Jolly et al. [4] in which a key management scheme based on identity based symmetric keying is given. This scheme requires very few keys (typically two) to be stored at each sensor node and shared with the base station as well as the cluster gateways. Rekeying involves reestablishment of clusters and redistribution of keys. Although the storage requirement is very affordable, the rekeying procedure is inefficient due to the large number of messages exchanged for key renewals. Another emerging

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category of schemes employ a combinatorial formulation of the group key management problem to affect efficient rekeying [5, 6]. These are examples of dynamic key management schemes. While static schemes primarily assume that administrative keys will outlive the network and emphasize pair wise communication keys.

Dynamic schemes advocate rekeying to achieve resilience to attack in long-lived networks and primarily emphasize group communication keys. Since the dynamic scheme has the advantage of long lived network and rekeying when compared to the static schemes, the dynamic key management is chosen as a security scheme for the WSN's.

2. KEY MANAGEMENT SCHEMES IN SENSOR NETWORKS

The success of a key management scheme is determined in part by its ability to efficiently survive attacks on highly vulnerable and resource challenged sensor networks. Key management schemes in sensor networks can be classified broadly into dynamic or static solutions based on whether rekeying (update) of administrative keys is enabled post network deployment.

2.1 Static Key Management Schemes

The static schemes assume that once administrative keys are predeployed in the nodes, they will not be changed. Administrative keys are generated prior to deployment, assigned to nodes either randomly or based on some deployment information, and then distributed to nodes. For communication key management, most static schemes use the overlapping of administrative keys to determine the eligibility of neighboring nodes to generate a direct pair-wise communication key. Communication keys are assigned to links rather than nodes. In order to establish and distribute a communication key between two non neighboring nodes and/or a group of nodes, that key is propagated one link at a time using previously established direct communication keys.

2.2 Dynamic Key Management Schemes

Dynamic key management schemes may change administrative keys periodically, on demand or on detection of node capture. The major advantage of dynamic keying is enhanced network survivability, since any captured key(s) is replaced in a timely manner in a process known as rekeying. Another advantage of dynamic keying is providing better support for network expansion; upon adding new nodes, unlike static keying, which uses a fixed pool of keys, the probability of network capture increase is prevented. The major challenge in dynamic keying is to design a secure yet efficient rekeying mechanism. A proposed solution to this problem is using exclusion-based systems (EBSs); a combinatorial formulation of the group key management problem

3. SENSOR NETWORK MODEL

Both the proposed and the existing security algorithm are based on a wireless sensor network consisting of a command node and numerous sensor nodes which are grouped into clusters. The clusters of sensors can be formed based on various criteria such as capabilities, location, communication range, etc. Each cluster is controlled by a cluster head, also known as gateway, which can broadcast messages to all sensors in the cluster. We assume that the sensor and gateway nodes are stationary and the physical location and communication range of all nodes in the network are known. Each gateway is assumed to be reachable to all sensors in its cluster, either directly or in multihop. Sensors perform two main functions: sensing and relaying. The sensing component is responsible for probing their environment to track a target/ event. The collected data are then relayed to the gateway. Nodes that are more than one hop away from the gateway send their data through relaying nodes. Sensors communicate only via short-haul radio communication. The gateway fuses reports from different sensors, processes the data to extract relevant information and transmits it to the command node via long-haul transmission.

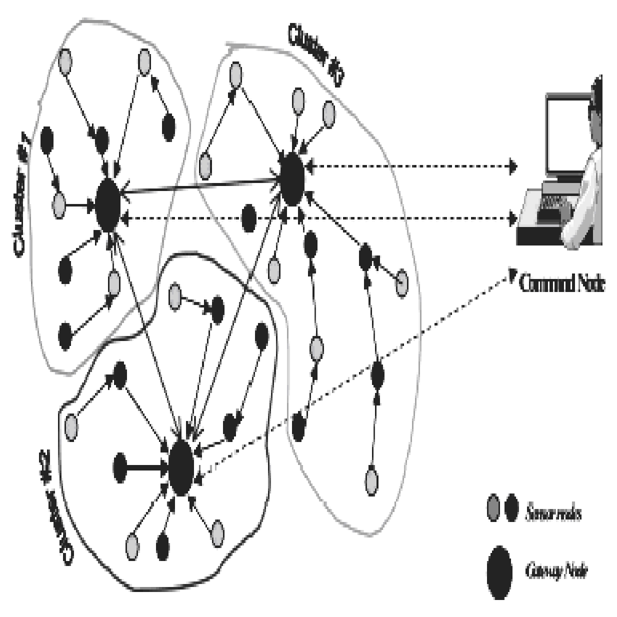

Fig. 1. Clustered Sensor Network

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The network architecture is depicted in Fig. 1. Each tier of the network possesses different capabilities. The command node is resource-rich. However, the amount of traffic flowing between the command node and gateways causes the communication channel between the command node and gateways to be restrained. Most often, the command node is situated at a considerable distance from the deployment region, and might only be reachable through slow satellite links. Larger communication distances also incur increased security vulnerability and packet loss during long haul transmissions.

4. COLLUSION PROBLEM

The security scheme proposed in [6] is based on the Exclusion Basis System (EBS) to address the collusion problem in EBS that performs location based key assignment to minimize the number of keys revealed by capturing collocated nodes. The network model is similar to the model developed in [6] with clusters and gateways. It uses the EBS framework to perform rekeying within each cluster. Keys are distributed to nodes by the gateways. SHELL uses post-deployment location information in key assignment; collocated nodes share more keys than nodes that are not collocated.

4.1 Exclusion Basis System (EBS)

EBS is a combinatorial formulation of the group key management problem in which each node is assigned k keys out of a pool of size P = k + m keys. Rekeying takes place either periodically or when one or more nodes are captured (or suspected of being captured). Replacement keys are generated, then encrypted with all the m keys unknown to the captured nodes, and finally distributed to other nodes that collectively know the m keys. A drawback of the basic EBS-based solution is that a small number of nodes may collude and collectively reveal all the network keys. This is particularly true when the value of m is selected to be relatively small (to make rekeying feasible in terms of number of messages). EBS-based key management can be prone to collusion attacks. Two nodes collude when they share their keys with each other. In other words, colluding nodes would grow their knowledge about the network security measures. In SHELL [6], keys are reused in multiple nodes and only key combinations are unique. Therefore, it is conceivable that few compromised nodes can collude and reveal all the keys employed in the network to an adversary. Such a scenario is considered as capturing the entire network since the adversary would be capable of revealing all encrypted communications in the network. SHELL exploits the physical proximity of nodes so that a node would share most keys with reachable nodes. To avoid the assignment of same key combinations, swapping of keys is employed. If S1 is a neighbor of S2, S2 is a neighbor of S3, and S1 colludes with S2, the resultant keys known to both of them would be [Keys of S1] U [Keys of S2]. Thereafter if S2 and S3 collude, the keys known to S2 and S3 would be [Keys of S1] U [Keys of S2] U [Keys of S3].

Thus, it can be seen that if multiple nodes collude, it is likely to uncover all employed keys. The collusion of nodes is illustrated in Fig 2. Due to swapping of keys, the key combination gets repeated at a particular time instant such that the number of nodes that share the same key combination increases.

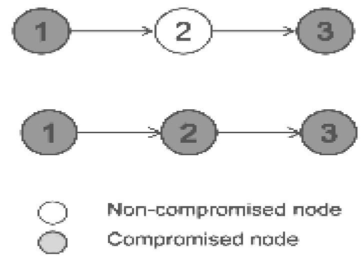

Fig.2. Collusion of Nodes

As a result the neighboring node gets colluded if it shares the same key combinations. When the number of nodes getting colluded increases, capturing few node will reveal all the keys that has been employed in the network which results in capturing the entire network. In order to address the collusion problem in [6], an efficient dynamic key management scheme is proposed.

5. DYNAMIC KEY MANAGEMENT

Due to swapping of keys the number of nodes getting colluded with the neighboring nodes is increased so capturing lesser nodes will reveal most of the keys and thus the whole network can be captured by the attacker. In order to reduce the number of colluding nodes a dynamic key assignment was chosen to employ the simple cryptography and random key distribution. Both the simple cryptography and random key distribution has its own advantages and limitations. Thus the dynamic key management scheme with the advantages of both the schemes and by taking the hamming distance into consideration is proposed as a security solution. Three methods are proposed for the dynamic key management namely

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1. Simple cryptography
2. Random key distribution
3. Dynamic key assignment

5.1 Simple Cryptography

A simple cryptography of x-oring two keys is first tried as a dynamic key management. In this simple cryptographic scheme, each sensor node is assigned a set of keys and a unique key. Communication takes place through any one of the set of keys x-oring with the unique key. Once the encryption is over, the decryption takes place through the unique key that is known to the gateway node. The major drawback in this scheme is that the security level is low i.e. when any two key is known the other key may be revealed which results in revealing the keys of that node.

5.2 Random Key Distribution

Since the security level is low in x-oring of two keys, random distribution of keys is tried to enhance the security of the proposed method. In this random key distribution scheme, a set of keys is assigned to each sensor node. The communication takes place through any one of the set of keys. Once the hamming distance between any two nodes is found high the set of keys are randomly replaced and the new set of keys will be generated. Since all the keys are newly generated whenever the hamming distance is high the power consumption will be higher in this scheme and the security level is also enhanced since keys cannot be revealed by the reversing of x-or operation.

5.3 Dynamic Key Assignment

The proposed dynamic key assignment takes the advantage of both the simple cryptography and random key distribution scheme to reduce the collusion of nodes. In this dynamic key management algorithm, each key combination can be represented in the form of bit strings of k 1's and m 0's, where k is the number of keys stored at each node and m is the number of rekey messages required. The Hamming distance between any two combinations is defined as the number of bits that the two key combinations differ in. Let d be the Hamming distance between a pair of key combinations.

The value of d is bounded by:

$$
\begin{array}{ll}
2 \le d \le 2k & k < m \\
2 \le d \le 2m & m < k \\
2 \le d \le k+m & k = m
\end{array}
$$

When two nodes collude, they both will know at least d keys, since d is the number of keys that they differ in. In addition, they will also know all the keys that are common to both nodes. The common keys are equal to k – d/2. Thus, the number of keys known to the two colluding nodes as k + d/2. This leads to the conclusion that the lower the Hamming distance (the value of d) fewer the total number of potentially revealed keys.

In this proposed dynamic key management, each sensor node is assigned a set of keys and a unique key as in the simple cryptography case. When the hamming distance between the two nodes is found high by the boundary condition, the unique key alone is changed instead of changing the set of keys and the communication takes place by using any one of the set of key x-oring with the new unique key. This method provides enhanced security with less power consumption when compared to the other two schemes.

6. SIMULATION

The simulations were carried out in MATLAB 6.5. The number of nodes getting colluded with time has been analyzed for both the SHELL and the dynamic key assignment and it is observed that the proposed dynamic key assignment performs better when compared to the existing method SHELL.

6.1 Simulation Parameters

The simulation parameters that are considered for simulation of both dynamic key assignment and SHELL are listed below:

(i) Transmission range	- 55m
(ii) Deployment region	- 850x500m
(iii) Frequency of key renewals	- 5 x 10^2 sec
(iv) Key size	- 128 bits

By taking the above parameters, the simulation were performed on a network of 2000 nodes deployed in an area of (850x500) meters size setting an transmission range of 55 meters. Each of the sensor nodes is assigned unique key and a set of keys. Once the keys are assigned, the keys of the neighboring nodes are verified whether the hamming distance is low based on the boundary condition given in section 5.3. If the hamming distance of any node is found to be high, the unique key of that node is dynamically changed and the communication takes place by x-oring the new unique key with any one of the set of keys. The operation continues for the other nodes also. The simulation were carried out and the results are obtained for the following cases

Case (i) : Number of nodes colluded with time

Case (ii): Comparison of methods with static and

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mobile nodes

6.2 Results and Discussion

6.2.1 Number of nodes colluded with time

From the simulation results it is found that the number of nodes getting colluded by the dynamic key assignment scheme is reduced to a greater extent. The average number of nodes colluded is found out by varying the time and the results are plotted in Fig 3. From Fig 3 it is observed that as the number of nodes colluding with each other in the dynamic key assignment is reduced when compared to the other methods like simple cryptography, random key distribution and SHELL. The dynamic key assignment out performs the simple cryptography and random key distribution scheme as expected since it is a combination of both the schemes. The random key distribution performs better than the simple cryptography which in turn performs better when compared to SHELL.

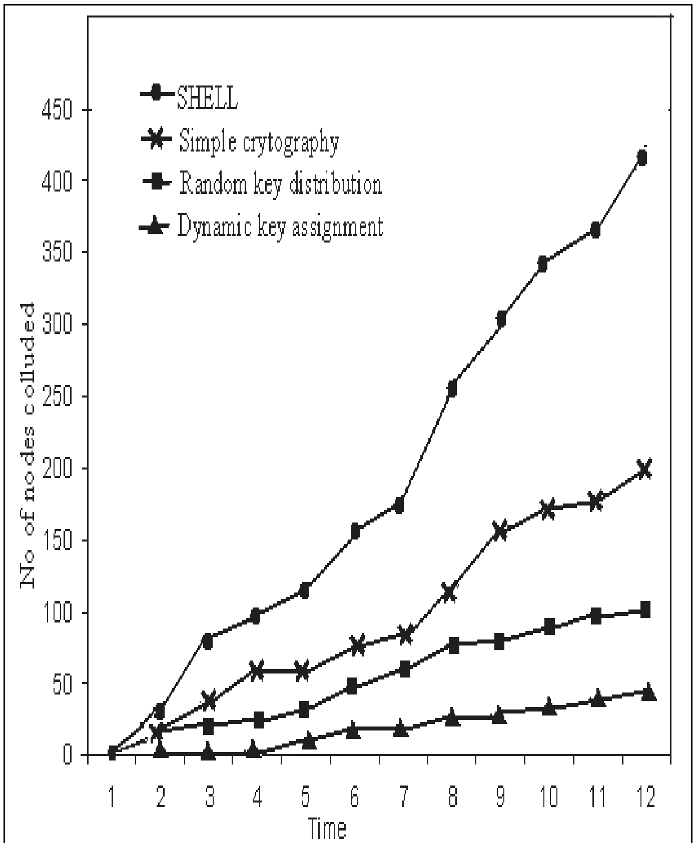

Fig. 3. Number of Nodes Colluded with Time

6.2.2 Comparison of methods with static and mobile nodes

In this case, both the dynamic key assignment and the SHELL are compared with static and mobile nodes. The simulation setup is the same for static nodes and the mobile nodes are given mobility with a speed of 20 meter per sec with the same simulation set up. Again the number of nodes colluding with each other gets reduced in the dynamic key assignment. The number of nodes colluded when the nodes are static and mobile for both conventional and proposed scheme is obtained by simulation and plotted in fig 4. It is observed that when both the schemes are compared for static and mobile nodes, the number of colluded nodes for the mobile nodes is lesser and approaches nearly zero preventing the collusion of nodes when compared to the static nodes because the hamming distance remains the same when the nodes are static and it differs when the nodes are given mobility. Thus by preventing the collusion of nodes the dynamic key assignment provides enhanced security when compared to other existing dynamic key management schemes.

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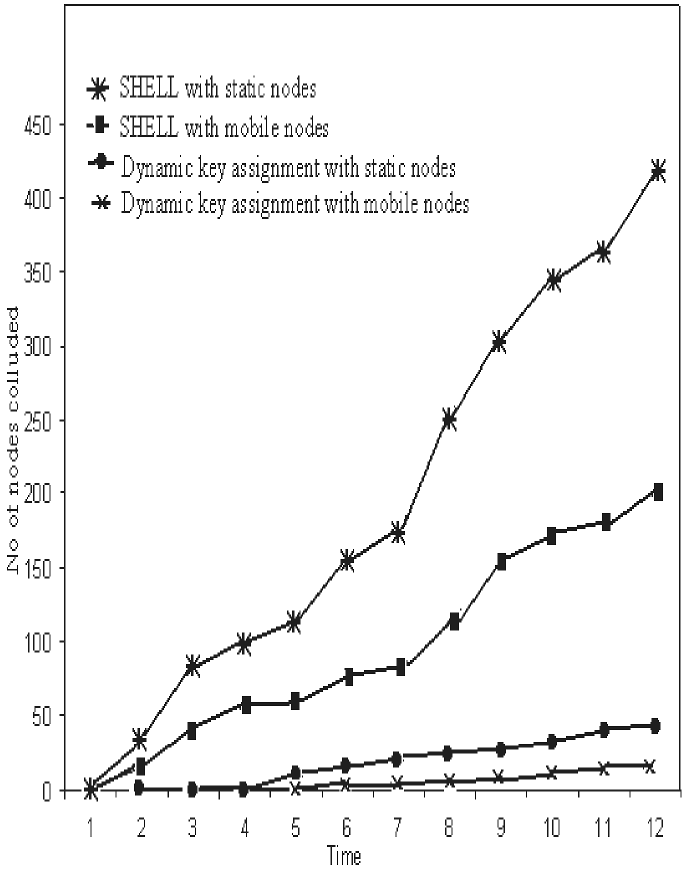

Fig. 4. Comparison of methods with Static and Mobile Nodes

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7 CONCLUSION

The number of nodes getting colluded with each other in the dynamic key assignment scheme is greatly reduced when compared to the other dynamic key management schemes. From Figure 3, it is observed that the proposed dynamic key management performs far better than the SHELL and from Figure 4, it is observed that by providing mobility to the nodes the collusion can be prevented. Thus the proposed dynamic key assignment prevents the collusion of nodes and provides enhanced security to the cluster based sensor network.

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Speedy Deconvolution using Vedic Mathematics

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Abstract— Deconvolution is a computationally intensive digital signal processing (DSP) function widely used in applications such as imaging, wireless communication, and seismology. In this paper deconvolution of two finite length sequences (NXM)**,** is implemented using direct method to reduce deconvolution processing time. Vedic multiplier is used to achieve high speed. Urdhava Triyakbhyam algorithm of ancient Indian Vedic Mathematics is utilized to improve its efficiency. For division operation non-restoring algorithm is modified and used. The efficiency of the proposed convolution circuit is tested by embedding it on Spartan 3E FPGA. Simulation shows that ,the circuit has a delay of 79.595 ns from input to output using 90nm process library. It also provides the necessary modularity, expandability, and regularity to form different deconvolutions for any number of bits.

Index Terms— Deconvolution, Non-Restoring algorithm, Urdhva Tiryagbhyam

1 INTRODUCTION

THE concept of deconvolution is widely used in the techniques of signal processing and image processing. The concept of deconvolution has applications in reflection seismology, in reversing the optical distortion, to sharpen images etc. Faster additions, multiplications and divisions are of extreme importance in DSP for deconvolution. Speeding up deconvolution using a Hardware Description Language for design entry not only increases (improves) the level of abstraction, but also opens new possibilities for using programmable devices.

In this paper, a novel method for computing the linear deconvolution of two finite length sequences is used. Method is explained in detail in [1]. This method is similar to computing long-hand division and polynomial division.

As a need of project, all required possible adders are studied. All these adders are synthesized using Xilinx9.2i. There delays and areas are compared. Adders which have highest speed and comparatively less area occupied, are selected for implementing deconvolution. Since 4×4 bit multiplier is need of this project, different 4×4 bit multipliers are studied and Urdhava Triyakbhyam algorithm which gives lowest delay among remaining all multipliers is used here. For division, different division algorithms are studied, by comparing drawbacks and advantages of each algorithm, Non restoring algorithm is modified according to need and then used.

This paper can be considered as extension of [2]. where discrete linear convolution of two finite length sequences(4 ×4) is implemented. That convolved output of [2]. is input to this proposed design, impulse response of system is known is another input, this paper proposes design that carry out high speed deconvolution and extracts input samples.

Paper is organized as follows: section 2 gives brief introduction of novel method for deconvolution. Section 3 describes division algorithm. Section 4 discusses the Vedic mathematics and Urdhva Tiryagbhyam algorithm for multiplication. Section 5 presents selection of speedy adder. In section 6 design verification is given. Finally, the conclusion is obtained.

2 NOVEL METHOD FOR CALCULATING DECONVOLUTION

In general, the object of deconvolution is to find the solution of a convolution equation of the form:

$$f * g = h \qquad (1)$$

Usually, *h* is some recorded signal, and *f* is some signal that wish to recover, but has been convolved with some other signal *g* before get recorded. The function *g* might represent the transfer function of an instrument or a driving force that was applied to a physical system.If one know g or at least form of g,then one can perform deterministic deconvolution.

If the two sequences f(n) and g (n) are causal, then the convolution sum is:

$$h(n) = \sum_{k=0}^{n} f(k)\, g(n-k), \qquad n \geq 0 \quad (2)$$

Therefore, solving for *f(n)* given *g(n)* and y(n) results in

$$f(n) = \frac{h(n) - \sum_{k=0}^{n-1} f(k)\, g(n-k)}{g(0)}, \qquad n \geq 1 \quad (3)$$

where

$$f(0) = \frac{h(0)}{g(0)} \qquad (4)$$

where solution requires that $g(0) \neq 0$

This recursion can be carried out in a manner similar to long division. Lets take example ,let h[n] = [16 36 56 17 28 12] and g[n] = [4 4 3 2] , solving for *f(n)* given *g(n)* and h(n). The sequences are set up in a fashion similar to long division, as shown below, but where no carries are performed out of a column.

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	4	5	6	=> f(n)		
4 4 3 2	16	36	56	47	28	12
	16	16	12	8		
		20	44	39	28	
		20	20	15	10	
			24	24	18	12
			24	24	18	12
						0

fig.1. Deconvolution by novel method

By observing figure 1. one can easily predict, for implementing speedy deconvolution by above method, divisor , multiplier and adder(to achieve subtraction in form of addition) used in design must be speedy.

High speed division can be carried out by selecting proper division algorithm.Vedic multiplier is used to get speedy multiplication.

3 ALGORITHM SELECTION FOR DIVISION

Division is most complex and time consuming operation for DSP.Basically division algorithm is classified as multiplicative and subtractive approaches. Multiplicative division algorithms do not compute the quotient directly, but use successive approximations to converge to the quotient. Normally, such algorithms only yield a quotient, but with an additional step the final remainder can be computed, if needed. Computations include several multiplications each iteration. The Goldschmidt division algorithm, binary search division algorithm, Newton-Raphson algorithm all these algorithms work by calculating estimates. Drawback of these algorithms is one has to compromise with exact result. Different errors need to be considered to calculate result. Though required number of iterations are less, steps required per iteration are more. The fastest implementation of a division function is a table lookup. A lookup-table implementation introduces a latency of just one clock cycle, but requires a table-size that grows exponentially with the input data width. another method is shift-and-subtract division algorithm.The algorithm is based on the well-known paper-and-pencil method of shifting the divisor from left to right of the dividend, and subtracting it when it is smaller then the remainder. Such an implementation scales linearly with the input data width, but requires a number of iterations equal to the input data width.

Hence here we concentrate ourselves to the subtractive approach. In the subtractive idea the algorithm is the same as the division methods that we were taught in the elementary school. Suppose that there are two n-digit numbers, X and D, which represent the dividend and divisor respectively. By the division operation we can find a n-digit quotient and a n-digit remainder denoted as Q and R respectively. The mathematical representations of X, D, Q, and R are as following .[3].

$$R^{(j+1)} = r \times R^j - q_{j+1} \times D \qquad (5)$$

Where $j = 0, 1, 2, \ldots, n-1$ is the iteration number.

$R\,j$ is the partial remainder at iteration j.

r is the radix number.

q_{j+1} is the $j+1$th digit of the quotient

The final quotient is represented as

$$Q = q_1\, q_2\, q_3 \ldots\ldots q_n$$

we use radix-2, i.e., r=2, for design. Therefore,equation (5) can be rewritten and represented in equation (6) as follows [3].

$$R^{(j+1)} = 2 \times R^j - q_{j+1} \times D \qquad (6)$$

In the hardware design we have to check the subtraction at each step to decide the quotient in that digit. There are two ways to find the quotient of the current digit. One is the restoring method, and the other is the non-restoring method.In the restoring approach, when the current partial remainder, R^{j+1} , is positive, the current quotient bit is equal to 1. On the other hand, if the current partial remainder is less than 0, then the current quotient bit is set to 0, and then the partial remainder should be added with the divisor and restore back to the previous partial remainder, R^j and it is so called the "restoring" method. In the non-restoring method,if the current partial remainder, $R^{(j+1)}$, is positive,the current quotient bit is equal to 1. On the other hand, if the current partial remainder is less than 0, then the current quotient bit is set to -1, and at the next step we have to add the divisor to the current partial remainder, $R^{(j+1)}$, to form the next partial remainder, $R^{(j+2)}$. By this method, there is no need to add divisor to restore the previous partial remainder.However, the quotient in the non-restoring scheme is represented in the signed bit (digit) format.Therefore, after we finish the division process, the non-restoring method needs an additional step to convert the signed bit format to the binary number representation. Since we do not need to check the polarity of the partial remainder to do the restoring of the partial remainder. Therefore, the speed of the non-restoring division algorithm is faster than the speed of the restoring division algorithm [3],[4].

Here asper need of task,non restoring division algorithm is modified.Here dividend is 8 bit long number and divisor is number represented by 4 bits .Hence quotient would have maximum length of 4bit.

Table 1. Show delay and area utilized by divisor prepared by using non restoring division algorithm.Xilinx 9.2i is used for synthesis and simulation.Family Spartan 3E(90 nm process technology) is selected,with speed grade -5.

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TABLE 1.
SIMULATION OF 8BIT BY 4BIT DIVISION USING NON RESTORING ALGORITHM

Area			Delay
Slices	LUTs	IOBs	ns
39	70	16	17.911

4 VEDIC MULTIPLIER

A multiplier is one of the key hardware blocks in convolution system. With advances in technology, many researchers have tried and are trying to design multipliers which offer either of the following- high speed, low power consumption, regularity of layout and hence less area or even combination of them in multiplier. . However area and speed are two conflicting constraints. So improving speed results always in larger areas. So here in this paper attempt is to find out the best trade off solution among the both of them.

Depending upon the arrangement of the components, there are different types of multipliers available. A Particular multiplier architecture is chosen based on the application. Two most common multiplication algorithms followed in the digital hardware are array multiplication algorithm and Booth multiplication algorithm. The computation time taken by the array multiplier is comparatively less because the partial products are calculated independently in parallel. The delay associated with the array multiplier is the time taken by the signals to propagate through the gates that form the multiplication array. After comparison of 4 bit array multiplier and 4 bit Booth multiplier it is found that array multiplier is superior than Booth. [2].

Among all these multipliers, this paper proposes to use the multiplier based on an algorithm Urdhva Tiryagbhyam (Vertical & Crosswise) of ancient Indian Vedic Mathematics. Vedic mathematics is part of four Vedas (books of wisdom). It is part of Sthapatya- Veda (book on civil engineering and architecture), which is an upa-veda (supplement) of Atharva veda. His Holiness Jagadguru Shankaracharya Bharati Krishna Teerthaji Maharaja (1884-1960) comprised all this work together and gave its mathematical explanation while discussing it for various applications. Swamiji constructed 16 sutras (formulae) and 16 Upa sutras (sub formulae) after extensive research in Atharva Veda. Urdhva Tiryagbhyam Sutra is a general multiplication formula applicable to all cases of multiplication. It literally means “Vertically and crosswise”. It is based on a novel concept through which the generation of all partial products can be done and then, concurrent addition of these partial products can be done. Thus parallelism in generation of partial products and their summation is obtained using Urdhava Tiryagbhyam. The algorithm can be generalized for n x n bit number. Since the partial products and their sums are calculated in parallel, the multiplier is independent of the clock frequency of the processor.

This design need 4×4 bit multilplier.As per.[1], 4×4 bit Array multiplier is fastest among Booth, Wallance tree etc. Here we proposed to use Vedic multiplier based on Urdhava Triyakbhyam algorithm as we found it is fastest of all multipliers. Comparison between Array and Vedic is given in table2

TABLE 2.
SIMULATION OF 4×4 MULTIPLIERS FOR DELAY COMPARISION

Multiplier	Vedic	Array
Spartan 3E	11.676 ns	13.773 ns
Virtex 5	6.036 ns	6.2 ns

.

5 ADDER SLECTION

Choice of speedy and area saving adder is done by implementing and comparing 8 bit carry look ahead adder performance with 8 bit ripple carry adder, below in table 3.It shows delay and area utilized by these adders, for family Spartan 3E(90 nm process technology) and with speed grade -5.

TABLE 3.
SIMULATION OF DIFFERENT ADDERS FOR ADDITION OF TWO NUMBERS, EACH ONE IS 8 BIT LONG

Adder name	Area			Delay
	Slices	LUTs	IOBs	ns
Carry look ahead	9	15	25	12.025
Ripple carry	9	15	25	12.675

After observing results of comparisons, for two 8bit numbers addition carry look ahead adder is selected.

6 DESIGN VERIFICATION OF DECONVOLVER

Verification is carried out by ISE simulator. (Simulator results are shown in figure 2.RTL results are shown in figure 3, of another attached file named ‘Results’.)We used these two arrays with samples:
First input array g[n]: [F_h A_h B_h 9_h]
Second input array h[n]: [$B4_h$ $F0_h$ $13D_h$ $1A0_h$ $F9_h$ AD_h $5A_h$]
Deconvolved output : [C 8 7 A]

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Area utilization summary is given below.

Cell Usage :

# BELS	: 605
# LUT2	: 27
# LUT3	: 142
# LUT4	: 397
# MUXF5	: 39
# IO Buffers	: 52
# IBUF	: 36
# OBUF	: 16

7 CONCLUSION

In this paper, we presented an optimized implementation of deconvolution. This particular model has the advantage of being fine tuned for signal processing. To accurately analyze our proposed system, we have coded our design using the VHDL hardware description language and have synthesized it for FPGA products using ISE. The proposed circuit uses less area and less power, and it takes 79.595 ns to complete on 90 nm process technology devices.Thus aim of high speed deconvolver implementation is achieved.

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Different Approaches of Spectral Subtraction method for Enhancing the Speech Signal in Noisy Environments

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Abstract—Enhancement of speech signal degraded by additive background noise has received more attention over the past decade, due to wide range of applications and limitations of the available methods. Main objective of speech enhancement is to improve the perceptual aspects of speech such as overall quality, intelligibility and degree of listener fatigue. Among the all available methods the spectral subtraction algorithm is the historically one of the first algorithm, proposed for background noise reduction. The greatest asset of Spectral Subtraction Algorithm lies in its simplicity. The simple subtraction process comes at a price. More papers have been written describing variations of this algorithm that minimizes the shortcomings of the basic method than other algorithms. In this paper we present the review of basic spectral subtraction Algorithm, a short coming of basic spectral subtraction Algorithm, different modified approaches of Spectral Subtraction Algorithms such as Spectral Subtraction with over subtraction factor, Non linear Spectral Subtraction, Multiband Spectral Subtraction, Minimum mean square Error Spectral Subtraction, Selective Spectral Subtraction, Spectral Subtraction based on perceptual properties that minimizes the shortcomings of the basic method, then performance evaluation of various modified spectral subtraction Algorithms, and conclusion.

Index Terms— speech enhancement; additive noise; Spectral Subtraction; intelligibility; Discrete Fourier Transform, vad.

1 INTRODUCTION

Speech signals from the uncontrolled environment may contain degradation components along with required speech components. The degradation components include background noise, speech from other speakers etc. Speech signal degraded by additive noise, this make the listening task difficult for a direct listener, gives poor performance in automatic speech processing tasks like speech recognition speaker identification, hearing aids, speech coders etc. The degraded speech therefore needs to be processed for the enhancement of speech components. The aim of speech enhancement is to improve the quality and intelligibility of degraded speech signal. Main objective of speech enhancement is to improve the perceptual aspects of speech such as overall quality, intelligibility and degree of listener fatigue. Improving quality and intelligibility of speech signals reduces listener's fatigue; improve the performance of hearing aids, cockpit communication, videoconferencing, speech coders and many other speech systems. Quality can be measured in terms of signal distortion but intelligibility and pleasantness are difficult to measure by any mathematical algorithm. Perceptual quality and intelligibility are two measures of speech signals and which are not co-related. In this study a speech signal enhancement using basic spectral subtraction and modified versions of spectral subtraction methods such as Spectral Subtraction with over subtraction, Non linear Spectral Subtraction, Multiband Spectral Subtraction, MMSE Spectral Subtraction, Selective Spectral Subtraction, Spectral Subtraction based on perceptual properties has been explained in detail with their performance evaluation.

2 METHODOLOGIES

2.1 Basic spectral subtraction algorithm

The speech enhancement algorithms based on theory from signal processing. The spectral - subtractive algorithm is historically one of the first algorithms proposed for noise reduction [4]. Simple and easy to implement it is based on the principle that one can estimate and update the noise spectrum when speech signal is not present and subtract it from the noisy speech signal to obtain clean speech signal spectrum[7]. Assumption is noise is additive and its spectrum does not change with time, means noise is stationary or it's slowly time varying signal. Whose spectrum does not change significantly between the updating periods. Let y(n) be the noise corrupted input speech signal, is composed of the clean speech signal x(n) and the additive noise signal d(n). In mathematical equation form one can

$$y(n) = x(n) + d(n) \qquad (1)$$

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Many of speech enhancement algorithms operates in the Discrete Fourier Transform (DFT) domain [3] assume that the real and imaginary part of the clean speech DFT coefficients can be modeled by different speech enhancement algorithms. In Fourier domain, we can write y(n) as

$$Y[w] = x[w] + D[w]. \qquad (2)$$

Y[w] can be expressed in terms of Magnitude and Phase as

$$Y[w] = Y\,|(w)|\; e^{j\varnothing y}$$

Where $|Y(w)|$ is the magnitude spectrum and Ø is the phase spectra of the corrupted noisy speech signal.Noise spectrum in terms of magnitude and phase spectra is

$$D[w] = |\,D[w]\,|\; e^{j\varnothing y}$$

The Magnitude of noise spectrum $|D(w)|$ is unknown but can be replaced by its average value or estimated noise $|D_e(w)|$ computed during non speech activity that is during speech pauses. The noise phase is replaced by the noisy speech phase Øy that does not affect speech ineligibility [4]. We can estimate the clean speech signal simply by subtracting noise spectrum from noisy speech spectrum in equation form

$$X_e(w) = [\,|Y(w)| - |D_e(w)|\,|]\; e^{j\varnothing y} \qquad (3)$$

Where Xe(w) is estimated clean speech signal. Many spectral subtractive algorithms are there depending on the parameters to be subtracted such as Magnitude spectral subtraction¸ Power spectral subtraction, Autocorrelation subtraction. The estimation of clean speech Magnitude signal spectrum is

$$X_e[w] = |Y[w]| - |D_e[w]|$$

Similarly for Power spectrum subtraction is

$$X_e[w]^2 = |Y[w]|^2 - |D_e[w]|^2 \qquad (4)$$

The enhanced speech signal is finally obtained by computing the inverse Fourier Transform of the estimated clean speech $|X_e[w]|$ for magnitude. Spectrum subtractions and $|X_e[w]|^2$ for power spectrum substation subtraction, using the phase of the noisy speech signal. The more general version of the spectral subtraction algorithms is

$$X_e[\omega]^p = |Y[\omega]|^p - |D_e[\omega]|^p \qquad (5)$$

Where P is the power exponent¸ the general form of the spectral subtraction, when p=1 yielding the magnitude spectral subtraction algorithm and p=2 yielding the power spectral subtraction algorithm. The general form of the spectral subtraction algorithm is shown in figure 1. [4]

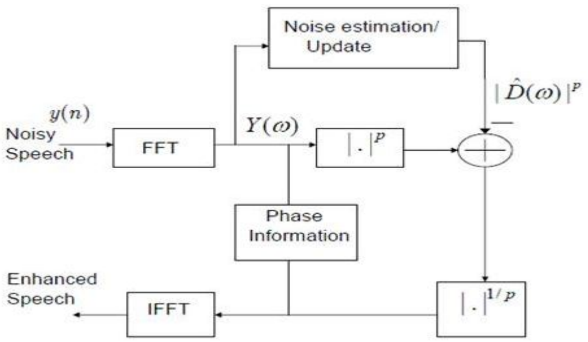

Figure1-The general form of the spectral subtraction algorithm [4]

2.2 Short comings of S. S. Algorithm

The subtraction process needs to be done carefully to avoid any speech distortion. If too little is subtracted than much of the interfering noise remains¸ if too much is the subtracted then some speech information might be removed [1]. It is clear that spectral subtraction method can lead to negative values, resulting from differences among the estimated noise and actual noise frame. Simple solution is set the negative values to zero, to ensure a non negative magnitude spectrum. This non linear processing of the negative values called negative rectification or half-wave rectification [4]. This ensure a non-negative magnitude spectrum given by equation (6)

$$|X_e(\omega)| = |Y(\omega)| - |\,D_e(\omega)|,\ \text{if } |Y(\omega)| > |D_e(\omega)|$$
$$\text{else}$$
$$= 0 \qquad (6)$$

This non-linear processing of the negative values creates small, isolated peaks in the spectrum occurring at random frequency locations in each frame. Converted in the time-domain, these peaks sound like tones with frequencies that change randomly from frame to frame. That is, tones that are turned on and off at the analysis frame rate (every 20 to 30 ms). This new type of noise introduced by the half-wave rectification process has been described as warbling and of tonal quality, and is commonly referred to in the literature as “musical noise.” Minor shortcoming of the spectral subtraction Algorithm is the use of noisy phase that produces a roughness in the quality of the synthesized speech [4]. Estimating the phase of the clean speech is a difficult task and greatly increases the complexity of the enhancement algorithm. The phases of the noise corrupted signal are not enhanced, because the presence of noise in the phase information does not contribute much to the degradation of speech quality [6]. The distortion due to noisy phase information is not very significant compared to that of the Magnitude spectrum especially for high SNRs. Combating musical noise is much more critical than finding methods to preserve the original phase. Due to that reason, much efforts has been fo-

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cused on finding methods to reduce musical noise which are explained in next section

2.3 Spectral Subtraction with over subtraction

Modifications made to the original spectral subtraction method are subtracting an over estimate of the noise power spectrum and preventing the resultant spectrum from going below a preset minimum level (spectral floor).This modifications lead to minimizing the perception of the narrow spectral peaks by decreasing the spectral excursions and thus lower the musical noise effect. Berouti [5] has taken a different approach that does not require access to future information. This Method consists of subtracting an overestimate of the noise power spectrum and presenting the resultant spectral components from going below a preset minimum spectral floor value. This algorithm is given in equation (7), where $|X_{ej}(\omega)|$ denotes the enhanced spectrum estimated in frame i and $|D_e(\omega)|$ is the spectrum of the noise obtained during non-speech activity

$$|X_{ej}(\omega)|^2 = |Y_j(\omega)|^2 - |D_e(\omega)|^2 \quad \text{if } |Y_j(\omega)|^2 > (\alpha + \beta)|D_e(\omega)|^2$$

$$= \beta|D_e(\omega)|^2 \quad \text{else} \qquad (7)$$

With $\alpha \geq 1$ and $0 < \beta \leq 1$.

Where α is over subtraction factor and β is the spectral floor parameter. Parameter β controls the amount of residual noise and the amount of perceived Musical noise. If β is too small, the musical noise will became audible but the residual noise will be reduced .If β is too large, then the residual noise will be audible but the musical issues related to spectral subtraction reduces. Parameter α affects the amount of speech spectral distortion. If α is too large then resulting signal will be severely distorted and intelligibility may suffer. If α is too small noise remains in enhanced speech signal. When $\alpha > 1$, the subtraction can remove all of the broadband noise by eliminating most of wide peaks. But the deep valleys surrounding the peaks still remain in the spectrum [1]. The valleys between peaks are no longer deep when $\beta > 0$ compared to when $\beta = 0$ [4] Berouti found that speech processed by equation (7) had less musical noise. Experimental results showed that for best noise reduction with the least amount of musical noise, α should be smaller for high SNR frames and large for low SNR frames. The parameter α varies from frame to frame according to Burouti [5] as given below

$$\alpha = \alpha_o - 3/20\,\text{SNR} \qquad -5\text{ dB} < \text{SNR} \leq 20\text{dB}$$

Where α_0 is the desired value of α at 0 dB SNR is the short time SNR estimate in each frame. It is an a posteriori estimate of the SNR computed based on the ratio of the noisy speech power to the estimated noise power. Berouti [5] determine the optimum values of α and β. For high noise levels (SNR = - 5dB), the suggested β is in the range of 0.02 to 0.06 and for lower noise levels (SNR > 0dB), β in the range 0.005 to 0.02. The parameter α suggested by Berouti [5] is in the range of 3 to 6. The influence of α also investigated by others Martin[4,15] suggest the range of α should lie between 1.3 and 2 for Low SNR conditions for high SNR conditions subtraction factor α less than one was suggested.

2.4 Non–linear Spectral Subtraction (NSS)

The NSS proposed by [8] Lockwood and Boudy. NSS is basically a modification of the method suggested in [5] by making the over subtraction factor frequency dependent and the subtraction process non-linear. In case of NSS assumption is that noise does not affects all spectral components equally. Certain types of noise may affect the low frequency region of the spectrum more than high frequency region. This suggests the use of a frequency dependent subtraction factor for different types of noise. Due to frequency dependent subtraction factor, subtraction process becomes nonlinear. Larger values are subtracted at frequencies with low SNR levels and smaller values are subtracted at frequencies with high SNR levels. The subtraction rule used in the NSS algorithm has the following form.

$$|X_e(\omega)| = |Y(\omega)| - \alpha(\omega)\,N(\omega) \quad \text{if } |Y(\omega)| > \alpha(\omega)\,N(\omega) + \beta|D_e(\omega)| \text{ else}$$

$$= \beta|Y(\omega)| \qquad (8)$$

Where β is the spectral floor set to 0.1 in [8] $|Y(\omega)|$ and $|D_e(\omega)|$ are the smoothed estimates of noisy speech and noise respectively, $\alpha(\omega)$ is a frequency dependent subtraction factor and $N(\omega)$ is a non-linear function of the noise spectrum where

$$N(\omega) = \text{Max}(|D_e(\omega)|) \qquad (9)$$

The $N(\omega)$ term is obtained by computing the maximum of the noise magnitude spectra $|D_e(\omega)|$ over the part 40 frames [4]. The $\alpha(\omega)$ given in [8] as

$$\alpha(\omega) = 1/r + p(\omega) \qquad (10)$$

Where $\curlyvee$ is a scaling factor and $P(\omega)$ is the square root of the posteriori SNR estimate given as

$$P(\omega) = |Y(\omega)| / |D_e(\omega)| \qquad (11)$$

The NSS algorithm was successfully used in [8] as a pre-processor to enhance the performance of speech recognition systems in noise.

2.5 Multiband Spectral Subtraction (MBSS)

In MBSS approach [9,4] the speech spectrum is divided into N overlapping bands and spectral subtraction is per-

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formed independently in each band. The processes of splitting the speech signal into different bands can be performed either in the time domain by using band pass filters or in the frequency domain by using appropriate windows. The estimate of the clean speech spectrum in the ith band is obtained by [9].

$$|X_{ei}(\omega_k)|^2 = |Y_i(\omega_k)|^2 - \alpha_i\,\delta_i\,|D_i(\omega_k)|^2 \qquad b_i < \omega_k < e_i \qquad (12)$$

Where ω_k = 2pi k / N, k = 0, 1 ... N – 1 are the discrete frequencies $|D_{ei}(\omega_k)|^2$ is the estimated noise power spectrum obtained during speech absent segment, α_i is the over subtraction factor of the i^{th} band and δ_i is an additional band. Subtraction factor can be individually set for each frequency band to customize the noise removal processor b_i and e_i are the beginning and ending frequency bins of the i^{th} frequency band. The band specific over subtraction factor is a function of the segmented SNR_i of the i^{th} frequency band and is computed as follows [4]

$$\alpha_i = \begin{cases} 4.75 & SNR_i < -5 \\ 3/20\,(SNRi) & -5 < SNR_i < 20 \\ 1 & SNR_i > 20 \end{cases}$$

The values for δ_i are set to

$$\delta_i = \begin{cases} 1 & f_i < 1\text{ KHz} \\ 2.5 & 1\text{KHz} < f_i < (Fs/2) - 2\text{ KHz} \\ 1.5 & f_i > (Fs/2) - 2\text{ KHz} \end{cases}$$

Where f_i is the upper frequency of the i^{th} band and Fs is the sampling frequency in Hz. The main difference between the MB and the NSS algorithm is in the estimation of the over subtraction factors. The MB approach estimates one subtraction factor for each frequency band, whereas the NSS algorithm estimates one subtraction factor for each frequency bin [4]

2.6 MMSE Spectral Subtraction Algorithm

Minimum Mean Square Error (MMSE) Spectral subtraction Algorithm is proposed by Sim [11]. A method for optimally selecting the subtractive parameters in the mean error sense [17,18]. Consider a general version of the spectral subtraction algorithm

$$|X(\omega)|^P = \gamma_p(\omega)\,|Y(\omega)|^P - \alpha_p(\omega)\,|D_e(\omega)| \qquad (13)$$

Where $\gamma_p(\omega)$ and $\alpha_p(\omega)$ are the parameters of interest. P is the power exponent and $|D_e(\omega)|$ is the average noise spectrum obtained during non speech activity. The parameter $\gamma_p(\omega)$ can be determined by minimizing the mean square error spectrum

$$e_p(\omega) = |Xp(\omega)|^P - |Xe(\omega)|^P \qquad (14)$$

Where $|Xp(\omega)|$ is the clean speech spectrum, assuring an ideal spectral subtraction model and $|Xe(\omega)|$ is enhanced speech. Here assumption is that noisy speech spectrum consists of the sum of two independent spectra the $|Xp(\omega)|^P$ spectrum and the true noise spectrum $|De(\omega)|^P$ .Where P is constant, considering P = 1 and processing equation (13) by minimizing the mean square error of the error spectrum giving equation (14) with respect to $\gamma_p(\omega)$ and $\alpha_p(\omega)$, we get the following optimal subtractive parameters [4].

$$\alpha_p(\omega) = \xi^P(\omega) / (1 + \xi^P(\omega)) \qquad (15)$$

$$\gamma_p(\omega) = \alpha_p(\omega)\,[1 - \xi^{-p/2}(\omega)] \qquad (16)$$

Where

$$\xi(\omega) = E[|Xp(\omega)|^2] / E[|D_e(\omega)|^2] \qquad (17)$$

2.7 Selective Spectral Subtraction Algorithm

All previously mentioned methods treated all speech segments equally, making no distinction between voiced and unvoiced segments. Due to the spectral differences between vowels and consonants [4] several researchers have proposed algorithms that treated the voiced and unvoiced segment differently. The resulting spectral subtractive algorithms were therefore selective for different classes of speech sounds [4]. The two band spectral subtraction algorithm was proposed in [13]. The incoming speech frame was first classified into voiced or unvoiced by comparing the energy of the noisy speech to a threshold. Voiced segments were then filtered into two bands, one above the determined cutoff frequency (high pass speech) and one below the determined cutoff frequency (low pass speech). Different algorithms were then used to enhance the low passed and high passed speech signals accordingly. The over subtraction algorithm was used for the low passed speech based on the short term FFT. The subtraction factor was set according to short term SNR as per [5]. For high passed voiced speech as well as for unvoiced speech, the spectral subtraction algorithm was employed with a different spectral estimator [4].

A dual excitation Model was proposed in [3] for speech enhancement. In the proposed approach, speech was decomposed into two independent components voiced and unvoiced components. Voiced component analysis was performed first by extracting the fundamental frequency and the harmonic amplitudes. The noisy estimates of the harmonic amplitudes were adjusted according to some rule to account for any noise that might have leaked to the harmonics. Following that the unvoiced component spectrum was computed by subtracting the voiced spectrum from the noisy speech spectrum. Then a two pass system, which included a modified Wiener Filter, was used to enhance the unvoiced spectrum. Finally the enhanced speech consists of the sum of the enhanced voiced and unvoiced components. Treating voiced and unvoiced segments differently can bring about substantial improvements in performance [4]. The

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major challenge with such algorithms is making accurate and reliable voiced, unvoiced decisions particularly at low SNR conditions.

2.8 Spectral Subtraction based on perceptual properties

In the preceding methods, the subtractive parameters were computed experimentally, based on short term SNR levels [5] or obtained optimally in a mean square error sense [11]. No perceptual properties of the auditory system have been considered. An algorithm proposed by Virag [14] that incorporates psycho acoustical properties of speech signal, in the spectral subtraction process. The main objective of this algorithm is to remove the residual noise perceptually inaudible and improve the intelligibilityof enhanced speech by taking into account the properties of the human auditory system [4]. Method proposed by Virag [14] was based on idea that, if the estimated masking threshold at a particular frequency is low, the residual noise level might be above. The threshold and will therefore be audible. The subtraction parameters should therefore attain their maximal values at that frequency. Similarly, if the masking threshold level is high at a certain frequency, the residual noise will be masked and will be inaudible. The subtraction parameters should attain their minimal values at that frequency. The subtraction parameters α & β are given as

$$\alpha(\omega) = F_a\,[\alpha_{min}, \alpha_{max}, T(\omega)] \qquad (18)$$
$$\beta(\omega) = F_b\,[\beta_{min}, \beta_{max}, T(\omega)]$$

Where $T(\omega)$ was the masking threshold, α_{min} and α_{max} were set to 1 and 6 respectively and spectral floor constants β_{min} & β_{max}, were set to 0 and 0.02 respectively in [4]. The $F_a(\omega)$ function had the following boundary conditions

$$F_a(\omega) = \begin{cases} a_{max} & \text{if } T(\omega) = T(\omega)_{min} \\ a_{min} & \text{if } T(\omega) = T(\omega)_{max} \end{cases} \qquad (19)$$

Where $T(\omega)_{min}$ and $T(\omega)_{max}$ are the minimal and maximum values of masking thresholds estimated in each frame. Similarly the function $F_b(\omega)$ was computed using β_{min} and β_{max} as boundary conditions. The main advantage of Virag's approach lies in the use of noise masking thresholds $T(\omega)$ rather than SNR levels for adjusting the parameters $\alpha(\omega)$ and $\beta(\omega)$. The masking thresholds $T(\omega)$ provide a smoother evolution from frame to frame than the SNR. This algorithm requires accurate computation of the masking threshold.

3 Performance of Specral Subtraction Algorithms

The spectral subtraction algorithm was evaluated in many studies, primarily using objective measures such as SNR improvement and spectral distances and then subjective listening tests. The intelligibility and speech quality measures reflect the true performance of speech enhancement [4] algorithms in realistic scenarios. Ideally, the SS algorithm should improve both intelligibility and quality of speech in noise. Results from the literature were mentioned as follows.

Boll[5] performed intelligibility and quality measurement tests using the Diagnostic Rhyme Test (DRT). Result indicated that SS did not decrease speech intelligibility but improved speech quality particularly in the area of pleasantness and inconspicuousness of the background noise. Lim [4] evaluated the intelligibility of nonsense sentences in white noise at –5, 0, and +5dB SNR processed by a generalized SS algorithm (eqa. No.5). the intelligibility of processed speech was evaluated for varies power exponents P ranging from P = 0.25 to P = 2. Results indicated that SS algorithm did not degrade speech intelligibility except when P = 0.25. Kang and Fransen [4] evaluated the quality of noise processed by the SS algorithm and then fed to a 2400 bps LPC recorder. Here SS algorithm was used as a pre-processor to reduce the input noise level. The Diagnostic Acceptability Measure (DAM) test [19] was used to evaluate the speech quality of ten sets of noisy sentences, recorded actual military platforms containing helicopter, tank, and jeep noise results indicated that SS algorithm improved the quality of speech. The largest improvement in speech quality was noted for relatively stationary noise sources [4, 2]. The NSS algorithm was successfully used in [8] as a pre-processor to enhance the performance of speech recognition systems in noisy environment. The performance of the multiband spectral subtraction algorithm [9] was evaluated by Hu Y. and Loizou [2, 19] using formal subjective listening tests conducted according to ITU–T P.835 [20]. The ITU T P.835 methodology is designed to evaluate the speech quality along with three dimensions signal distortion, noise distortion and overall quality. Results indicated that the MBSS algorithm performed the best consistently across all noise conditions, [4] in terms of overall quality. In terms of noise distortion the MBSS algorithms performed well, except in 5dB train and 10dB street conditions. The algorithm proposed by Virag was evaluated in [14] using objective measures and subjective tests, and found better quality than the NSS and standard SS algorithms. The low energy segments of speech are the first to be lost in the subtraction process; particularly when over subtraction is used. Overall most studies confirmed that the SS algorithm improves speech quality but not speech intelligibility.

4 Conclusion

Various spectral subtraction algorithms proposed for speech enhancement were described in above sections. These algorithms are computationally simple to implement as they involve a forward and an inverse Fourier transform. The simple subtraction processing comes at a price. The subtraction of the noise spectra from the noisy

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spectrum introduces a distortion in the signal known as Musical noise [4]. We presented different techniques that mitigated the Musical noise distortion. Different variations of spectral subtraction were developed over the years. The most common variation involved the use of an over subtraction factor that controlled to some amount of speech spectral distortion caused by subtraction process. Use of spectral floor parameter prevents the resultant spectral components from going below a preset minimum value. The spectral floor value controlled the amount of remaining residual noise and the amount of musical noise [4]. Different methods were proposed for computing the over subtraction factor based on different criteria that included linear [5] and nonlinear functions [8] of the spectral SNR of individual frequency bins or bands [9] and psychoacoustic masking threshold [14]. Evaluation of spectral subtractive algorithms revealed that these algorithms [4] improve speech quality and not affect much more on intelligibility of speech signals.

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Economic Power Dispatch Problem using Artificial Immune System

R.Behera, B.B.Pati, B.P.Panigrahi

Abstract---- This paper presents the genetic algorithm approach to adaptive optimal economic dispatch of Electrical Power Systems. Artificial Immune System Algorithms, also termed as the machine learning approach to Artificial Intelligence, are powerful stochastic optimization techniques with potential features of random search, hill climbing, statistical sampling and competition. Artificial immune system algorithmic approach to power system optimization, as reported here for a case of economic power dispatch, consists essentially of minimizing the objective function while gradually satisfying the constraint relations. The unique problem solving strategy of the genetic algorithm and their suitability for power system optimization is described. The advantages of the artificial immune system algorithm approach in terms of problem reduction, flexibility and solution methodology are also discussed. The suitability of the proposed approach is described for the case of a six generator thirty bus IEEE system.

Index Terms----Antibody, Antigen, Cloning, Hypermutation, Optimization, Softcomputing

1 INTRODUCTION

THE definition of economic dispatch provided in EP Act section 1234 is: “The operation of generation facilities to produce energy at the lowest cost to reliably serve consumers, recognizing any operational limits of generation and transmission facilities”. Most electric power systems dispatch their own generating units and their own purchased power in a way that may be said to meet this definition. There are two fundamental components to economic dispatch:

I Planning for tomorrow’s dispatch

II Dispatching the power system today

I Planning for tomorrow’s dispatch

a. Scheduling generating units for each hour of the next day’s dispatch

b. Based on forecast load for the next day

c. Select generating units to be running and available for dispatch the next day (operating day)

d. Recognize each generating unit’s operating limit, including it’s:

Ramp rate (how quickly the generator’s output can be changed), Maximum and minimum generation levels,

Minimum amount of time the generator must run,

Minimum amount of time the generator must stay off once turned off, Recognize generating unit characteristics

e. Cost of generation, which depends on its efficiency (heat rate), variable operating costs (fuel and non-fuel), variable cost of environmental compliance, start-up costs, next day scheduling is typically performed by a generation group or an independent market operator, reliability assessment.

Analyze forecasted load and transmission conditions in the area to ensure that scheduled generation dispatch can meet load reliability. If the scheduled dispatch is not feasible within the limits of the transmission system, revise it. The reliability assessment is typically performed by a transmission operations group.

II Dispatching the power system today

a) Monitor load, generation and interchange (imports/exports) to ensure balance of supply and load.

b) Monitor and maintain system frequency at 50/60 Hz during dispatch according to NERC standards, using Automatic Generation Control (AGC) to change generation dispatch as needed.

c) Monitor hourly dispatch schedules to ensure that dispatch for the next hour will be in balance.

d) Monitor flows on transmission system.

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e) Keep transmission flows within reliability limits.
f) Keep voltage levels within reliability ranges.
g) Take corrective action, when needed, by:
Limiting new power flow schedules, curtailing existing power flow schedules, changing the dispatch or shedding load.
h) This monitoring is typically performed by the transmission operator area factors limiting the effectiveness of dispatch in minimizing customer costs.
Geographic area included the size of the geographic region over which the dispatch occurs affects the level of costs: that is, which generation resources and which transmission facilities are considered in planning and economic dispatch. Generation resources included which generation resources in the area are included in the planning and economic dispatch, and whether they are included in the same manner, affects the level of costs. Transmission facilities included what transmission facilities are included in the planning and economic dispatch, and how the reliability security limits of the transmission facilities are incorporated into the economic dispatch. Implementation factors limiting effectiveness of dispatch in minimizing customer costs. Performing an economic dispatch more frequently (e.g., 5 or 15 minutes rather than each hour) affects the level of costs. Generation operators, transmission owners, and load serving entities must provide accurate and current information to those performing the planning and dispatch functions. Those performing planning and dispatch must provide accurate and current dispatch instructions to generation operators, transmission operators and load serving entities. Inadequate or incomplete communications affects the level of costs of the economic dispatch. Reliable and secure computer software is essential for rapidly responding to system changes to maintain power system reliability, while selecting the lowest cost generators to dispatch. Obsolete software affects the level of costs achieved by the economic dispatch.
Where there are multiple, independently performed, dispatches in a region, the effectiveness of coordination agreements and their implementation affect the level of costs of the economic dispatch.

Masashi Yoshimi Technical, Swamp, K. S. &Yoshio Izui [1] had presented the genetic algorithm approach to adaptive optimal economic dispatch of electrical power systems. The advantages of the genetic algorithmic approach in terms of problem reduction, flexibility and solution methodology are also discussed.

Mehrdad Salami and Greg Cain [2] had presented the application of a hardware genetic algorithm processor to handle the economic power dispatch problem. We have analyzed a variety of configurations including varying the string word length and the introduction of multiple processor configurations. Results show that multiple genetic algorithm processor configurations work better than other configurations with less complexity. It is possible to apply multiple configurations to larger numbers of generators in the problem.

Leandro Nunes de Castro & Fernando J. Von Zuben [3] had presented The clonal selection algorithm is used by the natural immune system to define the basic features of an immune response to an antigenic stimulus. It establishes the idea that only those cells that recognize the antigens are selected to proliferate. The selected cells are subject to an affinity maturation process, which improves their affinity to the selective antigens. In this paper, we propose a powerful computational implementation of the clonal selection principle that explicitly takes into account the affinity maturation of the immune response. The algorithm is shown to be an evolutionary strategy capable of solving complex machine learning tasks, like pattern recognition and multimodal optimization.

Leandro Nunes de Castro [4] had presented review the general algorithms of immune, swarm and evolutionary systems.

Leandro N. de Castro and Fernando J. Von Zuben [5] had presented the clonal selection principle used to explain the basic features of an adaptive immune response to an antigenic stimulus.

K Selvi, Dr N Ramaraj, & S P Umayal [6] had presented a genetic algorithm (GA) based effective method for the optimal scheduling of thermal generation incorporating the uncertainties in the

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system production cost data. The algorithm gives fairly accurate results. The effectiveness of the method has been demonstrated by analyzing sample systems and the results are presented.

Titik Khawa Abdul Rahman, Zuhaila Mal Yasin arid Wan Norani W.Abdullah [7] had presented Artificial Immune System based optimization approach for solving the economic dispatch problem in a power system. Economic Dispatch determines the electrical power to be generated by the committed generating units in a power system so that the generation cost is minimized, while satisfying the load demand simultaneously. The developed Artificial Immune System optimization technique used the total generation cost as the objective function and represented as the affinity measure. Though genetic evolution, the antibodies with high affinity measure are produced and become the solution .The simulation result reveal that the developed technique is easy to implement and converged within an acceptable execution time and highly optimal solution for economic dispatch with minimum generation cost can be achieved .The result also confirms that AIS based optimization technique can be a useful tool for solving optimization solution in economic dispatch problem ,which involves a large number of generating units and at the same time to comply with a large number of constraints

.

2 ECONOMIC LOAD DISPATCH

The major component of generator operating cost is the fuel input/hour, while maintenance contributes only to a small extent. The fuel cost is meaningful in case of thermal and nuclear stations, but for hydro stations where the energy storage is 'apparently free'; the operating cost as such is not meaningful. Here we will concentrate on fuel fired stations. The input –Output curve of a unit can be expressed in a million Kcalories per hour or directly in terms of Rs/hr vs. output in MW. The cost curve can be determined experimentally. A typical curve is shown in Fig.2.1 where MW (min)is the minimum loading limit below which it is uneconomical (or may be technically infeasible) to operate the unit and MW (max) is the maximum output limit. The input-output curve has discontinuities steam valve openings which have not been indicated in the figure. By fitting a suitable degree polynomial, an analytical expression for operating cost can be written as

$C_i(P_{Gi})$ Rs/hr at out put P_{Gi}

Where the suffix i stand for the unit number. It generally suffices to fit a second degree polynomial that is

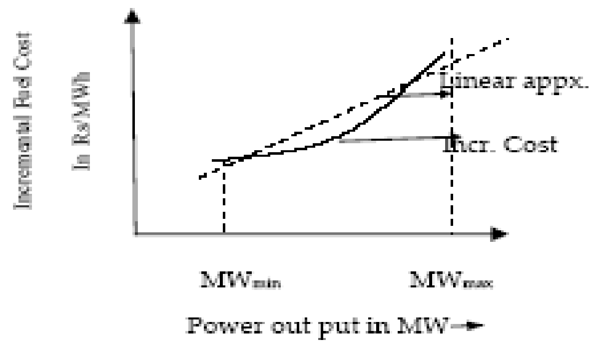

Fig. 1

$$C_i = (1/2)\, a_i P_{Gi}^2 + b_i P_{Gi} + d_i \text{ Rs/hour} \quad (1)$$

The slope of the cost curve, i.e. dC_i/dP_{Gi} is called the incremental fuel cost (IC) and is expressed in units of Rs/MWh .A typical plot of incremental fuel cost versus power output is shown in Fig.2.1 .If the cost curve is approximated as a quadratic as in Eq.(1), we have

$$(IC)_i = a_i P_{Gi} + b_i \quad (2)$$

i.e., a linear relationship. For better accuracy incremental fuel cost may be expressed by a number of short line segments. Alternatively, we can fit a polynomial of suitable degree to present IC curve in inverse form

$$P_{Gi} = \alpha_i + \beta_i (IC)_i + \gamma_i (IC)_i^2 + \ldots \quad (3)$$

Let us assume that it is known a priori which generators have to run to meet a particular load demand on the station. Obviously

$$\sum P_{Gi,max} \geq P_D \quad (4)$$

Where $P_{Gi,max}$ is the rated real power capacity of the i^{th} generator and P_D is the total power demand on the station. Further, the load on each generator is to be constrained within the lower and upper limits, i.e.

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$P_{Gi,min} \leq P_{Gi} \leq P_{Gi,max}$, i=1,2,3,…,k (5)

We also require that

$$\sum P_{Gi,max} > P_D \quad (6)$$

by a proper margin i.e. eq.(6) must be strict inequality. Since the operating cost is insensitive to reactive loading of a generator, the manner in which the reactive load of the stations shared among various online generators does not affect the operating economy. So the optimal manner in which the load demand P_D must be shared by the generators on the bus by minimizing the operating cost i,e.

$$C = \sum C_i(P_{Gi}) \quad 7)$$

Under the inequality constraint of meeting the load demand i.e.

$$\sum_{i=1}^{k} P_{Gi,max} - P_D = 0 \quad 8)$$

Where k is the number generators on the bus

The objective is to minimize the overall cost of generation

$$C = \sum_{i=1}^{k} C_i(P_{Gi}) \quad (9)$$

At anytime under equality constraint of meeting the load demand with transmission loss, i.e.

$$\sum_{i=1}^{k} P_{Gi} = P_D + P_L \quad (10)$$

Where

$$P_L = \sum_{m=1}^{k} \sum_{n=1}^{k} P_{Gm} * B_{mn} * P_{Gn} \quad (11)$$

Where

P_{Gm}, P_{Gn} = real power generation at m, n-th plants

B_{mn} = loss coefficients which are constraints under certain assumed operating conditions

3 GENETIC ALGORITHIM(GA)

Genetic algorithms, first introduced by John Holland in the early seventies, are becoming an important tool in machine learning and function optimization**.** The metaphor underlying GA is natural selection. To solve a learning task, a design, or an optimization problem, the GA maintains a population of 'chromosomes' or 'bit strings' and probabilistically modifies the population seeking a near-optimal solution to the given task. Beneficial changes to the parents are combined in their offspring. The GA adapts itself to the problem being solved through syntactic operations on the bit strings. GA has been tried on NP-hard combinatorial optimization problems and may provide a more advantageous approach to machine learning problems than neuromorphic networks and simulated annealing. The genetic algorithm consists of a string representation of nodes in the search space, a set of genetic operators for generating new search nodes, a fitness function to evaluate the search nodes and a stochastic assignment to control the genetic operators. The stepwise procedure of GA for the optimization of generation cost can be outlined as follows:

i. Initialization; Random generation of the initial population of the search nodes.

ii. Evaluation: Calculation of the fitness value of each node according to fitness function.

iii. Evaluation: Evaluation of strings or chromosomes of a population.

iv. Selection: Selection of reproducing sets from the population based on relative fitness values.

v. Reproduction: Generation of new strings from each reproducing set using various reproductive strategies. Replacing some or all of the original

vi. Population with new strings. The possible reproductive strategies are combinations of

vii. Reproduction: Generation of identical copies of some or all of the strings in the reproduction set.

viii. Mating: Construction of a new string by concatenating substrings chosen from members of the reproductive set.

ix. Mutation: Substitution of new symbols for selected positions in the new string.

4 ARTIFICIAL IMMUNE SYSTEM(AIS)

The immune system (IS) is a complex of cells, molecules and organs that represent an identification mechanism capable of perceiving and combating dysfunction from our own cells (infectious self) and the action of exogenous infectious microorganisms (infectious nonself). The interaction among the IS and several other systems and organs allows the regulation of the body, guaranteeing its stable functioning. Without the immune system, death from infection would be inevitable. Its cells and molecules maintain

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constant surveillance for infecting organisms. They recognize an almost limitless variety of infectious foreign cells and substances, known as nonself elements, distinguishing them from those native noninfectious cells, known as self molecules .When a pathogen (infectious foreign element) enters the body, it is detected and mobilized for elimination.

The AIS can be defined as a computational system based upon metaphors of the biological immune system. The immune engineering (IE) is a meta-synthesis process that uses the information contained in the problem itself to define the solution tool to a given problem, and then apply it to obtain the problem solution. It is not our intention to pose a strict limit between the AIS and the IE. Instead, we intend to make use of all immunological inspired phenomena and algorithm in order to solve complex problems. The topics involved in the definition and development of the artificial immune systems cover mainly:

a) Hybrid structures and algorithms that take into account immune-like mechanisms.
b) Computational algorithms based on immunological principles, like distributed processing, clonal selection algorithms, and immune network theory.
c) Immunity-based optimization, learning, self-organization, artificial life, cognitive models, multi-agent systems, design and scheduling, pattern recognition and anomaly detection.
d) Immune engineering tools.

Potential applications of the artificial immune systems can be listed (but are not limited to):

Pattern recognition, function approximation and optimization, anomaly detection, computer and network security, generation of diversity and noise tolerance.

The stepwise procedure of AIS for the optimization of generation cost can be outlined as follows:

i. Read the data which includes a_i, b_i,c_i, maximum and minimum limits of generation of power of each generator and population size etc.
ii. Generate random binary string
iii. Decode them to actual value
iv. Insert them in population pool
v. Check for the satisfaction of constraints of the objective function if 'yes' go to (vi) else go to (i).
vi. Evaluate fitness of each set of generation to meet the demand using

$$F = K \div \left(1 + \alpha\left(\frac{\varepsilon}{P_D}\right)\right)$$

Where $\varepsilon = \left|P_D + P_L - \sum_{i=1}^{n} P_i\right|$, n = number of generators.

vii. Select the antigen and antibody from the fitness values
viii. Calculate the Euclidean distance between antibody and antigen using

$$D = \sqrt{\sum_{i=1}^{L}(ab_i - ag_i)^2}$$

ix. If D is more select them for hyper mutation else simple mutation by cloning the antibody.
x. Enter the cloned population in new population pool.
xi. Check for the satisfaction of constraints of the objective function.
xii. Check for the convergence else go to clonal proliferation.

5 RESULTS AND DISCUSSION

IEEE data of 6 generators 30 bus system

Table-I (Generator Data)

Generator	a	b	c	P_{max}	P_{min}
G_1	0.0037	2.0000	0	200	50
G_2	0.0175	1.7500	0	80	20
G_3	0.0625	1.0000	0	50	15
G_4	0.0083	3.2500	0	35	10
G_5	0.0250	3.0000	0	30	10
G_6	0.0250	3.0000	0	40	12

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Mining knowledge using Decision Tree Algorithm

Mrs. Swati .V. Kulkarni

Abstract— Industry is experiencing more and more competitions in recent years. The battle is over their most valuable customers. With massive industry deregulation across the world, each customer is facing an ever-growing number of choices in telecommunications and financial services. As a result, an increasing number of customers are switching from one service provider to another. This phenomenon is called customer “churning” or “attrition,” which is a major problem for these companies and makes it hard for them to stay profitable. The data sets are often cost sensitive and unbalanced. If we predict a valuable customer who will be an attritor as loyal, the cost is usually higher than the case when we classify a loyal customer as an attritor. Similarly, in direct marketing, it costs more to classify a willing customer as a reluctant one. Such information is usually given by a cost matrix, where the objective is to minimize the total cost. In addition, a CRM data set is often unbalanced; the most valuable customers who actually churn can be only a small fraction of the customers who stay. The main focus is on the output of decision tree algorithms as the input to post processing algorithms. This algorithm relies on not only a prediction, but also a probability estimation of the classification, such as the probability of being loyal. Such information is available from decision trees.

Index Terms— Attritor, Churning, CRM, cost matrix, decision tree, post processing algorithm, ROC curve.

1 Introduction

Extensive research in data mining[1] has been done on discovering distributional knowledge about the underlying data. Models such as Bayesian models, decision trees, support vector machines, and association rules have been applied to various industrial applications such as customer relationship management (CRM) [2]. Despite such phenomenal success, most of these techniques stop short of the final objective of data mining, which is to maximize the profit while reducing the costs, relying on such post processing techniques as visualization and interestingness ranking. While these techniques are essential to move the data mining result to the eventual applications, they nevertheless require a great deal of human manual work by experts. Often, in industrial practice, one needs to walk an extra mile to automatically extract the real “nuggets” of knowledge, the actions, in order to maximize the final objective functions. In this paper, a novel post processing technique is presented to extract actionable knowledge from decision trees. To illustrate my motivation, customer relationship management CRM is considered, in particular, the Mobile communications industry is taken as an example [3]. This industry is experiencing more and more competitions in recent years. With massive industry deregulation across the world, each customer is facing an ever-growing number of choices in communications and financial services. As a result, an increasing number of customers are switching from one service provider to another. This phenomenon is called customer “churning” or “attrition,” which is a major problem for these companies and makes it hard for them to stay profitable. In addition, a CRM data set is often unbalanced; the most valuable customers who actually churn can be only a small fraction of the customers who stay. In the past, many researchers have tackled the direct marketing problem as a classification problem, where the cost-sensitive and unbalanced nature of the problem is taken into account. In management and marketing sciences, stochastic models are used to describe the response behavior of customers. In the data mining area, a main approach is to rank the customers by the estimated likelihood to respond to direct marketing actions and compare the rankings using a lift chart or the area under curve measure from the ROC curve.

Like most data mining algorithms today, a common problem in current applications of data mining in intelligent CRM is that people tend to focus on, and be satisfied with, building up the models and interpreting them, but not to use them to get profit explicitly.

In this paper, a novel algorithm for post processing decision trees is presented to obtain actions that are associated with attribute-value changes, in order to maximize the profit-based objective functions. This allows a large number of candidate actions to be considered, complicating the computation. More specifically, in this paper, two broad cases are considered. One case corresponds to the unlimited resource situation, which is only an approxima-

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tion to the real-world situations, although it allows a clear introduction to the problem. Another more realistic case is the limited-resource situation, where the actions must be restricted to be below a certain cost level. In both cases, the aim is to maximize the expected net profit of all the customers as well as the industry. It can be shown that finding the optimal solution for the limited resource problem and designing a greedy heuristic algorithm to solve it efficiently is computationally hard [4]. An important contribution of the paper is that it integrates data mining and decision making together, such that the discovery of actions is guided by the result of data mining algorithms (decision trees in this case)[5]. An approach is considered as a new step in this direction, which is to discover action sets from the attribute value changes in a non sequential data set through optimization. The rest of the paper is organized as follows:

First a base algorithm is presented for finding unrestricted actions in Section 2. Then formulate two versions of action-set extraction problems, and show that finding the optimal solution for the problems is computationally difficult in the limited resources case (Section 3). then greedy algorithms are efficient while achieving results very close to the optimal ones obtained by the exhaustive search (which is exponential in time complexity). A case study for Mobile handset manufacturing and selling company is discussed in section 4. Conclusions and future work are presented in section 5.

This is the unlimited-resource case. The data set consists of descriptive attributes and a class attribute. For simplicity, discrete-value problem is considered in which the class values are discrete values. Some of the values under the class attribute are more desirable than others. For example, in the banking application, the loyal status of a customer "stay" is more desirable than "not stay". The overall process of the algorithm can be briefly described in the following four steps:

1. Import customer data with data collection, data Cleaning, data preprocessing, and so on.

2. Build customer profiles using an improved decision tree learning algorithm from the training data. In this case, a decision tree is built from the training data to predict if a customer is in the desired status or not. One improvement in the decision tree building is to use the area under the curve (AUC) of the ROC curve to evaluate probability estimation (instead of the accuracy). Another improvement is to use Laplace correction to avoid extreme probability values.

3. Search for optimal actions for each customer (see Section 2 for details).

4. Produce reports for domain experts to review the actions and selectively deploy the actions.

In the next section, we will discuss the leaf-node Search algorithm used in Step 3 (search for optimal actions) in detail.

2 Leaf-Node Search in the Unlimited Resource Case:

First consider the simpler case of unlimited resources where the case serves to introduce computational problem in an intuitive manner. The leaf-node search algorithm searches for optimal actions to transfer each leaf node to another leaf node with a higher probability of being in a more desirable class.

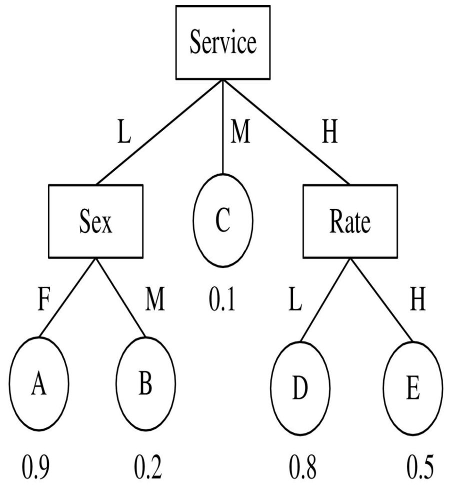

Fig. 1 An example of customer profile.

After a customer profile is built, the resulting decision tree can be used to classify, and more importantly, provide the probability of customers in the desired status such as being loyal or high-spending. When a customer, who can be either a training example used to build the decision tree or an unseen testing example, falls into a particular leaf node with a certain probability of being in the desired status, the algorithm tries to "move" the customer into other leaves with higher probabilities of being in the desired status. The probability gain can then be converted into an expected gross profit. However, moving a customer from one leaf to another means some attribute values of the customer must be changed. This change, in which an attribute A's value is transformed from v1 to v2, corresponds to an action. These actions incur costs. The cost of all changeable attributes is defined in a cost matrix (see Section 2.3) by a domain expert. The leaf-node search algorithm searches all leaves in the tree

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so that for every leaf node, a best destination leaf node is found to move the customer to. The collection of moves is required to maximize the net profit, which equals the gross profit minus the cost of the corresponding actions. Based on a domain-specific cost matrix (Section 2.3) for actions, we define the net profit of an action to be as follows:

P Net = PE X P gain – cost I

Where P Net denotes the net profit, PE denotes the total profit of the customer in the desired status, P gain denotes the probability gain, and cost I denotes the cost of each action involved.

In Section 3.1, this definition is extended to a formal definition of the computational problem.

The leaf-node search algorithm for searching the best actions can thus be described as follows:

Algorithm leaf-node search

1. For each customer x, do
2. Let S be the source leaf node in which x falls into;
3. Let D be a destination leaf node for x the max net profit P net
4. Output (S,D, P net).

To illustrate, consider an example shown in Fig. 1, which represents an overly simplified, hypothetical decision tree as the customer profile of loyal customers built from a bank. The tree has five leaf nodes (A, B, C, D, and E), each with a probability of customers' being loyal. The probability of attritors is simply 1 minus this probability. Consider a customer Jack who's record states that the Service = Low (service level is low), Sex = M (male), and Rate = L (mortgage rate is low). The customer is classified by the decision tree. It can be seen that Jack falls into the leaf node B, which predicts that Jack will have only a 20 percent chance of being loyal (or Jack will have an 80 percent chance to churn in the future). The algorithm will now search through all other leaves (A, C, D, and E) in the decision tree to see if Jack can be "replaced" into a best leaf with the highest net profit.

1. Consider leaf A. It does have a higher probability of being loyal (90 percent), but the cost of action would be very high (Jack should be changed to female), so the net profit is a negative infinity.
2. Consider leaf C. It has a lower probability of being loyal, so the net profit must be negative, and we can safely skip it.
3. Consider leaf D. There is a probability gain of 60 percent (80 percent - 20 percent) if Jack falls into D. The action needed is to change Service from L (low) to H (high). Assume that the cost of such a change is $200 (given by the bank). If the bank can make a total profit of $1,000 from Jack when he is 100 percent loyal, then this probability gain (60 percent) is converted into $600 (1000 X 0.6) of the expected gross profit. Therefore, the net profit would be $400 (600 -200).
4. Consider leaf E. The probability gain is 30 percent (50 percent - 20 percent), which transfers to $300 of the expected gross profit. Assume that the cost of the actions (change Service from L to H and change Rate from L to H) is $250, then the net profit of moving Jack from B to E is $50 (300 - 250). Clearly, the node with the maximal net profit for Jack is D, with suggested action of changing Service from L to H.

2.1 Cost Matrix

In the discussion so far, we assume that attribute-value changes will incur costs. These costs can only be determined by domain knowledge and domain experts. For each attribute used in the decision tree, a cost matrix is used to represent such costs. In many applications, the values of many attributes, such as sex, address, number of children, cannot be changed with any reasonable amount of money. Those attributes are called "hard attributes." For hard attributes, users must assign a very large number to every entry in the cost matrix. If, on the other hand, some value changes are possible with reasonable costs, then those attributes such as the Service level, interest rate, and promotion packages are called "soft attributes". Note that the cost matrix needs not to be symmetric. One can assign $200 as the cost of changing service level from low to high, but infinity (a very large number) as the cost from high to low, if the bank does not want to "degrade" service levels of customers as an action. For continuous attributes, such as interest rates that can be varied within a certain range, the numerical ranges can be discretized first using a number of techniques for feature transformation.

3 POSTPROCESSING DECISION TREES: THE LIMITED RESOURCE CASE

3.1 A Formal Definition of BSP

Previous case considered each leaf node of the decision tree to be a separate customer group. For each such customer group, we were free to design actions to act on it in order to increase the net profit. However, in practice, a company may be limited in its resources. The limited-resource problem can be formulated as a precise computational problem. Consider a decision tree DT with a number of source leaf nodes that correspond to customer segments to be converted and a number of candidate destination leaf nodes, which correspond to the segments we wish customers to fall in. Formally, the bounded segmentation problem (BSP) is defined as follows:

Given:

1. a decision tree DT built from the training examples, with a collection S of m source leaf nodes and a collection D of n destination leaf nodes

2. a prespecified constant k (k <= m), where m is the

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total number of source leaf nodes,

3. a cost matrix C(attri,u,v),i=1,2,….. which specifies the cost of converting an attribute attri's value from u to v, where u and v are indices for attri's values,

4. a unit benefit vector Bc(Li) denoting the benefit obtained from a single customer x when the x belongs to the positive class in a leaf node
Li, i=1,2,……..N ,Where N is the number of leaf nodes in the tree DT, and

5. a set Ctest of test cases.

A solution is a set of k goals {Gi , i=1, 2, . . .k}, where each goal consists of a set of source leaf nodes Sij and one designation leaf node Di, denoted as : ({Sij,j=1,2,….,|Gi|}→Di) where Sij and Di are leaf nodes from the decision tree DT. The meaning of a goal is to transform customers that belong to the source nodes S to the destination node D via a number of attribute-value changing actions [6].

Here the main aim is to find a solution with the maximal net profit (defined below).

Goals. Given a source leaf node S and a destination leaf node D, we denote the objective of converting a customer x from S to D as a goal, and denote it as S → D. The concept of a goal can be extended to a set of source nodes: To transform a set of leaf nodes Si to a designation leaf node D, the goal is {Si,i=1,2,….}→D.

Actions.

n order to change the classification of a customer x from S to D, one may need to apply more than one attribute-value changing action. An action A is defined as a change to an attribute value for an attribute attr. Suppose that for a customer x, the attribute attr has an original value u. To change its value to v, an action is needed. This action A is denoted as A={attr ,u→v}.

Action Sets.

A goal is achieved by a set of actions. To achieve a goal of changing a customer x from a leaf node S to a destination node D, a set of actions that contains more than one action may be needed. Specifically, consider the path between the root node and D in the tree DT. Let {(attri=vi),i=1,2,….ND} be set of attribute-values along this path. For x, let the corresponding attribute-values be {(attri = ui) ,i= 1,2,….ND}. Then, the actions of the form can be generated: Aset={(attri=ui→vi),i=1,2,….ND} where we remove all null actions where ui is identical to vi (thus, no change in value is needed for an attri). This action set ASet can be used for achieving the goal S → D.

Net Profits.

The net profit of converting one customer x from a leaf node S to a destination node D is defined as follows: Consider a set of actions Aset for achieving the goal S →D. For each action attri, u → v in Aset, there is a cost as defined in the cost matrix: C(attri, u, v). Let the sum of the cost for all of Aset be Ctotal, S → D(x). Let the probability of x to belong to the positive class in S be p(+|x,S). Likewise, let the probability of a customer in D be in the positive class be p(+|x,D). Recall that from the input, we have a benefit vector Bc (L)for the leaf nodes L. Thus, we have Bc(S) as the benefit of belonging to node S and Bc (D) as the benefit of belonging to node D. Then, the unit net profit of converting one customer x from S to D is:

Punit (x,S → D) = (Bc(D)* p(+|x,D) - Bc(S)* p(+|x,S)) – Ctotal,S→D(x)

Then, for a collection Ctest of all test cases that fall in node S, the total net profit of applying an action set for achieving the goal S →D is:

P(Ctest,S→D)=Sigma xeCtest(Punit (x,S → D)

When the index of S is i, and the index of D is j, we denote Punit (x,S → D) as Pij for simplicity.

Thus, the BSP problem is to find the best k groups of source leaf nodes (Groupi, i = 1,2, . . . ; k) and their corresponding goals and associated action sets to maximize the total net profit for a given test data set Ctest.

An Example to illustrate, consider an example in Fig. 2.Assume that for leaf nodes L1 to L4, the probability values of being in the desired class are 0.9, 0.2, 0.8, and 0.5, respectively. Now consider the task of transforming L2 and L4 to a higher probability node, such that the net profit of making all To illustrate the process, consider a test data set such that there is exactly one member that falls in each leaf node of this decision tree. In order to calculate the net profit, we assume all leaf nodes to have an initial benefit of one unit. For simplicity, we also assume that the cost of transferring a customer is equal to the number of attribute value changes multiplied by 0.1. Thus, to change from L2 to L1, we need to modify the value of the attribute Status; with a profit gain of transformations is maximized. (0.9*1-0.2*1) - 0.1= 0.6.

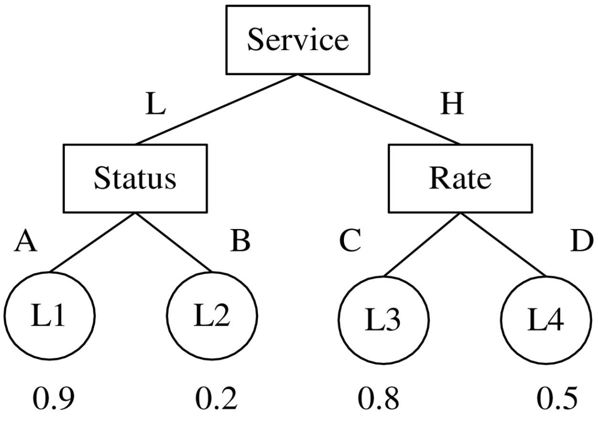

Fig. 2 An example of decision tree

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The BSP problem has an equivalent matrix representation. From (2) and (3), we obtain a profit matrix M=((Pij),i=1,2,…m,j=1,2,….n)formed by listing all source leaf nodes Si as the row index and all the action sets ASetj, for achieving the goal (Si → Dj), as the column index (here, we omit Si in the column headings). In this matrix M, (Pij >= 0), 1 < i < m (where m is the number of source leaf nodes), and 1< j < n (n is the number of destination leaf nodes). Pij denotes the profit gain computed by applying ASetj to Si for all test-case customers that falls in Si. If Pij > 0, that is, applying ASetj to transfer Si to the corresponding destination leaf node can bring about a net profit, we say that the source leaf node Si can be covered by the action set ASetj. From (2) and (3), the computation of the profit matrix M(..,..) can be done in O(m *n).

As an example of the profit matrix computation, a part of the profit matrix corresponding to the source leaf node.

TABLE 1
An Example of the Profit Matrix Computation

	$ASet_1(L_2)$(Goal=$\rightarrow L_1$)	$ASet_2(L_2)$ (Goal=$\rightarrow L_3$)	$ASet_3(L_2)$ (Goal=$\rightarrow L_4$)
L_2	0.6	0.4	0.1
L_4	...	...	...

4 CASE STUDY:

An Application is developed in Java, SQL Server for incrementing the profit of "Mobile handset selling"shop / Industry by applying different discounts to the customers. Before giving discount to the different types of customers, we can check how much profit can be gained by the shop / Industry as well as by the customer. Also we can find the profit gained by a particular customer for a particular scheme and accordingly we can offer most profitable scheme to the customer to gain high profit.

This system relies on not only a prediction, but also a probability estimation of the classification, such as the probability of being loyal. Such information is available from decision trees [7].

Input
(Feedback, Phones Viewed,
Refernces, Purchase amt, etc)

↓

Decision tree

↓

Output
(Loyal and Unloyal Customers Probability)

↓

Input

Post processing actions is the action performed on the customer, in an attempt to make him loyal……….!:

Post processing Decision Tree:

Actions:

In order to change the classification of a customer x from Loyal and UnLoyal, one may need to apply more than one attribute-value changing action. An action A is defined as a change to an attribute value for an attribute Attr.

Suppose that for a customer x, the attribute Attr has an original value u. To change its value to v, an action is needed.

U is probability that we got…

V is what we expecting..!!

Therefore Action a is to be taken on customer so that he is loyal, and Profit is also not affected..!!

This action A is denoted as A = (Attr, u--v)

5 CONCLUSIONS AND FUTURE WORK

Most data mining algorithms and tools produce only the segments and ranked lists of customers or products in their outputs. In this paper, we present a novel technique to take these results as input and produce a set of actions that can be applied to transform customers from undesirable classes to desirable ones. For decision trees considered, aim is to maximize the expected net profit of all the customers. We have found a greedy heuristic algorithm to solve both problems efficiently and presented an ensemble-based decision-tree algorithm that use a collection of decision trees, rather than a single tree, to generate the actions. Also it is shown that the resultant action set is indeed more robust with respect to training data changes.

In my future work, we will research other forms of limited resources problem as a result of post processing data mining models and evaluate the effectiveness of our algorithms in the real-world deployment of the action oriented data mining.

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New Approach to Weighted Pattern Sequential Mining-Dataset

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Abstract - In real world data the knowledge used for mining rule is almost time varying. The item have the dynamic characteristic in terms of transaction , which have seasonal selling rate and it hold time-based association ship with another item. Traditional model of association rule mining is adapted to handle weighted association rule mining problems where each item is allowed to have a weight. Association rule mining is to find out association rules that satisfy the predefined minimum support and confidence from a given database. End users of association rule mining tools encounter several in practice when data bases come with binary attributes. In this paper, we introduce a new measure, which does not require initially allotted weights .The quality of transactions is considered by link based models and a fast mining algorithm is adopted.

Keywords- Association Rule, Fast algorithm, weighted support.

1 INTRODUCTION

THE classical model of association rule mining employs the support measure, which treats every transaction equally. In contrast, different transactions have different weights in real-life data sets. During recent years, one of active research topic is Association rule discovery. The association rule discovery is used to identify relationships between items in very large databases, to extract interesting correlations, associations among sets of items in the transaction databases or other data repositories.

For example, given a market basket database, it would be interesting for decision support to know the fact that 30% of customers who bought coca powder and sugar also bought butter. This analysis may be used to provide some basis if is required to increase the sales and introduce from free schemes like, if 3 kg of sugar is bought then 100g butter free. In a census database, we should discover that 20% of persons who worked last year earned more than the average income, or in a medical database, that 35% of patients who have cold also have sinus.

Association Rule Mining aims to explore large transaction databases for association rules, which may reveal the implicit relationships among the data attributes. It has number of practical applications, including classification, text mining, and Web log analysis, and Share Market and recommendation systems. The classical model of association rule mining employs the support measure, which treats every transaction equally. In contrast, different transactions have different weights in real-life data sets. For example, in the market basket data, each transaction is recorded with some profit. Much effort has been dedicated to association rule mining with preassigned weights. However, most data types do not come with such preassigned weights, such as Web site click-stream data. There should be some notion of importance in those data.

Data mining technology has emerged as a means for identifying patterns and trends from large quantities of data. Data mining, also known as Knowledge Discovery in Databases, has been defined as "The nontrivial extraction of implicit, previously unknown, and potentially useful information from data". Data mining is used to extract structured knowledge automatically from large data sets. The information that is ‘mined’ is expressed as a model of the semantic structure of the dataset, where in the prediction or classification of the obtained data is facilitated with the aid of the model.

2 WEIGHTED ASSOCIATION RULE MINING

The concept of association rule was first introduced. It proposed the support-confidence measurement framework and reduced association rule mining to the discovery of frequent item sets. The following year a fast mining algorithm, A priori, was proposed]. Much effort has been dedicated to the classical (binary) association rule mining problem since then. Numerous algorithms

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have been proposed to extract the rules more efficiently. These algorithms strictly follow the classical measurement framework and produce the same results once the minimum support and minimum confidence are given.

WARM generalizes the traditional model to the case where items have weights. Ram Kumar et al. introduced weighted support of association rules based on the costs assigned to both items as well as transactions. An algorithm called WIS was proposed to derive the rules that have a weighted support larger than a given threshold. Cai et al defined weighted support in a similar way except that they only took item weights into account.

The goal is to steer the mining focus to those significant relationships involving items with significant weights rather than being flooded in the combinatorial explosion of insignificant relationships Discovery of association rules has been found useful in many applications.

3. RELATED WORKS

Quantitative association rule mining problem has been introduced in and some algorithms for quantitative values also have been proposed, where the algorithm finds association rules by partitioning the attribute domain, combining adjacent partitions and then transforming the problem into a binary state.

Mining QARs by a generic BAR mining algorithm, however, is infeasible in most cases for the following reasons. First, QAR mining suffers from the same problem of a combinatorial explosion of attribute sets as does BAR mining; that is, given a set of N distinct attributes, the number of its non-empty subsets is (2N-1). However, as shown by

it is necessary to combine the consecutive intervals of a quantitative attribute to gain sufficient support and more meaningful intervals. This leads to another combinatorial explosion problem: if the domain of a quantitative attribute is partitioned into n intervals, the total number of intervals of the attribute grows to O(n2) after combining the consecutive intervals. When we join the attributes in the mining process, the number of itemsets (i.e., a set of <attribute, interval> pairs) can become prohibitively large if the number of intervals associated with an attribute is large.

The second one is caused by the sharp boundary between intervals. To dominant this problem, Mining fuzzy association rules for quantitative values has been considered by a number of researches [8]-[13], most of which have based their methods on the important APriori algorithm. Chan and Au introduced F-APACS for mining fuzzy association rules .Instead of using intervals, F-APACS employs linguistic terms to represent the revealed regularities and exceptions . Kuok's algorithm expects the user or an expert to provide the required fuzzy sets of the quantitative attributes and their corresponding membership functions. Fu argues that experts may not give the right fuzzy sets and their corresponding membership functions. Hence, he proposed a method to find the fuzzy sets based on clustering techniques. Each of these researchers treated all attributes (or all the linguistic terms) as uniform. However, in real-world applications, the users perhaps have more interest in the rules that contain fashionable items. Gyenesei introduces the problem of mining weighted quantitative association rules based on fuzzy approach. He assigns weights to the fuzzy sets to reflect their importance to the user and proposes two different definitions of weighted support: with and without normalization similar to his previous method.
Ishibuchi et al. extended the genetic algorithm-based rule selection method in Ref. [16] to the case where various fuzzy partitions with different granularities are used for each input. This extension increases the number of candidate rules. Hence, they proposed a prescreening procedure which is based on two rule evaluation criteria of association rules, to decrease the number of candidate rules.

Kaya et al proposed an automated clustering method based on multi-objective genetic algorithms. This method automatically clusters the values of a given quantitative attribute in order to obtain large number of large itemsets in low duration.

The support counting procedure of the Apriori algorithm has attracted voluminous research owing to the fact that the performance of the algorithm mostly relies on this aspect. Park et al. proposed an optimization, called DHP (Direct Hashing and Pruning) intended towards restricting the number of candidate itemstes, shortly following the Apriori algorithms mentioned above. Brin et al put forth the DIC algorithm that

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partitions the database into intervals of a fixed size so as to reduce the number of traversals through the database . Another algorithm called the CARMA algorithm (Continuous Association Rule Mining Algorithm) employs an identical technique in order to restrict the interval size to 1.

4 W-SUPPORT & FAST MINING ALGORITHM

Item set evaluation by support in classical association rule mining is based on counting. In this section, we will introduce a link-based measure called w-support and formulate association rule mining in terms of this new concept.The problem of mining association rules that satisfy some minimum w-support and w-confidence can be decomposed into two subproblems: 1. Find all significant item sets with w-support above the given threshold. 2. Derive rules from the item sets found in Step 1. The first step is more important and expensive. The key to achieving this step is that if an item set satisfies some minimum w-support, then all its subsets satisfy the mini-mum w-support as well. It is called the downward closure property of wsupport. Besides, the hub weights of all transactions are non-negative.

$$\sum_{T:X\varsigma T\Lambda T\in D} hub(T) \leq \sum_{T:X\varsigma T\Lambda T\in D} hub(T)$$

Hence, based on this property, we can extract significant item sets in a levelwise manner, as the Apriori-like algorithm.

FAST MINING ALGORITHM

1) Initialize auth(i) to 1 for each item i
2) For(I=0;I<num_it;I++) do begin
3) Auth'◎◎◎◎◎(i)=0 for each item i
4) For all transactions t Є D do begin
5) Hub(t)= $\Sigma_{i:i\in t}$auth(i)
6) Auth.(i)=hub(t) for each item i Єt
7) End
8) Auth(i)=auth'(i) for each item I, normalize auth
9) End
10) L_1={{i}:wsupp(i)≥minwsupp}
11) For(k=2;L_{k-1}≠0;k++)do begin
12) C_k=apriori-gen(L_{k-1})
13) For all transactions t Є D do begin
14) C_t=subset(C_k,t)
15) For all candidates c Є Ct do
16) C.wsupp +=hub(t)
17) H+=hub(t)
18) End
19) L_k={cЄC_k|c.wsupp|H≥minwsupp}
20) End
21) Answer = U_k L_k

W-Support Algorithm

Input :(1) A transaction database: TDB
(2) A Minimum Support Threshold: σ
(3) An approximate factor, ε
(4) Normalized weights of the Item

Output: The result set of approximate Weighted frequent patterns.

Begin

Initialize WAFP {}; // Let WAFP Be the result set of approximate Weighted frequent patterns.

Scan TDB once and find the global Approximate weighted frequent items Whose maximum approximate Weighted supports (|MWS (X) ± ε|) are no less than a minimum threshold, σ

Remove the approximate weighted infrequent Items in each transaction by the weight Ascending order.

Scan the TDB again and build a global FP-Tree based on the weight ascending order.

Call WAF (FP-Tree, WAFP)

End

5. PERFORMANCE EVALUATION

To evaluate the link-based association rule mining frame-work, we have modified the Apriori implementation by Bodon so that it uses wsupport and w-confidence as the rule selection thresholds. Several tests have been carried out on some classical data sets. The Experiments were conducted on a 1.8-GHz Sempron 3000+ machine with 1 Gbyte of RAM.

The proposed mining algorithm requires an additional iterative procedure to compute the hub weights of all transactions. The database is scanned

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exactly once in each iteration. Therefore, the convergence rate of the hub weights is critical to the performance. Let Hi denote the vector of hub weights after the ith iteration.. It is clear that HITS converges fast on transaction databases. Generally, three or four Iterations are enough to achieve a good estimation, which means that our link-based method works at the cost of three or four additional database scans over the traditional techniques.

Since w-support and w-confidence are normally larger than support and confidence, respectively, a comparison of the two measurement techniques with the same thresholds does not make sense. Instead, we select the thresholds so that the two models produce about the same amount of item sets and association rules.

Consider the data set retail as an example. With minwsupp ¼ 4:6 percent and minwconf ¼ 66 percent in the link-based model, 81 item sets and 19 rules are generated; with minsupp ¼ 3:4 percent and minconf ¼ 88 percent in the traditional model, 84 item sets and 19 rules are discovered discovered. Observe that the two models agree well on most of the rules, though they both advocate some rules that are not discovered by the other. Basically, two types of association rules are likely missing in the traditional model but not in the link-based model and Compared with the traditional counting-based measurement, the proposed model emphasizes large transactions, because they are generally valuable. In the retail business, maintainers are more interested in customers who buy lots of stuff; in Web click-stream data, longer sessions may correspond to regular visitors; in recommendation systems, a user who has rated many movies (or anything else) is likely to have better taste. The assumption that large transactions are more important may not be a ground truth, but when it is (very likely), the model works 1. Good Transactions 2. Small confidence 3. Good hubs support. It is hard to tell whether a rule/item set is valuable by any objective measure, because traditional association rule mining does lack effective measures. A similar case happens in Web search. It is hard to tell which Web page should be ranked high. All we can argue academically is the model itself. The success of Google proves the efficiency of the link-based models.

6. CONCLUSION

As there are wide applications of association rules in data mining, it is important to provide good performance. In view of this, we proposed a new algorithm which considers the significance of the item also but not only support of the item. Experimental results show that the computational cost of the link-based model is reasonable. At the expense of three or four additional database scans, we can acquire results different from those obtained by traditional counting-based models. Particularly for sparse data sets, some significant item sets that are not so frequent can be found in the link-based model. Through comparison, we found that our model and method address emphasis on high-quality transactions. In this paper, a brief discussion of a number of algorithms was presented along with a comparative study of a few significant ones based on their performance and memory usage.

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Decreasing Inventory Levels Fluctuations by Moving Horizon Control Method and Move Suppression in the Demand Network

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Abstract— The significance of the basic idea implicit in the moving horizon control (MHC) has been recognized a long time ago in the operations management literature as a tractable scheme for solving stochastic multi period optimization problems, such as production planning and supply chain management, under the term moving horizon. In this paper, a moving horizon controller with move suppression term used for inventory management of the demand network (supply chain).

Index Terms— moving horizon control, production planning, supply chain management, move suppression term, inventory management ,demand network.

1 Introduction

Key elements to an efficient supply chain are accurate pinpointing of process flows and timing of supply needs at each entity, both of which enable entities to request items as they are needed, thereby reducing safety stock levels to free space and capital. The operational planning and direct control of the network can in principle be addressed by a variety of methods, including deterministic analytical models and stochastic analytical models, and simulation models, coupled with the desired optimization objectives and network performance measures [1].

The significance of the basic idea implicit in the moving horizon control (MHC) or MHC has been recognized a long time ago in the operations management literature as a tractable scheme for solving stochastic multi period optimization problems, such as production planning and supply chain management, under the term moving horizon [2]. In a recent paper [3], a MHC strategy was employed for the optimization of production/distribution systems, including a simplified scheduling model for the manufacturing function. The suggested control strategy considers only deterministic type of demand, which reduces the need for an inventory control mechanism [4,5].

For the purposes of our study and the time scales of interest, a discrete time difference model is developed [6]. The model is applicable to multi echelon supply chain networks of arbitrary structure. To treat process uncertainty within the deterministic supply chain network model, a MHC approach is suggested [7,8].

Typically, MHC is implemented in a centralized fashion [9]. The algorithm uses a moving horizon, to allow the incorporation of past and present control actions to future predictions [10,11,12,13].

In this paper, a moving horizon controller with move suppression term used for inventory management of the demand network.

2 Modelling and Control

In this work, a discrete time difference model is developed[4]. The model is applicable to multi echelon supply chain networks of arbitrary structure, that *DP* denote the set of desired products in the supply Chain and these can be manufactured at plants, *P*, by utilizing various resources, *RS*. The manufacturing function considers independent production lines for the distributed products. The products are subsequently transported to and stored at warehouses, *W*. Products from warehouses are transported upon customer demand, either to distribution centers, *D*, or directly to retailers, *R*. Retailers receive time varying orders from different customers for different products. Satisfaction of customer demand is the primary target in the supply chain management mechanism. Unsatisfied demand is recorded as backorders for the next time period. A discrete time difference model is used for description of the supply chain network dynamics. It is assumed that decisions are taken within equally spaced time periods (e.g. hours, days, or weeks). The duration of the base time period depends on the dynamic characteristics of the network. As a result, dynamics of higher frequency than that of the selected time scale are considered negligible and completely attenuated by the network [4,14]. Plants *P*, warehouses *W*, distribution centers *D*, and retailers *R* constitute the nodes of the system. For each node, *k*, there is a set of upstream nodes and a set of

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downstream nodes, indexed by (k',k''). Upstream nodes can supply node *k* and downstream nodes can be supplied by *k*. All valid (k',k) and/or (k,k'') pairs constitute permissible routes within the network. All variables in the supply chain network (e.g. inventory, transportation loads) valid for bulk commodities and products. For unit products, continuous variables can still be utilized, with the addition of a post processing rounding step to identify neighbouring integer solutions. This approach, though clearly not formally optimal, may be necessary to retain computational tractability in systems of industrial relevance.

A product balance around any network node involves the inventory level in the node at time instances *t* and *t* – 1, as well as the total inflow of products from upstream nodes and total outflow to downstream nodes. The following balance equation is valid for nodes that are either warehouses or distribution centers:

$$y_{i,k}(t) = y_{i,k}(t-1) + \sum_{k'} x_{i,k',k}(t - L_{k',k}) - \sum_{k''} x_{i,k,k''}(t), \quad \forall k \in \{W, D\}, \quad t \in T, \quad i \in DP \tag{1}$$

where $y_{i,k}$ is the inventory of product *i* stored in node *k*; $x_{i,k',k}$ denotes the amount of the *i*-th product transported through route (k',k); $L_{k',k}$ denotes the transportation lag (delay time) for route (k',k), i.e. the required time periods for the transfer of material from the supplying node to the current node. The transportation lag is assumed to be an integer multiple of the base time period.

For retailer nodes, the inventory balance is slightly modified to account for the actual delivery of the *i*-th product attained, denoted by $d_{i,k}(t)$.

$$y_{i,k}(t) = y_{i,k}(t-1) + \sum_{k'} x_{i,k',k}(t - L_{k',k}) - d_{i,k}(t), \quad \forall k \in \{R\}, \quad t \in T, \quad i \in DP. \tag{2}$$

The amount of unsatisfied demand is recorded as backorders for each product and time period. Hence, the balance equation for back orders takes the following form:

$$BO_{i,k}(t) = BO_{i,k}(t-1) + R_{i,k}(t) - d_{i,k}(t) - LO_{i,k}(t), \quad \forall k \in \{R\}, \quad t \in T, \quad i \in DP. \tag{3}$$

where $R_{i,k}$ denotes the demand for the *i*-th product at the *k*-th retailer node and time period *t*. $LO_{i,k}$ denotes the amount of cancelled back orders (lost orders) because the network failed to satisfy them within a reasonable time limit. Lost orders are usually expressed as a percentage of unsatisfied demand at time *t*. Note that the model does not require a separate balance for customer orders at nodes other than the final retailer nodes [4,15].

MHC originated in the late seventies and has developed considerably since then. The term MHC does not designate a specific control strategy but rather an ample range of control methods which make explicit use of a model of the process to obtain the control signal by minimizing an objective function. The ideas, appearing in greater or lesser degree in the predictive control family, are basically the explicit use of a model to predict the process output at future time instants (horizon), the calculation of a control sequence minimizing an objective function and the use of a moving strategy, so that at each instant the horizon is displaced towards the future, which involves the application of the first control signal of the sequence calculated at each step. The success of MHC is due to the fact that it is perhaps the most general way of posing the control problem in the time domain. The use a finite horizon strategy allows the explicit handling of process and operational constraints by the MHC. The control system aims at operating the supply chain at the optimal point despite the influence of demand changes [12,13]. The control system is required to possess built in capabilities to recognize the optimal operating policy through meaningful and descriptive cost performance indicators and mechanisms to successfully alleviate the detrimental effects of demand uncertainty and variability. The main objectives of the control strategy for the supply chain network can be summarized as follows: (i) maximize customer satisfaction, and (ii) minimize supply chain operating costs.

The first target can be attained by the minimization of back orders (i.e. unsatisfied demand) over a time period because unsatisfied demand would have a strong impact on company reputation and subsequently on future demand and total revenues. The second goal can be achieved by the minimization of the operating costs that include transportation and inventory costs that can be further divided into storage costs and inventory assets in the supply chain network. Based on the fact that past and present control actions affect the future response of the system, a moving time horizon is selected. Over the specified time horizon the future behavior of the supply chain is predicted using the described difference model (Eqs. (1)–(3)). In this model, the state variables are the product inventory levels at the storage nodes, *y*, and the back orders, *BO*, at the order receiving nodes. The manipulated (control or decision) variables are the product quantities transferred through the network's permissible routes, *x*, and the delivered amounts to customers, *d*. Finally, the product back orders, *BO*, are also matched to the output variables. The inventory target levels (e.g. inventory setpoints) are time invariant parameters. The control actions that minimize a performance index associated with the outlined control objectives are then calculated over the moving time horizon. At each time period the first control action in the calculated sequence is implemented. The effect of unmeasured demand disturbances and model mismatch is computed through comparison of the actual

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current demand value and the prediction from a stochastic disturbance model for the demand variability. The difference that describes the overall demand uncertainty and system variability is fed back into the MHC scheme at each time period facilitating the corrective action that is required.

The centralized mathematical formulation of the performance index considering simultaneously back orders, transportation and inventory costs takes the following form[4]:

$$
\begin{aligned}
J_{total} = & \\
& \sum_{t}^{t+P} \sum_{k\in\{W,D,R\}} \sum_{i\in DP} \left\{ w_{y,i,k}(y_{i,k}(t) - y_{s,i,k}(t))^2 \right\} \\
& + \sum_{t}^{t+M} \sum_{k\in\{W,D,R\}} \sum_{i\in DP} \left\{ w_{x,i,k',k}(x_{i,k',k}(t))^2 \right\} \\
& + \sum_{t}^{t+P} \sum_{k\in\{R\}} \sum_{i\in DP} \left\{ w_{BO,i,k}(BO_{i,k}(t))^2 \right\} \\
& + \sum_{t}^{t+M} \sum_{k\in\{W,D,R\}} \sum_{i\in DP} \left\{ w_{\Delta x,i,k',k}(x_{i,k',k}(t) - x_{i,k',k}(t-1))^2 \right\}
\end{aligned}
\qquad (4)
$$

The performance index, *J*, in compliance with the outlined control objectives consists of four quadratic terms. Two terms account for inventory and transportation costs throughout the supply chain over the specified prediction and control horizons (*P* , *M*). A term penalizes back orders for all products at all order receiving nodes (e.g. retailers) over the moving horizon *P*. Also a term penalizes deviations for the decision variables (i.e. transported product quantities) from the corresponding value in the previous time period over the control horizon *M*. The term is equivalent to a penalty on the rate of change in the manipulated variables and can be viewed as a move suppression term for the control system. Such a policy tends to eliminate abrupt and aggressive control actions and subsequently, safeguard the network from saturation and undesired excessive variability induced by sudden demand changes. In addition, transportation activities are usually preferred to resume a somewhat constant level rather than fluctuate from one time period to another.

However, the move suppression term would definitely affect control performance leading to a more sluggish dynamic response. The weighting factors, $w_{y,i,k}$, reflect the inventory storage costs and inventory assets per unit product, $w_{x,i,k',k}$, account for the transportation cost per unit product for route (k',k) .Weights $w_{BO,i,k}$ correspond to the penalty imposed on unsatisfied demand and are estimated based on the impact service level has on the company reputation and future demand. Weights $w_{\Delta x,i,k',k}$, are associated with the penalty on the rate of change for the transferred amount of the *i*-th product through route (k',k). Even though, factors $w_{y,i,k}$, $w_{x,i,k',k}$ and $w_{BO,i,k}$ are cost related that can be estimated with a relatively good accuracy, factors $w_{\Delta x,i,k',k}$ are judged and selected mainly on grounds of desirable achieved performance.

The weighting factors in cost function also reflect the relative importance between the controlled (back orders and inventories) and manipulated (transported products) variables. Note that the performance index of cost function reflects the implicit assumption of a constant profit margin for each product or product family. As a result, production costs and revenues are not included in the index.

In this centralized implementation, MHC will optimized for whole policy and then will sent downstream optimal inputs to upstream joint nodes to those nodes which it is coupled, as measurable disturbances.

Each node completely by a centralized MHC optimizes for whole policy. At each time period, the first control action in the calculated sequence is implemented until MHC process complete.

3 SIMULATIONS

A four echelon supply chain system is used in the simulated examples. The supply chain network consists of one product, two production nodes, two warehouses, four distribution centers, and four retailer nodes.

All possible connections between immediately successive echelons are permitted. One product is being distributed through the network. Inventory setpoints, maximum storage capacities at every node, and transportation cost data for each supplying route are reported in Table 1.

A prediction horizon of 20 time periods and a control horizon of 10 time periods were selected and was considered $LO=3$ for every times. So each delay was replaced by its 4th order Pade approximation.

Table 1. Supply chain data

Echelon	**W**	**D**	**R**
Max inventory level	1000	700	300
Inventory setpoint	500	300	180
Transportation cost	P to W $\begin{bmatrix} 0.5 & 0.2 \\ 0.2 & 0.5 \end{bmatrix}$	W to D $\begin{bmatrix} 0.5 & 0.2 \\ 0.5 & 0.2 \\ 0.2 & 0.5 \\ 0.2 & 0.5 \end{bmatrix}^T$	D to R $\begin{bmatrix} 0.5 & 0.2 & 0.5 & 0.5 \\ 0.2 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.2 \\ 0.5 & 0.5 & 0.2 & 0.5 \end{bmatrix}$
Inventory weights	1	1	1
Back-order weights		-	1
Delivery weights	-	-	-0.5
Move suppression weights term	3	**3**	3
Initial condition	500	300	180
Delays	5	3	2

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The simulated scenarios lasted for 50 time periods. Variant demand is presented in Fig. 1. The move suppression term would definitely affect control performance leading to a more sluggish dynamic response. In this part, centralized MHC method is applied to the supply chain network with a variant customer demand that is seeing in figures 2 and 3.

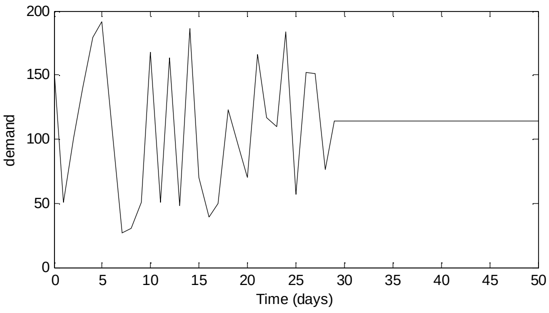

Fig. 1 Demand

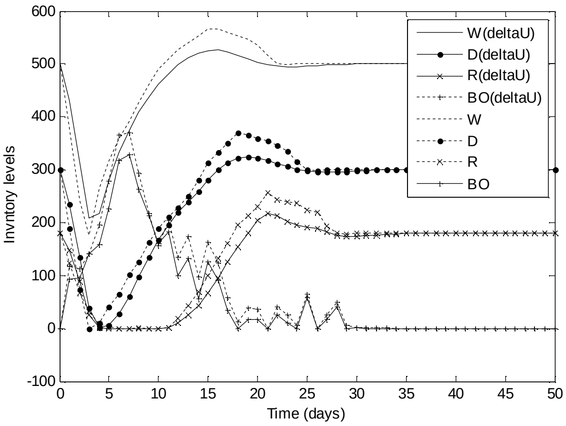

Fig. 2 MHC outputs of supply chain management system:deltaU curves is with move suppression effect

CONCLUSION

The large majority of successful MHC applications address the case of multivariable control in the presence of constraints, motivating its extensive distribution for applications where traditional control usually comes close to its limits. The success of MHC is due to the fact that it is perhaps the most general way of posing the control problem in the time domain. The use a finite horizon strategy allows the explicit handling of process and operational constraints by the MHC. Typically, MHC is implemented in a centralized fashion. In this paper, a centralized moving horizon controller applying to a supply chain management system consist of one plant (supplier), two distribution centers and three retailers. Also a move suppression term add to cost function, that increase system robustness toward changes on demands. Through illustrative simulations with variation of demand, it is demonstrated that move suppression effect decreases maximum changes of customer demands.

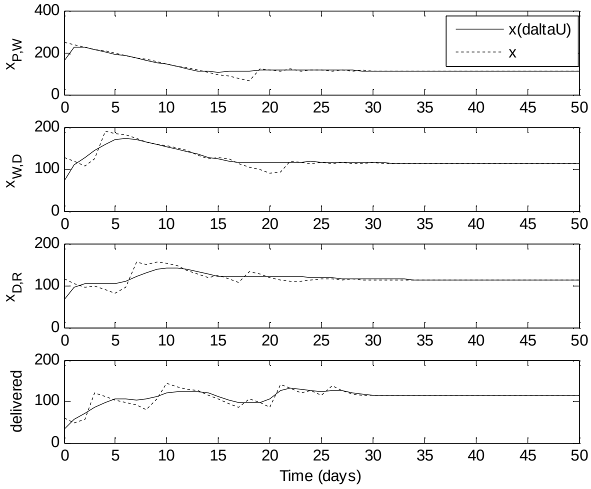

Fig. 3 MHC inputs of supply chain management system:deltaU curves is with move suppression effect

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Receding Horizon Control on Large Scale Supply Chain

Mohammad Miranbeigi, Aliakbar Jalali

Abstract— Supply chain management system is a network of facilities and distribution entities: suppliers, manufacturers, distributors, retailers. The control system aims at operating the supply chain at the optimal point despite the influence of demand changes. In this paper, a centralized constrained receding horizon controller applying to a supply chain management system consist of two product, one plant, two distribution centers and three retailers.

Index Terms— supply chain, supply chain management system, suppliers, manufacturers, distributors, retailers , control system, demand, receding horizon controller.

1 INTRODUCTION

THE network of suppliers, manufacturers, distributors and retailers constitutes a supply chain management system. Between interconnected entities, there are two types of process flows: information flows, e.g., an order requesting goods, and material flows, i.e., the actual shipment of goods. Key elements to an efficient supply chain are accurate pinpointing of process flows and timing of supply needs at each entity, both of which enable entities to request items as they are needed, thereby reducing safety stock levels to free space and capital. The operational planning and direct control of the network can in principle be addressed by a variety of methods, including deterministic analytical models and stochastic analytical models, and simulation models, coupled with the desired optimization objectives and network performance measures [1].

The significance of the basic idea implicit in the receding horizon control (RHC) or RHC has been recognized a long time ago in the operations management literature as a tractable scheme for solving stochastic multi period optimization problems, such as production planning and supply chain management, under the term receding horizon [2]. In a recent paper [3], a RHC strategy was employed for the optimization of production/distribution systems, including a simplified scheduling model for the manufacturing function. The suggested control strategy considers only deterministic type of demand, which reduces the need for an inventory control mechanism [4,5].

For the purposes of our study and the time scales of interest, a discrete time difference model is developed [6]. The model is applicable to multi echelon supply chain networks of arbitrary structure. To treat process uncertainty within the deterministic supply chain network model, a RHC approach is suggested [7,8].

Typically, RHC is implemented in a centralized fashion [9]. The algorithm uses a receding horizon, to allow the incorporation of past and present control actions to future predictions [10,11,12,13].

In this paper, a centralized receding horizon controller applying to a supply chain management system consist of one plant (supplier), two distribution centers and three retailers.

2 DISCRETE TIME DIFFERENCE MODEL

In this work, a discrete time difference model is developed[4]. The model is applicable to multi echelon supply chain networks of arbitrary structure, that *DP* denote the set of desired products in the supply Chain and these can be manufactured at plants, *P*, by utilizing various resources, *RS*. The manufacturing function considers independent production lines for the distributed products. The products are subsequently transported to and stored at warehouses, *W*. Products from warehouses are transported upon customer demand, either to distribution centers, *D*, or directly to retailers, *R*. Retailers receive time varying orders from different customers for different products. Satisfaction of customer demand is the primary target in the supply chain management mechanism. Unsatisfied demand is recorded as backorders for the next time period. A discrete time difference model is used for description of the supply chain network dynamics. It is assumed that decisions are taken within equally spaced time periods (e.g. hours, days, or weeks). The duration of the base time period depends on the dynamic characteristics of the network. As a result, dynamics of higher frequency than that of the selected time scale are considered

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negligible and completely attenuated by the network [4,14].

Plants P, warehouses W, distribution centers D, and retailers R constitute the nodes of the system. For each node, k, there is a set of upstream nodes and a set of downstream nodes, indexed by (k', k''). Upstream nodes can supply node k and downstream nodes can be supplied by k. All valid (k', k) and/or (k, k'') pairs constitute permissible routes within the network. All variables in the supply chain network (e.g. inventory, transportation loads) valid for bulk commodities and products. For unit products, continuous variables can still be utilized, with the addition of a post processing rounding step to identify neighbouring integer solutions. This approach, though clearly not formally optimal, may be necessary to retain computational tractability in systems of industrial relevance.

A product balance around any network node involves the inventory level in the node at time instances t and t – 1, as well as the total inflow of products from upstream nodes and total outflow to downstream nodes. The following balance equation is valid for nodes that are either warehouses or distribution centers:

$$y_{i,k}(t) = y_{i,k}(t-1) + \sum_{k'} x_{i,k',k}(t - L_{k',k}) - \sum_{k''} x_{i,k,k''}(t), \quad \forall k \in \{W, D\}, \quad t \in T, \quad i \in DP \tag{1}$$

where $y_{i,k}$ is the inventory of product i stored in node k; $x_{i,k',k}$ denotes the amount of the i-th product transported through route (k', k); $L_{k',k}$ denotes the transportation lag (delay time) for route (k', k), i.e. the required time periods for the transfer of material from the supplying node to the current node. The transportation lag is assumed to be an integer multiple of the base time period.

For retailer nodes, the inventory balance is slightly modified to account for the actual delivery of the i-th product attained, denoted by $d_{i,k}(t)$.

$$y_{i,k}(t) = y_{i,k}(t-1) + \sum_{k'} x_{i,k',k}(t - L_{k',k}) - d_{i,k}(t), \quad \forall k \in \{R\}, \quad t \in T, \quad i \in DP. \tag{2}$$

The amount of unsatisfied demand is recorded as back-orders for each product and time period. Hence, the balance equation for back orders takes the following form:

$$BO_{i,k}(t) = BO_{i,k}(t-1) + R_{i,k}(t) - d_{i,k}(t) - LO_{i,k}(t), \quad \forall k \in \{R\}, \quad t \in T, \quad i \in DP. \tag{3}$$

where $R_{i,k}$ denotes the demand for the i-th product at the k-th retailer node and time period t. $LO_{i,k}$ denotes the amount of cancelled back orders (lost orders) because the network failed to satisfy them within a reasonable time limit.

Lost orders are usually expressed as a percentage of unsatisfied demand at time t. Note that the model does not require a separate balance for customer orders at nodes other than the final retailer nodes [4,15].

3 RHC DESIGNATION

RHC originated in the late seventies and has developed considerably since then. The term RHC does not designate a specific control strategy but rather an ample range of control methods which make explicit use of a model of the process to obtain the control signal by minimizing an objective function. The ideas, appearing in greater or lesser degree in the predictive control family, are basically the explicit use of a model to predict the process output at future time instants (horizon), the calculation of a control sequence minimizing an objective function and the use of a receding strategy, so that at each instant the horizon is displaced towards the future, which involves the application of the first control signal of the sequence calculated at each step. The success of RHC is due to the fact that it is perhaps the most general way of posing the control problem in the time domain. The use a finite horizon strategy allows the explicit handling of process and operational constraints by the RHC. The control system aims at operating the supply chain at the optimal point despite the influence of demand changes [12,13].

The control system is required to possess built in capabilities to recognize the optimal operating policy through meaningful and descriptive cost performance indicators and mechanisms to successfully alleviate the detrimental effects of demand uncertainty and variability. The main objectives of the control strategy for the supply chain network can be summarized as follows: (i) maximize customer satisfaction, and (ii) minimize supply chain operating costs.

The first target can be attained by the minimization of back orders (i.e. unsatisfied demand) over a time period because unsatisfied demand would have a strong impact on company reputation and subsequently on future demand and total revenues. The second goal can be achieved by the minimization of the operating costs that include transportation and inventory costs that can be further divided into storage costs and inventory assets in the supply chain network. Based on the fact that past and present control actions affect the future response of the system, a receding time horizon is selected. Over the spe-

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cified time horizon the future behavior of the supply chain is predicted using the described difference model (Eqs. (1)–(3)).

In this model, the state variables are the product inventory levels at the storage nodes, *y*, and the back orders, *BO*, at the order receiving nodes. The manipulated (control or decision) variables are the product quantities transferred through the network's permissible routes, *x*, and the delivered amounts to customers, *d*. Finally, the product back orders, *BO*, are also matched to the output variables. The inventory target levels (e.g. inventory setpoints) are time invariant parameters. The control actions that minimize a performance index associated with the outlined control objectives are then calculated over the receding time horizon. At each time period the first control action in the calculated sequence is implemented.

The effect of unmeasured demand disturbances and model mismatch is computed through comparison of the actual current demand value and the prediction from a stochastic disturbance model for the demand variability. The difference that describes the overall demand uncertainty and system variability is fed back into the RHC scheme at each time period facilitating the corrective action that is required.

The centralized mathematical formulation of the performance index considering simultaneously back orders, transportation and inventory costs takes the following form[4]:

$$J_{total} = \sum_{t}^{t+P} \sum_{k\in\{W,D,R\}} \sum_{i\in DP} \left\{ w_{y,i,k} (y_{i,k}(t) - y_{s,i,k}(t))^2 \right\} + \sum_{t}^{t+M} \sum_{k\in\{W,D,R\}} \sum_{i\in DP} \left\{ w_{x,i,k',k} (x_{i,k',k}(t))^2 \right\} + \sum_{t}^{t+P} \sum_{k\in\{R\}} \sum_{i\in DP} \left\{ w_{BO,i,k} (BO_{i,k}(t))^2 \right\} \quad (4)$$

The performance index, *J*, in compliance with the outlined control objectives consists of four quadratic terms. Two terms account for inventory and transportation costs throughout the supply chain over the specified prediction and control horizons (*P* , *M*). A term penalizes back orders for all products at all order receiving nodes (e.g. retailers) over the receding horizon *P*.

The weighting factors, $w_{y,i,k}$, reflect the inventory storage costs and inventory assets per unit product, $w_{x,i,k',k}$, account for the transportation cost per unit product for route (k',k). Weights $w_{BO,i,k}$ correspond to the penalty imposed on unsatisfied demand and are estimated based on the impact service level has on the company reputation and future demand. Factors $w_{y,i,k}$, $w_{x,i,k',k}$ and $w_{BO,i,k}$ are cost related that can be estimated with a relatively good accuracy.

The weighting factors in cost function also reflect the relative importance between the controlled (back orders and inventories) and manipulated (transported products) variables. Note that the performance index of cost function reflects the implicit assumption of a constant profit margin for each product or product family. As a result, production costs and revenues are not included in the index.

In this centralized implementation, RHC will optimized for whole policy and then will sent downstream optimal inputs to upstream joint nodes to those nodes which it is coupled, as measurable disturbances.

Each node completely by a centralized RHC optimizes for whole policy. At each time period, the first control action in the calculated sequence is implemented until RHC process complete (Fig. 1).

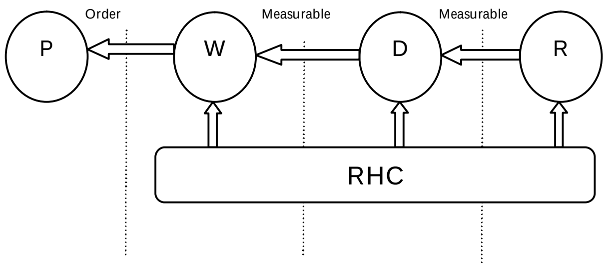

Fig. 1 Centralized RHC on supply chain management system

4 SIMULATIONS

A three echelon supply chain system is used in the simulated examples. The supply chain network consists of two product, one production nodes, two distribution centers, and three retailer nodes.

All possible connections between immediately successive echelons are permitted. Two product is being distributed through the network. Inventory setpoints, maximum storage capacities at every node, and transportation cost data for each supplying route are reported in Table 1.

A prediction horizon of 20 time periods and a control horizon of 10 time periods were selected and was considered $LO = 0$ for every times. So each delay was replaced by its 4th order Pade approximation (after system model transformed to continuous time model and then returned to discrete time model).

Table 1. Supply chain data

Echelon	D	R
Max inventory level	700	300

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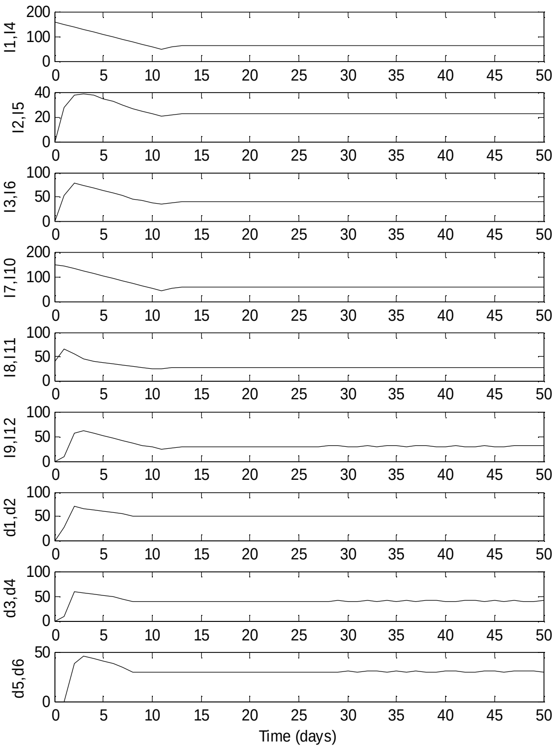
Inventory setpoint	Node1:300 Node2:250	Node1:180 Node2:120 Node3:80
Transportation cost	W to D $\begin{bmatrix} 0.2 & 0.1 \end{bmatrix}$	D to R $\begin{bmatrix} 0.2 & 0.1 & 0.1 \\ 0.1 & 0.2 & 0.1 \end{bmatrix}$
Inventory weights	1	1
Back-order weights	-	1
Initial condition	0	0
Delays	2	1
Demand	-	Node1:50 Node2:40 Node3:30

The simulated scenarios lasted for 50 time periods with Eq. 5. Response to constant demand is presented in Fig. 2. In this part, centralized RHC method is applied to the supply chain network with a constant customer demand that is seeing in figures 2 and 3.

$$Y = \begin{bmatrix} y_{1,D1} \\ y_{2,D1} \\ y_{1,D2} \\ y_{2,D2} \\ y_{1,R1} \\ y_{2,R1} \\ y_{1,R2} \\ y_{2,R2} \\ y_{1,R3} \\ y_{2,R3} \\ BO_{1,R1} \\ BO_{2,R1} \\ BO_{1,R2} \\ BO_{2,R2} \\ BO_{1,R3} \\ BO_{2,R3} \end{bmatrix}_{16\times1} = \begin{bmatrix} D1 \\ D2 \\ D3 \\ D4 \\ R1 \\ R2 \\ R3 \\ R4 \\ R5 \\ R6 \\ B1 \\ B2 \\ B3 \\ B4 \\ B5 \\ B6 \end{bmatrix}_{16\times1}, \quad U = \begin{bmatrix} x_{1,P,D1} \\ x_{1,D1,R1} \\ x_{1,D1,R2} \\ x_{2,P,D1} \\ x_{2,D1,R1} \\ x_{2,D1,R2} \\ x_{1,P,D2} \\ x_{1,D2,R1} \\ x_{1,D2,R3} \\ x_{2,P,D2} \\ x_{2,D2,R1} \\ x_{2,D2,R3} \\ d_{1,R1} \\ d_{2,R1} \\ d_{1,R2} \\ d_{2,R2} \\ d_{1,R3} \\ d_{2,R3} \\ R_{1,R1} \\ R_{2,R1} \\ R_{1,R2} \\ R_{2,R2} \\ R_{1,R3} \\ R_{2,R3} \end{bmatrix}_{24\times1} = \begin{bmatrix} I1 \\ I2 \\ I3 \\ I4 \\ I5 \\ I6 \\ I7 \\ I8 \\ I9 \\ I10 \\ I11 \\ I12 \\ d1 \\ d2 \\ d3 \\ d4 \\ d5 \\ d6 \\ r1 \\ r2 \\ r3 \\ r4 \\ r5 \\ r6 \end{bmatrix}_{24\times1} \qquad (5)$$



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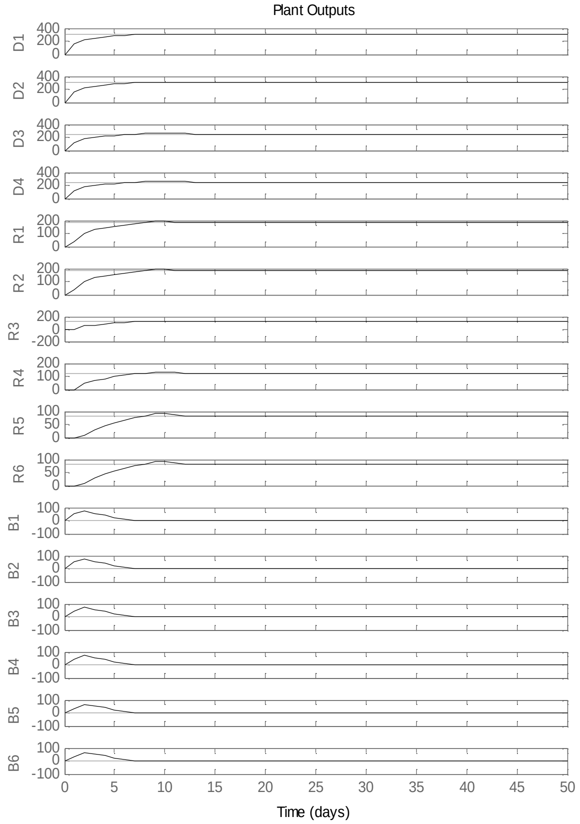

Fig. 2 RHC outputs of supply chain management system

Fig. 3 RHC inputs of supply chain management system

CONCLUSION

The large majority of successful RHC applications address the case of multivariable control in the presence of constraints, motivating its extensive distribution for applications where traditional control usually comes close to its limits. The success of RHC is due to the fact that it is perhaps the most general way of posing the control problem in the time domain. The use a finite horizon strategy allows the explicit handling of process and operational constraints by the RHC. Typically, RHC is implemented in a centralized fashion. In this paper, a centralized receding horizon controller applying to a supply chain management system consist of one plant (supplier), two distribution centers and three retailers.

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Load Forecasting Using New Error Measures In Neural Networks

Devesh Pratap Singh, Mohd. Shiblee, Deepak Kumar Singh

Abstract— Load forecasting plays a key role in helping an electric utility to make important decisions on power, load switching, voltage control, network reconfiguration, and infrastructure development. It enhances the energy-efficient and reliable operation of a power system. This paper presents a study of short-term load forecasting using new error metrices for Artificial Neural Networks (ANNs) and applied it on the England ISO.

Index Terms— Load forecasting, Neural networks, New neuron Models, New error metrics for neural networks, England ISO

1 Introduction

There is a growing tendency towards unbundling the electricity system. This is continually confronting the different sectors of the industry (generation, transmission, and distribution) with increasing demand on planning management and operations of the network. The operation and planning of a power utility company requires an adequate model for electric power load forecasting. Load forecasting plays a key role in helping an electric utility to make important decisions on power, load switching, voltage control, network reconfiguration, and infrastructure development.

Methodologies of load forecasts can be divided into various categories that include short-term forecasts, medium-term forecasts, and long-term forecasts. Short-term forecasting which forms the focus of this paper, gives a forecast of electric load one hour ahead of time. Such forecast can help to make decisions aimed at preventing imbalance in the power generation and load demand, thus leading to greater network reliability and power quality.

Many methods have been used for load forecasting in the past. These include statistical methods such as regression and similar-day approach, fuzzy logic, expert systems, support vector machines, econometric models, end-use models, etc. [2].

A supervised artificial neural network has been used in this work. Here, the neural network is trained on input data as well as the associated target values. The trained network can then make predictions based on the relationships learned during training. A real life case study of the power industry in Nigeria was used in this work.

In this paper a supervised artificial neural network has been used for load forecasting.

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Here, the neural network is trained on input data as well as the associated target values. The error measures used in the presented model is different from the conventional models. England ISO data has been used for the simulation.

In further sections of this paper, we discuss neural network in greater detail, introduce the conventional model of artificial neural network and the mathematical error models used in our model.

2 Neural Network

2.1 Introduction

Artificial neuron model is inspired by biological neuron. Biological neurons are the basic unit of brain for information processing system. Artificial Neural Network is a massive parallel distributed processing system that has a natural propensity for storing experimental knowledge and making it available for use [1]. The basic processing units in ANN are neurons. Artificial Neural Network can be divided in two categories viz. Feed-forward and Recurrent networks. In Feed-forward neural networks, data flows from input to output units in a feed-forward direction and no feedback connections are present in the network. Widely known feed-forward neural networks are Multilayer Perceptron (MLP) [3], Probabilistic Neural Network (PNN) [4], General Regression Neural Network (GRNN) [5] and Radial Basis Function (RBF) Neural Networks [6]. Multilayer Perceptron (MLP) is composed of a hierarchy of processing units (Perceptron), organized in series of two or more mutually exclusive sets layers. It consists of an input layer, which serves as the holding site for the input applied to the network. One or more hidden layers with desired number of neurons and an output layer at which the overall mapping of the network input is available [7]. There are three types of learning in Artificial Neural Networks, Supervised, unsupervised and Reinforcement learning. In supervised learning, the network is trained by providing it with input and target output patterns. In Unsupervised

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learning or Self-organization, an (output) unit is trained to respond to clusters of pattern within the input. In this paradigm the system is supposed to discover statistically salient features of the input population.Reinforcement learning may be considered as an intermediate form of supervised and unsupervised learning. Here the learning machine does some action on the environment and gets a feedback response from the environment. Most popular learning algorithm for feed-forward networks is Back-propagation. The first order optimization techniques in Back-propagation which uses steepest gradient decent algorithm show poor convergence. ANN is a very popular tool in the field of engineering. It has been applied for various problem like times series prediction, classification, optimization, function approximation, control systems and vector quantization. Many real life application fall into one of these categories. In the existing literature, various neural network learning algorithms have been used for these applications. In this paper, MLP neural network has been used successfully with different error measures for load forecasting.

2.2 New Error Measures

In Back-propagation algorithm, training of the neuron model is done by minimizing the error between target value and the observed value. In order to determine error between target and observed value, distance metric is used. It has been observed that Euclidean distance metric is the most commonly used for error measures in Neural Network applications. But it has been suggested that this distance metric is not appropriate for many problems [12]. In this work the aim is to find best error metric to use in Back propagation learning algorithm.

The likelihood and log-likelihood functions are the basis for deriving estimators for parameters, for given set of data. In maximum likelihood method we estimate the value of "*y*" for the given value of "*x*" in presence of error. (See equation (1))

$$y_i = x_i + e \tag{1}$$

Let x_i denote the data points in the distribution and let N denotes the number of data points. Then an estimator $\tilde{\mu}$ of μ can be estimated by minimizing the error metric with respect to $\tilde{\mu}$

$$\varepsilon = \sum_{i=1}^{N} f(x, \tilde{\mu}) \tag{2}$$

where $f(x, \tilde{\mu})$ is the distance metric. The error function ε is differentiated with respect to $\tilde{\mu}$ and equated to zero.

$$\frac{\partial \varepsilon}{\partial \tilde{\mu}} = \sum_{i=1}^{N} \frac{\partial}{\partial \tilde{\mu}} f(x, \tilde{\mu}) = 0 \tag{3}$$

Jie, et. al., [10-11] has proposed some new distance metrics based on different means. These distance metrics can be used to improve the performance of the neuron model for learning the best-fit weights of the neuron models. Distance metrics associated with the distribution models that imply the arithmetic mean, harmonic mean and geometric mean in (See Table 1) are inferred using equation (3).

TABLE 1
ERROR METRICS AND MEAN ESTIMATION

	Error metric	Mean
Arithmetic	$\varepsilon = \sum_{i=1}^{N} (x_i, \tilde{\mu})^2$	$\hat{\mu} = \frac{1}{N} \sum_{i=1}^{N} x_i$
Harmonic	$\varepsilon = \sum_{i=1}^{N} x_i \left(\frac{\tilde{\mu}}{x_t} - 1 \right)^2 = 0$	$\hat{\mu} = \frac{N}{\sum_{i=1}^{N} \frac{1}{x_i}}$
Geometric	$\varepsilon = \sum_{i=1}^{N} \left[\log \left(\frac{x_i}{\hat{\mu}} \right) \right]^2 = 0$	$\hat{\mu} = \left(\prod_{i=1}^{N} x_1 \right)^{\frac{1}{N}}$

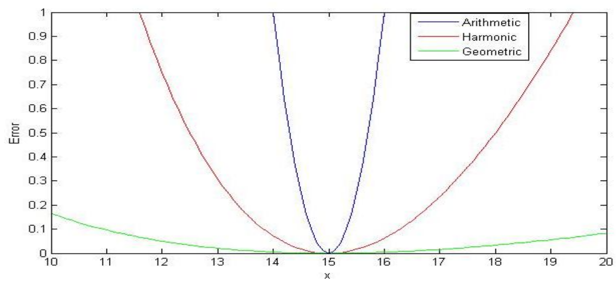

Fig. 1.the error criterion of the arithmetic mean, harmonic and geometric mean

Figure 1 illustrates the difference between the distance (error) metrics for the arithmetic mean, harmonic mean and geometric mean. For the sake of comparison, the value of μ is set to 15. It is found that in the distribution associated with the harmonic and geometric estimations, the observations x_i which are far away from $\hat{\mu}$ will contribute less towards μ, in contrast to arithmetic mean and thus the estimated values will be less sensitive to the bad observations (i.e., observation with large variance), and therefore they are more robust in nature [9].

Due to the robust property of harmonic and geometric distance metrics, generalizations of these distance metrics have also been done which may fit the distribution of data better [8-9]

2.2.1 Generalized Harmonic Type I Error Metric

Generalized Harmonic Type I Error metric derived from the Generalized Harmonic Type I mean estimation using

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equation (3) is given below.

Generalized Harmonic Type I Mean:

$$\tilde{\mu} = \frac{\sum_{i=1}^{N} (x_i)^{p-1}}{\sum_{i=1}^{N} (x_i)^{p-2}} \qquad (4)$$

The corresponding error metric is given below:
Generalized Harmonic Type I Error Metric:

$$\varepsilon = \sum_{i=1}^{N} (x_i)^p \left(\frac{\tilde{\mu}}{x_i} - 1 \right)^2 \qquad (5)$$

The parameter ‘p’ is used to define the specific distance metrics. If p=1, it becomes ordinary harmonic distance metric and for p=2, it will become Euclidean distance metric. Figure 2 illustrates the generalized harmonic Type I distance metric for the Generalized Harmonic Mean Type I.

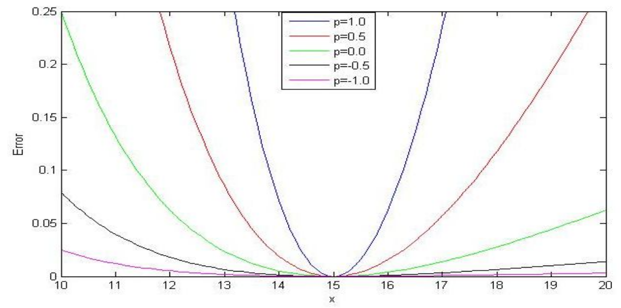

Fig. 2: The error criterion of the Generalized Harmonic Mean Type 1

2.2.2 Generalized HarmonicType II Error metric

Harmonic Type II Error metric derived from the Generalized Harmonic Type II mean estimation using equation (3) is given below.

GeneralizedHarmonicType II Mean:

$$\tilde{\mu} = \left[\frac{N}{\sum_{i=1}^{N} (x_i)^q} \right]^{-\frac{1}{q}} \qquad (6)$$

Generalized Harmonic Type II Error Metric:

$$\varepsilon = \sum_{i=1}^{N} \left[(x_i)^q - (\tilde{\mu})^q \right]^2 \qquad (7)$$

The parameter q is used to define the specific distance metrics. If q= -1, it becomes ordinary harmonic distance metric and for q=1, it will become Euclidean distance metric. Figure 3 illustrates the generalized harmonic Type II distance metric for the generalized harmonic mean Type II

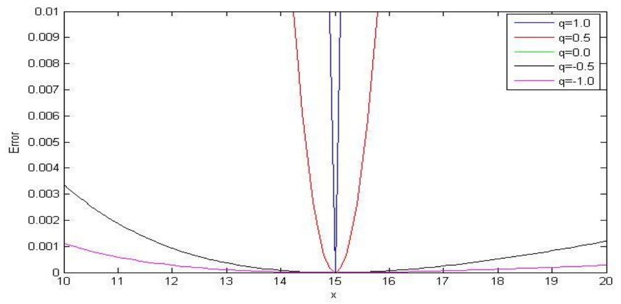

Fig. 3: The error criterion of the Generalized Harmonic Mean Type II

2.2.3 Generalized Geometric Error Metric

Generalized Geometric Error Metric derived from the Generalized Geometric Mean estimation using equation (3) is given below

.Generalized Geometric Mean:

$$\tilde{\mu} = \left[\prod_{i=1}^{N} (x_i)^{(x_i)^{2r}} \right]^{-\frac{1}{\sum_{i=1}^{N} (x_i)^{2r}}} \qquad (8$$

The corresponding error metric is given below:
Generalized Geometric Error Metrics :

$$\varepsilon = \sum_{i=1}^{N} \left[(x_i)^r \log\left(\frac{x_i}{\tilde{\mu}} \right) \right]^2 \qquad (9)$$

The parameter ‘r’ is used to define the specific distance metrics. For the generalized geometric mean estimation, if r = 0, it will become an ordinary geometric mean. Figure 4 illustrates the generalized geometric distance metric for the generalized geometric mean.

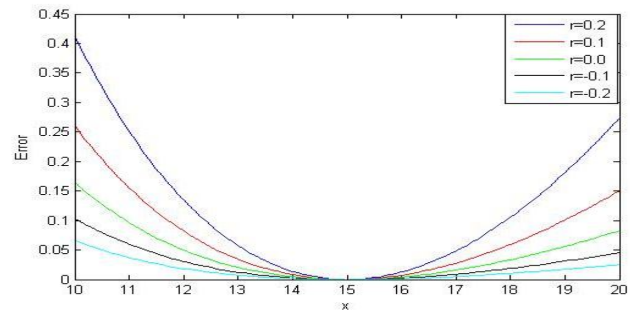

Fig. 4: The error criterion of the Generalized Geometric Mean

It is obvious that the generalized metrics correspond to a wide range of mean estimations and distribution models. These error metrics have been used in the Back propagation algorithm of MLP which enhances the prediction efficiency. Section 2.3; describes in brief the MLP model ,

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the learning algorithm of MLP with new error metrics has been derived.

2.3 Multilayer Perceptron

Multilayer Perceptron (MLP) is composed of a hierarchy of processing units (Perceptron), organized in series of two or more mutually exclusive sets layers. It consists of an input layer, which serves as the holding site for the input applied to the network. One or more hidden layers with desired number of neurons and an output layer at which the overall mapping of the network input is available [13-14]. The input signal propagates through the network layer-by-layer [2].

The architecture of the MLP network is shown in Figure 5. It has been proved that a single hidden layer is sufficient to approximate any continuous function [15]. A three layer MLP is thus taken into account in this chapter. It has "nh" neurons in hidden layer and "no" neurons in output layer. It has "ni" inputs. The input and output vectors of the network are $X = [x_1, x_2, ..., x_{ni}]^T$ and $Y = [y_1, y_2, ..., y_{no}]^T$, respectively.

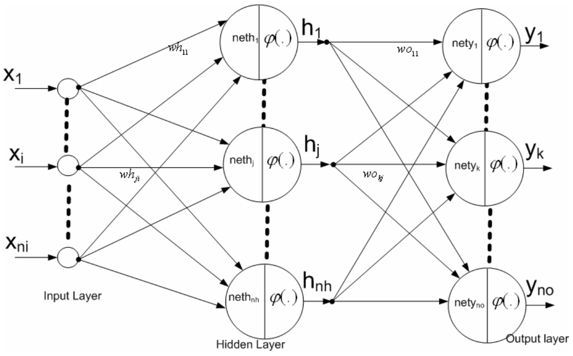

Fig. 5: Architecture of the MLP network

.

If the weight that connects the i^{th} neuron of the input layer with the j^{th} neuron of the hidden layer is w_{ij} and bias of the j^{th} neuron of the hidden layer is bh_j the net value of the j^{th} neuron can be given as:

$$neth_j = \sum_{i=1}^{ni} (wh_{ji} \cdot x_i + bh_j) \qquad j = 1, 2, ..., nh \quad (10)$$

The output of the j^{th} neutron h_j of the hidden layer after applying activation can be given as

$$h_j = \varphi(neth_j) = \frac{1}{1 + e^{-neth_j}} \qquad (11)$$

Similarly the net value "$nety_k$ "and the final output y_k of k^{th} neuron of the output layer can be given as

$$nety_k = \sum_{i=1}^{nh} (wo_{kj} \cdot h_j + bh_k) \qquad k = 1, 2, ..., no \quad (12)$$

where φ is the activation function.

- h_j is the output of j^{th} neuron of hidden layer.
- wo_{kj} is the connection weight of j^{th} hidden layer neuron with k^{th} output layer neuron.
- bo_k is the weight of the bias at k^{th} neuron of output layer.
- no is the number of output neuron.

Output of k^{th} neuron of output layer is

$$y_k = \varphi(nety_k) = \frac{1}{1 + e^{-nety_k}} \qquad (13)$$

2.3.1 Training algorithm of MLP with new error metrics

In this section the error back-propagation learning of MLP with different error metrics have been derived. Let E denote the cumulative error at the output layer. In BP algorithm aim is to minimize the error at the output layer.

The weight update equations using gradient descent rule are given bellow:

$$wh_{ji}(new) = wh_{ji}(old) + \eta \cdot \frac{\partial E}{\partial y_k} \cdot \frac{\partial y_k}{\partial wh_{ji}} \qquad (14)$$

$$bh_j(new) = bh_j(old) + \eta \cdot \frac{\partial E}{\partial y_k} \cdot \frac{\partial y_k}{\partial bh_j} \qquad (15)$$

$$wo_{kj}(new) = wo_{kj}(old) + \eta \cdot \frac{\partial E}{\partial y_k} \cdot \frac{\partial y_k}{\partial wo_{kj}} \qquad (16)$$

$$bo_k(new) = bo_k(old) + \eta \cdot \frac{\partial E}{\partial y_k} \cdot \frac{\partial y_k}{\partial bk_k} \qquad (17)$$

where, η is the learning rate and

$$\frac{\partial y_k}{\partial wh_{ji}} = [\sum_{k=1}^{no} (1 - y_k) \cdot y_k \cdot w_{kj}] \cdot (1 - h_j) \cdot h_j \cdot x_i \qquad (18)$$

$$\frac{\partial y_k}{\partial bh_j} = [\sum_{k=1}^{no} (1 - y_k) \cdot y_k \cdot w_{kj}] \cdot (1 - h_j) \cdot h_j \qquad (19)$$

$$\frac{\partial y_k}{\partial bo_k} = (1 - y_k) \cdot y_k \qquad (20)$$

$$\frac{\partial y_k}{\partial wo_{jk}} = (1 - y_k) \cdot y_k \cdot h_j \qquad (21)$$

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For different error criterion only $\partial E / \partial y$ will change and is shown as follows: This is dependent on the distance metric used in computation of the total error E.

Case 1: Least Mean Square Error

$$\text{LMSE}= E = \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{no}(t_k - y_k)^2 \quad (23)$$

$$\text{Then, } \frac{\partial E}{\partial y_k} = -\eta \cdot (t_k - y_k) \quad (24)$$

Case 2: Geometric error metric

$$E = \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{no}[\log(\frac{y_k}{t_k})]^2 \quad (25)$$

$$\text{Then } \frac{\partial E}{\partial y_k} = -\eta \cdot (\log(t_k) - \log(y_k)) \cdot \frac{1}{y_k} \quad (26)$$

Case 3: Harmonic error metric

$$E = \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{no} t_k \cdot (\frac{y_k}{t_k} - 1)^2 \quad (27)$$

$$\text{Then } \frac{\partial E}{\partial y_k} = \eta \cdot t_k \cdot (y_k / t_k - 1) \quad (28)$$

Case 4: Generalized geometric error metric

$$E = \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{no}[t_k^{\,r} \cdot \log(\frac{t_k}{y_k})]^2 \quad (29)$$

$$\text{Then } \frac{\partial E}{\partial y_k} = -\eta \cdot t_k^{\,r} \cdot (\log(t_k) - \log(y_k)) \cdot t_k^{\,r} \cdot \frac{1}{y_k} \quad (30)$$

Case 5: Generalized harmonic error metric Type I

$$E = \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{no} t_k^{\,p} \cdot (\frac{y_k}{t_k} - 1)^2 \quad (31)$$

$$\text{Then } \frac{\partial E}{\partial y_k} = \eta \cdot (t_k^{\,p}) \cdot (y_k / t_k - 1) \quad (32)$$

Case 6: Generalized harmonic error metric Type II

$$E = \frac{1}{2}\sum_{n=1}^{N}\sum_{k=1}^{no}(t_k^{\,q} - y_k^{\,q})^2 \quad (33)$$

$$\text{Then } \frac{\partial E}{\partial y_k} = -\eta \cdot (t_k^{\,q} - y_k^{\,q}) \cdot q \cdot y_k^{\,q} \quad (34)$$

Where, y_t denotes the desired vlue of neuron.and t_i notes the target value for the i^{th} pattern.

3 Results

The data is taken from England ISO, and the simulation is done using MATLAB.the network designed is of two lag-ers with 20 neuron .For converentional model mean abso-lutes error (MAE) is used. To display the result clearly only forcasting of one week is given. The results are shown in following figures. The x axis in all the figures below represents the days (data here shown is only for 1 week; 1st January 2008 to 8th January 2008) and the y axis depict the forecasted load demand (in MW).

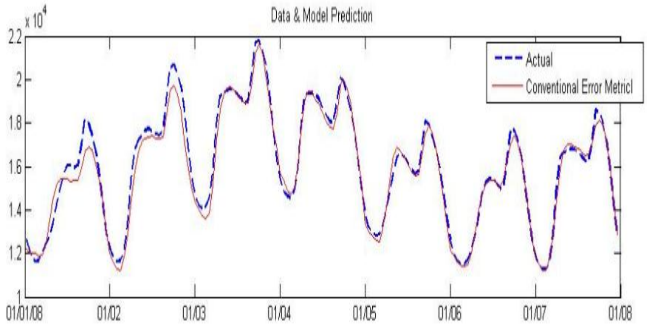

Fig. 6: Forecasting using MAE (conventional model).

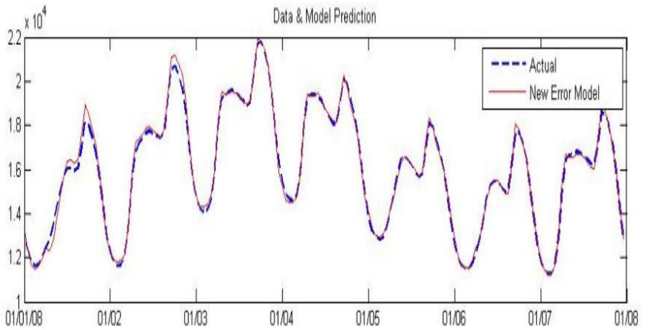

Fig. 7: Forecasting using Generalized Harmonic Type I Error Metric

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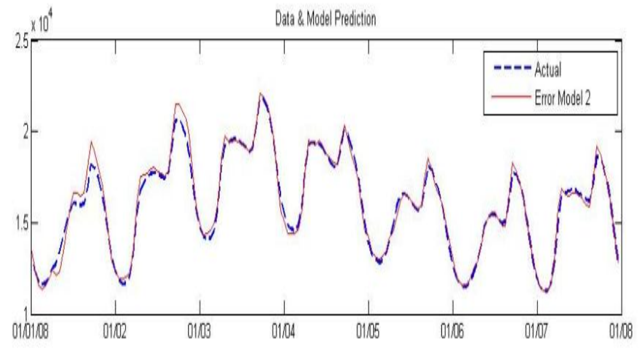

Fig. 8: Forecasting using Generalized Harmonic Type II Error Metric

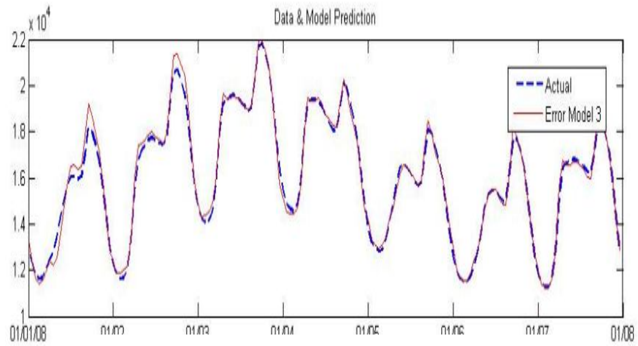

Fig. 9: Forecasting using Generalized Geometric Error Metric

4 Conclusion

As it is clearly analyazed from the result. The new models are giving better result from the convestional model.this result are justified from the theory that the generalized mean models will capture the variation well.the reason is clear that the variation are largely nonlinear & stocasting in nature so conventional linear models are unable to catch it.

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Effect of Temperature on Deformation Characteristics of Gold Ball Bond in Au-Al Thermosonic Wire Bonding

Gurbinder Singh, Othman Mamat

Abstract- Wire bonding is a process that is used to form solid-state bonds to interconnect metals such as gold wires to metalized pads deposited on silicon integrated circuits. Typically, there are 3 main wire bonding techniques; Thermo-compression, Ultrasonic and Thermosonic. This experiment utilizes thermosonic bonding which applies heat, ultrasonic energy and force on an Au-Al system. Sixteen groups of bonding conditions at various temperature settings were compared to establish the relationship between ball deformation and temperature. The results of this study will clearly indicate the effects of applied bonding temperature towards bond strength and deformation characteristics of gold ball bonding.

Index Terms - Gold ball bond, Intermetallic phase , Shear strength, Thermosonic wire bonding

1. INTRODUCTION

IN recent years, thermosonic wire bonding has been prevalent in the application of solid state interconnect technology. In the process of making an interconnection, two wire bonds are formed. The first bond involves the formation of a ball with Electric Flame Off (EFO) process. The ball is placed in direct contact within the bond pad opening on the die. With application of load (bond force) and ultrasonic energy within a few milliseconds (bond time) under the influence of heat, a ball bond is formed at the aluminum bond pad. Factors such as ultrasonic energy, temperature, and pressure may influence the quality of bonding quality [1, 2].

Upon application of the primary factors to form an intermetallic layer that makes the connection on the bond pad of a die, the wire is the lifted to form a loop and then placed in contact with the desired bond area of a leadframe to form a wedge bond. In this process, the bonding temperature is one of the main bonding parameters which play an important role in the bonding [3]. Essentially, different temperature will lead to different bonding output response as different temperature conditions mean different bonding environment. In previous studies, a parabolic relationship between temperature and strength has been determined. Too low or too high temperature for bonding can lead to unsuccessful bonding or low bonding strength [4, 5].

Although many studies about temperature effect in wire bonding has been carried out, it is worth investigating the criticality of temperature application on thermosonic wire bonding while keeping other factors at constant. This study will be able to depict the actual deformation characteristics of Gold (Au) ball bond with respect to temperature, while keeping other bonding factors as constant. Sixteen groups of bonding data at various temperature settings were compared to establish the relationship between ball deformation and temperature.

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2. Experiment Method

Gold wire bonding was carried out using a 138 KHz Thermosonic wire bonder. The bonding temperature was tuned to produce different thermosonic bonding process while all other bonding parameters such as bonding ultrasonic power, bonding force and time were kept unchanged. The bonding parameters are listed in Table 1.

Table1: Bonding Parameters

US Power (DAC)	Bond Force (gm)	Bond Time (ms)	Temperature (°C)
48	28	15	40°C - 340°C

The diameter of gold wire (99.99% Au) used is 1 mil. The gold wire bonding was performed on a 16mil x 16 mil die size with metal composition Al-99.5%, Cu-0.5%. The bond pad opening is 4mil x 4 mils and bond pad pitch is 5 mils.

The following is an outline of the gold wire bonding procedure which was carried out. Refer to Figure 1.

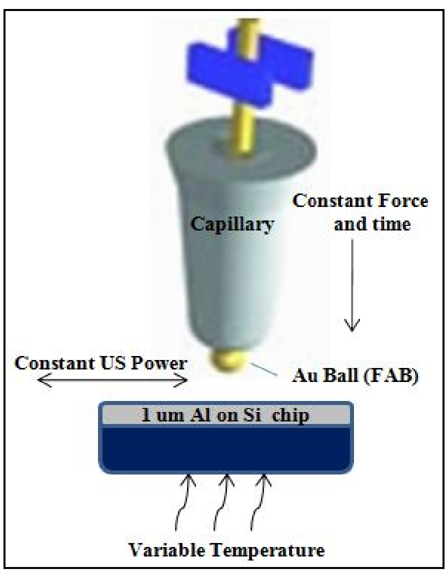

Fig.1. Thermosonic wire bonding setup

i. The Au wire at the capillary tip was melted to produce the Free air ball (FAB) using discharge from electric flame off (EFO)

ii. The capillary is lowered and the free air ball is compressed onto the Al pad for bonding.

iii. The capillary is lifted and the Au wire is connected to the lead to produce a wedge bond.

iv. The Au wire is cut.

Steps 1 – 4 are repeated.

The bonding temperature was measured by a K-type thermocouple sensor with a measurement range of 0 - 500°C. A total of 16 runs were performed with bonding temperature range of 40°C to 340°C with a step of 20°C.The bonding experiments were consistently repeated for 50 times under each testing condition for statistical analysis.

To assess the output response of the thermosonic bonding, the wire pull test and ball shear test are performed using Westbond wire pull tester and Royce 550 wire bond tester respectively. The destructive shear strength between the gold ball and substrate is a common judgment for bondability [6, 7].

To further analyze the bondability, intermetallic coverage assessment is also carried out using fuming potassium hydroxide, KOH. Cross sectioning using grinding and polishing machines were used to enable analysis on gold ball bond. Samples were observed using an optical microscope and scanning electron microscope (SEM). Thickness and diameter of the ball bond profile and Inter Metallic Coverage (IMC) growth was measured using micrometer scale attached to the optical microscope and the scope was calibrated using the standards provided with the scope.

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3. Result and Discussion

I. Effect of Temperature on Bond Strength of Au-Al Wire Bonding

During the bonding process of Au and Al system in thermosonic system, the temperature plays a very important role. The relationship between bonding strength and temperature was successfully obtained from the experiment carried out and is in coherence with previous studies carried out [4, 5]. Results of relationship of shear strength and temperature are shown in Figure 2.

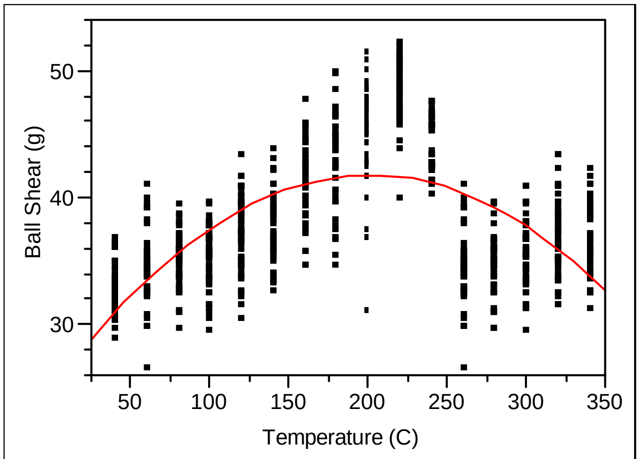
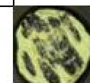
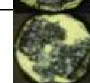
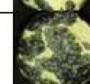
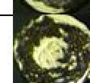


Fig 2: Shear strength against temperature

Statistical mean, standard deviations, process capability index of bonding strength and intermetallic coverage for each experimental temperature consisting of 50 tests each is listed in Table 2. IMC is distinguishable in its dark colored formation in Table 2. It is observed that too low or too high temperature may result in unfavorable bonding or low bonding strength. This experiment suggests that, the most suitable bonding temperature for Au and Al system is between 200°C and 240°C. This observable fact can be further explained by the following related theories [8, 9, and 10] and experiment:

Table 2: Bond strength response against temperature

Temperature (°C)	Bonding Strength Response				
	Ave (g)	St Dev	CpK	IMC	Approx. IMC %
40	32.50	1.83	2.28		50
60	34.23	2.70	1.76		50
80	35.09	2.02	2.48		50
100	35.22	2.38	2.13		50
120	37.31	2.99	1.93		60
140	37.56	2.72	2.15		70
160	40.95	3.09	2.26		80
180	43.32	3.56	2.18		75
200	45.39	3.68	2.30		75
220	48.37	2.38	3.97		80
240	43.79	2.11	3.76		80
260	34.23	2.70	1.76		75
280	34.61	2.24	2.18		65
300	35.52	2.57	2.01		65
320	36.76	3.07	1.82		65
340	36.63	2.67	2.08		65

a. The presence of oxide and other forms of contamination may not be able to be removed and may impede diffusion between the bonding metals. This may lead to unsuccessful bonding or lower bonding strength with poor IMC.

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b. The application of appropriate and adequate temperature will soften the metal surface and accelerate the diffusion between the bonding systems.

c. Higher application of temperature may cause the atom to diffuse to each other more quickly and may cause cracks and voids in the interface; Results of this experiment show voids at higher temperature range in Table 2, leading to lower bonding strength.

II. Effect of Temperature on Ball Bond Deformation

Results of this experiment shows significant difference in ball bond profiles with respect to different temperature levels. Research carried out previously with the application of short-time Fourier transform (STFT) to input/ output power of an ultrasonic transducer is able to deduce this phenomena [11, 12].

The ball bond image in figure 3 shows a thicker ball deformation as compared to at higher temperatures. At 60°C the gold ball bond thickness obtained is 19.9um. The available theory [4] depicts, at this stage of lower temperature, the impedance of piezo-transducer is low and the consumed power of piezo-transducer is high. This may result in poor exertion of bonding power to the ball bond. This result co-relates to the lower ball shear strength and lower IMC that was obtained in this study

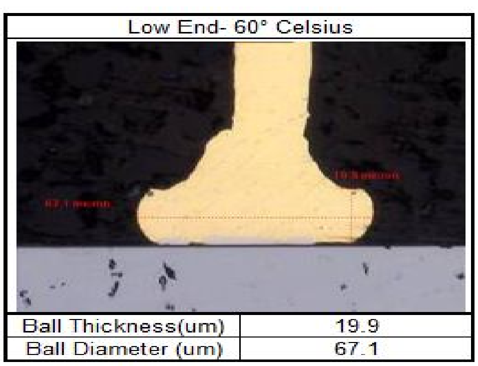

Fig 3: Ball Bond profile at 60°C

Results of experiment at temperature range 200°C to 220 °C shows; this is a good range which results in the desired output response. The impedance of piezo-transducer is high and the consumed power of piezo-transducer is low. This effect may exert adequate physical bonding power to the bonded aluminum interface and result in a thinner ball bond of 17.9um; Figure 4. Intermetallic coverage response from the experiment carried out in this temperature range is observed to be much uniformed and homogeneous as compared to the lower range temperature.

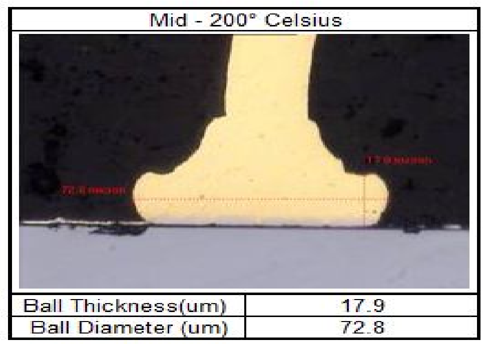

Fig 4: Ball Bond profile at 200°C

Results of ball bond obtained at higher temperature shows a thinner ball bond of 12.5um; Figure 5. At this state, the available theory from previous study depicts, impedance of piezo-transducer is higher and the consumed power of the piezo-transducer is lower. This effect may result in higher physical exertion of bonding power to the ball bond and produces a thinner ball bond of 12.5um. This result co-relates to the low shear strength obtained from this study, and may attribute to the non-uniform and non-homogenous intermetallic coverage which shows voids in the center of ball bond.

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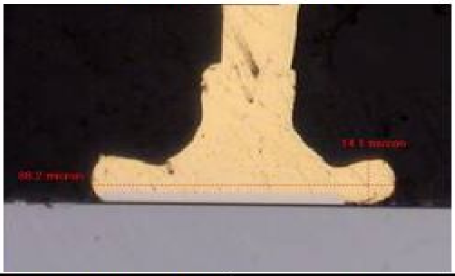
High End- - 320° Celsius



Ball Thickness(um)	12.5
Ball Diameter (um)	86.2

Fig 5: Ball bond profile at 320°C

4. Conclusion

From the experimental measurements, the effect of applied temperature on deformation of gold ball bond in Au-Al thermosonic wire bonding was investigated. It is revealed and understood that poor gold bonding happens with low temperature which produces thicker ball bonds which results in lower bonding strength and poor intermetallic coverage. The application of high temperatures lead to ultra thin ball bonds and also results in lower bonding strengths and poor intermetallic coverage. Only when moderate temperature is applied, good shear strengths are attained with homogeneous intermetallic coverage from the medium ball bond thicknesses obtained

It is concluded that, applied bonding temperature, unaccompanied by other bonding factors, has an effect on ball bond deformation, bonding strength and intermetallic coverage. Further studies and experimentation of pre-heating on bonding surfaces should be explored for enhanced wire bondability

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Sorption of Cr (VI) & As (V) on HDTMA –Modified Zeolites

Vandana Swarnakar, Nishi Agrawal, Radha Tomar

Abstract-Sorption of Cr (VI) & As (V) on HDTMA modified zeolites were investigated by batch technique, X-ray diffraction, Fourier transform infrared analysis, Energy dispersive spectroscopy and Scanning electron microscopy. HDTMA was exchanged with extra structural cations of zeolite up to the external cation exhange capacity. The HDTMA modified surface was stable when exposed to extremes in pH, ionic strength and to oxoanions. The HDTMA modified zeolites showed significant sorption for chromate and arsenate ions in aqueous solution. Sorption data for each anion was well described by Freundlich isotherm equation. Increase in Cr (VI) & As (V) sorption on to modified surface occurred in neutral solution (pH7) and the amount of sorbed Cr (VI) & As (V) described rapidly with increasing pH since (OH^-) concentration competes against Cr (VI) & As (V) for the sorption sites, thus, inhibiting formation of Cr (VI)-SMZ & As (V)-SMZ complex. FTIR analysis showed that sorbed SMZ forms an ad-micelle surfactant surface coverage, which is responsible for Cr (VI) and As (V) sorption.

Keyword: Sorption; Cr (VI); As (V); HexaDecylTriMethylAmmonium-Bromide (HDTMAB)

1. Introduction

Chromium is one of the most abundant inorganic groundwater contaminant at hazardous waste sites. Compared to its trivalent counterpart, hexavalent Cr forms chromate (CrO_4^{2-}) or hydrogen chromate ($HCrO_4^-$) that is more toxic and more soluble at various pH. Because of the negative charges, chromate sorption on aquifer minerals is limited, making it more mobile in subsurface soils and aquifers. Conventional treatment of chromate-rich effluent is to reduce Cr (VI) to Cr (III) and precipitate Cr (III) as chromium hydroxide, or chromium iron hydroxide at high pH, followed by disposal of resulting dewatered sludge. Wastewater containing relatively low concentrations of Cr (VI) is usually treated with ion exchange resins to remove Cr (VI) [1]. These conventional methods for Cr (VI) removal are expensive and thus research to find inexpensive sorbent materials have been conducted recently [2-8].

These metals are found well above the tolerance limit many a times in the aquatic environment [9]. Chromium is widely used in electroplating, leather tanning, dye, cement and photography industries producing large quantities of effluent containing the toxic metal [10]. Cr (VI) is of particular concern because of its toxicity [11]. The recommended limit of Cr (VI) in potable water is only 0.05 mgl^{-1} [12]. However, industrial and mining effluents contain much higher concentrations compared to the permissible limit. Arsenic in groundwater is largely due to minerals dissolving naturally from weathered rocks and soils. Also, it has many industrial applications and is also used extensively in the production of agricultural pesticides [13, 14]. Runoff from these uses and the leaching of arsenic from generated wastes has resulted in increased levels of various forms of soluble arsenic in water. Use of arsenic contaminated water may cause numerous diseases of the skin and internal organs [13–17]. Consequently, extensive research to develop cost-effective methods for arsenic removal has been carried out recently using various sorbents [17–21]. Sorption technique is generally considered to be promising method amongst the existing technologies due to easy separation of sorbent from aqueous media after treatment [22]. Naturally occurring zeolites are hydrated aluminosilicate materials with high cation exchange capacities [23–27]. Sorption of arsenic on natural zeolites has been studied extensively in recent years due to their low cost and availability in nature [28–42]. See Fig. 1.

Thus, treatment of effluent to reduce / remove the pollutant before discharging into the environment becomes inevitable. Different methods such as reduction and precipitation [43], ion exchange [44], electrolysis, reverse osmosis, solvent extraction [45],

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sorption [46], and electrochemical precipitation [47] have been suggested for the removal of Cr (VI). Among

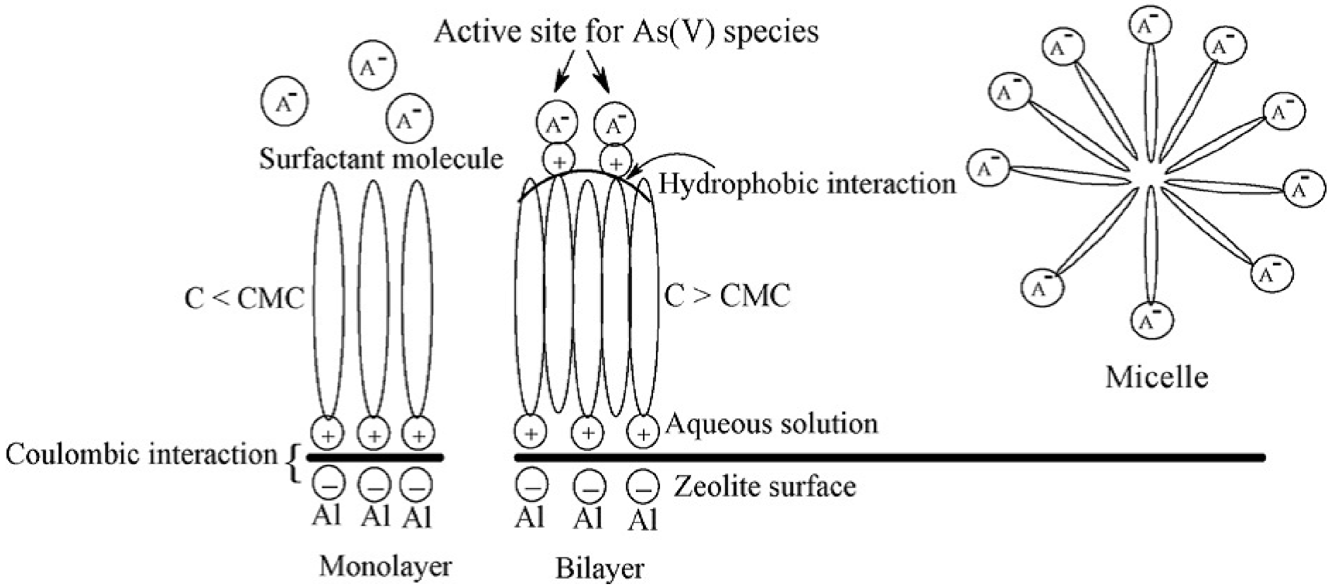

Fig.1 - A model of modification of zeolite surface by surfactant and sorption of As (V) species.

all these, sorption is the most promising technique and a feasible alternative [48]. A variety of materials have been tried as sorbents for Cr (VI) and a number of studies have been reported using sorbents like granular activated carbon [49], soya cake [50], rubber tyres and sawdust [51], activated sludge [52], lingocellular substrate [53], fly ash [54], rice husk based activated carbon [55] etc.

The present work deals with sorption of Cr (VI) & As (V) on Surfactant Modified Zeolites and to determine their sorption capacity. The well known thermodynamic functions and isotherm studies have been reported to elucidate the equilibrium adsorption behavior at different temperatures. In addition to the effect of temperature, the effect of pH, adsorbent dose, time and concentration of sorbate on percentage sorption have been investigated. Thus, Zeolites Erionite, Cowlesite and Willhendersonite modified by cationic surfactant hexdecyltrimethylammonium bromide HDTMAB has been potentially used as sorbents to remove anionic contaminants such as Cr (VI) and As (V) from waste water.

2.1. Sample

Zeolites were synthesized by hydrothermal method and modified by hexadecyltrimethylammonium bromide (HDTMAB) followed by centrifugation. Scanning electron microscope (SEM) fig.2 and X-Ray diffraction analysis (XRD) fig.3 confirmed that the sample was of high purity. The zeolites were modified by HDTMAB (from HIMEDIA). In centrifugal tube, 5gm of raw zeolites were mixed with 2.5 gm of HDTMAB with 180ml of distilled water. The solutions were mixed on a water bath shaker for 24 hrs. Zeolites were then separated from solution by centrifugation. After the supernatant solutions were decantated the zeolites were washed twice with deionized (DI) watered and air dried.

The surface morphology change after surfactant modification was similar to that of Ca-montmorillonite after hexadecyletrimethyl ammonium (HDTMA) modification [56]. Energy dispersion spectrum showed increase in carbon after surfactant modification.

2.2. X-Ray Diffraction Analysis

Powder X-ray diffraction analysis was performed on an X-ray diffractometer with CuKα radiation at 45 kV and 40mA. XRD patterns of randomly oriented samples were collected from 2θ equal to 5^o to 70^o at the scanning rate of 2^o/min using 1^o divergent slit and scatter slit and 0.3 mm receiving slit, while those of oriented samples were collected from 2θ equal to 5^o to 50^o.

2.3. Sorption of Cr (VI) and As (V)

Cr (VI) solution of desired concentration was made using K_2CrO_4 and As (V) solution was made using Na_2HAsO_4. The pH of Cr (VI) and As (V) solution was adjusted to 1, 3, 5, 7, 9 using HNO_3 or NaOH. To each centrifugal tube 0.1 gm of surfactant modified Erionite

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(E-SMZ), Cowlesite (C-SMZ) and Willhendersonite (W-SMZ) were added to 50ml Cr (VI) and As (V) solution at Cr (VI) and As (V) concentration 108.96 mg/L and 104.0 mg/L respectively. The highest Cr (VI) and As (V) sorption on E-SMZ, C-SMZ & W-SMZ were achieved at pH 7. Thus, all the solutions were adjusted to pH 7 in the subsequent sorption experiments. For Cr (VI) and As (V) sorption isotherm determination, different weights of E-SMZ, C-SMZ and W-SMZ were added to 50 ml metal oxoanions solution of initial concentration 108.96- 645.80 mg/L for Cr (VI) and 104.12-502.01mg/L for As (V) with 0.01N increment. To study the thermodynamic parameters 0.1gm of E-SMZ, C-SMZ and W-SMZ were added to 50ml of 0.01N Cr (VI) and As (V) solutions at pH 7. Sorption was carried out at temperature 288, 298 and 308K in a constant temperature water bath shaker. The amount of Cr (VI) and As (V) sorbed on to E-SMZ, C-SMZ and W-SMZ were calculated from the difference between the initial and equilibrium concentrations of Cr (VI) and As (V).

2.4. FTIR Analysis

FTIR analysis was carried out on a (NICOLET- 410) Fourier–transform infrared spectrometer. The spectra were recorded in the region 400-4000cm^{-1} with a spectral resolution of 2cm^{-1}, using a pressed KBr pellet technique.

2.5. Quality Assurance

In order to ascertain reliability, accuracy and reproducibility of the assembled data, the batch equilibrium tests carried out for Cr (VI) and As (V) sorption were replicated twice and experimental blanks were run in parallel. All the glass wares were pre soaked before use in 5% HNO_3 for about 24 h followed by washing with deionized water and drying in an oven. Sample blanks were analyzed for correction of background effect on instrument response.

1. Results & Discussion

3.1 XRD Analysis

X-ray diffractogram of synthetic gel has been recorded using Cu Kα radiation in a range $2\theta = 5^o$ to 70^o at a scanning speed of 1step/second. Powder X-ray diffraction pattern of hydrothermally synthesized material E-SMZ, C-SMZ and W-SMZ are represented in Fig 2a, Fig. 2b and Fig. 2c. In all cases medium was NaOH, the degree of crystallinity is very high as shown by the peak intensity for the major diffraction peak. These pattern shows maxima at $2\theta = 26.85^o$, 14.75^o & 25.94^o, therefore d spacing between the plane is found to be d = 0.20Å, 0.20 Å &0.10 Å. Powder X-ray diffraction analysis shows that NaOH medium for E-SMZ, C-SMZ & W-SMZ type material synthesis resulted in crystalline products.

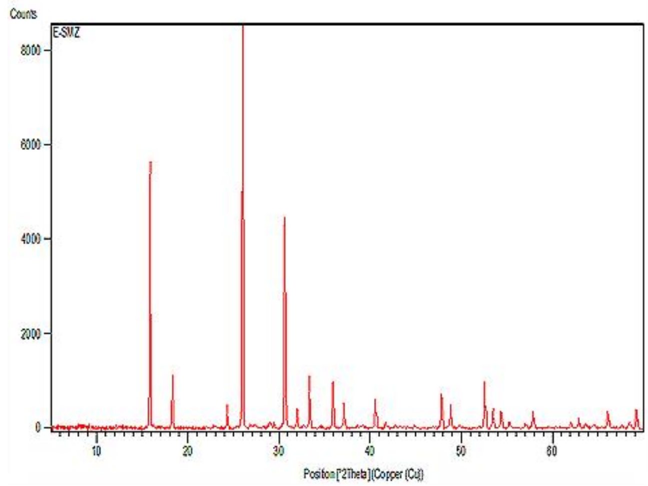

Fig. 2a - XRD diffractogram of hydrothermally synthesized E-SMZ

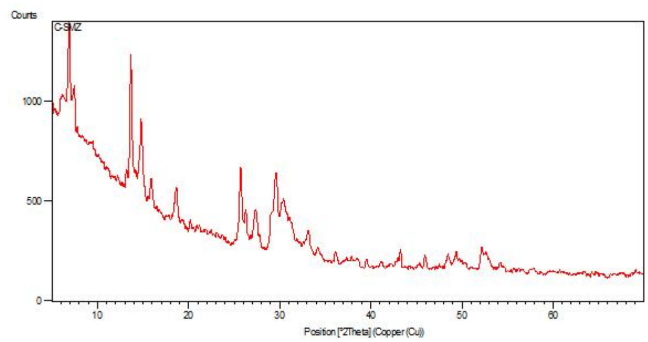

Fig. 2b - XRD diffractogram of hydrothermally synthesized C-SMZ

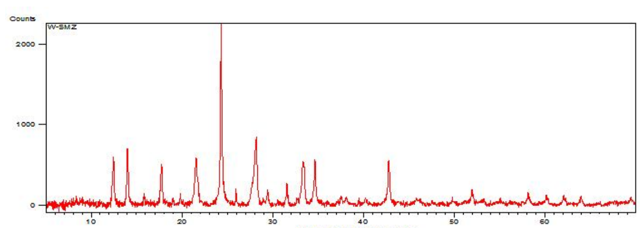

Fig. 2c - XRD diffractogram of hydrothermally synthesized W-SMZ

3.2. FTIR Spectroscopy

FTIR (NICOLET - 410 Spectrometer) spectra of E-SMZ, C-SMZ and W-SMZ are presented in Fig. 3. It is found in the range 950-1250 cm^{-1} & 420-500cm^{-1} strongest vibration at 950-1250 cm^{-1} is assigned to T-O stretching and the next strongest band at 420-500 cm^{-1} is assigned to T-O bending mode (T= Si or Al).

The Hydroxyl bond –OH stretch near 3550 cm^{-1} in Spectra indicates the bimodal absorbance. The water

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molecules attached to zeolite frame work shows strong characteristic structure sensitive bands due to water (H_2O) bending vibration at 1630 cm^{-1}. The peaks below 550 cm^{-1} indicates (O-T-O) bending of rotation mode. The peaks between 700-850cm^{-1} and 1000-1150 cm^{-1} are assigned to symmetric and anti-symmetric T-O-T stretching vibration. Two bands around 3000-3500 cm^{-1} & 2800-2900 cm^{-1} appeared in the E-SMZ, C-SMZ and W-SMZ indicate asymmetric & symmetric stretching vibration of $–CH_2$ of alkyl chain and band at about 1200 - 1600 cm^{-1} was assigned to vibration of trimethyl ammonium quaternary group CN $(CH_3)_3^+$.

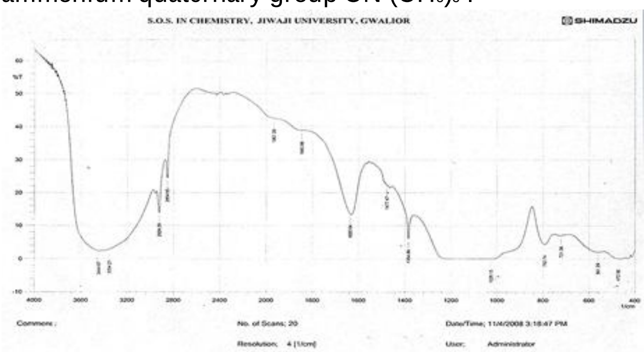
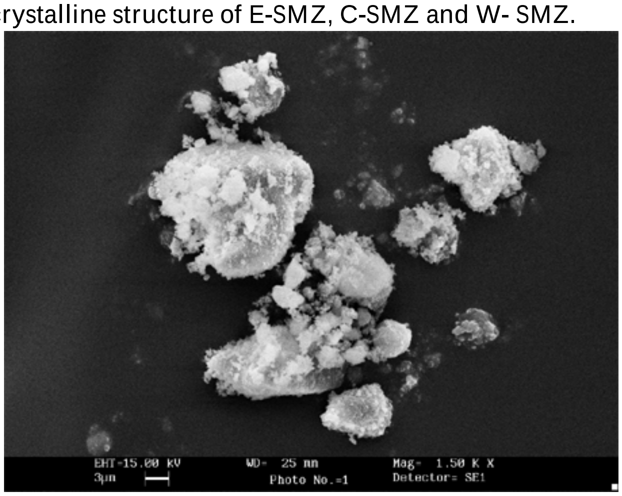
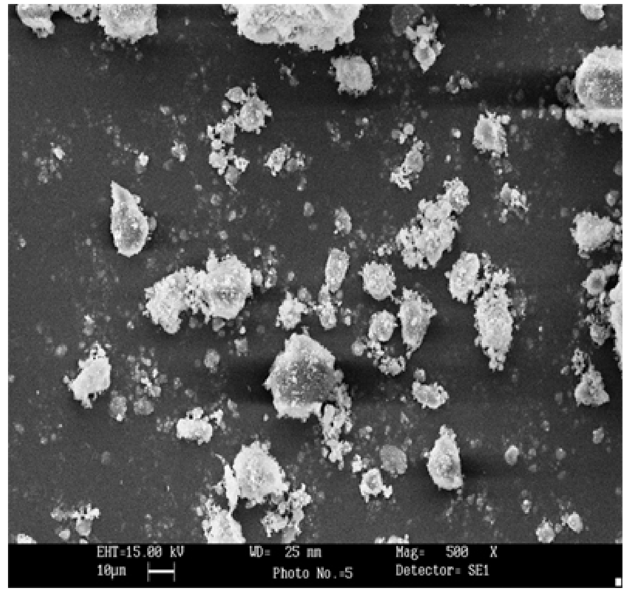


Fig. 3 - FTIR spectra of hydrothermaly synthesize E-SMZ

3.3. Scanning Electron Microscopy (SEM)

The SEM images Fig. 4 of synthetic modified Erionite, Cowlesite and Willhendersonite gel suggest the crystal size of the material to be in the range 1μm- 10μm show various morphology of the meso structured material depending on the crystallization conditions. Photomicrographs of the synthetic modified E-SMZ, C-SMZ & W-SMZ exhibited well defined narrow shape with excellent crystal edges. The aggregation of zeolites as HDTMAB is sorbed provides information about surfactant aggregation on the surface. These scanning electron microscopy images show the underlying crystalline structure of E-SMZ, C-SMZ and W- SMZ.





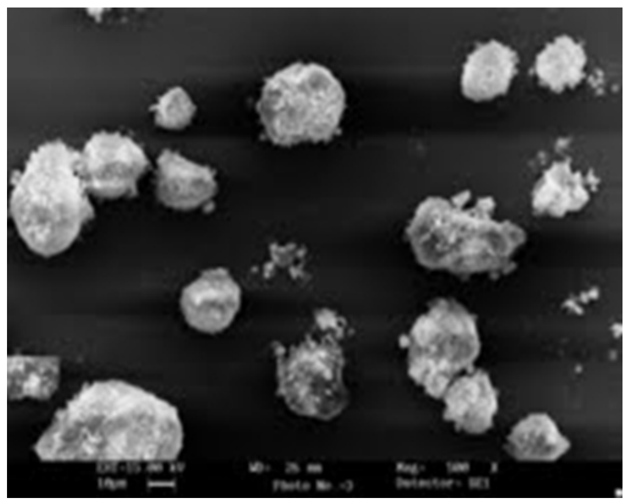


Fig.4 - SEM images showing high purity of Surfactant Modified E-SMZ, C-SMZ & W- SMZ.

3.4. Energy dispersive spectrometry (EDS)

The chemical composition of the synthesized modified material was checked for metal ions Na, Ca, Al, and Si using energy dispersive spectrometry. A revealing feature in the synthesis of zeolite is the strong correlation between Si/Al ratio of the resulting crystals, the nature of the cation used and medium of synthesis. The flexibility in the synthesis to produce desired composition of zeolite represent a critical step in the improvement of the material for many environmental process in which Si/Al ratio is the key for maximizing performance. The chemical composition of the prepared material is given in Fig. 5 for E-SMZ, C-SMZ and W-SMZ. It is observed that composition of the prepared material is quite close to modified zeolites E-SMZ, C-SMZ and W-SMZ.

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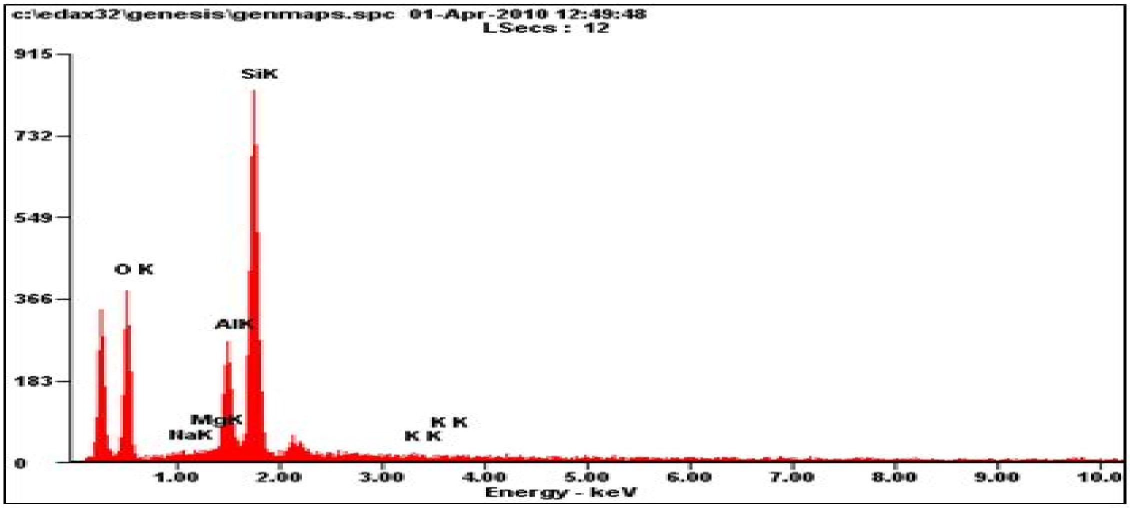

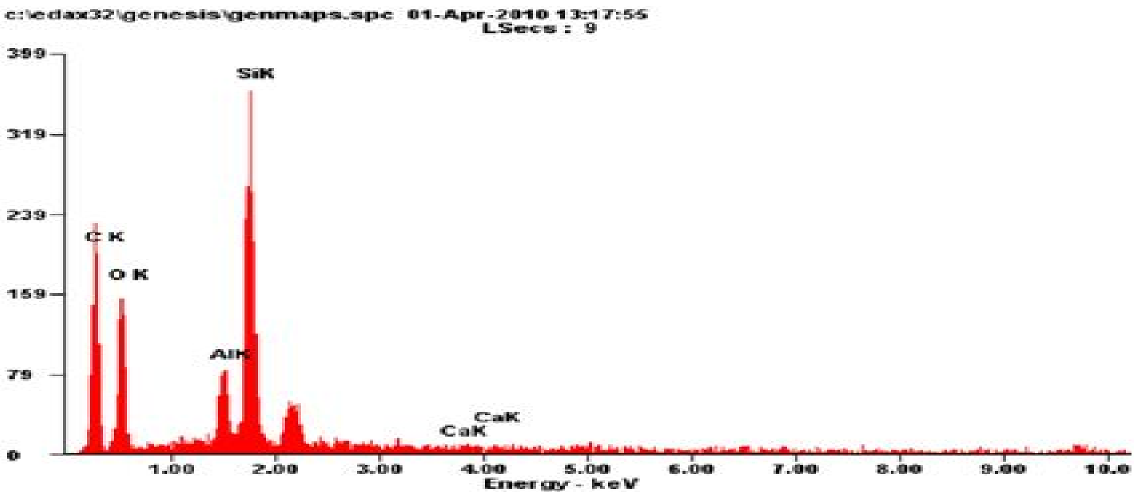

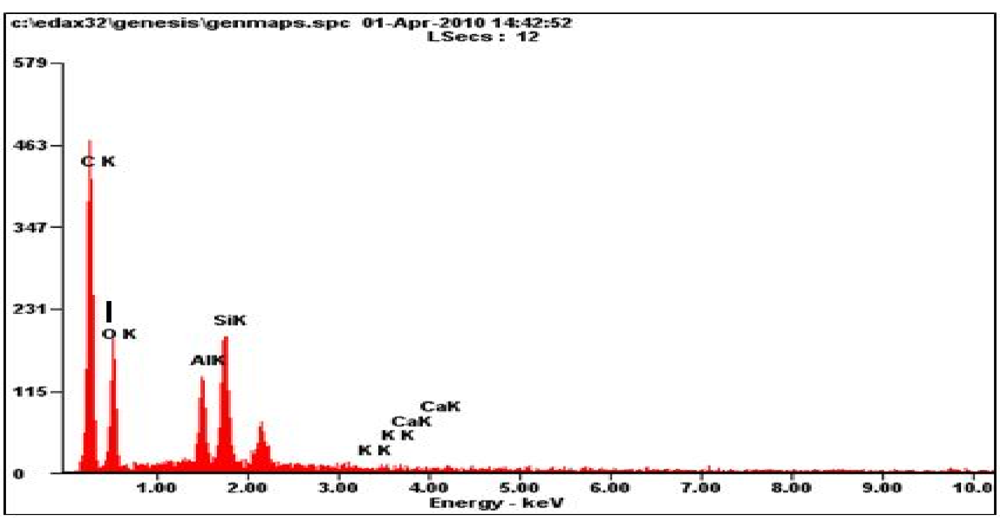

Fig.5 - EDAX spectra showing high purity of Surfactant Modified E-SMZ, C-SMZ & W- SMZ

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3.5. Thermodynamics of Sorption

The effect of temperature on the sorption of oxoanions on E-SMZ, C-SMZ & W-SMZ was also checked using the optimized conditions. The temperature was varied from 288 to 308K. The amounts of metal oxoanions sorbed at various temperature which reveals that the uptake of Cr (VI) and As (V) increase with increase in temperature, indicating better sorption at higher temperature. The enhancement amount of oxoanions sorbed at equilibrium with the rise in temperature may be either due to creation of some new active sites on the sorbent surface.

The amounts of oxoanions sorbed at equilibrium at different temperatures have been utilized to evaluate the thermodynamically parameters for the sorption system. The van't Hoff plot of lnkc V/s 1/T was a straight line Fig. 6(a) & Fig. 6(b).

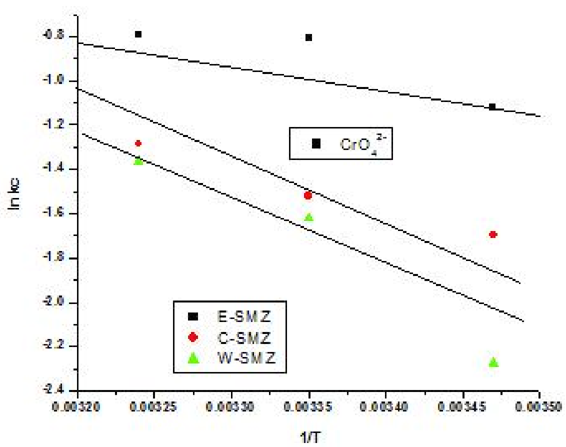


Fig. 6(a) - Vant's Hoff Plot of lnkc Vs 1/T for Cr (VI) sorption on Zeolites.

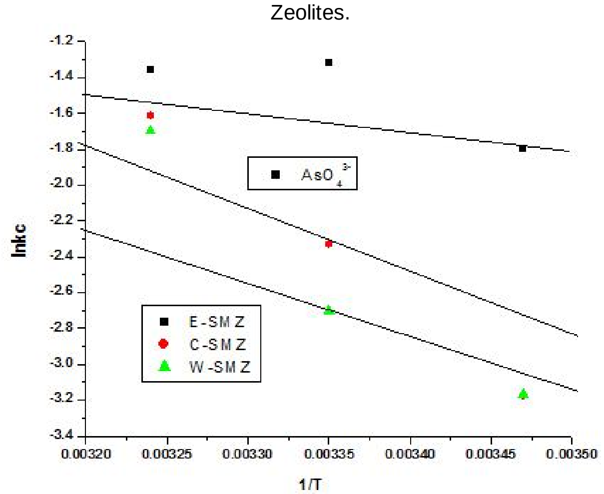


Fig. 6(b) - Vant's Hoff Plot of lnkc Vs 1/T for As (V) sorption on modified zeolites.

3.6. Sorption Isotherm

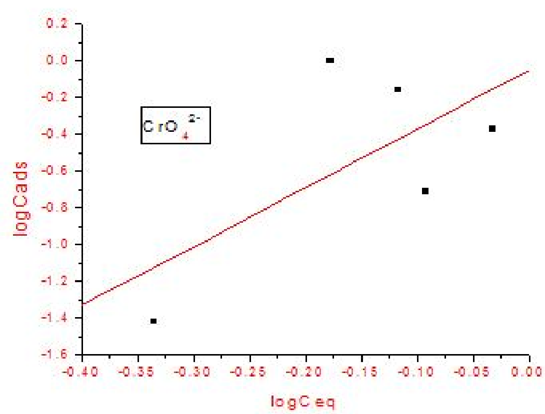
Analysis of the isotherm data is necessary in order to develop an equation that can accurately represent the results and could be used for design purposes. The data obtained from the sorption isotherm studies were fitted to the Freundlich Isotherms.

The Freundlich isotherm shown in above equation assumes that the uptake of metal ions occurs on a heterogeneous surface by multi-layer sorption and the amount of sorbate adsorbed increases with increasing concentration. The K and 1/n are the constants of the Freundlich isotherm that corresponds to the sorption capacity and intensity respectively. The parameter C_{eq} correspondence to the remaining concentration of the sorbate in the solution and C_{ads} is the amount sorbed at equilibrium.

The constants of the isotherm equations can be computed from the intercept and slope of the linearized plot of the experimental:

$$[C_{ads} = K\, C_{eq}^{\,1/n}] \qquad (1)$$

The isotherm constants were calculated from the slope and intercept, which is shown in Fig. 7(a) & Fig. 7(b). The values of correlation coefficient R^2 for CrO_4^{2-} & AsO_4^{3-} are higher in the Freundlich isotherm which indicates that the sorption process is well represented by the Freundlich equation.



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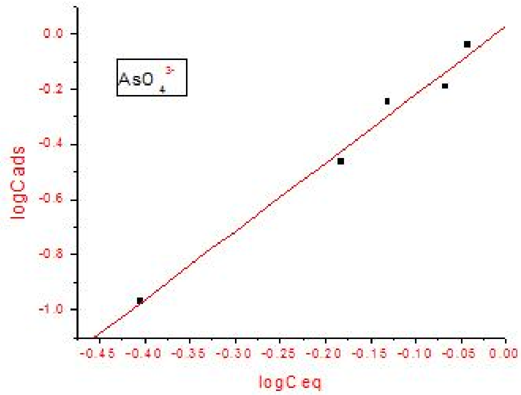

Fig .7(a) & (b) - Freundlich sorption isotherm of CrO_4^{2-} & AsO_4^{3-} on E-SMZ at 25 ^{0}C

3.7. Effect of pH on Cr (VI) And As (V) Sorption:

The results of experiments carried out in order to evaluate the efficiency of E- SMZ, C-SMZ & W-SMZ sorbent in removing As (V) over a range of pH 1-9. The sorbent removed arsenic effectively over the initial pH range 6–10. The predominant forms of arsenate in this pH range are $H_2AsO_4^-$ and $HAsO_4^{2-}$ [14]. The surface anion exchange between these two arsenate forms and counter ion bromide of surfactant-modified zeolites (SMZ) can be presented conceptually by Eq. (2) and (3) which were well verified and discussed by previous workers [21]. It is evident from the figure that both of these forms can be effectively sorbed by E-SMZ, C-SMZ & W-SMZ. Compared to the previous works related to As (V) sorption by surfactant-modified zeolites, where optimum pH range were reported to be 7.2–7.5 [21] and 7.4 [37], the sorption for As (V) by investigated surfactant-modified zeolites is of a wide optimum pH range, which should be of significant importance for practical operation. At initial pH <1, As (V) in solution exist in neutral form H_3AsO_4 [14], no ion exchange took place with bromide and observed As (V) sorption is only for physical sorption. Therefore, As (V) sorption efficiency is remarkably low at pH~1.

$$SMZ–Br + H_2AsO_4^- = SMZ–H_2AsO_4^- + Br– \quad (2)$$

$$2SMZ–Br + HAsO_4^{2-} = SMZ_2–HAsO_4 + 2Br– \quad (3)$$

The change of final pH as a function of initial pH range 1-9. The sorbent follow the same trend of pH change indicating homogeneous nature of the surfaces in respect of existing ions. In the pH range 6–10, the pH of solution shifted towards acidic region. This may be due to the fact that zeolite surface could still generate protonated $AlOH_2^+$ groups in solution even after modification with HDTMAB. The drop of final pH is due to OH^- consumption via deprotonation of surface $AlOH_2^+$ groups giving back terminal aluminol group, AlOH (Eq. (4)):

$$AlOH_2^+ \leftrightarrow AlOH + H^+ \quad (4)$$

In case of Cr (VI) ion maximum sorption occure at pH 7 chromium is present in the form of CrO_4^{2-} which is more stable form of Cr (VI). However, at lower pH dichromate ions are formed which has larger particle size as compared to chromate ions. The pore size of zeolite is suitable for the sorption of CrO_4^{2-} ions rather than the $Cr_2O_7^{2-}$ ions.

$$HCrO_4^- \leftrightarrow CrO_4^{2-} + H^+ \quad (5)$$

$$H_2CrO_4 \leftrightarrow HCrO_4^- + H^+ \quad (6)$$

$$Cr_2O_7 + H_2O \leftrightarrow HCrO_4^- \quad (7)$$

In case of basic solution when pH is greater than 7 the chromate ions are converted into $Cr(OH)_3$ species, it has less oxidizing ability. In the case of Cr, +6 oxidation states are more stable as compared to +3 oxidation state therefore chromium shows maximum sorption at pH 7.

$$CrO_4^- + 4H_2O + 3e^- \longrightarrow Cr(OH)_3 + 5OH^- \quad (8)$$

The sorption behavior of CrO_4^{-2} & AsO_4^{-3} on E-SMZ, C-SMZ and W-SMZ were checked at different pH of the solution viz. pH 1, 3, 5, 7, 9. Fig. 8 (a) & Fig. 8 (b) show the effect of pH on sorption of CrO_4^{-2} & AsO_4^{-3} on E-SMZ, C-SMZ and W-SMZ. The data shows maximum sorption at pH 7 for E–SMZ. The results show that the sorption percentage increases up to pH 7 with increase in pH of the solution and thereafter sorption percentage decreases.

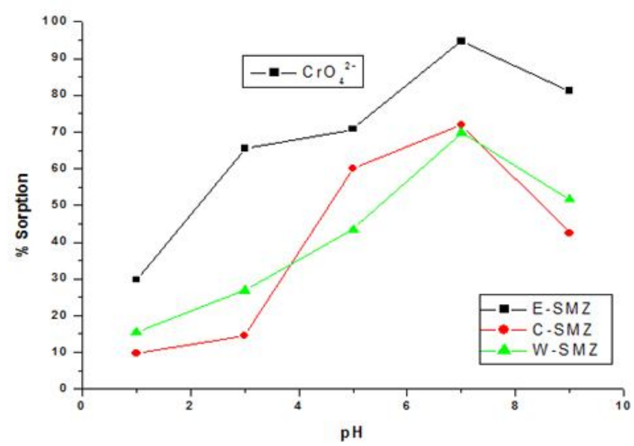

Fig. 8(a) - Sorption Cr (VI) on surfactant modified zeolites as a function of solution pH

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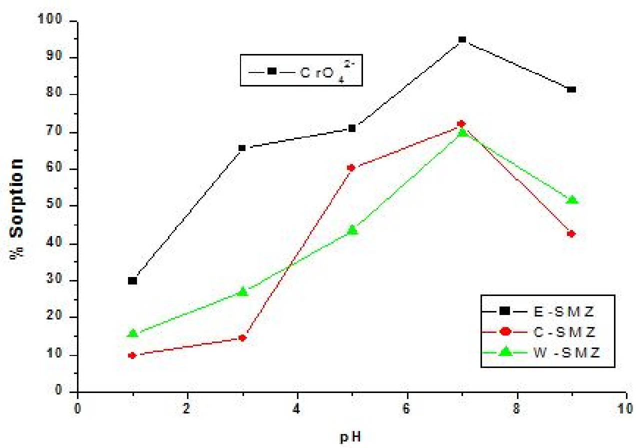

Fig. 8(b) - Sorption As (V) on surfactant modified zeolites as a function of solution pH

4. Conclusion:

Surfactant modified- Erionite, Cowlesite and Willhendersonite sorbs Cr (VI) and As (V) effectively in neutral solutions and sorption of Cr (VI) and As (V) is strongly pH dependent. Cr (VI) sorption capacity reached 21 kg, and As (V) sorption capacity reached 19g/kg the sorption process is well described by freundlich equation. The enthalpy change (ΔH) of the sorption is 0.1258 kj/mol and 0.9188 kj/mol indicating sorption of Cr (VI) and As (V) on to surfactant modified Erionite . FTIR analysis shows that HDTMA cations in the interlayer region caused polarization of adsorbed H_2O molecules. The uptake of negatively charged Cr (VI) and As (V) ions in the interlayer regions of surfactant modified – Erionite, Cowlesite and Willhendersonite are probably due to electrostatic force derived from the polarized water molecules and positively charged groups of the HDTMA cations.

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Analysis of a Population of Diabetic Patients Databases in Weka Tool

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Abstract - Data mining is an important tool in many areas of research and industry. Companies and organizations are increasingly interested in applying data mining tools to increase the value added by their data collections systems. Nowhere is this potential more important than in the healthcare industry. As medical records systems become more standardized and commonplace, data quantity increases with much of it going unanalyzed. Taking into account the prevalence of diabetes among men and women the study is aimed at finding out the characteristics that determine the presence of diabetes and to track the maximum number of men and women suffering from diabetes with 249 population using weka tool. In this paper the data classification is diabetic patients data set is developed by collecting data from hospital repository consists of 249 instances with 7 different attributes. The instances in the Dataset are pertaining to the two categories of blood tests, urine tests. WEKA tool is used to classify the data and the data is evaluated using 10-fold cross validation and the results are compared.

Keywords- Data Mining, Diabetics data, Classification algorithm, Association algorithm Weka tool

1. Introduction

THE main focus of this paper is the classification of different types of datasets that can be performed to determine if a person is diabetic. The solution for this problem will also include the cost of the different types of datasets. For this reason, the goal of this paper is classifier in order to correctly classify the datasets, so that a doctor can safely and cost-effectively select the best datasets for the diagnosis of the disease. The major motivation for this work is that diabetes affects a large number of the world population and it's a hard disease to diagnose. A diagnosis is a continuous process in which a doctor gathers information from a patient and other sources, like family and friends, and from physical datasets of the patient. The process of making a diagnosis begins with the identification of the patient's symptoms. The symptoms will be the basis of the hypothesis from which the doctor will start analyzing the patient.

This is our main concern, to optimize the task of correctly selecting the set of medical tests that a patient must perform to have the best, the less expensive and time consuming diagnosis possible. A solution like this one, will not only assist doctors in making decisions, and make all this process more agile, it will also reduce health care costs and waiting times for the patients. This paper will focus on the analysis of data from a data set called Diabetes data set.

2. Related Work

The few medical data mining applications as compared to other domains. [4] reported their experience in trying to automatically acquire medical knowledge from clinical databases. They did some experiments on three medical databases and the rules induced are used to compare against a set of pre-defined clinical rules. Past research in dealing with this problem can be described with the following approaches: (a) Discover all rules first and then allow the user to query and retrieve those he/she is interested in. The representative approach is that of templates [3]. This approach lets the user to specify what rules he/she is interested as templates. The system then uses the templates to retrieve the rules that match the templates from the set of discovered rules. (b) Use constraints to constrain the mining process to generate only relevant rules. [12] proposes an algorithm that can take item constraints specified by the user in the association rule mining process so that only those rules that satisfy the user specified item constraints are generated. This also does not work well because doctors often do not have any specific rules to mine. (c) Find unexpected rules. This approach first asks the user to specify his/her existing knowledge about the domain. The system finds those unexpected rules [5, 6, 13].

3. Data Mining In The Expert System

Data mining (sometimes called data or knowledge discovery) is the process of analyzing data from different perspectives and summarizing it into useful information - information that can be used to increase revenue, cuts costs, or both. Data mining software is one of a number of analytical tools for analyzing data. It allows users to analyze data from many different

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dimensions or angles, categorize it, and summarize the relationships identified. Technically, data mining is the process of finding correlations or patterns among dozens of fields in large relational databases. In our thesis, some data mining methods on social-demographic data of the users were applied. Correction and actuality of the data is very important for data mining for diabetes.

3.1 Data Mining by WEKA Engine

Weka is a collection of machine learning algorithms for data mining tasks. The algorithms can either be applied directly to a dataset or called from your own Java code. Weka contains tools for data pre-processing, classification, regression, clustering, association rules, and visualization. It is also well-suited for developing new machine learning schemes. Weka is developed by the University of Waikato. In our paper we used the Weka as data mining engine, and made a bridge between the Diabetes Expert System interface and Weka. No user needs to install Weka in his workstation, but it do already enough to be installed on server machine.

3.1.1 Classification

Classification is a data mining (machine learning) technique used to predict group membership for data instances. For example, you may wish to use classification to predict whether the weather on a particular day will be “sunny”, “rainy” or “cloudy”. Popular classification techniques include decision trees and neural networks.

Bayes Network Classifier

Bayes Network learning uses various searching algorithms and quality measures. This is the base module for a Bayes Network Classifier, and also provides data structures (network structure, conditional probability distributions, etc.) and facilities common to Bayes Network learning algorithms like K2 and B

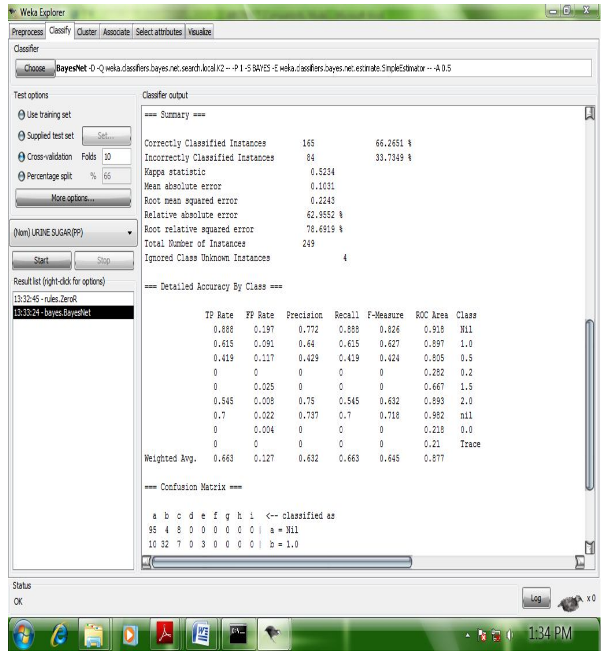

Figure1 BayesNet

J48 Pruned Tree

J48 is a module for generating a pruned or unpruned C4.5 decision tree. When we applied J48 onto refreshed data, we got the results shown as below on Figure2 .

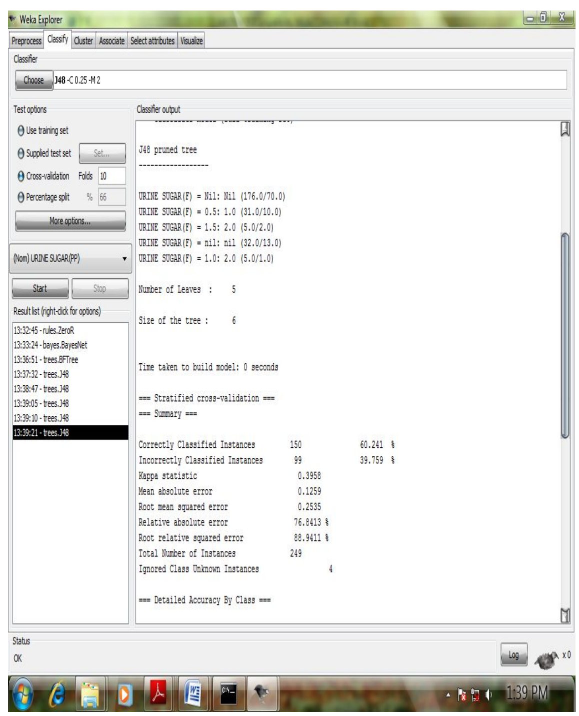

Figure2 J48 Tree

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REP Tree

Fast decision tree learner. Builds a decision/regression tree using information gain/variance and prunes it using reduced-error pruning (with back fitting). Only sorts values for numeric attributes once. Missing values are dealt with by splitting the corresponding instances into pieces (i.e. as in C4.5).

Figure3 REP tree

Random Tree

Class for constructing a tree that considers K randomly chosen attributes at each node. Performs no pruning. Also has an option to allow estimation of class probabilities based on a hold-out set (backfitting).

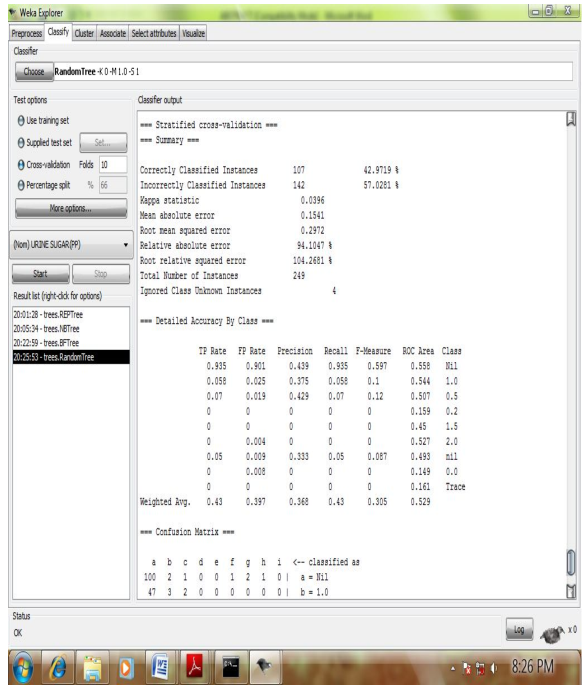

Figure4 Random Tree

3.1.2 Association Rules

One of the reasons behind maintaining any database is to enable the user to find interesting patterns and trends in the data. For example, in a supermarket, the user can figure out which items are being sold most frequently. But this is not the only type of `trend' which one can possibly think of. The goal of database mining is to automate this process of finding interesting patterns and trends. Once this information is available, we can perhaps get rid of the original database. The output of the data-mining process should be a "summary" of the database. This goal is difficult to achieve due to the vagueness associated with the term `interesting'. The solution is to define various types of trends and to look for only those trends in the database.

Apriori

Apriori is a module implementing an Apriori-type algorithm. Iteratively reduces the minimum support until it finds the required number of rules with the given minimum confidence. The algorithm has an option to mine class association rules. It is adapted as explained in the second reference. Apriori is a classic algorithm for learning association rules. Apriori is designed to operate on databases containing transactions (for example, collections of items bought by customers, or details of a website frequentation). Other algorithms are designed for finding association

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rules in data having no transactions. As is common in association rule mining, given a set of itemsets (for instance, sets of retail transactions, each listing individual items purchased), the algorithm attempts to find subsets which are common to at least a minimum number C (the cutoff, or confidence threshold) of the itemsets. Apriori uses a "bottom up" approach, where frequent subsets are extended one item at a time (a step known as candidate generation), and groups of candidates are tested against the data. The algorithm terminates when no further successful extensions are found (Agrawal et al. 1994).

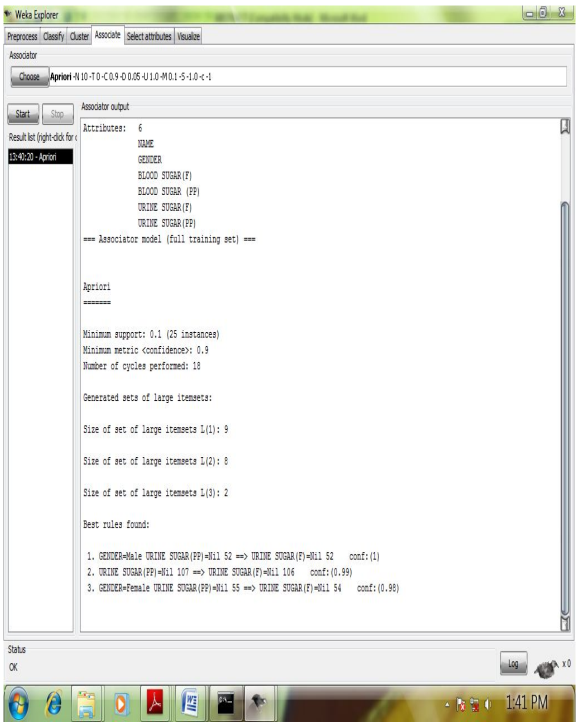

Figure5 Apriori

4. RESULTS & DISCUSSIONS

The main purpose of the system is to guide diabetic patients during the disease. Diabetic patients could benefit from the diabetes expert system by entering their daily glucoses rate and insulin dosages; producing a graph from insulin history; consulting their insulin dosage for next day. The diabetes expert system is not only for diabetic patient, but also for the people who suspect if they are diabetic. It's also tried to determine an estimation method to predict glucose rate in blood which indicates diabetes risk. In our Paper, the target class consists of 249 men and women who are actually affected with diabetes. However, it is unknown that in what stage the disease is. Hence this study will not only help in estimating the maximum number of people suffering from diabetes with specific characteristics but also helps in identifying the state of the disease.

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A Study and Application on Cross-Disciplinary Proficiency Learning of Artificial Intelligence

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Abstract—This paper broadly elaborated the concept, significance and main strategy of cross disciplinary proficiency learning as well as the basic structure of cross disciplinary proficiency learning system. By combining several basic ideas of main strategies, great effort are laid on introducing several cross disciplinary proficiency learning methods, such as Memorizing a type of learning, Reason–based learning, Learning from instruction, Learning by deduction, Learning by analogy and Inductive learning, Learning by Experts etc. Meanwhile, comparison and analysis are made upon their respective advantages and limitations. At the end of the article, it proposes the research objective of cross-disciplinary proficiency learning and points out its development trend. Cross-disciplinary proficiency learning is a fundamental way that enable the computer to have the intelligence ; Its application which had been used mainly the method of induction and the synthesis rather than the deduction has already reached many fields of Artificial Intelligence area.

Index Terms - Cross Disciplinary Proficiency(CDP) learning , AI , System structure , learning strategy , algorithm .

1 INTRODUCTION

Along with the latest development of modern Internet technology and multimedia technical, Artificial Intelligence (AI) research has emerged a number of new challenging issues.AI has captured increasing attention in many area and disciplines, which is an edge of line disciplines that is used to simulate the process of human thought. Scientists who are in many different professional backgrounds get some new thoughts process and new methodologies in the fields of AI . As a branch of computer science, these systems are showing a human intelligence and behavior characteristics. AI expert system for sub as a branch of AI has entered a stage of practical application in various departments on the national economy and government as well as many aspects of social life in sociology to play a role and continue moving in the direction of in-breadth and in-depth development.

2 THE CONCEPT AND SIGNIFICANCE OF CDP LEARNING

2.1 The Concept of CDP Learning

CDP learning (CDPL) is studying how the computer to simulate or to realize the study and behavior of human being of there thoughts. The intention is to obtain the new derived knowledge or the skill , organize the knowledge representation structure ,which can make drastic and progressive improvement of it's own potential and performance. It is the core part of AI; It is a elementary and fundamental way that enable the computer to have the intelligence ; The application of it is reach in many application areas of AI and is mainly emphasize uses the method of induction and the synthesis but not the deduction or other knowledge representation . The CDPL research establishes the computation model or the Comprehensive understanding model, according to the study mechanism of humanity through the sociology physiology, the cognitive science and philosophy develops each kind of study aspect and the study method, studies the general algorithm and carries on the theoretically analysis, and establishes study approach that has the specific application facing the duty.

2.2. The Significance of CDPL Learning Research

Whether CDPL ability can surpass the human's or not, the main argument that many human beings who are holding denial opinion is:

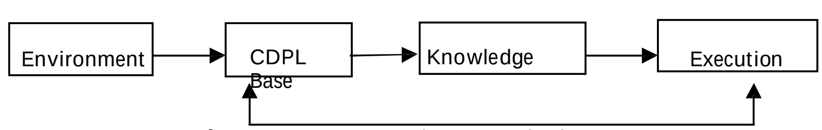

Figure 1. C D P Learning system basic structure

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The CDPL is man-made, its performance and the movement are completely stipulated by the architect or designer , therefore its ability cannot surpass designer in any case. This opinion is right for the CDPL which do not have study ability , but is worth considering for the learning capability CDP. Because the ability of this kind of CDP can be increased constantly in the application, after period of time, even the designer would not know the level of it's ability. The CDPL has the extremely important status in the AI research work. The intelligent machine system which does not have the learning capability is difficulty to be called a true one, but the former intelligent machine system generally lacks of the study ability . Its application has been throughout the various branches of AI area , such as gaming system ,expert or domain systems, automated reasoning system ,NLP, understanding Comprehension,PR, computer vision, intelligent electromechanical robots and other fields. Specific applications such as any search engines, medical diagnosis and medical search engines, detection of credit card fraud, stock market analysis applied in e-commerce, DNA sequencing sequences in bio-informatics, voice and handwriting detection and recognition , strategy games and the use of machinery robots .

3.THE BASIC STRUCTURE OF THE CDPL LEARNING SYSTEM

Fig. 1 is the basic model and structure of CDPL. The environment provides certain energy information's to the learning part of system, and the learning part revisions knowledge base or library by using these information. To enhance the unique performance of system implementation part. In the environment of complete application, the knowledge base and library and the execution part have decided the precise work content the learning part which needed to solve the task to be determined completely by the above three parts. We are going to narrate the impact of these three parts to design the CDP learning system separately as follows:

The most important factor which affects to CDP learning machine system design is the information which is provided to the system by the environment, specifically, or the information quality. Knowledge stored in guiding the development and implementation of part of the general principles of action. However, the overview and environment and to the CDP learning system is provided by a variety of information. If the information quality is higher and the difference of the general principle of equality is smaller, then the learning part is quite little easy to deal with. If CDP learning system to provide guidance and disorderly implementation of specific action specific information, the learning system deletes of the unnecessary details after gaining sufficient data(Deduction), sums up the promotion, to form the general principles of guiding the action, and puts it into the knowledge base. Then the task of learning some of is heavier, the design is more tedious ,difficult and complex .

Because the information obtained from the CDP learning system is often incomplete, reasoning is not entirely reliable which is carried out by reasoning . The rules summed up by reason is fact possibly, or not. This must be tested through the implementation of the effect. The fact(correct) rules make the system efficiency improve, it should be retained; The incorrect rules should be modified or be deducted or deleted from the knowledge database.

The knowledge base is the second factor which affects to the CDP learning system design. The knowledge expressed in different forms, for instance, characteristic vector, step comparing sentence, reproduction pattern rule, semantic network ,association and frame and so on. These expressions have their feature characters respectively, when you choose any one of these expressions, you must take into four or many aspects account: For example the four aspects for our work (1) Ability to express strong (2) Easy reasoning (3) It is easy to modify Knowledge Base (4) Knowledge Representation is easy to expand and interpret.

A problem finally needs to explain which regarding the knowledge base library is studies the system not to be able not to completely have in any knowledge situation the baseless knowledge base in acquisition, each CDP learning system all requests to have certain knowledge to understand the environment provides the information, the analysis comparison, makes the supposition, examines and revises these structured suppositions.

Therefore, to be precisely , the learning system is to the existing knowledge expansion and the dynamic improvement. The execution fourth part is core of the entire CDP learning system, because operative part of the action is targeted and aimed at improving learning action. With the development and implementation of some related three issues are: complexity©, feedback(F) and transparency(T).

4.SEVERAL COMMONLY LEARNING METHOD BASED ON LEARNING STRATEGY

The learning strategy is a reasoning strategy which is used in the process of CDP learning system. The learning system is always composed by the learning and the environment had two parts. Learning Strategies is on the basis of the division and classification criteria for converting an electronic message students to achieve the necessary degree of difficulty reasoning and how to classify and follow simple to complex messages , from small to many multi-order divided into the following five basic types:

4.1 Memorizing OR Rote Learning

The rote learning is the most simple machine learning method. The rote learning is the memory. That is, the new fact of knowledge is stored, the supply and demand wants when retrieves transfers, but does not need to compute and the inference.

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When the rote learning system operative to solve specific problems, the learning system remembers this query and the solutions. We can regard the learning system execution part as some function abstractly, before computing and outputting the function value (y1, y2,…, yp), this function obtains the independent variable input value (x1, x2,…, xn). The rote learning makes a simple memory storage in the memory ((x1, x2,…, xn),(y1, y2,…,yp)). When it needs f(x1, x2,…, xn), but the execution part on (y1, y2,…, yp) retrieves from the memory stored rather than recomptation. This kind of simple learning pattern is as follows:

(x1,x2,…x n) f (y1,y2,… yp) store ((x1,x2,…x n), (y1,y2,…yp))

4.2 Expert or Learner Explanation-Based Learning

The target goal concept, a specific example, the domain expert theory which provides according to the teacher and learner's operational guidelines. First, a struct explanation showed satisfies the target goal idea for the assorted this qualified example. Then, explained the promotion explains for target concept may operate the criterion the sufficient condition. EBL has been widely applied in the knowledge base refinement and the improvement of the learning system performance by explanation.

4.3 Learning from Instruction

The student (teachers or other information sources such as journals, articles, textbooks and so on) gains the information from the environment, transforms the knowledge into the expression form which the interior to exterior may use, and combines the new knowledge with the original knowledge non-mechanically and organically. Therefore, the student is required to have certain degree inference caliber and ability. However, now the environment still have to do a lot of work.

The teacher proposes and organizes knowledge base by some form, to increase the knowledge base which the student has continuously. This learning method is similar with human being society's university teaching way. The learning duty is to establish a learning system that enables it to accept the opinion , guidance and the suggestion, stores and implies the learning knowledge method effectively. Now, At present, many expert domain systems use this method to realize the knowledge base gain when they established the knowledge domain.

4.4 Learning by deduction

The deductive reasoning is used by the learner . The reasoning embarks from the lemma , axiom ,implications infers the conclusion after the logical transformation. This kind of reasoning is a process that is from "fealty or *allegiance*" transform to specialize (specialization) , the learner can obtain the useful knowledge in the reasoning process. This learning method contains macro-operation learning, the knowledge edition and the chunking technique . The inverse process of deductive reasoning is inductive reasoning.

4.5 Learning by Cognitive Process or Analogy

The module maintains analogy prodigy is one kind of useful and effective inference method, it can succinctly describe similarity clearly between the entities ; At the same time, it also (either departer, d) shifts certain test similar nature duty from the orator to the listener (or learner ,l).Through the analogy, using the similarity between two different domains of the knowledge, (including similar characteristic and other nature) infers the goal territory from the source territory knowledge the corresponding knowledge, we can learn from it. The analogy learning needs more case reasoning than the three kinds of learning ways above. It requests to retrieve the available knowledge generally from the knowledge source, then transforms it into the new form, apply it to the new condition . The analogy learning is playing the vital role in the human science ,engineering and technology history, many scientific discoveries are obtained by the analogy.

4.6 Inductive Learning

The inductive learning is the most widely as a symbol learning logics and methods. It expressed conceives the supposition from the example the process. The teacher or the environment provides some examples or the counter-example in some concept, lets the student obtain the general description in this concept through the inductive reasoning.

This kind of learning reasoning work load is more heavier than the demonstration learning and the deduct learning , because the environment does not provide the general concept description (for example axiom).To some extent, the number of induction learning reasoning is heavier than he analogy learning , because there is no one similar concept can be used as " source concept ". The inductive learning is the most basic method, its development is a mature learning method as well, it has been used to research and apply widely in the artificial intelligence, knowledge management domain.

5. CROSS-DISCIPLINARY PROFICIENCY LEARNING RESEARCH AIM

There are three aims in the Machine learning: General learning algorithm theoretical analysis and development; Develops the humanity to learning the process the computation model; The structure special-purpose learning system face the duty research.

5.1 General Learning Algorithm

This direction research is the theoretical analysis duty and the development uses in the non-usable learning duty the algorithm. There is no limit to the algorithm type. The algorithm not necessarily is similar the method which uses in the humanity. Some person thought studies the knowledge structure which produces to be supposed to be similar humanity's knowledge structure at least, even if the learning process is different.

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At present, some scientists are researching the possible learning algorithm the theory space.

5.2 Cognitive Model

This direction is a studying human's learning computation theory and an experimental model for prediction. Not only had this kind of research vital significance of humanity education, but also of developing the machine learning system in diversity model.

5.3 The Goal of the Project

This direction is aimed at solving the special actual problem, and developing to accomplish these tasks the project system. Not only do these questions often concern on the learning but also on other questions, for example, input signal by reasonable explanation or development question special-purpose data conversion and transformation .

6. Conclusion

AI science is the only way that raises the CDP learning intelligence level . Only improve the CDP-learning function and model continuously, can we make the CDP machine close to or surpasses the humanity's intelligent leve(interface). To the CDPL discussion and the CDPL research progress, will certainly make the artificial intelligence and the entire science and technology further development in current era.

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A Navel Approach for Evaluating Completeness of Business Rules using First Order Logic

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Abstract - Organizations are under increasing scrutiny to develop the rules to regulate their business requirements and it is important to standardize the business rules to automate the complex process into simple logic. So several process modeling languages and rule modeling languages are evolved to modulate the organizational policies and procedures. Business rules are the constraints which influence the behaviors and also specify the derivation of conditions that affect the execution flow. These rules are form of conditional operations attached to the process to give data result. These systems implement business rules that are restructured when organizations change the data to the varying business needs. When these rules are changed, it must be efficient to provide a decision based on the given constraints or based on business requirements. The correct decision logic are verified by evaluating or validating the completeness of the business rule. More often the rules can associate with another rule to derive business logic, but these rules are not complete enough to determine the computability of business logic. So it is necessary to check whether the rule is complete, this can be proved when the rules are interpreted with first order logic. This paper provides standard approach to evaluate the completeness of business rules by formulating the rules using first order logic. Applying these strategies introduces a structured approach and management aspects within rules by focusing on rule sources which are important for the process goal and providing a meaningful rule structure. It points out the necessity and also the real possibilities to establish new facilities for manipulation of business rules into the software development process. This can give rise increase in the performance of the legacy system.

Index Terms - Completeness, Rule Execution, Business process, Business rules, Business Rules Approaches, First Order Logic, Business rules, First Order logic, Completeness algorithm.

1. INTRODUCTION

Many efforts are already made to promote and integrate business rules modeling and management tools into business processes automation. Being ready for execution as a part of business process management applications business rules and the business rules approach still seem to lack a common methodological ground and support. Especially the fact that, before business rules can be modeled and managed they first need to be captured and extracted from different sources is often left to analyst's intuition. Well- known possible sources to look at to identify business rules are, among others: process documentation, source code or implicit sources like internal problem-solving knowledge of the employees involved in this process. But since not many enterprises capture their business rules in a structured, explicit form like documents or implicit software codes, they need to be identified first, before being captured and managed. Here the question about how to identify the potential sources of business rules emerges. Though some of them may seem obvious, like legal restrictions, standards or mandatory best practices, some are implicitly included within the elements involved in the process. On the other hand, many enterprises capture their business processes in business process models, providing a structured view for further analysis and management. Business is performed according to rules. They make an important and integral part of each information system (IS) by expressing business logic, constraints on concepts, their interpretation and relationships. Therefore is relevant to pay special attention to business rules in development of information systems. Defined rules of structure and behavior are captured in the models of structures, states, processes and other IS models. In general, models can be expressed using graphic symbols, text and formulas. Modeling constructs are grouped into a variety of diagram types by various aspects, for example, process, static structure, states. These rules are need to check for

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consistency and completeness. In order to facilitate the completeness of the rules we are using First Order Logic.

2. LITERATURE SURVEY

Business Process Management (BPM) is an established discipline for building, maintaining, and evolving large enterprise systems on the basis of business process models. A business process model is a flow-oriented representation of a set of work practices aimed at achieving a goal, such as processing a customer request or complaint, satisfying a regulatory requirement, etc. The Business Process Modeling Notation (BPMN) is gaining adoption as a standard notation for capturing business processes. The main purpose of business process models generally, and BPMN models in particular, is to facilitate communication between domain analysts and to support decision-making based on techniques such as cost analysis, scenario analysis, and simulation Chun Ouyang [1] proposed an acyclic BPMN model, or an acyclic fragment of a BPMN model, falls under the class if it satisfies a number of semantic conditions such as absence of deadlock. He applied Petri net analysis techniques to statically check these semantic conditions on the source BPMN model. According to Michael zur Muehlen [2], Business Processes are sets of activities that create value for a customer. While research in Business Process Management initially focused on the documentation and organizational governance of processes, organizations are increasingly automating processes using workflow systems, and are building elaborate management systems around their processes. Such management infrastructures integrate modeling, automation, and business intelligence applications. The inclusion of compliance management activities is a logical next step in governing the business process life cycle. Josef Schiefer [3] says that Business Process Management (BPM) systems are software solutions that support the management of the life cycle of a business process. For the execution of business processes, many organizations are increasingly using process engines supporting standard-based process models (such as WSBPEL) to improve the efficiency of their processes and keep the testing independent from specific middleware. A major challenge of current BPM solutions is to continuously monitor ongoing activities in a business environment and to respond to business events with minimal latency. One of the most promising concepts that approaches the problems of closed-loop decision making and the lack of gaining real-time business knowledge is the concept of Complex Event Processing (CEP), The system automatically discovers and analyzes business situations or exceptions and can create reactive and proactive responses, such as generating early warnings, preventing damage, loss or excessive cost, exploiting time-critical business opportunities, or adapting business systems with minimal latency. Claire Costello [4] says A business process as a complete set of end-to-end activities that together create value for the customer. Business process management is the ability to orchestrate and control the execution of a business process across heterogeneous systems and allow users to view the components of an infrastructure from a process view rather than set of applications and databases. Anca Andreescu [5] says every organization operates according to a set o business rules. These may be external rules, coming from legal regulations that must be observed by all organizations acting in a certain field, or internal rules which define the organization's business politics and aim to ensure competitive advantages in the market. Starting from the previous observations, it is obvious the important role that business rules play within the development process of a software system. Milan Milanović1 [6] proposed that BPM languages have limited support for representing logical expressions, business vocabularies, and business rules, which severely limits their flexibility and expressivity. To address these challenges, he integrated business rule modeling constructs of the REWERSE Rule Markup Language (R2ML) with the Business Process Modeling Notation (BPMN), resulting in a *rBPMN* proposal. Olegas Vasilecas [7] says Business rules make an important

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and integral part of each information system (IS) by expressing business logic, constraints of concepts, and their interpretation and relationships. Therefore it is relevant to pay special attention to business rules in development of information systems. Rules related to domain structure and behavior are presented in data, states, processes and other IS models. Taking into account that rules are expressed in several models, there is a risk that overall specification is inconsistent. Unambiguous models are crucial for the successful implementation of IS models transformation and finally code generation tasks. Therefore it is necessary to check consistency among related rules models. The problem of models inconsistency can be solved by using of formal or partially formal models with constraints. However formal models are often too complex to be used in practice. Semi-formal models are widely used, but constraints used in such a models often are suitable only for one model and relationships among models are not defined. He suggests extending of IS approach based on semi-formal models and constraints, by adding the consistency rules for IS models. Anis Charfi [8] applied the divide and conquer principle to web service composition by explicitly separating business rules from the process specification. The combination of the business rules approach with the process-oriented composition solves a twofold problem. First, he provided a solution to the problem of dynamic adaptation of the composition. In fact, current standards for process-based web service composition are not capable to deal with the flexibility requirements of composite web services. Second, business rules are important assets of a business organization that embody valuable domain knowledge. So, it is no longer acceptable to bury them in the rest of the composition. Bruno de Moura Araujo [9] proposed Business rules (BR) are declarations which constrain, derive and give conditions for existence, representing the knowledge of the business. BRs are not descriptions of a process or processing. Rather, they define the conditions under which a process is carried out or the new conditions that will exist after a process has been completed. BR can be represented using Semantics of Business Vocabulary and Rules (SBVR). SBVR is appropriate to be used by business experts, since it allows the representation of business vocabulary and rules using controlled natural language. Business vocabulary concepts can be automatically transformed into conceptual models, like the UML class model. Nicholas Zsifkov [10] says Enterprise business rules are usually defined as constraints or as metadata about business operations: on the business side, business rules are special policies that define constraints/metadata about the business operation; on the information system (implementation) side, business rules are constraints about the data, about data manipulation and about system processes. Antonio Oliveira Filho [11] proposed a new traceability technique that defines dependency links with the same semantics that can be observed in the relationships among business rules. The goal of the technique is to provide rates of recall and precision of 100% for changes in software requirements that correspond to business rules. Jose F. Mejia Bernal [12] says decomposing the initial business process structure in a set of rules is a procedure based on pattern identification. This approach consists of two phases: mapping of business process to rules, and reliable adaptation of the business process according to the context data. The first phase is executed to provide a representation of the initial business process definition in terms of rules. The second phase is applied to provide a reliable workflow process modification.

Timon C. Du and Hsing-Ling Chen propose an active collaboration and negotiation framework (ACNF), which is a negotiation support system that uses active documents with embedded business logics or business rules that can adapt to different collaborative strategies in a business-to-business (B2B) environment [13]. Sam Weber and Isabelle Rouvellou describe a fully functional prototype middleware system which provides the users to control software components without the need of programming knowledge. Thus the core applications need not be altered for anticipated changes from external factors. In this system, application behavior modification is fast and easy, making this middleware suitable for

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frequently changing programs [14]. H. M. Sneed[15], in the context of reverse engineering source code into UML diagrams many tools and approaches have been developed.CPP2XMI is a reverse engineering tool which lows extracting UML class, sequence and activity diagrams in XMI format from C++ source code. Sangseung Kang[16], Business rules are business statements that define some aspect of a business. They describe, constrain and control the structure, operations and strategy of the business. In his paper, he analyzes business rules and business rule systems, and present requirements and considerations for the business rule expression and system. Olga Levina[17], suggests an extraction process for business rules identification from business process models. Applying this process introduces a structured approach and management aspects within rules discovery by focusing on rule sources that are important for the process goal and providing a rule structure. Mohammed Alawairdhi[18], suggests a business-logic-based framework for evolving software systems is proposed. The goal of the framework is evolving software in a higher abstract layer. Olegas Vasilecas[19], suggests The rules are expressed in several models, there is a risk that overall specification is inconsistent. Unambiguous models are crucial for the successful implementation of IS models transformation and finally code generation tasks. Therefore it is necessary to check consistency among related rules models. The problem of models inconsistency can be solved by using of formal or partially formal models with constraints. According to Anis Charfi[20], the Business Rules Group , a business rule is a statement that defines or constrains some aspect of the business. It is intended to assert business structure or to control the behavior of the business. Business rules are usually expressed either as constraints or in the form if conditions then action. The conditions are also called rule premises. The business rule approach encompasses a collection of terms (definitions), facts (connection between terms) and rules (computation, constraints and conditional logic). Terms and Facts are statements that contain sensible business relevant observations, whereas rules are statements used to discover new information or guide decision making. Jose F. Mejia Bernal[21], proposed a way for representing Dynamic Business Process in terms of Rules based on patterns identification. With this approach it is easy to apply on a business process instance both user-based personalization rules and automatic rules inferred by an underlying context-aware system. Gulnoza Ziyaeva proposed framework to enable the content-based intelligent routing path construction and message routing in ESB which defines the routing tables and mechanisms of message routings and facilitate the service selection based on message content [22].

3. Rules for Car license

	Rule	Syntax	JESS Syntax	Jrule	First Order Logic
1	Car must not be rented to	if(Customer.ValidLicenceNumber == "FALSE")	(def rule no car rented without lenience no) (if(=(Customer.ValidLicenceNumber ? true)	(def rule no car rented without lenience no) when (Customer.ValidLicence	$\exists\ y[customer\ \ id(y)] \wedge z[licence\ \ no(z)] \nrightarrow f(false(f) \rightarrow application$

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	customers without a valid license number.	{ application. Status = "Reject"; Customer.Eligibile = false; }	=>(add(application.status)(/?reject) (add(customer.eligible)(/?false)	Number =? true) => then (application.status)(?reject) (customer.eligible)(?false)	*status(reject(y,z)).*
2	Car must not be rented to customers of Age less than 18.	if(Customer.age < 18) { application.Status = "Reject"; Customer.Eligibile = false; }	(def rule no car rented to customer of age less than 18) (if(=<(customer.age ? 18)(age?age) =>(add(application.status)(/?reject) (add(customer.eligible)(/?false)	(def rule no car rented to customer of age less than 18) when (customer.age ? =< 18)(?age) => then (application.status)(?reject) => (customer.eligible)(/?false)	∃ *y[customer.age(y)]* ≤ 18 → *application status[valid(y)]* ⋀ *c [customer eligible(c,y)]*
3	Car must not be rented to customers with bad history level 3	if(Customer.BadHistoryLevel == 3) { application.Status = "Reject"; Customer.Eligibile = false; }	(def rule no car to customer of bad history level 3) (if(=(Custome.badhistorylevel ? 3) =>(add(application.status)(/?reject) (add(customer.eligible)(/?false)	(def rule no car to customer of bad history level 3) when (Custome.badhistorylevel= ? 3) => then (application.status)(?reject) (customer.eligible)(?false)	∃ *y[customer.bad historylevel(y)]* ≤ 3 → *application status[reject(y)]* ⋀ *c [customer eligible(false (c,y)]*
4	Rent for small cars is 80 aud per day	if (Customer.Eligible == true) { if(Car.type == Small) { ent.RentPerDay = 80;	(def rule rent for small car is 80/day) (if(=(Customer.Eligible ? true) { if(=(cartype?small) { =>add(rent.perday)(/?	(def rule rent for small car is 80/day) when (Customer.Eligible=? true) { if(cartype=?small) { then	∋*y[customer.eligible=true(y*)⋀*c(car type = small(c)]* → *r[(rent per day(80,y,c)]*

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		}	price 80)) }	=> (rent.perday)(?price 80)) }	
5	Rent for awd cars is 100 aud per day.	if(Car.type == AWD) { rent.RentPerDay = 100; }	(def rule rent for awd cars 100/day) (if(=(car.type?AWD) { =>add(rent.perday)(/?price 100) }	(def rule rent for awd cars 100/day) when (car.type=?AWD) { => then (rent.perday)(?price 100) }	*∃y[car.type=true(y,AWD(c))] → r[(rent per day(100,y,c)]*
6	Rent for luxury cars is 150 aud per day	if(Car.type == Luxury) { rent.RentPerDay = 150; }	(def rule rent for luxury cars 150/day) (if(=(car.type?luxury) { =>add(rent.perday)(/?price 150) }	(def rule rent for luxury cars 150/day) when (car.type=?luxury) { => then (rent.perday)(?price 150) }	*∃y[car.type=true(y,luxury car(c))] → r[(rent per day(150,y,c)]*
7	Rent payable is calculated as the product of rentperday and rentalperiod in days.	{ rent.RentPayable = rent.RentPerDay * rent.No of rent days; if (CustomerBadHistoryLevel > 0) }	(def rule rent calculated as the product of rentperday and rentalperiod in days) (rent.rentpayable)(=(*(?rentperday?rentalperiod))) (if(>(Custome.badhistorylevel ? 0) =>(add(rent.rentpayable)(price?price)	(def rule rent calculated as the product of rentperday and rentalperiod in days) when (rent.rentpayable)*(?rentperday=?rentalperiod))) (if(>(Custome.badhistorylevel ? 0) => then (rent.rentpayable)(price?price)	*∃ y[rent.payable]=rent.per day(z)]*no of rent per day(a)] → c(customer .bad history level>0) → (z,a,c)*
8	Penalty of 20 % of rent must be applied for customers with bad history level 2.	if(Customer.BadHistoryLevel == 2 { rent.PenaltyFee = rent.RentPayable * 0.2; }	(def rule Penalty of 20 % of rent for customers with bad history level 2) (if(=?Customer.BadHistoryLevel?2) { => add(rent.penaltyfee)(=(*(?rent.rentpayable?0.	(def rule Penalty of 20 % of rent for customers with bad history level 2) when (?Customer.BadHistoryLevel=?2) { => then (rent.penaltyfee)*(?rent.rentpayable?0.2)))	*∃ y[customer.badhistorylevel(y)]=p[Penality.fee(p)] →r[(rent.payable(r)*0.2)]*

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			2)))		
9	Penalty of 10 % of rent must be applied for customers with bad history level 1.	if(Customer.BadHistoryLevel == 1) { rent.PenaltyFee = rent.RentPayable * 0.1; } }	(def rule Penalty of 10 % of rent for customers with bad history level 1) (if(=?Customer.BadHistoryLevel?1) { => add(rent.penaltyfee)(=(*(?rent.rentpayable?0.1)))	(def rule Penalty of 10 % of rent for customers with bad history level 1) (if?Customer.BadHistoryLevel=?1) { => then (rent.penaltyfee)*(=(?rent.rentpayable?0.1))	∋ *y[customer.badhistorylevel(y)]=p[Penality.fee(p)] →r[(rent.payable(r)*0.1)]*

4. COMPLETENESS

The problem is to prove the business rules are complete and also to show the rules are semantically valid. When the correspondence between the syntax and semantics tighter , we would say the logic is complete. Generally the business logic consists of four major tuples such as Rules, Functions, Parameters and dependency relation which are related as

$$\begin{aligned}\exists r[rules(r)] &\rightarrow \exists\forall f[functions(f)]\\ &\leftrightarrow \exists\forall p[parameter(p)\\ &\leftrightarrow \exists\forall r[relation(r)]\end{aligned}$$

Therefore any semantically valid argument can be captured by formal proof. The choice of rules are to be made for its completeness. It can be easily done when the system is in static phase. When it is done in runtime the conditional variable and iterative variable are also changes. When these variables are modified it brings out bugs in the logic. So these variables must be declared with certain range. The extra complications come about because of these restrictions, needed to guarantee soundness of the rules , on the status of the variables. An algorithm has been proposed by considering the above standards.

L={R,F,P,D}

Let 'L' be the Business Logic, which consists of 4-tuples such as R – Set of Rules, F- Set of Functions, P- Set of Parameters
D- Set of dependency relation

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Completeness Theorem

L={R,F,P,D}
Let 'L' be the Business Logic, which consists of 4-tuples such as
R – Set of Rules
F- Set of Functions
P- Set of Parameters
D- Set of dependency relation

Theorem: *The Business Logic 'L' is complete iff the associated Rules, Functions, Parameters and the dependency relations are complete.*

Proof:
Parameters are complete

Input Parameters <I_1,I_2,I_3> are bound with discrete values then return Boolean value (True)

$$B(p) = \begin{cases} 0\ if\ l\ is\ false : l \to not\ valid \\ 1\ if\ l\ is\ valid : l \to valid \end{cases}$$

Get all the parameters including the temporary variables and add it into the parameter list.
Let T be the temporary variable.
T is valid only if f(x),f(y),f(z) is in bound
$F(t)=\{ f(x),f(y),f(z) \} \in P$
$F(t)=\int_0^n [f(x), f(y)] \in t \to P(z)$
Since $f(t) \in P$
Let $(x,y) \in P\ o\ f$
$X \in P\ o\ f <=> [f(x), f(y)] \in P\ o\ f$
$[f(x),f(y)) \wedge [f(z,y)] \in P$ *for some y,z;*
$f(x) \in f \wedge (f(x),y) \in P$ *for some y*
$x \in f \wedge f(x) \in P$
$x \in f(x) \in P$
Hence every temporary variable which has parameter is associated with function.
Create FSM for the parameter list by following the sequential relation from the logic source to terminating point.
If the parameter and the function gives the logic at the runtime the iterative and conditional value are get changed.
Let conditional variable be $i=\{i_1,i_2,i_3,......i_n\}$
Let the iterative variable be j and $k=\{j_1,j_2,j_3...j_n\ k_1,k_2,k_3.....k_n\}$

$$F(i)=\begin{cases} 0\ if\ i\ is\ out\ of\ bound \\ 1\ if\ i\ value\ is\ in\ bound\ \ \forall \in P,f,l \end{cases}$$

When i value is between 0 to n

Then add => i value to function {f(x),f(y),f(z)}
Modify the Logic and store in FSM
and if it does not tend to give logic make
$i \rightarrow \{\emptyset\}$
else repeat.

Each state of the simulated FSM stores the parameters and its current value
Find all the parameters are
$P(x_1), p(x_2)........p_K \leftarrow q_1, q_2,....q_n, t\ \ t, r_1, r_2,..., r_m \leftarrow s_1, s_2, s_3............s_n$

$P1, p2....pk, r1, r2,...rm \leftarrow q_1, q_2,...q_1,\ s_1, s_2, s_3,...s_n$
Theorem: Set of rules is contradictory if and only if another rule can be derived from it.
[proves completeness]
Proof :

Consider the conclusion is not empty.
The value of F, $q_1,q_2,q_3....q_l,\ s_1,s_2,s_3...s_n$ *all have value T and* $p_1,p_2,p_k,\ q_1,q_2,......q_{l)}\ r_1,r_2,...,r_m$ all have value F. If t has value f then t, $r_1,r_2,...,r_m \leftarrow s_1,s_2,s_3............s_n$ has value f.

(The value of F, $q_1,q_2,q_3....q_l,\ s_1,s_2,s_3...s_n$ *all have value T)*

$F(q)=\{q_1,q_2,q_3....q_l\}, \{s_1,s_2,s_3...s_n\} \in T$
$(p_1,p_2,p_k,\ q_1,q_2,......q_{l)}\ r_1,r_2,...,r_m$ all have value F.)
$\{p_1,p_2,p_k,\ q_1,q_2,......q_{l)}\} \ t \in f$
(If t has value f then t, $r_1,r_2,...,r_m \leftarrow s_1,s_2,s_3............s_n$ has value f.)
If $T \rightarrow f(x)$
Then

$r_1,r_2,...,r_m \leftarrow s_1,s_2,s_3............s_n \leftarrow f$
else

If conclusion is empty then k=l=m=n=0.
Output Parameters <O_1,O_2> are bound with discrete values then return Boolean value (True)

$$B(p) = \begin{cases} 0\ if\ O\ is\ false : l \to not\ valid \\ 1\ if\ O\ is\ valid\ \ \forall \in x,y,z \end{cases}$$

It proves the Completeness logic.

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Algorithm for speed up

```
begin procedure
Define business rule→ Jrule
def rule →string
get the rule
rule← string defining business policy
pass array str[]→ function
input[]→ str [] (rule)
do
//read the rule from rule base
a←input.next()
while(adding→rule)
get the set of conditional rules
        for each rule in the memory()
// locating memory size
        set . memory size→size of memory
//add facts *(rule) to memory
If(old_size=null)
then
        update rule→memory
if(rule.active=true)
search new facts (rules)
        if(conditional rule==positive)
then
        add→new rule
else
no action()
end if
// for deleting rule from memory
        if( size of memory==null)
        set rule active→false
else if
        if (rule active==true)
        validate the rule
end if
end if
end for
end procedure
```

Fig-1. Performance of speed up algorithm

Defines the time taken to response for each rule change request/ second.This graph shows the responsiveness of the rule editor based on the given request. The proposed work responsiveness for the developer's request / sec is less when compared to the previous work.

6. CONCLUSION

This paper provides platform for the business rules to be complete with the help of well defined language. It not only provides completeness for the business rules, but also they could generate definitions of executable rules, processes, and services for the developers. Previous attempts mainly provide rules on the level of concrete syntax without precise language definitions. This system will allow users to model and manage comprehensive rule sets which generate responses in the form of new events. A key focus of this future research work will be the visualization of events which have been processed with sense and respond rules.

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Implementation of RSA Cryptosystem Using Verilog

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Abstract-The RSA system is widely employed and achieves good performance and high security. In this paper, we use Verilog to implement a 16-bit RSA block cipher system. The whole implementation includes three parts: key generation, encryption and decryption process. The key generation stage aims to generate a pair of public key and private key, and then the private key will be distributed to receiver according to certain key distribution schemes. Data security is achieved after the 64-bit input data are block encrypted by RSA public key. The cipher text can be decrypted at receiver side by RSA secret key. These are simulated in NC LAUNCH and hardware is synthesized using RTL Compiler of CADENCE. Netlist generated from RTL Compiler will be used to generate IC.

Index Terms - Cadence, Cryptosystem, Decryption, Encryption, Implementation, Key Generation, Modular Exponentiation, Modular Multiplication, RSA, Verilog.

1 INTRODUCTION

THE first public key scheme was developed in 1977 by Ron Rivest, Adi Shamir, and Len Adleman at MIT. Now Rivest-Shamir-Adleman (RSA) is the most widely accepted and implemented public key cryptosystem. The public key system is based on using different keys, one key for encryption and a different but related key for decryption. The whole process involves computing the remainder after exponential and modular operation of large number. Encryption and decryption have the following form, for some plaintext block M and cipher text block C:

C = M e mod n.
M = C d mod n.

Generally, it includes a third party to generate a pair of public key and to distribute keys to transmitter and receiver. Transmitter and receiver should both know the value of n. The transmitter has the knowledge of public key e, and only the receiver knows the private key d. Thus, a public key of (e, n) and secret key (d, n) generated by third party is distributed to transmitter and receiver separately. For this algorithm to be satisfactory for public-key encryption, the following requirements must be met:

1. It is possible to find values of e, d, n that M^d*e mod n = M1 for all M < n.
2. It is relatively easy to calculate M^e mod n and Cd for all values of M < n.
3. It is infeasible to determine d given e and n.

Steps involved in Implementation of RSA:

The following step is taken to implement the RSA public key scheme:

1. Choose two large prime numbers, p and q. Let n=p*q, Let Φ(n) = (p-1)*(q-1).
2. Randomly choose a value e (1< e < Φ(n)), which is relative prime to Φ(n) that gcd (e, Φ(n)).
3. Calculate d≡e-1 mod Φ(n), send public key (e, n) to transmitter and secret key (d, n) to receiver.
4. Transmitter encrypt the original message, C = M e mod n, then send cipher text to receiver.
5. Receiver decrypt cipher text by
M = C d mod n and retrieve the original message.

The rest of the paper is organized as follows: Section 2 gives an overview of RSA Implementation. Section 3 gives the simulation results. Section 4 gives the conclusion. The final section gives the references used.

2 RSA Implementation

The RSA algorithm was inverted by Rivest, Shamir, and Adleman in 1977 and published in 1978. It is one of the simplest and most widely used public-key cryptosystems. Fig.1 summarizes the RSA algorithm.

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Key Generation

Select p, q	p, q both prime, $p \neq q$
Calculate $n = p \times q$	
Calculate $\phi(n) = (p-1) \times (q-1)$	
Select integer e	$gcd(\phi(n), e) = 1; 1 < e < \phi(n)$
Calculate d	
Public key	$KU = \{e, n\}$
Private key	$KR = \{d, n\}$

Encryption

Plaintext:	$M < n$
Ciphertext:	$C = M^e \pmod n$

Decryption

Ciphertext:	C
Plaintext:	$M = C^d \pmod n$

Fig.1 The RSA algorithm

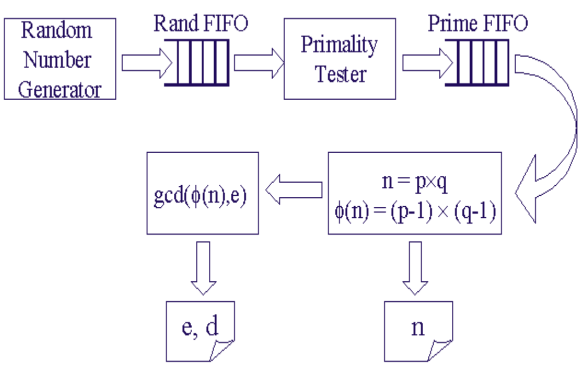

Fig.2 The system architecture for RSA key generation

The system architecture for key generation is shown in Fig.2. A random number generator generates 16-bit pseudo random numbers and stores them in the rand FIFO. Once the FIFO is full, the random number generator stops working until a random number is pulled out by the primality tester. The primality tester takes a random number as input and tests if it is a prime. Confirmed primes are put in the prime FIFO. Similarly to the random number generator, primality tester starts new test only when prime FIFO is not full. A lot of power is saved by using the two FIFOs because computation is performed only when needed. When new key pair is required, the down stream component pulls out two primes from the prime FIFO, and calculates n and $\varphi(n)$. N is stored in a register. $\varphi(n)$ is sent to the Greatest Common Divider (GCD), where public exponent e is selected such that $gcd(\varphi(n), e) = 1$, and private exponent d is obtained by inverting e modulo $\varphi(n)$. E and d are also stored in registers.

Once n, d, and e are generated, RSA encryption/decryption is simply a modular exponentiation operation. Fig.3 shows the RSA encryption/decryption structure in hardware implementation.

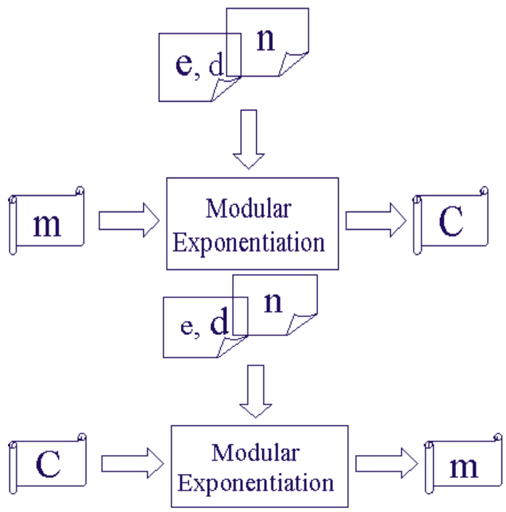

Fig.3 The RSA encryption/decryption structure

The core of the RSA implementation is how efficient the modular arithmetic operations are, which include modular addition, modular subtraction, modular multiplication and modular exponentiation. The RSA also involves some regular arithmetic operations, such as regular addition, subtraction and multiplication used to calculate n and $\varphi(n)$, and regular division used in GCD operation

2.1 Random Number Generator

Linear Feedback Shift Register (LFSR) is used to generate random numbers. In theory, an n-bit linear feedback shift register can generate a (2n - 1)-bit long random sequence before repeating. However, an LFSR with a maximal period must satisfy the following property: the polynomial formed from a tap sequence plus the constant 1 must be a primitive polynomial modulo 2. We are unable to find the primitive polynomial for a 16-bit LFSR, so we implemented a 16-bit LFSR and used its least significant 16 bits to generate 16-bit random numbers. Fig.4 shows the structure of the 16-bit LFSR.

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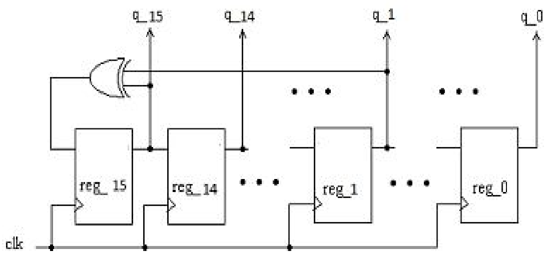

Fig.4 Structure of the 16-bit LFSR

2.2 GCD

After we get φ(n), we need to find a small number e with gcd(φ(n),e) = 1, which indicates that e is relative prime to φ(n).

Extended Euclidean algorithm was implemented to find gcd(φ(n),e), if the gcd is 1, e and its multiplicative inverse d are returned. The following pseudo code shows Euclidean algorithm and extended Euclidean algorithm.

```
Euclid(a,b)
A<=a; B<=b;
loop if B=0
  Return A=gcd(a,b);
end if
R=AmodB;
A<=B;
B<=R;
goto loop;
```

```
Extended Euclid (m,b)
(A1, A2, A3) <= (1, 0, m); (B1, B2, B3) <= (0, 1, b);
loop: if B3 = 0
  return A3 = gcd(m,b);
end if
if B3 = 1
  return B3 = gcd(m,b);B2 = b-1 mod m;
end if
Q <=⌊A3/B3⌋;
(T1, T2, T3) <= (A1 - Q*B1, A2 - Q*B2, A3 - Q*B3);
(A1, A2, A3) <= (B1, B2, B3); (B1, B2, B3) <= (T1, T2, T3);
goto loop;
```

2.3 Encryption and Decryption

Modular Multiplication: We constructed modular multiplication using shift-add multiplication algorithm. Let A and B are two k-bit positive integers, respectively. Let Ai and Bi are the ith bit of A and B, respectively. The algorithm is stated as follows:

```
Modular Multiplication:
Input: A, B, n
Output: M = A*B mod n

P <= A;
M <= 0;
for i = 0 to k-1
  if Bi = 1
     M <= (M + P) mod n;
  end if
  P <= 2*P mod n;
end for
return M;
```

For a 16-bit modular multiplier, inputs A and B are both 16 bits. However, B might be a small number with a lot of leading 0s. In the implementation, before getting into the shift-add iterations, we search for the position of the first leading 1 in B, and set (k-1) to be this position. By doing this, we avoid unnecessary shift and modular operations, making the multiplication faster when B is small. We used Omura's method to correct the partial product M and temporary value P when any of them becomes greater than 216. The corrected M and P may still greater than n, so before returning M, we will do final correction on M to make sure M is less than n.

Modular Exponentiation: The modular exponentiation operation is simply an exponentiation operation where modular multiplication is intensively performed. We implemented the 16-bit modular exponentiation components using LR binary method, where LR stands for the left-to-right scanning direction of the exponent.
The following pseudo code describes the LR binary algorithm.

Modular Exponentiation:
Input: A, B, n
Output: $E = A^B \bmod n$

$E <= 1;$
for $i = k\text{-}1$ *to* 0
if $B_i = 1$
$E <= A*E \bmod n;$
end if
if $i \neq 0$
$E <= E*E \bmod n;$
end if

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end for
return E;

Similar to modular multiplication, we search for the position of the first leading 1 in exponent B and set (k - 1) to be the position. This avoids unnecessary modular squaring operations. For small exponent such as the public exponent e, the modular exponentiation is much faster than big exponent such as the private exponent d.

3 Simulation results

The Random number generator, Primality tester, GCD, Encryption and decryption are written in Verilog Code and simulated in NC Launch and synthesized in RTL Compiler and Results are mentioned below. Sections below gives the respective simulation results.

3.1 Random number generator

The 16-bit random number generator implemented in Cadence using the 16-bit LFSR is shown in Fig.5.

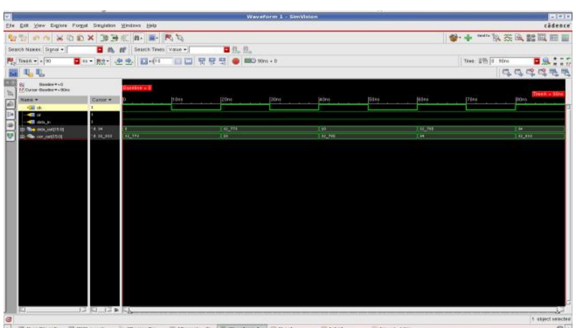

Fig.5 Simulated Waveform for Random number generator in nclaunch

Fig.5 shows the waveform of the random odd number generator which has generated few odd numbers that is 1091, 5455 and 20863.

After using the path of setup.g and slow_normal.lib and elaborating, the RTL view is generated for random number generator.

3.2 Primality tester

The 16-bit Primality tester implemented in Cadence is shown in Fig.6.

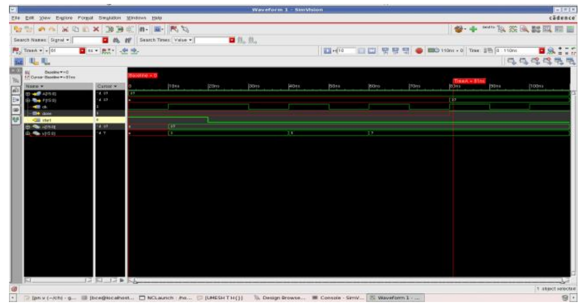

Fig.6 Simulated Waveform for Primality tester in nclaunch

Fig.6 shows the waveform for primality tester in which 37 is given as input and it checks whether the number is prime or not, and resulted in giving 37 as prime number.

After using the path of setup.g and slow_normal.lib and elaborating, the RTL view is generated for Primality tester.

3.3 GCD

The 16-bit GCD (extended Euclidean algorithm) implemented in Cadence is shown in Fig.7.

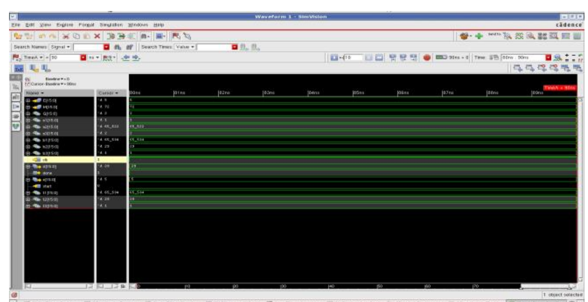

Fig.7 Simulated Waveform for GCD in nclaunch

Fig.7 shows the waveform for extended Euclidean algorithm in which two inputs are given A3=72 and B3=5, the resulted output is the public key e=5 and the private key d=29.

After using the path of setup.g and slow_normal.lib and elaborating, the RTL view is generated for GCD.

3.4 Encryption and Decryption

The 16-bit Modular Multiplication implemented in Xilinx ISE design suit is shown in Fig.8.

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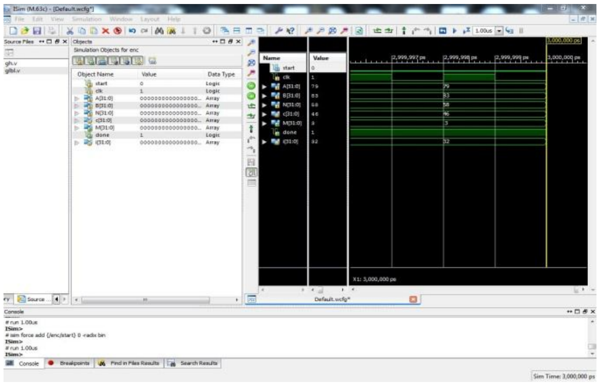

Fig.8 Simulated Waveform for Modular multiplication in Xilinx

Fig.8 shows the waveform for modular multiplication module in which the input value is A=79, B=83 and N=58, the resulted output is M=3.

The 16-bit Encryption module implemented in Cadence is shown in Fig.9,10.

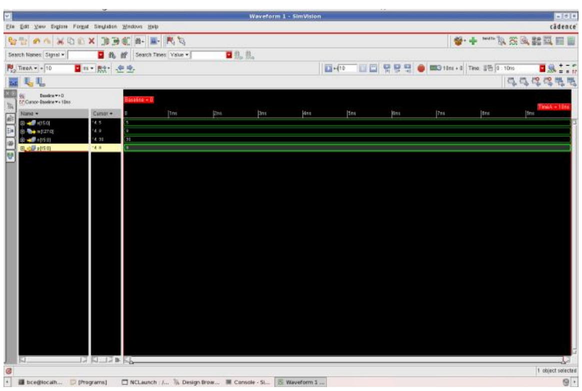

Fig.9 Simulated Waveform for encryption in nclaunch

Fig.9 shows the waveform for encryption module in which the input value is e=5, n=91 and plain text p=8, the resulted output is the encrypted cipher text m=8.

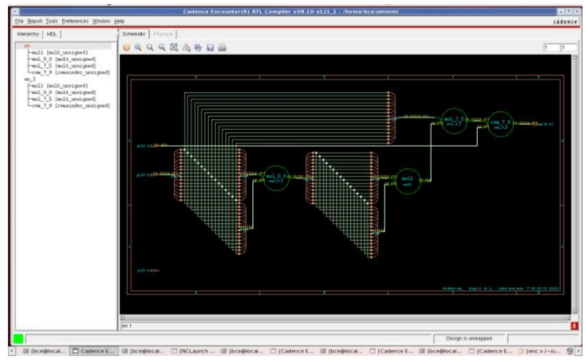

Fig.10 RTL view of encryption

After using the path of setup.g and slow_normal.lib and elaborating, the RTL view generated for Encryption is shown in Fig.10.

The 16-bit decryption module implemented in Cadence is shown in Fig.11,12.

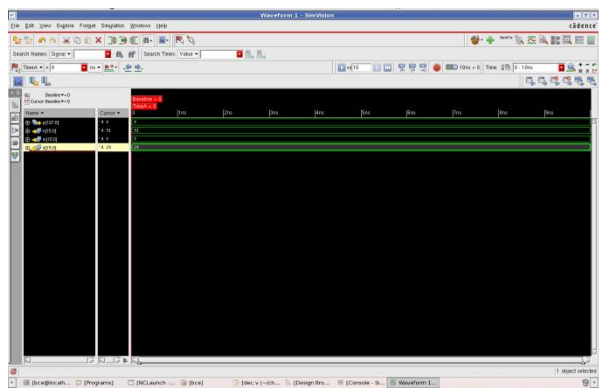

Fig.11 Simulated Waveform for decryption in nclaunch

Fig.11 shows the waveform for decryption module in which the input value is d=29, n=91 and cipher text p=8, the resulted output is the encrypted plain text m=8.

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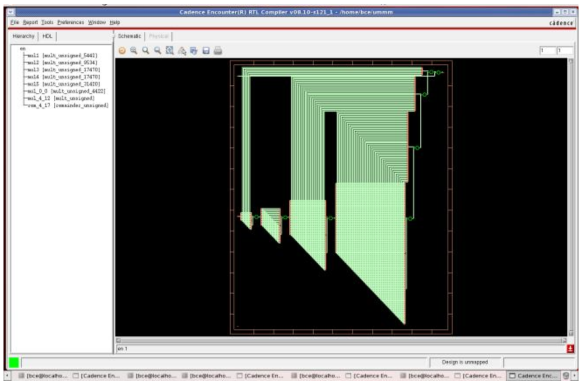

Fig.12 RTL view of decryption

After using the path of setup.g and slow_normal.lib and elaborating, the RTL view generated for decryption is shown in Fig.12

3.5 Top Module (RSA)

The 16-bit Entire RSA Module implemented in Xilinx ISE design suit is shown in Fig.13.

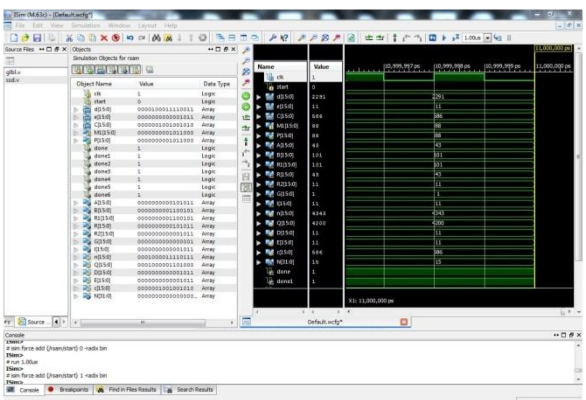

Fig.13 Simulated Waveform for Top module (RSA) in Xilinx

Fig.13 shows the waveform of the Top module of entire RSA. Here the random prime number generated are 101 and 43 which are P and Q ie P=101 and Q=43. After getting P and Q, n and $\Phi(n)$ are calculated ie n=4340 and $\Phi(n)$=4200. And public key e is selected by random prime number as e=11. GCD checks whether e and $\Phi(n)$ are relatively prime or not by getting the GCD as 1, and using Extended Euclidean algorithm d is calculated as d=2291. Now the plain text M=88 is given, and by using e and n, after encryption we get the cipher text C=586. Now by using d, n and the cipher text, after decryption we got back the plain text P=88.

4 Conclusion

In this, we implemented a 16-bit RSA circuit in Verilog. It is a full-featured RSA circuit including key generation, data encryption and data decryption. In our Verilog implementation of RSA, we have implemented GCD algorithm using Euclidean algorithm, random number generator using LFSR and Encryption and Decryption using Modular multiplication and modular exponentiation algorithms (L-R binary algorithms). Each sub-component and top module of RSA was simulated in Cadence/Xilinx and proved functionally correct. Netlist were generated which will be used to generate IC. The total area required for encryption and decryption is 6060nm.

We can gain more security than the other strategy because we use the random numbers. And our implementation can easily extend to large bits such as 256 or 1024 or even longer. Future work has to be carried out on Cadence and xilinx to implement in FPGA and to generate IC.

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Metrics for Component Based Measurement Tools

P. Edith Linda, V. Manju Bashini, S. Gomathi

Abstract— The main aim of this paper is to integrate the different object oriented metric tools and make them available as a single add-on. The first part of this paper analyzed five different tools and they are migrated into one to make use of those tools in efficient manner.

Index Terms— Metrics, component, de-compiler, SLOC, LOC, NOS, NOP, Cyclomatic complexity

1 Introduction

THE emerging Object oriented programming is most widely used by the programmers to develop the software. The object oriented programs are used in the IT world which is used for secured transactions and mainly convenient. Even though they are widely used, the complex and confusing structure may arise if the program is not properly measured and not properly structured. To overcome this problem many proposed varieties of metric tools to measure the criteria of Object oriented programming are used. Again the problem arises that some metric tools measure the particular criteria of the object oriented programs. In order to overcome the individuality of those tools, they should be migrated.

Component based measurement tool is the concept of migrating many tools available widely. The main aim is to search some important tools and making them as a single add-on to provide the user friendly environment.
Each individual tool will measure some parameter to measure the java program. But a single tool will **not** measure all the parameters.

Thus there exist a need of collection of tools to measure the java programs which will satisfy all the parameters to be measured.

2 Metrics

Software metrics are used to measure the software quality to check whether it satisfies the requirements. Metrics are defined as "Quantifiable measures that could be used to measure characteristics of a software system or the software development process." Software metrics are essential to plan, predict, monitor, control, evaluate, products and processes. The main goal of the software metrics is to reduce costs, Improve quality, Control/Monitor schedule, small testing effort, many reusable fragments, to better understand the quality of the product and the program.

3 Metrics Categorization

Metrics can be categorized into three Kinds, measures and size.

Two ***kinds*** of software metrics they are Product metrics: quantify characteristics of the product being developed to measure the size, reliability and Process metrics: quantify characteristics of the process being used to develop the software to measure the efficiency of fault detection.

Types of ***Measures*** are Direct Measures (internal attributes): to measure the Cost, effort, LOC, speed, memory and Indirect Measures (external attributes): to measure the Functionality, quality, complexity, efficiency, reliability, maintainability.

Size-oriented metrics are *LOC* - Lines Of Code, *KLOC* - 1000 Lines Of Code, L*OC* – Statement Lines of Code (ignore whitespace).

4 Component

Components are the collections of many pre programmed tools which is used as the add-on page which is to make use of those tools. There are various tools available to measure the Java source code. Those tools are developed

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and modeled based on the developer's point of view. Some tools will measure some parameters to be measured in java program. Initially the tools which are used to measure the java object oriented programs are searched and analyzed individually to make it as a component. The component based tools will be executed separately but available in a same location and some tools will provide a chart for the results when the program is executed.

5 Evolution of Components

In 1990's, software systems for e-business transactions were built of components across multiple platforms, programming language and network protocols. No tools were available for detecting "bugs" or to measure the efficiencies in the programs (object oriented programs). Initially the errors are printed using the output statement and the number of lines [1] , number of packages and most important concepts of object oriented programs with the critical programs

Those programs which are used to measure the OOPS programs seem to be critical and they are implemented with the large number of coding. In 1997, Intermetrics, a software engineering company , proposed to develop a debugging tool for Component- based software systems. It only identifies the errors and yields the error free program.

But finding the error won't give the remedy. Thus the problem to find the efficiency of the program is solved with the help of the component based tools which efficiently provides the charts for the results and measures the program.

The main advantage of component based tool is that the_user can select their own tool to measure their program according to their needs. In this, the user can also see the links from where the tools are available, that is the user can also download or know more about the tool from the direct link.

The collection of more tools which will provide more flexibility and choice to the user or the programmer and he can know more about tools. Those tools will display an error if the program is not correct.

Some tools will also provide the charts and warning message if the program is not structured and programmed in a proper format based on the measurement criteria.

6 Component Integration

All the tools won't meet the user required criteria. Some may be useful for generating report and some may be used just for measuring the program. Some tool may measure the oldest method of measuring the program with some limited parameters which are not in current use and which may be efficient to measure. All the listed tools will measure the common parameter like SLOC (Source Line Of Coding) and LOC (Lines Of Coding). The need depends on the programmer or the user who uses the component metrics. Integrating the various tools have many advantages and also some disadvantages. Those are listed.

Advantages on integrating components

1. Flexible
2. User friendly
3. Compatibility
4. Comparability

Disadvantages on integrating components

1. Confusion may arise about which tool to be used
2. Some may not meet the user requirement
3. Some tools are only trial versions
4. All the tools which are listed may have some common criteria which is not useful.

7 Related Works

The paper by Amandeep Kaur et. al. [7] to formulate a framework of metrics representing the attributes of object oriented system. And the suggestion is that the impact of OO design on software quality characteristics made an experimental validation and a rework in defect programs. Encapsulation, inheritance, polymorphism, reusability, Data hiding and message-passing are the major attribute of an Object Oriented system and are the indicators of the object oriented programs. The well known quantifiable approach to express any attribute is a metrics. Empirical Data is collected from three different projects based on object oriented paradigms to calculate the metrics.

Lakshmi Narasimhan and Bayu Hendradjaya[8] defined a two suites which cover the static and dynamic aspects of the component assembly. The triangular metric which is used to classify the type and nature of the application, is formed with the complexity and criticality metrics. During the runtime of the complete application the dyamic metrics are collected. This paper is mainly deals with the collection of some metrics and evaluated the results.

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Shyam R. Chidamber and Chris F. Kemerer [11] stated that the metrics is must and needed for a new organization which is adopting a new technology for whom the proper practice is needed to evaluate the program size and other paradigms. To practice and to evaluate the programmer need to implement the a new metric suite for Object Oriented programs for OO design. The empirical validation of a theoretical metrics of OO design and the development is the main idea of the paper.

Dr. Linda H. Rosenberg [12] stated the development of object oriented programs is very much needed in today's life cycle. A different approach of design and implementation, and also a different approach to software metrics is required by Object oriented development. Object oriented technology uses the objects as its fundamental blocks and not algorithms. The object oriented programs needs a special metrics to evaluate. Cyclomatic complexity is standard for traditional functional and procedural programs. There are many proposed object oriented metrics for evaluating the object oriented program.

Dr K. Anbumani, K.P. Srinivasan [13] stated use of software metrics in evaluating the quality of software products and the software development process. There are currently three sets of design metrics for object oriented software which are suggested by different groups of authors, Chidamber and kemerer metrics.

Lakshmi Narasimhan et. al.[14] of Department of Computer Science from East Carolina University, Greenville, NC, USA suggested that during the execution phase, there exist lack of metrics which will reduce the maintenance costs and defined metrics whose values are collected. Metrics are useful for increase the re-usability and assessing the maintenance cost of individual components and that of the application in which the component is integrated.

Radu Marinescu [15] given that the object oriented paradigm has influenced the software engineers for ease of program writing and implementing. The impact of misunderstanding the object oriented designs made the design complex and more tedious to program and poor OO design. Object oriented metrics have the benefits with the high degree of code reuse, higher maintainability and flexibility, etc., Now they can improve the quality of the design using the object oriented metrics.

Lakshmi Narasimhan and Bayu Hendradjaya[16] defined a two suites which cover the static and dynamic aspects of the component assembly. The triangular metric which is used to classify the type and nature of the application, is formed with the complexity and criticality metrics. During the runtime of the complete application the dyamic metrics are collected. This paper is mainly deals with the collection of some metrics and evaluated the results.

Magnus Andersson Patrik Vestergren[17] targeted to evaluate whether the software metrics can be used to determine the object-oriented design quality of a software system. There are several metrics to evaluate the object oriented design and programs. To validate each metric an experimental study was conducted. The final conclusion is software metrics can improve the system design quality such as complexity of methods/classes, package structure design and the level of abstraction in a system. Therefore metrics can be assured that the rules are followed and the program is properly written with the rules.

According to Saida Benlarbi et. al.[18] the basic premise behind the object oriented metrics which is an earlier predictors of classes that contains error which may be found during the testing. In this paper they conclude that the empirical validation methods provide misleading conclusion to the validity of object oriented metrics. The result of the empirical validation is studied with the C++ which is an object oriented program.

The paper by Tieng Wei Koh et. al.[19] review the 12 objected- oriented software metrics proposed in 90's by Chidamber, Kemerer and Li. The authors stated that the software cost estimation is mainly based on the size or predicting the volume of various kinds of software deliverable items. Size and complexity is very critical and it influences the integral software development effort. Software cost estimation is criticsl because it is mainly based on the software size estimation.

Marco Scotto et. al.[20] metrics tools is to be updated for the standardization of software measures but it is not still standardize. Intermediate abstraction layer is the possible solution suggested here to decouple the extraction process from the use of the information. This paper presents the web metrics which is an automated tool for software metrics collection. This open source project is computed with the CK metric suite.

8 EXISTING SYSTEM

The tools which are analyzed in this paper are LOCC, JHAWK, CODE COUNTER. These tools are used to

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measure the object oriented paradigms in the program. The main advantages of these tools are, it will generate the charts and will produce the reports about the programs. The programmer should re-model or re-structure the program according to the report or the warning chart generated by those tools[9,10]. Another software called cavaj Decompiler which is used to convert the class files into java files for user convenience is also integrated into this component.

8.1 LOCC

This is the tool to measure the Object oriented program to yield the LOC, SLOC, NOP, NOC, NOM, NOI in that particular program which is given as input. The main drawback of this metric tool is that it won't generate the charts for the report or result generated by the tool [4]. LOCC metrics, which provides a grammar-based architecture and interface to the production and use of different size metrics. Developers can use the size metrics distributed with LOCC or can design their own metrics, which can be easily incorporated into LOCC. LOCC pays specific attention to the problem of supporting incremental development, where a work product is not created all at once but rather through a sequence of small changes applied to previously developed programs.

8.2 JHAWK

This tool is used to measure the various parameters of CYCLOMATIC COMPLEXITY, COMMENT LINES, NOP in the given input program. The main advantage is that it will generate a chart for the program and also it will show the warning chart. It will mainly measures the looping and iterations which are present in the input program[6].

JHawk is a Stand alone, Eclipse plugin and command line versions. JHawk Metric interchange format that allows you to record a snapshot of a code base and keep it for future use either in JHawk itself or in our new DataViewer product. JHawk Data Viewer, a standalone product that allows graphical and textual comparison of metrics over time.

The disadvantage is that the Halstead metrics are not used now for measuring the program. Some may need to measure those metrics.

8.3 CODE COUNTER

This metrics is mainly used to measure the NOS, COMMENT LINES, TOTAL of the two metrics. The main advantage of this tool is, it will measure and generate the report for many languages like ASP, HTML, C++, C etc. The main advantage is it will measure many languages and will generate the three forms of reports according to the user needs. The main drawback is it won't cover the important parameters to be measured for the object oriented programs [4].

The main features of code counter are Easy to use with just 3 steps, Quickly counts several types of source code - including Java, JSP, C or C++, VB, PHP, HTML, Delphi or Pascal, ASM, XML, COBOL etc., Smart Comment feature - knows which comment types are used by each language and counts accordingly, Save and load count profiles - no need to enter the same information over and over for the same source files to count, Supports unicode files and contents. Can also count unix type or windows type of text files (CRLF/CR only)

8.4 LOC METRICS

This tool is mainly used to measure the total lines of code (LOC), blank lines of code (BLOC), comment lines of code (CLOC), lines with both code and comments (C&SLOC), logical source lines of code (SLOC-L), McCabe VG complexity (MVG), and number of comment words (CWORDS). Physical executable source lines of code (SLOC-P) is calculated as the total lines of source code minus blank lines and comment lines. Counts are calculated on a per file basis and accumulated for the entire project. Loc Metrics also generates a comment word histogram[4].

8.5 SLOC METRICS

SLOC Metrics measures the size of your source code based on the Physical Source Lines of Code metric recommended by the Software Engineering Institute at Carnegie Mellon University (CMU/SEI-92-TR-019). Specifically, the source lines that are included in the count are the lines that contain executable statements, declarations, and/or compiler directives. Comments, and blank lines are excluded from the count. When a line or statement contains more than one type, it is classified as the type with the highest precedence[5]. The order of precedence for the types is: executable, declaration, compiler directive, comment and lastly, white space.

Main features of SLOC are Fast and efficient processing of source files, Process any size of file, Process any number of files. Flexible support for C/C++, C#, Java, HTML, Perl, Visual Basic and more. Ability to add definitions for other file types, Formatted and hyperlinked results in HTML file format. Project folders and files are sorted by their Source Lines of Code so that you can easily identify code intensive modules and files, Shows differences in counts of source lines of codes between two measurements by SLOCMetrics as DIFF.html in the output folder , Formatted results in CSV (Comma Delimited) file format,

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Prepares results as a well-formed XML document , Multiple SLOC Configurations can be saved as files and reused, can be run as a Console application using *sloccmd.exe* present in the SLOCMetrics 3.0 installation directory. Configuration file path can be passed as a parameter to sloccmd.exe, An easy to use, Windows-based graphical user interface.

9 PROPOSED SYSTEM

Main drawback of the existing system is they are available individually. So the users may meet some difficulty in order to measure the program.In this proposed system, those tools are integrated and made as a single add-on for the users flexibility and user friendliness. All the tools are available in the single web page so that the user can access those tools efficiently. The java decompiler, an open source, also combined in this page which will convert the class files into java files.

The tools will measyre the different parameters which need to be measured. The tools itself will generate the charts and reports according to the result. The tools also shows the warning message if the program have to restructure and also the error message if the given program is contain any error.

10 COMPARISION OF EXISTING METRIC TOOLS

Metric tools	**Parameters measured**	**Chart Generation**
LOCC	loc, sloc, nop ,noc ,nom, noi	No
JHAWK5	cyclomatic complexity, comment lines, nop	Yes
CODE COUNTER	nos, comment lines, total	Yes
LOC METRICS	loc, bloc, cloc, c&sloc, sloc-l, mvg, cwords, sloc-p	Yes
SLOC METRICS	comments, blank lines, executable declarations, compiler directive, white space	yes xml, xsl, html, notepad

11 CONCLUSION

As there are wide applications of association rules in data mining, it is important to provide good performance. In view of this, we proposed a new algorithm which considers the significance of the item also but not only support of the item. The results through experiment shows that the computational cost of the link-based model is reasonable. At the expense of three or four additional database scans, we can acquire results different from those obtained by traditional counting-based models. Particularly for sparse data sets, some significant item sets that are not so frequent can be found in the link-based model. Through comparison, we found that our model and method address emphasis on high-quality transactions. In this paper, a brief discussion of a number of algorithms was presented along with a comparative study of a few significant ones based on their performance and memory usage.

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Reactive Power Management for Wind Electric Generator

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Abstract- Energy in the Wind is converted into Rotary Mechanical Energy by the Wind turbine. Most of the Wind Electric Generators are having Induction Motor, (Asynchronous Motor) with constant speed and drawing more Reactive Power from the Grid, during starting / low wind period. This thesis emphasized the need of replacing the existing conventional Asynchronous Induction motor of Constant Speed by Wound Rotor Synchronous Induction motor of variable speed, namely, Doubly Fed Induction Generator (DFIG). The control principle is either the Direct Torque Control (DTC) method, Or, Two – axis Current Vector Control Method. The Direct Torque Control Method is more effective than the two axis current vector control method, for Reactive Power Management for Wind Electric Generator. The minimum usage of only about 30% of Power Electronics results in considerable cost savings and reduction of harmonics when compared with Fully Converter Wind Electric Generators.

Index Terms- Asynchronous Generator, DFIG (Doubly Fed Induction Generator), Direct Torque Control Method, Generator Side Converter, Grid Side Converter, Two Axis Current Vector Control Method, Reactive Power Control, Synchronous Generator.

I. INTRODUCTION

THE mankind has witnessed the tremendous advancement in Science and Technology, modernization and industrialization in the last 100 years, which was not seen for millions of years. Energy had been a key issue to industrialization after discovery of Fossil fuels like Petroleum and Coal. This came together with Pollution of Environment like Air, Water, Earth, including vegetation, animals and even new born Babies. Burning of Fossil Fuel over the last 200 years had added 400Giga tones of Carbon - di - Oxide into the atmosphere. (1GT=1000 Million tones)

The Plants have been able to absorb only 200 GT and the balance is still there in the atmosphere. This is the primary cause of Global Warming and climate change.

It is now felt by mankind through Climate changes, melting of Ice caps in Artic Zone, rise in the sea level reducing the Land area, threat to marine life etc.

The solution to the Global Warming lies in the development of the Green cover or Forest cover to absorb the excess CO2, to gether with harnessing Renewable Sources of Energy in lieu of Fossil fuel so as to arrest the Pollution level from further increasing. Carbon Emission, a major cause of Global Warming is primarily due to use of fossil fuels such as Coal and Petroleum in Thermal power Plants and Automobiles. [2] It is proved that Fossil Fuels continue to diminish. [5]

Renewable Energy is energy which comes from Natural Resources such as Sun Light, Wind, Rain, Movement of Water (Hydro Power, including ocean Surface Waves used for Wave Power – Tides), and Geothermal heat, which are Renewable (Naturally Replenished).[1] Among the said alternative Power Sources, Wind Power is one of the most promising New Energy Sources. Wind is appealing for several reasons. It is abundant, cheap, inexhaustible, widely distributed, clean and climate-benign, a set of attributes that no other Energy Source can match.[5] Wind has considerable potential as a Global Clean Energy Source and producing no Pollution during Power Generation– GREEN ENERGY DEVLOPMENT. [7]

Harnessing of Wind Energy could play a significant role in the Energy Mix of each Nation. Wind is caused due to the uneven heating of the earth surface by the Sun. The Air in contact with the ground gets heated up and becomes light in weight by losing its density and starts rising up. Thus heated air is displaced by the cold air which is higher in density. This is how the air is displaced and set in motion to generate winds and it is called Wind Breeze.

The most prominent feature of the Wind Climatology in India is the Monsoon Circulations.

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Winds in India are influenced by the strong South-West Summer Monsoon, which starts in May-June, when cool, humid air moves towards the land and weaker North- East Winter Monsoon, which starts in the month of October, when cool dry air moves towards the ocean.

During the period March to August, the kinds are uniformly strong over the whole Indian Peninsula, except the Eastern Peninsular coast. Wind speeds during the period November to March are relatively weaker, though higher winds are available during a part of this period on the Tamil Nadu Coastline. [2]

Also, the State of Tamil Nadu is blessed with conductive Natural Metrological and to geographical settings for wind Energy Generation. Three Passes namely, Palghat Pass, Shengottah Pass and Aralvoimozhi Pass are endowed with heavy Wind Flows due to the Tunneling Effect during South West Monsoon.

Tamil Nadu is endowed with 3 lengthy Mountain Ranges on the Western side with Potential of 1650 MW in Palghat Pass in Coimbatore District, 1300 MW in Shengottai Pass in the Tirunelveli District and 2100 MW in Aralvoimozhi Pass in Kanyakumari District and 450 MW in other areas totaling to 5500 MW. [7]

As on 31.03.2010, the installed capacity of the Wind Electric Generators in Tamil Nadu is 4907 MW, stand first among all the States in India; whereas, the capacity in Maharashtra is 2078 MW; in Gujarath, it is 1864 MW; and in Karnataka, it is 1473 MW. [8]

India stood 5th place all over the world as the installed capacity of the Wind Electric Generators is 13,065 MW; as on 31.12.2010. China stood 1st place, as the installed capacity is 44,733 MW. United States of America stood 2nd place, as the installed capacity is 40,180 MW; Germany stood 3rd place as the installed capacity is 27,214 MW; Spain is having 20,676 MW and stood 4th place. [9]

II. Power Conversion from Kinetic Wind Energy to Rotational Energy:

The Kinetic Energy of a Mass of Air 'm' having the speed v_W is given by:

$$E_k = \frac{m}{2} \cdot v_w^{\ 2}$$

The Power associated to this moving air Mass is the derivative of the Kinetic Energy with respect to time.

$$P_0 = \frac{\partial E_k}{\partial t} = \frac{1}{2} \cdot \frac{\partial m}{\partial t} \cdot v_w^{\ 2} = \frac{1}{2} \cdot q \cdot v_w^{\ 2}$$

Where q represents the mass flow given by the expression

$$q = \rho \cdot v_w \cdot A$$

ϱ is the air density and A is the cross section of the air mass flow and 'q' represents the mass flow. Only a fraction of the total Kinetic Power can be extracted by a Wind Turbine and converted into Rotational Power at the shaft. This fraction of Power (P_{wind}) depends on the Wind Speed, Rotor Speed and Blade Position (for Pitch and active stall control turbines) and on the turbine design. (C_P) [3]

The best utilization of the Wind Energy in Wind Electric Generators (WEGs) establishing a theoretical limit for the Power Extraction, independently of the turbine design, at most $\frac{16}{27} \approx 0.593$ (theoretical maximum) of the Wind Kinetic Energy can be converted into Mechanical Energy. [4] Every particle in motion has an associated Kinetic Energy proportional to its mass and the square of its speed. Turbines convert this Kinetic Energy to a mechanical motion and during the conversion process the speed of the flow is reduced. (Bet'z limit)

Finally, the Mechanical Power extracted from the Wind is calculated using:

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$P_{Mech} = \varrho / 2 \Pi R^2 \ C \ (\lambda, Ø) \ v^3$ [3] or, say

$$P_{Wind} = 1/2 \varrho A_{wt} C_p (\lambda, \theta) v^3_{wind} [W]$$

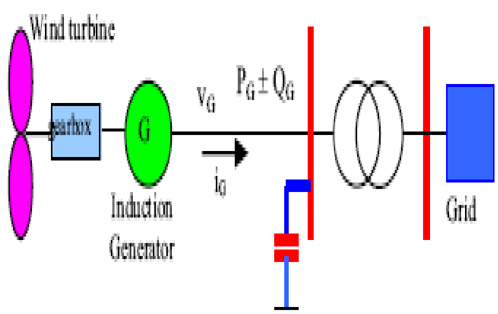
where ϱ is the Air density (Kg/m^3), A_{wt} is the Wind Turbine Swept area in m^2, v_{wind} is the Wind Speed in m/s ; Cp is the Power Co-efficient and dimensionless depends on both the Tip Speed Ratio λ (lower than Bet'z limit) and Pitch angle Ø (degrees) [4]

III. Types of the Wind Electric Generators:

Wind turbines can rotate about either a Horizontal for a Vertical axis, the former being both older and common.

The first electricity generating Wind Turbine was a battery charging machine installed in July 1887 by Scottish academic, James Blyth to light his holiday home in Marykirk, Scotland. The first automatically operated wind turbine, built in Cleveland in 1888 by Charles F. Brush. It was 60 feet (18 m) tall, weighed 4 tons (3.6 metric Tones) and powered a 12KW Generator. [1]

In the 1990s, wind power turbines were characterized by a fixed-speed operation. Basically, they consisted of the coupling of a Wind Turbine, a Gearbox and an Induction Machine directly connected to the Grid.



Additionally, a soft starter is used to energize the machine and a bank of Capacitors to compensate the machine Power Reactive absorption. Although being simple, reliable and robust, the fixed-speed wind turbines were inefficient and power fluctuations were transmitted to the network due to wind speed fluctuations. [4]

The Induction Generators are gaining the popularity due to its simplicity and no Synchronization problem. However, the major drawback of the Induction Generator is its additional Reactive Burden on the system, where it is connected.

The two most common modern Wind Power Plant configurations are: a) Wind power plants with a Synchronous generator and two full-sized converters or b) doubly-fed induction generators with two converters in the Rotor Circuit. Schematic representations are shown below.

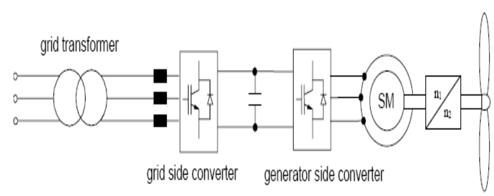


Fig (2) Synchronous Machine – Fully Converter WEG (Using Power Electronics).

In order to enable variable speed operation Synchronous Generators are decoupled from the Power Grid with its fixed frequency (50 or 60 Hz) through two back-to- back frequency converters, which have a common DC-link. The main disadvantage of this topology is that the frequency converters are designed to handle the full Generator power output. This inevitably means higher costs.

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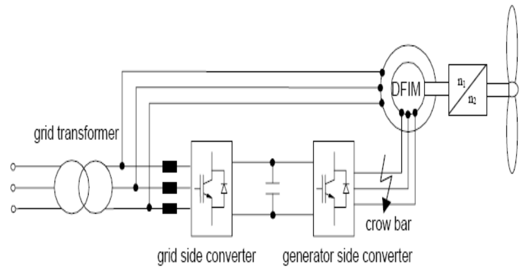

Fig (3) Doubly Fed Induction Generator (Using Power Electronics only on Rotor Side)

Doubly - fed electric machines are Electric in or Electric Generators that have windings on both stationary and rotating parts, where both windings transfer significant Power between Shaft and Electrical System. Doubly-fed machines are useful in applications that require varying speed of the machine's shaft for a fixed Power System Frequency. [6]

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III. Analysis and Comparison at par with the P.F (KWhr, rKVAh, and iKVAh) components of the existing Conventional and Fully Converter types WEG(other than DFIG):

Case Study-1:

A conventional WEG ('**S**'make) having the Induction Squirrel Cage - synchronous Motor, which is directly coupled with the utility Grid, kept installed at Tirunelveli district in Tamil Nadu of India and in working condition till date, is taken for the study purpose.

The Reactive Power compensation is fed by using the Capacitors, in to the circuit, on switched / relay mode, whenever required to carryout the compensation and not by adopting the method of full Controlling mechanism, as available in the Modern Wind Electric Generators. All the parameters have been studied and the details of the month wise Power Factor for the year of 2009 and 2010 are displayed below:

YEAR: 2009 **YEAR: 2010**

Import

Mon	KWHr	iKVAh	P.F	KWHr	iKVAh	P.F
Jan	234	882	0.27	558	2250	**0.25**
Feb	630	2574	0.25	486	1746	**0.28**
Mar	1602	6120	0.26	1674	6390	**0.26**
Apr	2592	9900	0.26	2070	7668	**0.27**
May	648	2250	0.29	2106	7344	**0.29**
June	450	1710	0.26	882	2304	**0.38**
July	216	990	0.22	738	2682	**0.28**
Aug	378	1908	0.20	630	2052	**0.31**
Sep	936	4068	0.23	918	3348	**0.27**
Oct	756	3438	0.22	1332	5274	**0.25**
Nov	2232	9810	0.23	1260	5148	**0.24**
Dec	1098	4428	0.25	2016	8676	**0.23**

It is understood that the 'S' type WEG is drawing Reactive Power from the Grid and the Power Factor ranging from 0.2 to 0.38 only.

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Case Study- 2:

A Modern WEG ('E' make) having Synchronous Motor, with AC-DC-AC Converter and Inverter (Fully equipped with Power Electronics) and kept connected with the Grid, installed at Dindukul district in Tamil Nadu of India and in working condition till date, is taken for the study purpose.

The details of the month wise Active and Reactive Power generated and drawn from the Grid are studied and the Power Factor at the Grid side is charted below.

YEAR: 2010

Import

Mon	KWHr	iKVAh	**P.F**
Jan	528	1176	**0.45**
Feb	312	576	**0.54**
Mar	840	1488	**0.56**
Apr	768	1272	**0.60**
May	744	1224	**0.61**
June	4	144	**0.67**
July	216	360	**0.60**
Aug	4	48	**1.00**
Sep	7	144	**0.50**
Oct	816	1632	**0.50**
Nov	768	1272	**0.60**
Dec	744	1224	**0.61**

It is understood that the 'E' type WEG is drawing Reactive Power from the Grid with the P.F ranging from 0.45 to 1.00. The Unity P.F has been achieved during August 2010. The reason for the U.P.F is due to the application of Power Electronics & the availability of the continuous Wind and the good condition of the Machine (WEG) during the study period.

IV. The Doubly Fed Induction Machine Concept:

DFIG is an abbreviation for Double Fed Induction Generator, a generating principle widely used in Wind Turbines. It is based on an Induction Generator with a multiphase wound rotor and a multiphase slip ring assembly with brushes for access to the rotor windings. It is possible to avoid the multiphase slip ring assembly (Brushless Doubly– Fed Electric Machines), but there are problems with efficiency, cost and size. A better alternative is a Brush less Wound Rotor DFIG.

The principle is that Rotor Windings are connected to the Grid via slip rings and back - to - back Voltage source converter that controls both the rotor and the grid currents. Thus rotor frequency can freely differ from the grid frequency (50 or 60 Hz).

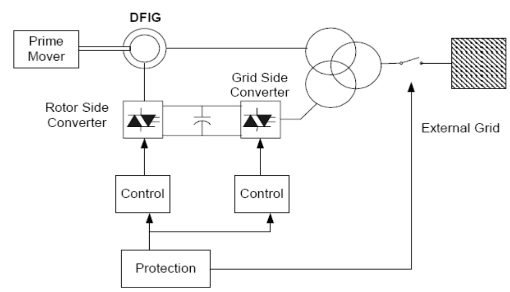

Fig (4) WEG with DFIG Concept

By using the converter to control the rotor currents, it is possible to adjust the Active and Reactive power fed to the Grid from the Stator independently of the Generator's turning speed. The control principle used is either the two-axis current Vector control or Direct Torque Control (DTC) has turned out to have better stability than current vector control especially when high Reactive currents are required from the Generator [1]

The Prime Mover, consisting of a pitch-angle controlled wind turbine, the shaft and the gear-box drives a slip-ring Induction Generator. The stator of the DFIG is directly connected to the Grid; the slip-rings of the rotor are fed by self-commutated converters. These converters allow controlling the

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rotor voltage in magnitude and phase angle and can therefore be used for Active- and Reactive Power control. [3]

V. Function of the D. F. I. G (Reactive Power Control)

The Wound-Rotor Doubly - Fed Electric Machine is the only Electric Machine that operates with rated torque to twice Synchronous speed for a given frequency of excitation (i.e., 6000 rpm @ 50 Hz and one pole-pair versus 3000 rpm for singly-fed electric machines). Higher speed with a given frequency of excitation gives lower cost, higher efficiency, and higher power density.

In concept, any electric machine can be converted to a Wound – Rotor Doubly -Fed Electric Motor or Generator by changing the rotor assembly to a multiphase wound rotor assembly of equal stator winding set rating. If the rotor winding set can transfer power to the electrical system, the conversion result is a Wound - Rotor Doubly - Fed Electric Motor or Generator with twice the speed and power as the original singly-fed electric machine. The resulting dual-ported transformer circuit topology allows very high torque current without core saturation, all by electronically controlling half or less of the Total Motor Power for Full Variable Speed Control. [1]

Due to the main advantage of allowing Variable - Speed Operation, the Power Extraction from the Wind can be optimized. The converters feed the Low- Frequency Rotor circuits from the Grid. The converters are partially scaled requiring a rated power of about 30% of the generator rating. Usually, the slip varies between 40% at Sub-Synchronous speed and -30% at Super-Synchronous speed. The Grid-Side Converter is controlled to have a Unity Power Factor and a constant voltage at the DC-link.

The Rotor-Side Converter is usually controlled to have (a) Optimal Power Extraction from the Wind and (b) a specified Reactive Power at the Generator terminal. (Sinusoidal 3 Phase Voltages at the Slip Frequency).

Therefore, assuming that the converters are lossless, the Net Power injected by theGenerator to the grid is given by

$P_{gen} = P_s - P_r \qquad Q_{gen} = Q_s$ [4]

VI. Conclusion

It is concluded that a DFIG is a Wound-Rotor Doubly-fed electric machine (basically operates similar to a Synchronous Generator), and as its rotor circuit is controlled by a Power Electronics Converter, the Induction Generator is able to Manage (Control) Import and Export Reactive Power.

Apart from the Reactive Management, the control of the rotor voltages and currents enables the Induction Machine to remain synchronized with the grid while the wind turbine speed varies. A variable speed wind turbine utilizes the available wind resource more efficiently than a fixed speed wind turbine, especially during light wind conditions.

The cost of the converter is low when compared with other variable speed solutions because only a fraction of the Mechanical Power, typically 25-30 %, is fed to the Grid through the Converter, the rest being fed to Grid directly from the Stator. [1]

The Mechanical Efficiency in a Wind Turbine is dependent of the Power Co-efficient. The Power Co-efficient of a rotating Wind Turbine is given by the Pitch Angle and the Tip Speed Ratio. Adjustable speed will improved the system efficiency since the turbine speed can be adjusted as a function of Wind Speed to maximize output Power.

Also, the Cost of inverter filters is reduced. Filters are rated for 0.25 to 0.30 p.u of the total System Power and Inverter Harmonics represent smaller fraction of Total System Harmonics.

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Security Challenges & Preventions in Wireless Communications

Kashif Laeeq

Abstract— Without the need of an infrastructure, low-cost, auto-managed, flexible and low power consumer, wireless communication is becoming emerging technology. It shows great binder for present as well as future hi-tech applications. Increasing reliance on wireless communication also brings great challenges to the security measures and other correlated issues. Although the newly introduced corrected security standard, IEEE 802.11i, offers extensive security for the wireless environment but it is still premature and does not provide effective measures to protect the wireless networks from confidentiality and integrity threats. The main issues for deployment of wireless networks are security attacks, vulnerabilities, battery power and improper security models. This paper provides a study on these problems especially in ad-hoc wireless networks. The study is based on numerous proposed schemes in the endeavor to secure such networks. The goal of this paper is to probe the principal security issues, challenges and fundamental security requirements of wireless communications on the bases of their proposed solutions.

Index Terms— Attack, Denial of service, Mobile Ad-hoc Networks, Security issues, Vulnerabilities, Wireless Communication, WSN.

1 INTRODUCTION

DUE to low cost, low power consumption, flexible, no physical infrastructure and easy to deploy, wireless communications have been an admired research area over the past few years with tremendous growth in the population of wireless users. Many systems are still mapping wire to wireless media. Nowadays , there are number of wireless technologies on hand for long range applications like cellular mobile, satellite communications, Radio Frequency (RF), and short range applications such as Bluetooth, Infrared (IR), Near Field Communication (NFC), ZigBee, Ultra Wide Band (UWB). These short range wireless technologies are being used in many wireless technologies like wireless local area networks (WLAN), wireless body area networks (WBANs), wireless personal area networks (WPANs), and, ad-hoc network etc. Although wireless communications have numerous compensations over the usual wired networks in contrast it is exposed to a range of intrusion attacks. Unlike the wired networks, the wireless networks face unique challenges due to their inherent vulnerabilities. Any wireless signal is subject to interception, jamming and false command disruption.

The coverage area of wireless communication is dependable on the devices used. The more powerful device may cover large area but it will be expensive, consume more power and also produce more electromagnetic radiation that might be danger for human health [11]. One of the solution provides in that enlarge the coverage area hop by hope, by applying the ZigBee protocol, but the energy issue remain constant. Majority of times the limited energy restrict the security schemes [15].

Nearly all the proposed solutions concentrate on a specific security problem but pay no attention to others, those which pull off low energy and memory burning up negotiates on security level. Therefore the demand for a model; which fulfills all these issues with low cost, high security and low power, is increasing with raising the wireless technology.

Attack, is also one of the major issues in wireless communications. The technology suffers with two major types of attacks, i.e. inside and outside attacks. Outside attacker can't get access to the network but inside attacker can do it and may disrupt the network resources such that encryption keys or further codes used by the network. It is observed many times that only cryptographic security schemes may be failed to combat with numerous types of attacks in contrast all the proposed intrusion detection systems are not surely detect and remove the intruders. In reactive routing protocols like AODV, chances of attack are higher [18].

2 ISSUES AND CHALLENGESS

Wireless communication has emerged as a major breakthrough in traditional wired communications. It has changed messy wired world into a clean and flexible atmosphere. According to a well known adage, *there is no unmixed good in this world*; implementation of wireless network carries numerous performance and security issues. These issues include:

2.1 Vulnerabilities in Current Wireless Communications

The wireless communications survivability relates to wireless communication protection mechanism and robustness against attacks and failure of wireless network elements or communication itself. Some of these issues are as follows:

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- The Wireless Sensor Network gateway forms a single point of breakdown for the back-to-back sensor network infrastructure [1].
- After deployment of network, sensor nodes remain unattended which is a root cause of security lapses [2].
- The existing location tracking methods have their own boundaries in tracing wireless intruders [3].
- Major threat and challenges of wireless communications are still not considered in IEEE 802.11i revised specification [4]
- Ad-hoc Wireless Sensor Networks deployment for monitoring physical environments are still in vulnerable zone [5].

2.2 Current Security Models and Prevailing Security Threats

Different performance issues of wireless networks operation, administration and management are encountered due to improper security model. Many security schemes don't guard against some prevailing threats. Some of these issues are as follows:

- Present security schemes for Wireless Personal Area Networks (WPANs) are immature [6]
- There is no proper visualization technique present for wireless communications [7]
- Security model for wired network not necessarily effective for wireless networks [8].
- Compressed Real time Transport Protocol (CRTP) is not appropriate for wireless links, that have a very high and erratic bit error rate (BER)[9]
- Inadequate security integration scheme for heterogeneous networks [10].
- The current wireless smart home system has range limitation issue [11].

2.3 Major Attacks on Wireless Sensor Net works (WSN)

Wireless Sensor Network (WSN) is a prevailing technology that shows great promise for diverse ultramodern applications both for mass public and intelligence. Security in wireless sensor networks is still in its childhood, as little consideration has been made to this area by the research community, due to this ignorance, WSN still facing numerous issues and challenges. Some of these issues are as follows:

- There is no common model to guaranteed security for each layer in a Wireless Sensor Networks (WSNs) [12].
- Current security Solutions for wireless Sensor networks are not feasible against all Prevailing security threats [13]
- Protection mechanism in wireless sensor network is still adolescent age [14].
- The current protocols for data link layer & network layers are not adequate for handling various security threats in WSN [15].
- The existing security measures for wireless sensor networks (WSN) are insufficient [16].

2.4 Security Attacks on Ad-hoc Wireless Networks

Truly speaking the most demanding area of wireless networking is ad-hoc wireless networks, but unfortunately it is the most at risk. Any intruder can easily get the access on the network resources and disrupts the communications. Some of these issues are as follows:

- In many cases cryptographic-based solution for detection the intruder in ad-hoc networks are ineffective [17].
- Attacks on wireless ad hoc network specially on routing protocols upsets network performance and reliability [18]
- No response method and limitations to handle wormhole attacks in Wireless Ad-hoc Networks (WANs). [19].
- Many existing ad-hoc routing protocols concern only the length of the routers [20].

3 APPROACHES TO MITIGATE ABOVE CHALLENGES

The main issues for deployment of wireless networks are security attacks, vulnerabilities, battery power and improper security models. The research on security issues and challenges in wireless communication comprises performance implications due to different factors. The effects of these factors or problem areas have been addressed by using different tools, algorithms, models, simulations and design modifications. These sub domains and the approaches or methodologies are discussed in subsequent paragraphs:

3.1 Protecting Wireless Network against Vulnerabilities

The Wireless Sensor Network gateway forms a single point of collapse for the back-to-back sensor network infrastructure. Even if a strong security model is used, but whenever intruder attacks on WSN-gateway, the whole network operations hampered. The fault endurance of WSN-gateway should be increased to avoid single point failure. In [1] a commercial grade WSN is considered and threw a ping-based DDos attack on the gateway of WSN. Various computers send ping attack traffic simultaneously to the WSN-gateway. For the entire testing of 4 hours of DDoS attack, processor fatigue and sensed data were collected. It is clearly observed that the computing resources of network gateway exhaustion under ping-based DDoS attack traffic. At a load exceeds by 20% of the ping attack, the WSN gateway processor became 100% busy, which caused the WSN-gateway to discontinue collection, reporting and recording the log sensor data. Result of this experiment stress to increase the fault endurance to avoid

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single point failure. [1].

Due to the vulnerable attributes of sensor networks, there is always a risk of threats, along with the objective to ensure the privacy, integrity and reliability of transmission over these sensor networks. Model present in [2] associated with Communal Reputation and Individual Trust (CRIT) within sensor nodes overcomes this problem. In this model, a node judge the reliability or adequacy of a neighbor node throughout a set of values associated to the neighbor node's reliability and reputation. A node observes their neighboring nodes and positions the neighbors in conditions of a trust vote. Trust table kept by neighboring nodes conclude the communal and individual trustworthiness of nodes. A node keeps two tables, a trust table and other is reputation table. Trust table keeps the trust and un-trust observations for all other neighbor nodes. In the same way reputation table keeps reputation observations for all the neighbor nodes. If a node throws a unique message, and that is not confirmed by all other nodes, then the reliability of the node is under question, and also the un-trust value for the node increases. This message comes to cluster leader, by all other nodes about a specific node, it transmit the information so that all other nodes disregard the untrustworthy node and it is discarded from the network [2].

The current location tracking schemes have their own boundaries in tracing wireless intruders. The modification for Triangulation method present in [3] seeks to overcome this limitation. The technique based on two separate databases, the values of these databases consider by two locations, one for inside and other for outside the building. For location tracking using databases, execute the Triangulation method followed by matching up to the value with entries of data bases. It will be at a glance that attacker is inside the building or outside, then looking for closest values in databases; the matching observations in column without having triangulation would be the more precise location of device [3].

The IEEE 802.11i modification has concluded to deal with security issues in wireless local area networks but major threats like DoS attacks, insider attacks and offline guessing attacks are still looked-for consideration. An improved authentication mechanism present in [4] can overcome this ignorance. This scheme adopts an asymmetric cryptography technique to achieve effective defense in six categories that are discovery phase, authentication and association phase, RADIUS authentication, 4-way handshake, group key handshake, and secure data communication. This integrated protection for, null data frames, EAPOL frames, management frames as well as protection from some fundamental DoS attacks, Offline guessing attacks and insider attacks. This authentication mechanism is also capable to allow stations to organize themselves automatically [4].

Ad-hoc wireless sensor networks deployment for monitoring physical environments, where targets have unforeseen motions, are still in vulnerable zone. For such type of Self Organizing Wireless Sensor Networks (SOWSNs), stat-mesh architecture and mobility scheme provide an efficient monitoring system [5]. The architecture has a base station (BS) node and sensor nodes (SN), which unites a mesh of routers to expand radio coverage with star endpoints. Star-Mesh architecture utilizes multi-hopping to offer multipath routing, by means of an ad-hoc network based approach. The SN collects environmental in formations and re-arranging events generated by BS. The BS performs actions on receiving events also managing the routes. Initially when a node gets a message it stores the flooded one and transmit the message to all its neighbors. A new received message that has the same flood id is erased. Each SN has an initial amount of power hence it can drive signals to all nodes surrounded by its transmission range. Each SN connected at least one B.S. the BS, with great amount of energy, works as a gateway that connects SN to the analysis center. The BSs are fixed and each BS knows exactly its position information. The BSs are assumed to be arbitrarily located. [5]

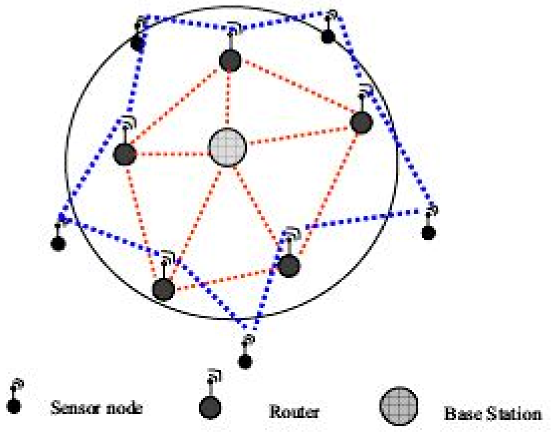

Fig.1: The Ad-hoc SOWSN architecture [5]

3.2 Schemes to Reduce Current Security Threats and Range Limitation Issues

At hand security schemes for Wireless Personal Area Networks (WPANs) needed more research. In [6] T.Kennedy and R. Hunt review WPAN security according to them protection mechanism for Bluetooth is that PIN should not entered into the Bluetooth devices for paring in public and only known devices should pair. Encryption technology is essential for unique session key. For ZigBee the source decides whether a protected or non-protected acknowledge frame is needed, also performing authentication of the source address. Use symmetric key key exchange (SKKE) acknowledgement of a link key between trust centre and connected devices. For Near Field Communication, a standard key handshake protocol such as diffie-Hellman associated on elliptic

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curve cryptography, or RSA could be used to set up a shared secret between two devices for securing the channel [6].

Wireless network visualization techniques in presentation mode visualize the information of access points, mobile devices and relationship using the icons, colored lines and symbol. in this way more information about network status and performance can be achieve, and will help the network performance and security attacks [7].

A novel method using MAC Spoofing proposed in [8] used to avoid any intruder into the wireless communications. MAC address of authenticated user can be used to save any unauthorized access a data base of all authorized client MAC address maintain by organization. If the intrusion detection system finds more than one request of MAC address in the same network, it can be sure that the MAC address has been fraud and can block access to that MAC address temporarily [8].

A modified Enhance Compressed Real-time Transport Protocol (ECRTP) is suitable for wireless point-to-point links, which have a very high and erratic Bit Error Rate (BER). In modified ECRTP, the size of header is reduced. In compressed RTP packets occupy only 2 bytes. These bytes may be the UDP check-sum or the compressor interleaved header checksum. By sending these checksums only in some packets, the average header size can be reduced [9].

Heterogeneous Network Integration Model proposed in [10], yields a security scheme for wireless mesh networks. Each of the mixed wireless networks has produced connection with mesh backbone throughout the mesh gateway interface. Whenever these networks correspond with the mesh cloud, they cross the gateway routers of mesh backbone. Security issues of the border between the heterogeneous wireless networks and the mesh communications should be contracted intensively. In order with this, when passing during the mesh cloud, every of these heterogeneous networks require the mesh infrastructure to perform their own individual security requirements.

The current wireless home system has range limitation issue. By using IEEE 802.15.4 standard a system is proposed for smart home environment. The most vital part of the structure is main controller, which will provide interfacing between users and the system. PICI8f452 microcontroller is used as a brain of the main controller for low power consumption CMOS technology's ICs are used. A GSM modem is attached with the controller for SMS. Approximately nine phone numbers can be stored and only these numbers can communicate with main controller for sending & receiving SMS & system resource controller. User can enter into system by entering password. The software consists of programming PICI6LF452 microcontroller using Mikroc compiler from Mikroelectronika. Using C-Language, all of this programming is completed [11].

3.3 Preventive Measures against Security Issues in Wireless Sensor Networks

Majority of proposed security schemes are supported by particular network model. It is needed to have a model that accomplishes the need of security for each layer in a network. The proposed holistic approach [12] with respect to security for wireless sensor networks mitigates this issue. The holistic scheme has some fundamental principles like in a certain network; security is to be guaranteed for all the layers of protocol stack, the value for ensuring security should not exceed the assessed security risk at a particular time, if there is no substantial security ensured for the sensors. In a particular network; safety is to be ensured for every layers of the protocol stack then the cost for guarantee security should not exceed the assessed security risk at a particular time, if there is no physical security guaranteed for the sensors. The security evaluate must be capable to exhibit a refined degradation if some of sensors in the system are compromised. The security considered should be developed to function in a decentralized mode. If security is not measured for all the security layers there are a few efficient security methods working in other layers. By formation security layers as in the holistic scheme, protection could be recognized for the overall network [12].

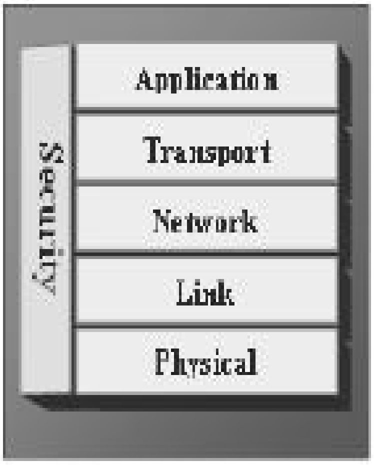

Fig.2: Holistic View of Security in wireless sensor networks [12]

Classification and association of security VTA (Vulnerabilities Threats & Attack), is proposed to remodel application-specific WSNs. The proposed scheme has redefined the concepts of vulnerability, threats and attacks with respect to wireless sensor network. On the basis of this differentiation we can check the list of security VTAs, which can reduce the ambiguity of security information on VTAs. Then; by probing each of VTAs we relate it with a security appraisal framework for analysis [13].

Table 1. Classification and Association of Security VTAs with Discrete Security Assessment Framework [13]

N E	Vulnerability: average energy exhaustion (network), low computational capacity, limited network storage time,

TWORK	self organization, fault-tolerance level, distributed storage, task details, simple ciphering, and node deployment
	<u>Threat:</u> Topology change, change of frequency, large messaging overhead, non-scalability, recursive routing, system failures
	<u>Attack:</u> complete DoS or DDoS
LINK	<u>Vulnerability:</u> Radio link, Signal transmission range (916MHz,2.4GHz), Broadcasting, Topology-less infrastructure, Ad hoc Topology information
	<u>Threat:</u> Non-Reachable, Link-failure, High-density of nodes, Indefinite jamming of signals, Data tampering, High noise, unmanaged mobility, Higher delays (link-setup)
	<u>Attack:</u> Collision or checksum mismatch, Unfairness, Spoofing, Sybil, Wormholes, Hello flood, ACK-spoofing
SINK	<u>Vulnerability</u>: Energy exhaustion at Sink, Task details
	<u>Threat:</u> Unauthorized access
	<u>Attack:</u> Sinkhole, de-synchronization
NODE	<u>Vulnerability</u>: Energy exhaustion at node, Resilience to physical security, Limited memory, short-storage time
	<u>Threat</u>: Node failure, Recursive localization, Indefinite flooding
	<u>Attacks</u>: Selective Forwarding
OTHER	<u>Vulnerability</u>:------
	<u>Threat:</u> Natural hazards, Environmental interference, Human Interaction (to damage network), catastrophic(man-made)
	<u>Attack:</u> Nil

Multitier security architecture is required where each mechanism has different resource requirements. Identification of the data type present in sensor network identifies the security threats to the communication for each data type. Every employing multitier security scheme is tailored to make the most out of the available resources. Use localized algorithm in which only one node heap all others sensors data and then sends this mix data to a sensor node which can communicate network and users [14].
The current protocols for data link layer and network layers are not adequate for handling various security threats in WSN. The proposed scheme in [15] is turn to account in the form of two layers, link and network layers. This strategy seep through the jumble attacks layer by layer to reduce the price of energy for processing. Type of attacks that proposed intrusion detection scheme in link layer can easily notice integrity, collision and exhausting attacks, and in network layer it behold sewage pool, wormhole, selective-forwarding and hello flood news attacks. This security architecture needed no extra component or hardware [15].
The Ad-hoc personal area network & Wireless Sensor Secure NETwork (AWISSENET) distributed detection system (DIDS) proposed in [16] for secure WSNs. The model has plug-in based design in order to enable a flexible management of the algorithms that running on each node. The local IDS agent is composed of four components. The plug-in manager, data manager, decision model and communication model. Intrusion algorithm runs just a subset of the AWISSENET nodes. The AWISSENET cluster can be multi-hop. The size of a cluster is nearly same scale as the number of bunches in network. The AWISSENET DIDS employs timestamps and absorbs, secrete keys are shared within each cluster and among the cluster heads. Timestamps are used to decide the freshness of the messages and stop replay attacks [16].

3.4 Schemes to Secure Ad-hoc Networks

The proposed system in [17] acts on control messages by checking the truthfulness of their content. Nodes operating the OLSR protocol keep neighborhood information's. All nodes of the network participate in IDS. This solution represents the first line of protection for the OLSR protocol. It alleviates threats exploiting flaws in the OLSR specifications to reroute the common routing operation [17].
A Grouped Black Hole Attack Security Model (GBHASM) mitigates the grouped malicious nodes to broadcast the shortest pathway through them to source and destination. Scheme is consisting of two modules; first module has the explanation about new node connectivity & communications. Server receives request acket from new node. It answers with membership acknowledgement to the node and stay for the acceptance. If node doesn't replay within a time limit, the server discards the joining request. Otherwise it throws its information. The information received by new joining node is placed in the database and also assign Node Code Pkk1 or pkk2.The second module handles all communication activities within the network. Once becoming a part of the network, the node drives call for shortest path through pkk2 packet. Each node will check pkk1 with pkk2, if key matches with in a given time limit, information will be released; otherwise the time of the packets to live, force it to become meaningless [18].
An effective wormhole attack defense method is proposed to limits the wormhole attacks on wireless ad-hoc network. In this method each new node of ad-hoc network collects information about one hope and two-hope neighbors, in this way the nodes construct a neighbor list and allocate a session key with all neighbor. The identity and MAC address is also present with a packet comes from every node. The next node then verifies whether the forwarder is a neighbor. This technique drops the replayed packet, and it broadcasts the exit of the wormhole [19].
A secure routing mechanism called security-aware ad-hoc routing (SAR) not only concern the length of the routers. The security metric is integral part of routing request or RREQ packet and change the forwarding behavior of the nodes receive on RREQ packet with a particular security matrix or trust level. SAR conforms that the node can only forward it, if the node itself can recommend the required security, otherwise the RREQ is discarded. If back-to-back path with the mandatory security elements can be found, an appropriate modified RREQ is launched from

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an intermediate node or the ultimate destination. SAR can be employed, based on ad-hoc on-demand routing protocol such as AODV with suitable modification [20].

Domain		Challenges & Issues	Suggestions
Mobile Ad Hoc Networks		Cryptographic-based scheme may be failed to find out the intruders.	Use any proper intrusion detection system (IDS).
		Ad hoc network routing protocols are prone to security attacks.	Use any attack prevention scheme particularly at the time of root construction.
		Majority of routing protocols concern only the length of the routers.	The security metric should be integral part of routing protocols.
SENSOR NETWORK	**Deployment Issues**	WSN gateway form single point failure.	Fault endurance of WSN-gateway should be increase.
		After deployment sensor nodes are gone unattended.	Periodically checking all the attached nodes of a WSN.
	Protocol Issues	Current protocols for link layer and network layer can be failed to handle security threads in WSN.	Need for security architecture to handle this issue.
		No common model to guarantee security for each layer in WSN.	Holistic approach with respect to security can mitigate this issue.
	Inherited Issues	Limited computation power, short memory and low power supply.	Extensive research is required to resolve these inherited issues.
		Increment in the range of devices will increase the energy consumption.	
		Increment in the range will create high electromagnetic radiation.	
		Energy issue restricts the implementation of security schemes.	

Table 2. Major issues and Suggestions

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4 CONCLUSION

In this survey paper, we look into the security issues and challenges in wireless communications, particularly in ad hoc communications. We have divided our studies into four sub-domains that are Security attacks, Vulnerabilities, Security models and Range limitation issues. Main issues addressed in this paper comprise the continuity of environment monitoring, limitation and vulnerabilities of sensors networks, the ad-hoc communication scheme, and the security scheme that protects against large number of attacks including DoS, Wormhole attacks, HELLO flood news attacks etc. we also discussed some security model for protection against attacks, these mechanisms still have limitations, which are discussed in this paper. We also provide a tabular form of major issues and challenges in WSN and MANETs and also provide some suggestion towards solutions. The contribution of this paper is to spell out the current security threats and other correlated issues in wireless communications and discussed

the proposed solutions which may offer a new way of thinking towards the solution space.

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Compost Adsorption Desdorption of Picloram in the Presence of Surfactant on Six Agricultural Soils

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Abstract— To investigate the effect of different types of surfactants on adsorption behavior of pesticide, picloram [4-amino-3, 5, 6-trichloropicolinic acid] which is an ionic herbicide on six agricultural soil samples, picloram soil –water system-surfactant. The Freundlich adsorption coefficients K_s values for picloram adsorption in the presences of surfactant in three concentration of critical micelles concentration (cmc), batch equilibrium experiments performed of cationic surfactant Hexadecyltrimethylammonium bromide (HDTMA). The K_s values of picloram range between 0.940-1.344, 0.943-1.407, and 0.952-1.434 ml/g, for cmc/10, cmc and cmc*20 respectively. Freundlich adsorption coefficients of picloram in the presence of anionic surfactant sodium dodecyl sulphate (SDS) was determined, the values of K_s obtained were in the range 0.761-1.151, 0.654-1.141, and 0.631-1.099ml/g, for cmc/10, cmc, and cmc*20 respectively. The K_s values for polyoxyethylene sorbitanmonooleate (tween-80) were in the range 0.971 -1.229, 1.104-1.303, and 1.189-1.404 ml/g, for cmc/10, cmc, and cmc*20 respectively. The values of Freundlich desorption coefficients (K_{sdes}), linearity factor for desorption (n_{sdes}) and regression factor for desorption (R^2) ranged from 0.839-1.286, 0.267-0.619, and 0.889-0.993 respectively with HDTMA. The values of K_{sdes}, n_{sdes} and R^2 values ranged from 0.895-1.289, 0.494-0.818, and 0.889-0.999 for desorption process respectively by anionic surfactant SDS, the values of K_{sdes}, n_{sdes} and R^2 ranged from 0.953-1.270, 0.429-0.650, and 0.888-0.995 respectively for non-ionic surfactant Tween-80.

Index Terms — Adsorption - desorption kinetics, Adsorption isotherms, HPLC, Picloram, Surfactant.

1 INTRODUCTION

The use of kinetic models in the study of adsorption and desorption processes in heterogenous system is important. Three reasons for the use of kinetic or time-dependent models in soils have been suggested. First, many reactions in soil are slow; yet, they proceed at measurable rates. Second, non-equilibrium conditions can exist as a result of the physical transport of gases and solutes. Third, information about reaction mechanisms and processes occurring may be obtained from such data [1], [2]. The sorption pattern indicates an initial fast sorption that occurs within the first 24h tail it attainted the equilibrium within 48h. This was followed by slow reactions that appear to be the dominant processes i.e desorption of picloram if compared to the amount of picloram still sorbed on the soil. Picloram; is anionic herbicide is used to control unwanted woody plants and to prepare sites for planting trees and used to control broad-leaf plants and trees [3], [4]. Its adsorption involved ionic interaction with positive charges in soil and also the less energetic Van der Waals forces and charge transfer [5], [6]. A two step adsorption-desorption mechanism was used to model the observed behavior that can be described in terms of external and internal sorption sites. Desorption from external sites is relatively fast, taking place in about 5h and is characterized by a first-order rate constant. Many studies have indicated that the sorption and desorption of the organic chemicals in soils are not rapid, reversible process, despite past assumption to the contrary [7], [8]. A study of picloram desorption isotherms show positive hysteresis coefficients H in the six selected soil samples [9], [10]. Hysteresis coefficients H_1, where N_a / N_{des} ratio for Ferundlich adsorption and desorption constants, respectively, indicating the greater or lesser irreversibility of adsorption in all samples, the highest values corresponding for which the highest adsorption constant was obtained. The coefficient H_1 is a simple one and easy to use, indicating an increase in the irreversibility of the adsorption of herbicid as the clay content increases [8].

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2 METHODLOGY

2.1 Soils

Fresh soil samples were taken from plough layer (0-15 cm depth), after removal of stones and debris, air dried under shade, ground then sieved through 2mm sieve and stored in black plastic container in dark[11], [12]. The six soil samples were collected from six main agricultural, representing a range of physico-chemical properties. Subsamples of homogenized soils were analyzed for moisture content, organic matter content, particle size distribution, texture, pH, loss on ignition and exchangeable basic cations were listed in Table 1 a & b.

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2.2 Pesticide and Surfactant

Analytical grad substituted picloram herbicide was purchased from Riedal-de Haen, Sigma-Aldrich company ltd. With following purities expressed in weight percent picloram >97.4% [CAS-No.1918-02-1] respectively. The three different surfactants employed in this study comprised; the cationic Hexadecyltrimethylammonium bromide (HDTMA), the anionic sodium dodecyl sulphate (SDS) and nonionic polyoxyethylene sorbitanmonooleate (Tween-80). These compounds were purchased at reagent grade purity from BDH, and were used without further treatments. The critical micelles concentration cmc of the three surfactants are shown in Table 2. The three surfactants were studied at three concentrations: the critical micelles concentration (cmc), twenty-fold higher than cmc (20cmc), and 10-fold lower than cmc (cmc/10). All chemicals used were of analytical grade reagents and used without pre-treatments. Standard stock solutions of the pesticides were prepared in deionised water.

2.3 Adsorption Experiments

Adsorption of picloram from aqueous solution was determined at laboratory temperature (25±1 C°) employing a standard batch equilibrium method [13], [14]. Duplicate air-dried soil samples were equilibrated with different pesticide concentrations (2, 5, 10, and 15 μg ml^{-1}) were for the pesticide at the soil solution ratios 4:8, in 16 ml glass tube fitted with Teflon-lined screw caps. The samples plus blanks (no pesticide) and control (no soil) were thermostated and placed in shaker for 0.5, 1, 3, 6, 9, 12, 24, 48h. The tubes were centrifuged for 20 min. at 3500 rpm. One ml of the clear supernatant was removed and analyzed for the pesticide concentration [15]. Pesticide identification was done by PerkinElmer series 200 USA family high performance liquid chromatography (HPLC) equipped with a changed loop (20μl), C_{18} reversed phase column, flow rate 1.0 ml min^{-1}, and a variable wave length UV detector at wavelength 220 nm . Separation of picloram in aqueous phase was achieved with a mobile phase of 40% acetonitrile and 60% water (acidified with 0.1% phosphoric acid). Each sample was injected twice to determine the pesticide content by integrating the obtained peak with the respective standard pesticides. The pesticide content was average of two measurements, with no more than 5% deviation between the measurements. The same procesure is repeted in precence of surfactants.

2.4 Desorption Experiments

Desorption processes were done as each test tube was placed in a thermostated shaker at 25ºC after equilibration for 48 h with different pesticide concentrations (2, 5, 10 and 15 μg ml^{-1}) the samples were centrifuged, 5ml of supernatant was removed from the adsorption equilibrium solution and immediately replaced by 5ml of water and was this repeated for four times. The resuspended samples were shaken for 0.5, 1, 3, 6, 9, 12, 24, and 48h for the kinetic study. Desorption of picloram was studied in the six selected soil samples, initially treated with different concentrations alone (2, 5, 10 and 15) μgml^{-1} in presence of surfactant, after equilibrium had been reached for 24h, 5ml were removed from the solution and immediately replaced by 5ml of the surfactant suspension used in the study. The resuspended samples were shaken for 24h, after sufficient time, were centrifuged and the desorbed picloram was measured as reported previously, this desorption procedure was repeated two times for each soil. The amount of picloram at each desorption stage was calculated as the difference between the initial amount adsorbed and the amount desorbed, all determinations were carried out in duplicate. Competitive picloram adsorption-desorption between soil and surfactant in the soil-picloram-water-surfactant system, in the presence HDTMA, SDS, and Tween-80 at concentrations of cmc/10, cmc, and cmc*20 were conducted adsorption-desorption isotherms [16].

3 Data Analysis

3.1 Adsorption Isotherms

During adsorption studies, equilibrium concentration of pesticide in solution (Ce) was determined by direct analysis of the solution and amount of pesticide adsorbed on soil (Cs) was computed by the difference between the initial and the equilibrium concentration in the aqueous phase. Analysis of control samples showed that, in the absent of soil, pesticide concentration remained constant during the course of the batch experiments [17].

3.2 Freundlich Adsorption-Desorption Isotherms

Adsorption isotherm parameters were calculated using the linearized form of Freundlich equation [18]. C_s and C_e were defined previously, K_F is Freundlich adsorption coefficients, and n is a linearity factor, it is also known as adsorption intensity, 1/n is the slope and $\log K_F$ is the intercept of the straight line resulting from the plot of $\log C_s$ versus $\log C_e$ shown in Fig-1. The values of K_F and 1/n calculated, from the regression equation showed that Freundlich adsorption model effectively describes isotherms for the pesticides in all cases were listed in Table 3.

$$\log C_s = \log K_F + \frac{1}{n}\log C_e \quad (1)$$

Desorption isotherms of picloram were fitted to the linearzed form of the Freundlich equation [19], [20].

$$\log C_s = \log K_{Fdes} + \frac{1}{n_{des}}\log C_e \quad (2)$$

The values of K_{Fdes} is Freundlich desorption coefficients, and 1/ n_{des} is a linearity factor, it is also known as desorp-

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tion intensity and from the regression equation showed that Freundlich desorption model effectively describes isotherms for the pesticides in all cases, [21], [22] were listed in Table 4. To investigate the effect of different types of surfactants on adsorption behavior of pesticides [23], [24].The Freundlich adsorption equation in the presence of surfactant used to determined follows as [8], [25].

$$\log C_s = \log K_s + \frac{1}{n_s}\log C_e \quad (3)$$

Where C_s is the amount of adsorbed herbicide equation in the presence of surfactant (µg ml^{-1}), C_e is the equilibrium concentration of herbicide in solution of herbicides in solution equation in the presence of surfactant (µg ml^{-1}), and K_s and n_s are the Freundlich affinity and nonlinearity coefficients respectively in the presence of surfactant. The Freundlich equation for desorption in the presence of surfactant, values of K_{sdes} for all experiments were calculated using the following equations

$$\log C_s = \log K_{sdes} + \frac{1}{n_{sdes}}\log C_e \quad (4)$$

Where C_s is the amount of picloram still adsorbed (µg g^{-1}), C_e is the equilibrium concentration of picloram in solution after desorption equation in the presence of surfactant (µg mL^{-1}), and K_{Fdes} (µg $g^{1-nfdes}$ / ml^{nfdes} g^{-1}) and n_{fd} are the Freundlich desorption affinity and nonlinearity coefficients, respectively equation, for all the three surfactant at the three different concentrations.

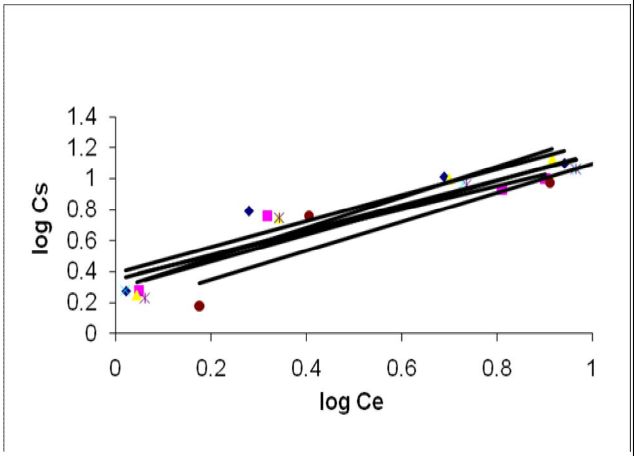

Fig.1. Fitted adsorption isotherm models (Ferundlich model) for picloram selected soils (♦ S_1, ■ S_2, ▲ S_3, x S_4, * S_5, ●S_6).

3.3 Hystersis ceofficient

A study of picloram desorption isotherms show positive hysteresis coefficients H in the six selected soil samples [8], [10]. Hysteresis coefficients H_1, can be determined by using the following equation.

$$H_1 = \frac{N_a}{N_{des}} \quad (5)$$

Where N_a / N_{des} ratio for Ferundlich adsorption and desorption constants, respectively, indicating the greater or lesser irreversibility of adsorption in all samples, the highest values corresponding for which the highest adsorption constant was obtained. The coefficient H_1 is a simple one and easy to use, Data in Table 5 demonstrated H_1 values for picloram from the selected soil samples in the range from 0.223-0.553 for desorption process, indicating an increase in the irreversibility of the adsorption of herbicide as the clay content increases [8].

4 Result and Discussion

2.1 Adsorption – Desorption Isotherms

Previously work indicated that the linear model not fitted properly most experimental data with the pesticides [12]. The non-linear adsorption isotherms might be expected for the compounds for which competition for a limited number of cation exchange sites contributes significantly to adsorption process. Data from batch equilibrium method revealed that the adsorption of herbicides on the selected soil samples followed the first order rate law. To investigate the effect of different types of surfactants on adsorption behavior of pesticides [26], [27]. The K_s values for picloram adsorption in the presences of cationic surfactant (HDTMA) The K_s values of picloram range between 0.940-1.344, 0.943-1.407, and 0.952-1.434 ml/g, for cmc/10, cmc, and cmc*20 respectively. Freundlich adsorption coefficients of picloram in the presence of anionic surfactant (SDS) was determined and summarized in table 3, the K_s values obtained were in the range 0.761-1.151, 0.654-1.141, and 0.631-1.099 ml/g, for cmc/10, cmc, and cmc*20 respectively. Batch equilibrium experiments performed for tween-80, picloram soil –water system and K_s values were determined and summarized in table 3. The K_s values were in the range 0.971 -1.229, 1.104-1.303, and 1.189-1.404 ml/g, for cmc/10, cmc, and cmc*20 respectively. The values of K_F, n and R^2 ranged from 1.078-1.211, 0.344-0.966, and 0.882-0.993 respectively for adsorption picloram without surfactant, while the values of K_{Fdes}, n and R^2 ranged from 1.045-1.586, 0.718-1.947, and 0.987-0.999 respectively for desorption of picloram without surfactant. The desorption isotherms of picloram with HDTMA treatment was lower. Data demonstrated in table 4 represents the values of K_{sdes}, n_{sdes} and R^2 for desorption of picloram from the selected soil samples. The values of Ksdes, n_{sdes} and R^2 ranged from 0.839-1.286, 0.267-0.619, and 0.889-0.993 respectively. However sorption of anionic herbicides picloram was almost unaffected by anionic surfactant SDS, slightly decrease in adsorption, with slightly increased in desorption of picloram was detected. Data demonstrated in table 4. K_{sdes}, n_{sdes} and R^2 for desorption of picloram from the selected soil samples.

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K_{sdes}, n_{sdes} and R^2 values ranged from 0.895-1.289, 0.494-0.818, and 0.889-0.999 for the desorption process respectively. The non-ionic surfactant Tween-80 at different concentrations enhanced desorption of herbicides from soils. All desorption isotherms showed that hysteresis coefficients were decreased. These variations were dependent on surfactant concentration and soil OM and the clay contents. The effect of tween-80 on desorption of the picloram was very low in soil with a high clay content. The results indicate the potential use of tween-80 to facilitate desorption of these herbicides from soil to the water-surfactant system. Values of K_{sdes}, n_{sdes} and R^2 for desorption of picloram from the selected soil samples. Data in Table 4 listed the values of K_{sdes}, n_{sdes} and R^2 ranged from 0.953-1.270, 0.429-0.650, and 0.888-0.995 respectively. Important aspect to be considered is the interaction of surfactant with soil, since it may, on one hand, alter the surfactant concentration in solution, thereby decreasing its efficiency for desorption, and on the other, alter the soil surface, where surfactant molecules may be adsorbed in the form of monomer or forming hemicelles or admicelles. Thus surfactant adsorption increases the organic content of the soil and increased hydrophobic surfaces, which may contribute to decrease in the organic compound desorption. Of all the above processes, the study of surfactant-enhanced desorption for organic pollutants adsorbed on soil has been addressed by many investigators in recent years although such information can only be considered a beneficial effect in the context of major engineered remediation processes. In the study of surfactant-enhanced desorption it is necessary to take into account the characteristics of the surfactant (e.g., chemical structure, hydrophilic-lipophilic balance [HLB], or cmc), its concentration in the soil-water system, the solubility and hydrophobicity of the characteristics of soil (e.g., OM, clay content). Enhanced solubility of pollutants has been clearly indicated by several authors at surfactant concentrations higher than the cmc. However, at surfactant concentrations below the cmc competitive adsorption of organic compound by soil and/or by a surfactant in solution may occur, and hence an increase or decrease in desorption of compound from soil, depending on the characteristics of soil and organic compound [28], [29].

4.2 *Hystersis* Coefficients

Desorption isotherms of picloram show a positive hysteresis coefficients H_1. Values of hysteresis coefficient for adsorption –desorption of picloram on the selected soil samples in the presence of HDTMA, SDS and tween-80 were summarized in Table 5. The results of present study, which show the decrease in H_1 values indicated higher hysteresis at lower pesticide concentration in presence of HDTMA, exhibited a higher sorption affinity and higher resistance for desorption[30]. Data in Table5 demonstrated that H_1 for desorption of picloram from the selected soil samples in the presence of HDTMA were in the range $S_3 > S_6 > S_5 > S_4 > S_1 > S_2$, values of H_1 ranged from 0.693-2.594. The increase or decrease in hysteresis of the adsorption-desorption isotherms in the presence of SDS solutions depend on the SDS concentration and on OM content of the soils .Below the cmc, SDS only increase the desorption of picloram in the highest OM content(3.196%). However, above the cmc*20 desorption of picloram increases in all soils while the efficiency of desorption increasing with OM content of the Soil [31], [32]. Data in Table 4 demonstrated the value of H_1 for desorption of picloram from the selected soil samples in the presence of SDS were in the range $S_5 > S_4 > S_6 > S_1 > S_2 > S_3$, and values of H_1 ranged from 0.493-1.667. Consistent with the previous study [33], [34]. The H_1 values for tween-80 decrease indicated higher hysteresis at lower picloram concentration. OM considered as the primary soil component responsible for the adsorption of non-ionic pesticides. Desorption of the neutral form was completely reversible, however, the charged species exhibited desorption-resistance fraction. The difference in sorption and desorption between the neutral and charged species is attributed to the fact that the neutral form partition by the hydrophobic binding to the soil, while anionic sorbs by a more specific exothermic adsorption reaction [35], [36]. Data in Table 4 demonstrated that H_1 for adsorption-desorption of picloram from the selected soil samples in the presence of tween-80 were in the range $S_2 > S_1 > S_5 > S_4 > S_6 > S_3$, and values of H_1 ranged from 0.331-2.741. Desorption of soil-associated pesticides, hysteresis, and possible mechanisms have received considerable attention in literature [37], [38]. Desorption rates of pesticides can be characterized by three types of processes, rapid desorption, rate-limited desorption, and a fraction that does not desorbed over experimental time scale. Many factors affect the adsorption-desorption of pesticides such as pesticide type; soil properties, organic matter, clay content, soil pH and environmental conditions [39], [40]. Equation 5 shows the main effect of surfactant at concentrations close to cmc is to increase the affinity of picloram for the soil with, except for soils high in clay content where the surfactant effect is to enhance the affinity of picloram for aqueous phase [41].

5 Conclution

Desorption rates of pesticides can be characterized by three types of processes, rapid desorption, rate-limited desorption, and a fraction that does not desorbed over experimental time scale. Many factors affect the adsorption-desorption of pesticides such as pesticide type; soil properties, organic matter, clay content, soil pH and environmental conditions. The batch kinetics experiments were used to differentiate the behavior of the pesticide in six agricultural soil samples. The desorption studies demonstrated that picloram has stronger affinity to all the selected soil samples than adsorption, and the soils varied widely in their adsorption capacities for picloram. We have further found that soil OC and clay content and the

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chemical nature of the constituents determined the adsorption affinity of the soil. Soil characteristics as solubility and hydrophobicity (e.g., OM, clay content). Enhanced solubility of pollutants has been clearly indicated by several authors at surfactant concentrations higher than the cmc.

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TABLE 1A
SOME PHYSICO-CHEMICAL PROPERTIES OF THE SELECTED SOIL SAMPLES

Soil	OM %	Moisture%	Loss On ignition%	C EC meq100g^{-1}	E.C*10^{-2} sm- inD.w	pH	
						In D.W	in $CaCl_2$
S_1	2.799	2.544	7.864	47.760	0.414	7.516	7.501
S_2	1.039	1.864	3.445	54.276	0.431	6.825	6.805
S_3	3.196	2.633	6.160	26.780	0.572	6.981	6.906
S_4	2.356	2.604	4.058	41.133	0.388	7.651	7.621
S_5	1.914	2.012	5.442	32.488	0.492	6.395	6.305
S_6	1.509	3.417	2.926	55.121	0.545	6.940	6.900

TABLE 1B
PARTICALE SIZE DISTIBUTION A AND THE TEXTURE OF THE SELECTED SOIL SAMPLES

No.	Soil	X (m)	Y (m)	Sand%	Silt %	Clay %	Texture
S1	Ha-labjh	$45^{+}58.905^{-}$	$35^{+}101.166^{-}$	4.4	39.4	56.2	Clay
S2	Darb nidik-han	$45^{+}42.31^{-}$	$35^{+}06.39^{-}$	37.4	46.1	20..2	Loam
S3	Jam-jamal	$44^{+}50.026^{-}$	$35^{+}31.355^{-}$	11.7	52.2	36.1	Silty Clay Loam
S4	Ha-labjh	$45^{+}58.786^{-}$	$45^{+}10.338^{-}$	20.2	48.0	31.8	Clay loam
S5	Kir-kuk	$44^{+}21.825^{-}$	$35^{+}34.940^{--}$	17.6	61.8	20.6	Silt Loam
S6	Duhok	$42^{+}53.944^{-}$	$36^{+}51.185^{-}$	11.6	45.7	42.7	Silty Clay

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TABLE 2
SELECTED PROPERTIES OF THE SURFACTANTS (M=6 TO 13, N=7 TO13)

Surfactant	Type	Formula	cmc gL^{-1}
HDTMA	Cationic	$C_{16}H_{33}$ $N(CH_3)_3Br$	0.3
SDS	anionic	$C_{18}H_{29}SO_4Na$	2.38
Tween-80	nonionic	$CH_3(CH_2)_mCH_2O(CH_2CH_2O)_nH$	0.04

TABLE 3
FREUNDLICH ADSORPTION COEFFICENT FOR THE ADSORPTION OF PICLORAM IN THE PRESENCE OF HDTMA, SDS AND TWEEN-80 OF THREE DIFFERENT CONCENTRATIONS ON THE SELECTED SOIL SAMPLES

Soil	K_F(ml/g) Without surfac. /n /R^2	K_s (ml/g) HDTMA /n_s /R^2			K_s (ml/g) SDS /n_s /R^2			K_s (ml/g) Tween-80/ n_s /R^2		
		cmc/10	cmc	cmc*20	cmc/10	cmc	cmc*20	cmc/10	cmc	cmc*20
S_1	1.171	1.006	1.092	1.177	1.061	1.035	0.865	1.054	1.277	1.327
	0.397	0.558	0.519	0.472	0.431	0.516	0.547	0.945	0.881	1.211
	0.933	0.970	0.957	0.994	0.973	0.951	0.903	0.973	0.881	0.901
S_2	1.085	0.940	0.943	0.952	0.984	0.974	0.814	1.199	1.218	1.221
	0.435	0.423	0.398	0.605	0.456	0.655	0.824	0.671	0.884	0.797
	0.973	0.991	0.990	0.980	0.977	0.989	0.939	0.960	0.939	0.937
S_3	1.211	1.344	1.374	1.397	0.761	0.654	0.631	1.021	1.104	1.211
	0.497	0.785	0.943	1.063	0.337	0.872	0.557	0.301	0.645	0.839
	0.997	0.985	0.975	0.974	0.811	0.852	0.704	0.971	0.974	0.974
S_4	1.078	1.142	1.153	1.195	0.963	0.936	0.852	0.971	1.117	1.189
	0.344	0.652	0.647	0.885	0.707	0.782	0.763	0.290	0.926	1.395
	0.999	0.965	0.976	0.938	0.929	0.914	0.901	0.997	0.923	0.893
S_5	1.168	1.198	1.199	1.211	1.151	1.141	1.099	1.229	1.303	1.404
	0.559	0.751	0.796	0.919	0.657	0.548	0.853	0.508	0.808	1.124
	0.978	0.950	0.948	0.949	0.920	0.928	0.971	0.989	0.963	0.936
S_6	1.189	1.328	1.407	1.434	0.816	0.794	0.675	1.003	1.198	1.211
	0.966	1.046	1.269	1.398	0.706	0.886	0.970	0.204	0.802	0.692
	0.882	0.871	0.865	0.884	0.788	0.762	0.752	0.926	0.987	0.990

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TABLE 4
FREUNDLICH DESORPTION COEFFICENT FOR THE DESORPTION OF PICLORAM IN THE PRESENCE OF HDTMA, SDS AND TWEEN-80 OF THREE DIFFERENT CONCENTRATIONS ON THE SELECTED SOIL SAMPLES

Soil	K_{Fdes}(ml/g) Without surfac. /n /R^2	K_{sdes} (ml/g) HDTMA /n_{sdes} /R^2			K_{sdes} (ml/g SDS/n_{sdes} /R^2			K_{sdes} (ml/g) Tween-80/ n_{sdes} /R^2		
		cmc/10	cmc	cmc* 20	cmc/10	cmc	cmc* 20	cmc/10	cmc	cmc* 20
S_1	1.045	0.839	1.211	1.237	0.895	0.964	1.219	1.174	1.199	1.256
	0.718	0.408	0.617	0.619	0.558	0.658	0.494	0.650	0.561	0.542
	0.999	0.985	0.991	0.993	0.901	0.889	0.949	0.995	0.919	0.992
S_2	1.586	1.286	1.270	1.273	1.014	1.161	1.184	0.953	1.152	1.175
	1.947	0.553	0.574	0.555	0.599	0.671	0.537	0.429	0.520	0.523
	0.987	0.979	0.988	0.989	0.939	0.981	0.996	0.888	0.938	0.94
S_3	1.066	1.136	1.217	1.223	1.156	1.198	1.202	1.018	1.167	1.270
	1.189	0.267	0.543	0.519	0.683	0.614	0.641	0.909	0.599	0.499
	0.999	0.961	0.948	0.979	0.999	0.961	0.963	0.999	0.974	0.970
S_4	1.277	1.004	1.199	1.208	1.058	1.164	1.189	1.189	1.197	1.212
	1.425	0.429	0.545	0.535	0.738	0.617	0.659	0.564	0.518	0.509
	0.992	0.932	0.957	0.959	0.912	0.966	0.999	0.977	0.971	0.974
S_5	1.398	1.038	1.196	1.212	1.009	1.082	1.241	1.097	1.146	1.158
	1.733	0.479	0.563	0.566	0.621	0.631	0.577	0.495	0.512	0.501
	0.998	0.896	0.926	0.938	0.981	0.975	0.995	0.952	0.961	0.965
S_6	1.493	1.162	1.177	1.197	1.105	1.211	1.289	1.183	1.196	1.206
	1.867	0.539	0.536	0.539	0.818	0.714	0.582	0.561	0.540	0.545
	0.995	0.889	0.911	0.934	0.998	0.923	0.974	0.982	0.968	0.975

TABLE 5
HYSTERSIS COEFFICENT FOR ADSORPTION- DESORPTION OF PICLORAM ON THE SELECTED D SOIL SAMPLES

Soi l	H_1 (HDTAM)			H_1(SDS)			H_1 (Tween-80)		
	cmc/10	cmc	cmc* 20	cmc/10	cmc	cmc*20	cmc/10	cmc	cmc*20
S_1	1.368	0.841	0.763	0.772	0.784	1.107	1.454	1.570	2.234
S_2	0.765	0.693	1.090	0.761	0.976	1.534	1.564	1.700	1.524
S_3	2.940	1.737	2.048	0.493	1.420	0.869	0.331	1.077	1.681
S_4	1.519	1.187	1.654	0.958	1.267	1.158	0.514	1.788	2.741
S_5	1.568	1.413	1.624	1.058	0.868	1.478	1.026	1.578	2.243
S_6	1.941	2.367	2.594	0.863	1.241	1.667	0.364	1.485	1.269

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A Few Aspects of Power Quality Improvement Using Shunt Active Power Filter

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Abstract- Power quality standards (IEEE-519) compel to limit the total harmonic distortion within the acceptable range .This paper mainly deals with shunt active power filter which has been widely used for harmonic elimination. Active power filter which has been used here monitors the load current constantly and continuously adapt to the changes in load harmonics. The performance of three phase shunt active power filter using instantaneous power theory with PI and Hysteresis current controller is explained in this paper.

Index Terms- Active power filters (APF), composite load, harmonic compensation, linear and non linear load, reactive power.

1 INTRODUCTION

A harmonic is a component of a periodic wave having a frequency that is an integral multiple of the fundamental power line frequency. Harmonics are the multiple of the fundamental frequency, and whereas total harmonic distortion is the contribution of all the harmonic frequency currents to the fundamental. Harmonics are the by-products of modern electronics. They occur frequently when there are large numbers of personal computers (single phase loads), uninterruptible power supplies (UPSs), variable frequency drives (AC and DC) or any electronic device using solid state power switching supplies [1] to convert incoming AC to DC. Non-linear loads create harmonics by drawing current in abrupt short pulses, rather than in a smooth sinusoidal manner.

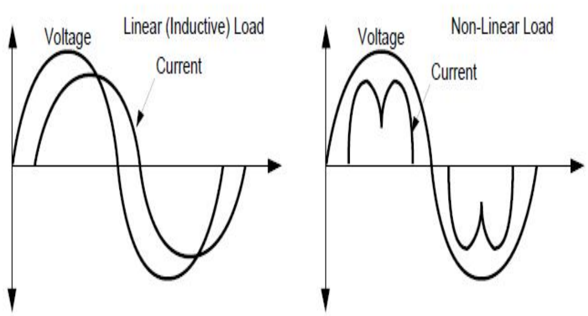

Fig: 1 Difference between Linear and Non-Linear Loads

The terms “linear” and “non-linear” define the relationship of current to the voltage waveform. A linear relationship exists between the voltage and current, which is typical of an across-the-line load. A non-linear load has a discontinuous current relationship that does not correspond to the applied voltage waveform. All variable frequency drives cause harmonics because of the nature of the frontend rectifier.

1.1 Need For Harmonic Compensation:

The implementation of Active Filters in this modern electronic age has become an increasingly essential element to the power network. With advancements in technology since the early eighties and significant trends of power electronic devices among consumers and industry, utilities are continually pressured in providing a quality and reliable supply. Power electronic devices [2] such as computers, printers, faxes, fluorescent lighting and most other office equipment all create harmonics. These types of devices are commonly classified collectively as ‘nonlinear loads’. Nonlinear loads create harmonics by drawing current in abrupt short pulses rather than in a smooth sinusoidal manner. The major issues associated with the supply of harmonics to nonlinear loads are severe overheating and insulation damage. Increased operating temperatures of generators and transformers degrade the insulation material of its windings. If this heating were continued to the point at which the insulation fails, a flashover may occur should it be combined with leakage current from its conductors. This would permanently damage the device and result in loss of generation causing widespread blackouts.

One solution to this foreseeable problem is to install active filters for each nonlinear load in the power system network. Although presently very uneconomical, the installation of active filters proves indispensable for solving power quality [1][2] problems in distribution networks such as harmonic current compensation, reactive current compensation, voltage sag compensation, voltage flicker compensation and negative phase sequence current compensation. Ultimately, this would ensure a polluted free system with increased reliability and quality.

The objective of this project is to understand the modeling and analysis of a shunt active power filter. In

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doing so, the accuracy of current compensation for current harmonics found at a nonlinear load, for the PQ theory control technique is supported and also substantiates the reliability and effectiveness of this model for integration into a power system network. The model is implemented across a two bus network including generation to the application of the nonlinear load.

The aim of the system simulation is to verify the active filters effectiveness for a nonlinear load. In simulation, total harmonic distortion measurements are undertaken along with a variety of waveforms and the results are justified accordingly.

One of the most important features of the shunt active filter system proposed is its versatility over a variety of different conditions. The application of the positive sequence voltage detector from within the active filter controller is the key component of the system. The positive sequence voltage detector gives incredible versatility to the application of the active filter, because it can be installed and compensate for load current harmonics even when the input voltage is highly distorted. When filters alike do not contain this feature and is installed with a distorted voltage input, the outcome is a low efficient current harmonic compensator with poor accuracy of compensation current determination.

1.2 Harmonic filters:

Harmonic filters are used to eliminate the harmonic distortion caused by nonlinear loads. Specifically, harmonic filters are designed to attenuate or in some filters eliminate the potentially dangerous effects of harmonic currents active within the power distribution system. Filters can be designed to trap these currents and, through the use of a series of capacitors, coils, and resistors, shunt them to ground. A filter may contain several of these elements, each designed to compensate a particular frequency or an array of frequencies.

1.3 Types of harmonic filters involved in harmonic compensation:

Filters are often the most common solution that is used to mitigate harmonics from a power system. Unlike other solutions, filters offer a simpler inexpensive alternative with high benefits. There are three different types of filters each offering their own unique solution to reduce and eliminate harmonics. These harmonic filters are broadly classified into passive, active and hybrid structures. The choice of filter used is dependent upon the nature of the problem and the economic cost associated with implementation.

A passive filter is composed of only passive elements such as inductors, capacitors and resistors thus not requiring any operational amplifiers. Passive filters are inexpensive compared with most other mitigating devices. Its structure may be either of the series or parallel type. The structure chosen for implementation depends on the type of harmonic source present. Internally, they cause the harmonic current to resonate at its frequency. Through this approach, the harmonic currents are attenuated in the LC circuits tuned to the harmonic orders requiring filtering. This prevents the severe harmonic currents traveling upstream to the power source causing increased widespread problems.

An active filter is implemented when orders of harmonic currents are varying. One case evident of demanding varying harmonics from the power system are variable speed drives. Its structure may be either of the series of parallel type. The structure chosen for implementation depends on the type of harmonic sources present in the power system and the effects that different filter solutions would cause to the overall system performance.

Active filters use active components such as IGBT-transistors to inject negative harmonics into the network effectively replacing a portion of the distorted current wave coming from the load.

This is achieved by producing harmonic components of equal amplitude but opposite phase shift, which cancel the harmonic components of the non-linear loads. Hybrid filters combine an active filter and a passive filter. Its structure may be either of the series or parallel type. The passive filter carries out basic filtering (5th order, for example) and the active filter, through precise control, covers higher harmonics.

1.4 Passive Filters:

Passive filters are generally constructed from passive elements such as resistances, inductances, and capacitances. The values of the elements of the filter circuit are designed to produce the required impedance pattern. There are many types of passive filters, the most common ones are single-tuned filters and high-pass filters. This type of filter removes the harmonics by providing a very low impedance path to the ground for harmonic signals.

1.4.1 Advantages and Disadvantages of the Passive Filters

The advantages of the Passive filters are:

- Shunt filters have the extra advantage of providing reactive compensation needed by the harmonic producing devices.

The disadvantages of the Passive filters are:

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- The source impedance influences the compensation characteristics of the LC filters.
- Frequency variation of the power system and tolerances in filter components affect the compensation characteristics of the LC filters.

1.5 Representation of harmonics:

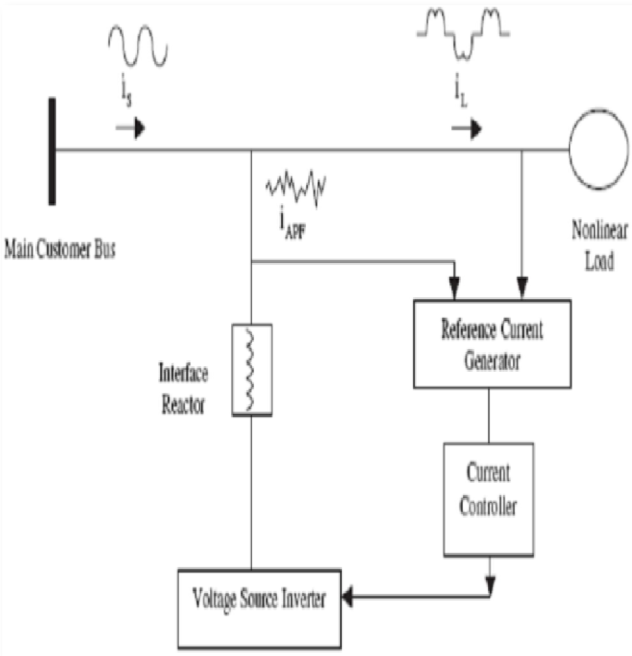

Fig: 2 Harmonics from a Non Linear Load

Fig 2 illustrates components of shunt connected active power filter with wave forms showing cancellation of harmonics from a non-linear load.

The current waveform for cancelling harmonics is achieved with the voltage source inverter and reactor. The reactor converts the voltage signal created by the inverter to a current signal. The desired waveform is obtained by accurately controlling the switches in the inverter. Control of the current wave shape is limited by the switching frequency of the inverter and by the available driving voltage across the interface reactor.

The driving voltage across the reactor determines the maximum di/dt that can be achieved by the filter. This is important because relatively high values of di/dt may be needed to cancel higher order harmonic components.

2 ACTIVE FILTERS

2.1 Introduction to Active Filters:

The increasing use of power electronics-based loads (adjustable speed drives, switch mode power supplies,etc.) to improve system efficiency and controllability is increasing the concern for harmonic distortion levels in end use facilities and on the overall power system. The application of passive tuned filters creates new system resonances which dependent on specific system conditions. In addition, passive filters often need to be significantly overrated to account for possible harmonic absorption from the power system. Passive filter ratings must be co-coordinated with reactive power requirements of the loads and it is often difficult to design the filters to avoid leading power factor operation for some load conditions.

Active filters have the advantage of being able to compensate for harmonic without fundamental frequency reactive power concerns. This means that the rating of the active power can be less than a comparable passive filter for the same non-linear load and the active filter will not introduce system resonances that can move a harmonic problem from one frequency to another.

2.2 Types of Active Filters:

Active filter can be classified based on the connection scheme as:

- Shunt active filter
- Series active filter and
- Hybrid active filter.

2.2.1 Shunt Active Filter:

The active filter concept uses power electronic equipment to produce harmonic current components that cancel the harmonic current components that cancel the harmonic current components from the non-linear loads.. In this configuration, the filter is connected in parallel with the load being compensated .Therefore the configuration is often referred to as an active parallel or shunt filter.

Fig 3 illustrates the concept of the harmonic current cancellation so that the current being supplied from the source is sinusoidal. The voltage source inverter used in the active filter makes the harmonic control possible. This inverter uses dc capacitors as the supply and can switch at a high frequency to generate a signal that will cancel the harmonics from the non-linear load.

The active filter does not need to provide any real power to cancel harmonic currents from the load. The harmonic currents to be cancelled show up as

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reactive power. Reduction in the harmonic voltage distortion occurs because the harmonic currents flowing through the source impedance are reduced. Therefore, the dc capacitors and the filter components must be rated based on the reactive power associated with the harmonics to be cancelled and on the actual current waveform (rms and peak current magnitude) that must be generated to achieve the cancellation.

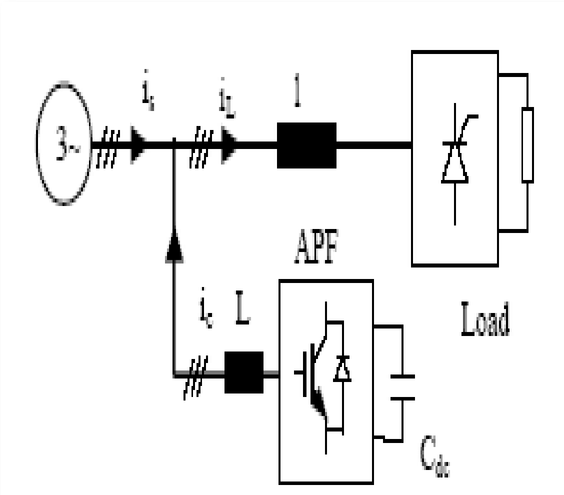
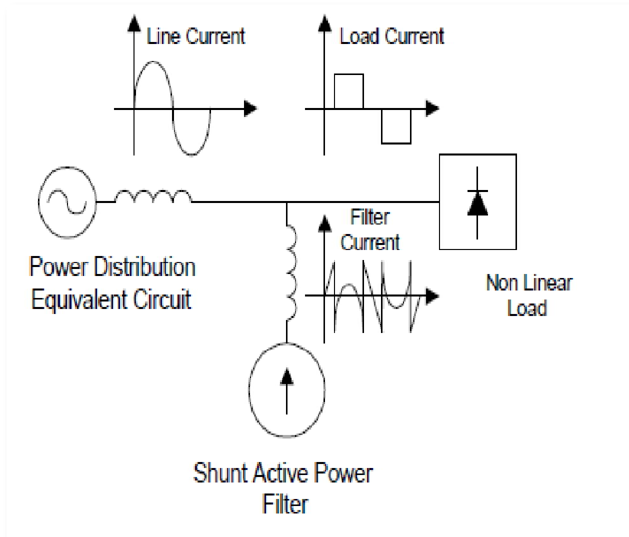


Fig: 3 Shunt Active Power Filter

The current wave form for canceling harmonics is achieved with the voltage source inverter in the current controlled mode and an interfacing filter. The filter provides smoothing and isolation for high frequency components. The desired current waveform is obtained by accurately controlling the switching of the insulated gate bipolar transistors (IGBT's) in the inverter. Control of the current wave shape is limited by the switching frequency of the inverter and by the available driving voltage across the interfacing inductance.

The driving voltage across the interfacing inductance determines the maximum di/dt that can be achieved by the filter. This is important because relatively high values of di/dt may be needed to cancel higher order harmonic components. Therefore, there is trade –off involved in sizing the interface inductor. A large inductor is better for isolation from the power system and protection from transient disturbances. However, the larger inductor limits the ability of the active filter to cancel higher order harmonics.

The inverter in the Shunt Active Power filter is a bilateral converter and it is controlled in the current Regulated mode i.e. the switching of the inverter is done in such a way that it delivers a current which is equal to the set value of current in the current control loop. Thus the basic principle of Shunt Active Filter is that it generates a current equal and opposite to the harmonic current drawn by the load and injects it to the point of coupling there by forcing the source current to be pure sinusoidal. This type of Shunt Active Power Filter is called the Current Injection Type APF.



. Fig: 4 shows need of shunt active filter

2.3 Harmonic compensation:

2.3.1 Current Harmonic Compensation:

Current harmonic compensation strategies are exceptionally important .Current harmonics are greatly reduced by the compensation of voltage harmonics at the consumer's point of common coupling. The reduction in current harmonics is not only important for reasons such as device heating and reduction in life of devices but also in design of power system equipment. One of the major design criteria covers the magnitude of the current and its waveform.

This is to reduce cable and feeder losses. Since the root mean square (RMS) of the load current incorporates the sum of squares of individual harmonics, true current harmonic compensation will aid system designers for better approached power rating equipment.

2.3.2 Harmonic detection and extraction:

A shunt active filter acts as a controllable harmonic current source. In principle, harmonic compensation is

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achieved when the current source is commanded to inject harmonic currents of the same magnitude but opposite phase to the load harmonic currents. Before the inverter can subtly inject opposing harmonic currents into the power system, appropriate harmonic detection strategies must be implemented to efficiently sense and determine the harmonic current from the nonlinear load.

2.4 Types of harmonic detection strategies:

There are 3 different types of harmonic detection strategies used to determine the current reference for the active filter. These are:

1. Measuring the load harmonic current to be compensated and using this as a reference command.

2. Measuring source harmonic current and controlling the filter to minimize it.

3. Measuring harmonic voltage at the active filter point of common coupling (PCC) and controlling the filter to minimize the voltage distortion.

So out of these harmonic detection strategies here we are using first method i.e., measuring the load current.

2.5 SPECIFICATION OF THE DESIGN

2.5.1 PI Controller Gain value:

K_P=0.32

K_I=0.12

Filter inductance=0.01H

Filter capacitance=1400µf

2.5.2 Active power filter:

Table 1: active power filter specifications

Dc link voltage		600V
DC side capacitance	C	1000µF
AC side inductance	L_c	30mH
AC side resistance	R_c	10Ω

3 SHUNT ACTIVE POWER FILTER

3.1) Introduction to Open Loop System:

In typical distribution systems the proliferation of diode rectifiers has resulted in serious utility interface issues as well as power quality degradation such as supply current and voltage harmonics, reactive power, flicker and resonance problems in industrial applications. Voltage distortion due to current harmonics is becoming a major problem for the utilities at distribution levels.

Utilities more frequently encounter harmonic related problems, such as higher transformer and line losses, reactive power and resonance problems, required derating of distribution equipment, harmonic interactions between customers or between the utility and load, reduced system stability and reduced safe operating margins. This has led to the proposal of more stringent requirements regarding power quality; standards such as IEEE-519 [5] reflect these preoccupations.

Passive filters are being used widely for harmonic elimination. However, they may create system resonances, need to be significantly overrated to account for possible harmonic absorption from the power system, must be coordinated with reactive power requirements of the loads and need a separate filter for each harmonic frequency to be cancelled. The concept of using active power filters to mitigate harmonic problems and to compensate reactive power was proposed more than two decades ago. Since then the theories and applications of active power filters have become more popular and have attracted great attention. The concept of using active power filters to mitigate harmonic problems and to compensate reactive power was proposed more than two decades ago.

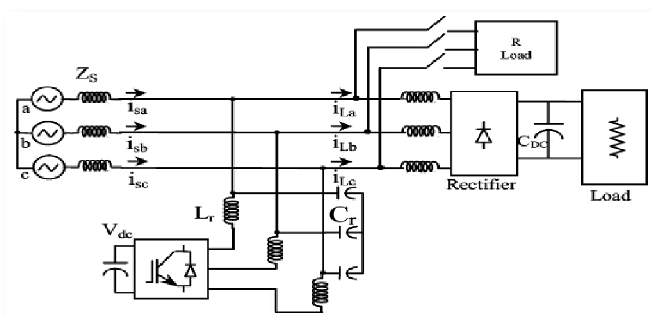

Fig:5 Main block diagram of an open loop system

. Without the drawbacks of passive harmonic filters, the active power filter appears to be a viable solution for reactive power compensation as well as for eliminating harmonic currents.

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The schematic diagram of a power conditioner system employing shunt APF is as shown above. The composite load includes a three-phase diode rectifier, and a three phase R load. The ac side inductance is often sufficiently provided by the connected transformer. The unbalance in the present study is created by connecting resistive load between two phases.

3.3 Instantaneous Power Theory:

Proposed theory[6] based on instantaneous values in three-phase power systems with or without neutral wire, and is valid for steady-state or transitory operations, as well as for generic voltage and current waveforms called as Instantaneous Power Theory[7] or Active- Reactive (p-q) theory which consists of an algebraic transformation (Clarke transformation) of the three-phase voltages in the *a-b-c* coordinates to the α-β-*0* coordinates, followed by the calculation of the p-q theory instantaneous power components.

$$\begin{bmatrix} vo \\ v\alpha \\ v\beta \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \\ 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & \sqrt{3}/2 \end{bmatrix} \begin{bmatrix} va \\ vb \\ vc \end{bmatrix}$$

Here va,vb,vc are(voltages at load) converted into vo,$v\alpha$,vβ by using above matrix[8]

$$\begin{bmatrix} io \\ i\alpha \\ i\beta \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1/\sqrt{2} & 1/\sqrt{2} & 1/\sqrt{2} \\ 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} ia \\ ib \\ ic \end{bmatrix}$$

Here ia,ib,ic (load currents)converted into io,iα,iβ by using above matrix

$$\left.\begin{aligned} P &= v\alpha i\alpha + v\beta i\beta; \\ q &= v\alpha i\beta - v\beta i\alpha; \end{aligned}\right\} \text{Real and reactive power}$$

So from the above equations active and reactive powers are obtained

$$\begin{bmatrix} p \\ q \end{bmatrix} = \begin{bmatrix} v\alpha & v\beta \\ -v\beta & v\alpha \end{bmatrix} \begin{bmatrix} i\alpha \\ i\beta \end{bmatrix}$$

Above equations pandq can be written in a matrix form

$$\begin{bmatrix} i\alpha \\ i\beta \end{bmatrix} = \frac{1}{\Delta} \begin{bmatrix} v\alpha & -v\beta \\ v\beta & v\alpha \end{bmatrix} \begin{bmatrix} p \\ q \end{bmatrix}$$

p and q are converted in to by using iα,iβ.

$$\Delta = v\alpha^2 + v\beta^2$$

$$\begin{bmatrix} i\alpha \\ i\beta \end{bmatrix} = \begin{bmatrix} i\alpha_p \\ i\beta_p \end{bmatrix} + \begin{bmatrix} i\alpha_q \\ i\beta_q \end{bmatrix}$$

$$\begin{bmatrix} ica^* \\ icb^* \\ icc^* \end{bmatrix} = \sqrt{\frac{2}{3}} \begin{bmatrix} 1/\sqrt{2} & 1 & 0 \\ 1/\sqrt{2} & -1/2 & \sqrt{3}/2 \\ 1/\sqrt{2} & -1/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} ico^* \\ ic\alpha^* \\ ic\beta^* \end{bmatrix}$$

so finaly we can obtain ica^*,icb^*,icc^*.

3.4 Block Diagram :

Active filters produce a nearly sinusoidal supply current by measuring the harmonic currents and then injecting them back into the power system with a 180° phase shift.

The output waveform is thus the harmonic power which is recognized as containing only current harmonics.

This is justified as once can assume a perfectly sinusoidal voltage source by virtue of the integrated positive sequence voltage detector.

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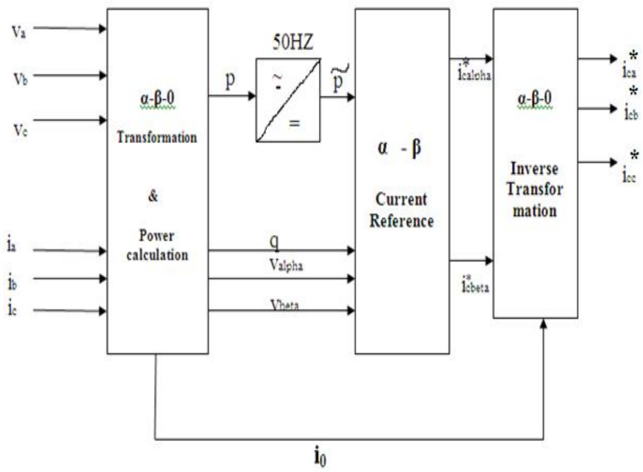

Fig:6 Reprsenting instantaneous power theory

3.5 Hysterisis current controller:

A controlled current inverter is required to generate this compensating current. Hysteresis current control is a method of controlling a voltage source inverter so that an output current is generated which follows a reference current waveform. This method controls the switches in an inverter asynchronously to ramp the current through an inductor up and down so that it tracks a reference current signal. Hysteresis current control is the easiest control method to implement.

A hysteresis current controller is implemented with a closed loop control system and is shown in diagrammatic form in Fig 7. An error signal, e(t), is used to control the switches in an inverter. This error is the difference between the desired current, iref(t), and the current being injected by the inverter, iactual(t). When the error reaches an upper limit, the transistors are switched to force the current down. When the error reaches a lower limit the current is forced to increase. The minimum and maximum values of the error signal are emin and emax respectively.

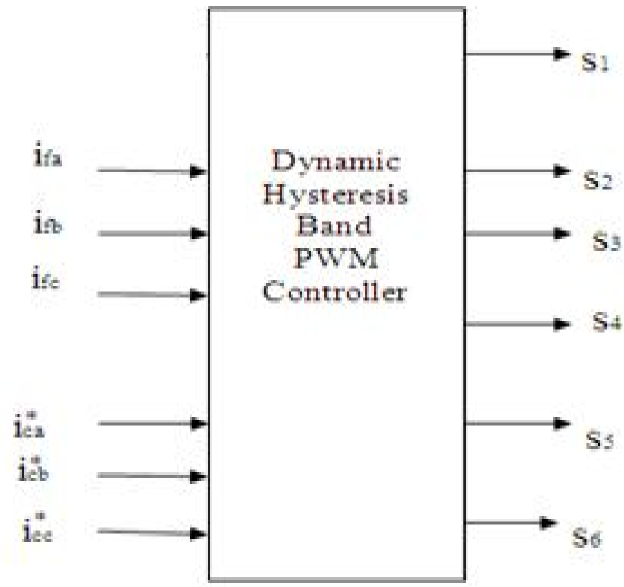

Fig: 7 block diagram

The range of the error signal, $e_{max} - e_{min}$, directly controls the amount of ripple in the output current from the inverter and this is called the Hysteresis Band.

The hysteresis limits, e min and e max, relate directly to an offset from the reference signal and are referred to as the Lower Hysteresis Limit and the Upper Hysteresis Limit. The current is forced to stay within these limits even while the reference current is changing.

So these switching pulses $S_1, S_2, S_3, S_4, S_5, S_6$ are given to the voltage source inverter,that will produce harmonic current to compensate the harmonic current produced by non linear load.

4 SIMULATION RESULTS WITH FFT ANALYSIS

4.1 Open Loop with Voltage source inverter as a Filter with one load:

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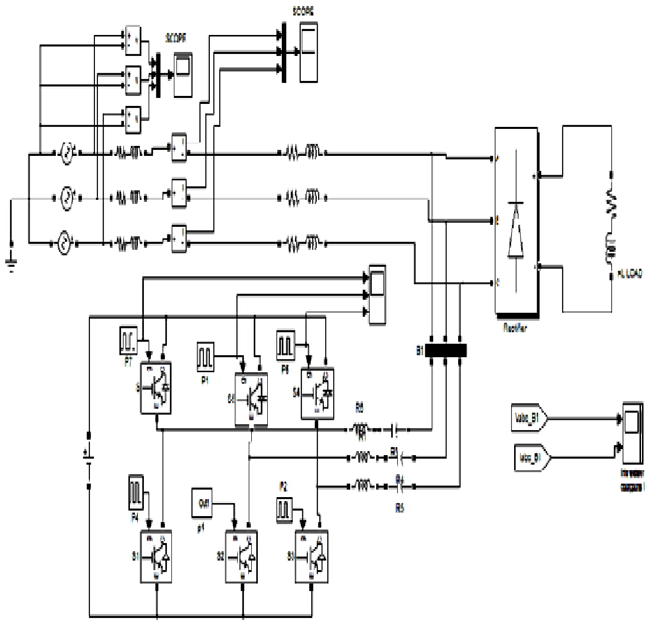

Fig 8: Open Loop with Voltage source inverter as a Filter with one load

The voltage source inverter used in the active power filter makes the harmonic control possible. This inverter uses a D.C capacitor. as the supply and can switch at a high frequency to generate a signal which will cancel the harmonics from the nonlinear load. Here a VSI with 180^0 mode is used which will reduce the T.H.D.

4.1.1 Voltage source inverter output:

Here filter is taken with voltage source inverter to reduce higher order harmonics.

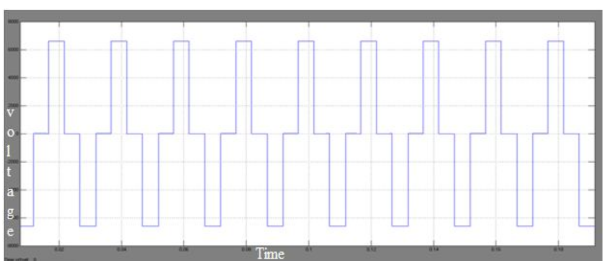

Fig:9 Voltage source inverter out put

4.1.2 FFT Analysys Of Load Current with one load:

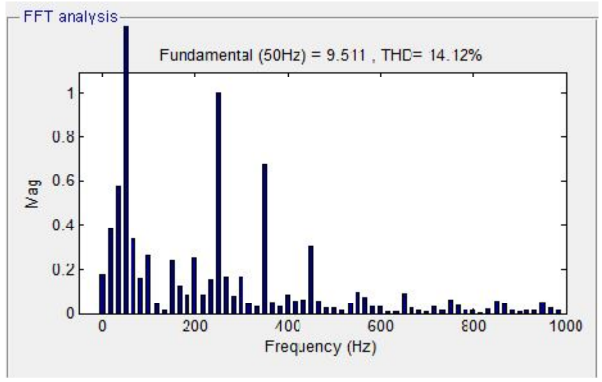

Fig: 10 FFT Analysys Of Load Current with one load

Here open loop with one load (power electronic load) is used,line voltage of vsi and fft analysis for load current is taken.

4.2 Open loop circuit with composite load:

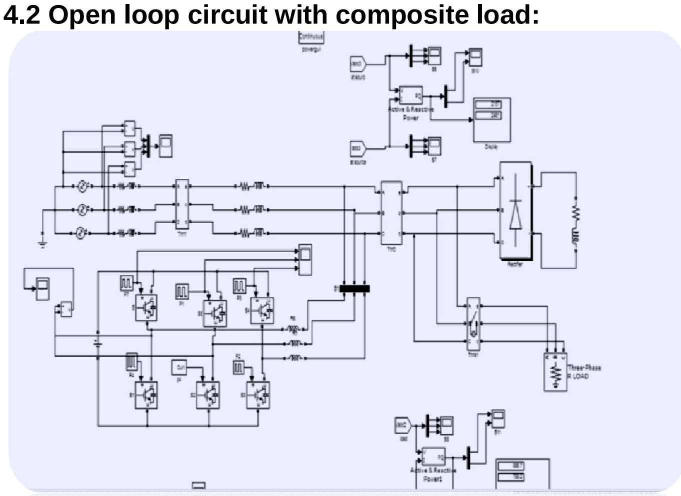

Fig:11 open loop system with both linear and non-linear load

Open-loop systems sense the load current and the harmonics it contains. They inject a fixed amount of power in the form of current (mainly reactive) into the system, which may compensate for most of the harmonics and/or reactive power available. Since there is no feedback loop on this system, there is no reference to check the performance and accuracy of the filter.

4.2.1 Fft analysis of load current:

Here we can observe in open loop system higher order hormonics are reduced.Here as another load is added to the system at system total hormonic current distortion will be increased.

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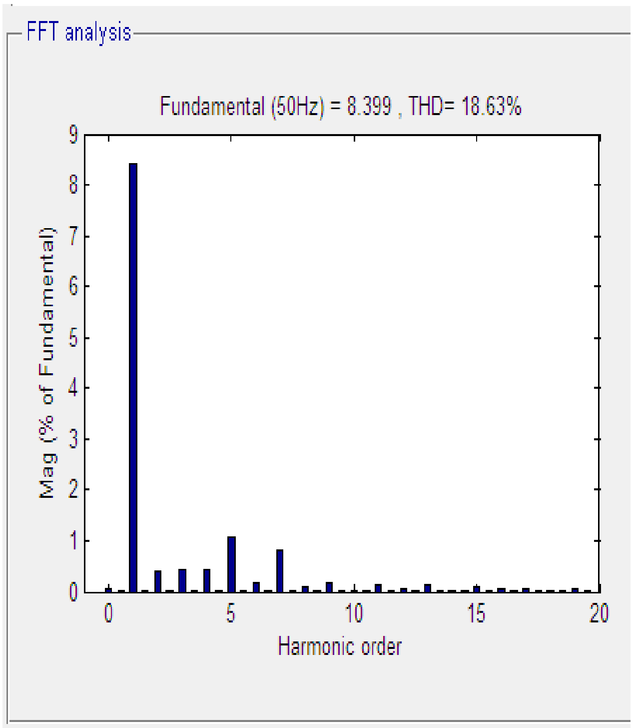

Fig:12 fft analysis of load current

4.3 Closed loop system:

Closed loop control systems incorporate a feedback loop providing greater accuracy of current injection for harmonic compensation as well as reactive power reduction well over the open loop design.

Here in the closed loop system a reference current is generated. This reference current is generated by using instantaneous power theory based on active power filter .This current is given input to the hysteresis current controller and compared with the one the phase current.

So these two currents are compared and an error will be produced this error given to the hysteresis loop band. In the hysteresis control technique the error function is centered in a preset hysteresis band. When the error exceeds the upper or lower hysteresis limit the hysteretic controller makes an appropriate switching decision to control the error within the preset band.

4.3.1 Closed Loop Simulation Circuit:

Closed loop control systems incorporate a feedback loop providing greater accuracy of current injection for harmonic compensation as well as reactive power reduction well over the open loop design.

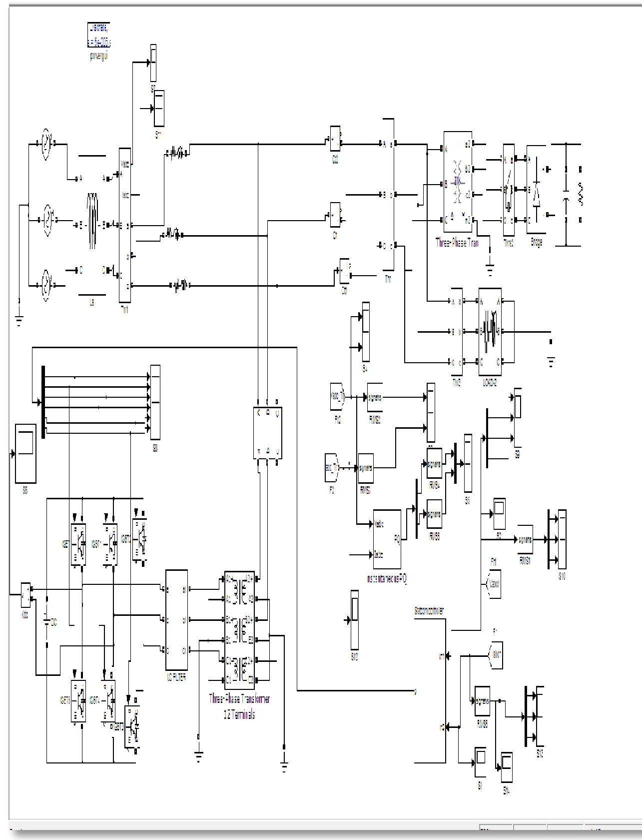

Fig:13 closed loop

4.3.2 Triggering pulses :

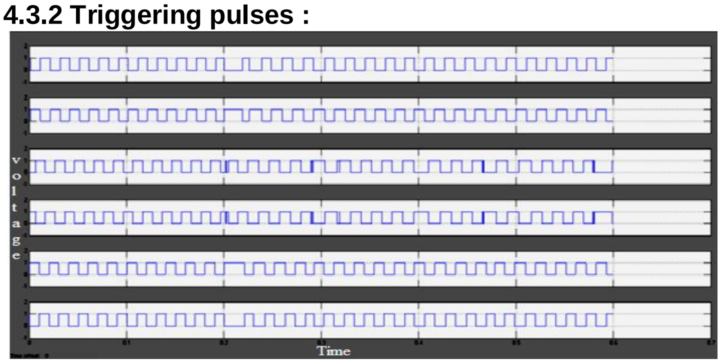

Fig:14 Triggering pulses obtained by hysteresis controller

4.3.3 Compensating voltage:

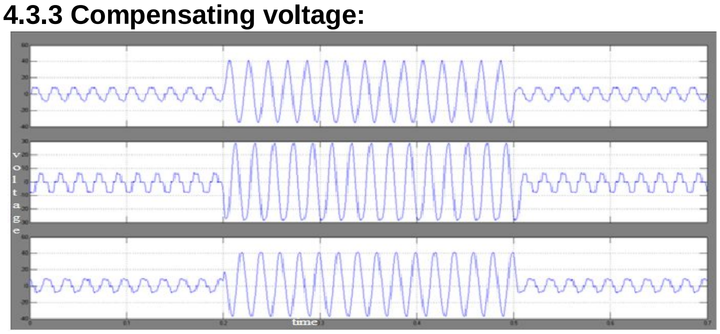

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Fig: 15 Compensating current in open loop

4.3.4 Compensating current in closed loop:

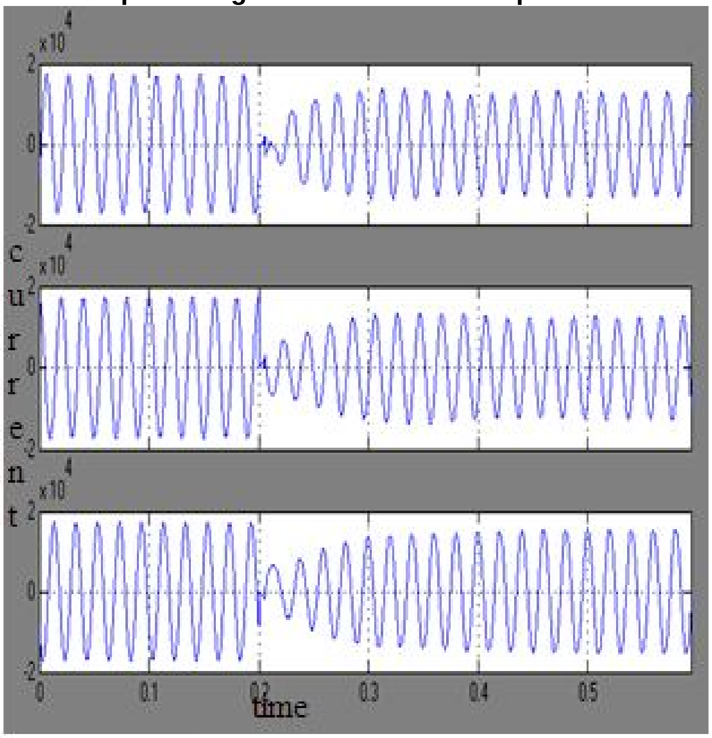

Fig:16 compensating current in closed loop

4.3.8 Fft analysis of load current:

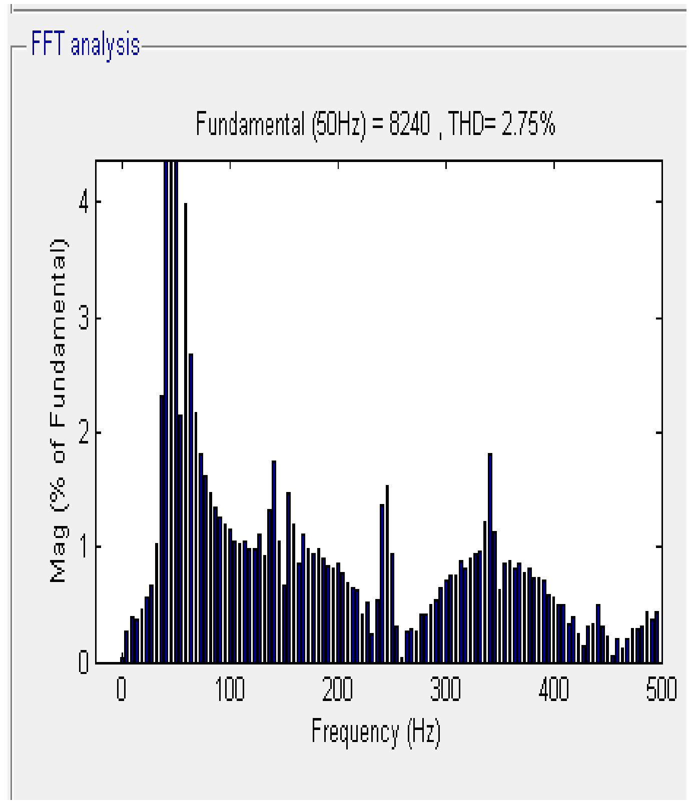

Fig: 17 FFT analysis for load current

4.4 Comparison:

Table 2:Total Harmonic Distortion Comparison Table

TOTAL HARMONIC DISTORTION (%)			
Method	Open loop only with Nonlinear load	Open loop with Composite load	Closed loop with composite load
Instantaneous Power Theory used for active power filters with PI and hysteresis current controller	14.12	18.26	2.75

CONCLUSION

A current decomposition technique based on instantaneous power theory for shunt active power filters is studied, a simu link model is designed and total harmonic distortion is calculated using FFT analysis.Active power filter which has been used here monitors the load current constantly and continuously adapt to the changes in load harmonics. The performance of three phase shunt active power filter using instantaneous power theory with PI and hysteresis current controller is explained in this paper.

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Tidal Power: An Effective Method of Generating Power

Shaikh Md. Rubayiat Tousif, Shaiyek Md. Buland Taslim

Abstract—This article is about tidal power. It describes tidal power and the various methods of utilizing tidal power to generate electricity. It briefly discusses each method and provides details of calculating tidal power generation and energy most effectively. The paper also focuses on the potential this method of generating electricity has and why this could be a common way of producing electricity in the near future.

Index Terms — dynamic tidal power, tidal power, tidal barrage, tidal steam generator.

1 Introduction

TIDAL power, also called tidal energy, is a form of hydropower that converts the energy of tides into electricity or other useful forms of power. The first large-scale tidal power plant (the Rance Tidal Power Station) started operation in 1966.

Although not yet widely used, tidal power has potential for future electricity generation. Tides are more predictable than wind energy and solar power. Among sources of renewable energy, tidal power has traditionally suffered from relatively high cost and limited availability of sites with sufficiently high tidal ranges or flow velocities, thus constricting its total availability. However, many recent technological developments and improvements, both in design (e.g. dynamic tidal power, tidal lagoons) and turbine technology (e.g. new axial turbines, cross flow turbines), indicate that the total availability of tidal power may be much higher than previously assumed, and that economic and environmental costs may be brought down to competitive levels.

Tidal power traditionally involves erecting a dam across the opening to a tidal basin. The dam includes a sluice that is opened to allow the tide to flow into the basin; the sluice is then closed, and as the sea level drops, traditional hydropower technologies can be used to generate electricity from the elevated water in the basin.

2 Generation of Tidal Energy

Tidal power is the only form of energy which derives directly from the relative motions of the Earth–Moon system, and to a lesser extent from the Earth–Sun system. Tidal forces produced by the Moon and Sun, in combination with Earth's rotation, are responsible for the generation of the tides. Other sources of energy originate directly or indirectly from the Sun, including fossil fuels, conventional hydroelectric, wind, biofuels, wave power and solar. Nuclear energy makes use of Earth's mineral deposits of fissile elements, while geothermal power uses the Earth's internal heat which comes from a combination of residual heat from planetary accretion (about 20%) and heat produced through radioactive decay (80%).

Tidal energy is extracted from the relative motion of large bodies of water. Periodic changes of water levels, and associated tidal currents, are due to the gravitational attraction of the Sun and Moon. Magnitude of the tide at a location is the result of the changing positions of the Moon and Sun relative to the Earth, the effects of Earth rotation, and the local geography of the sea floor and coastlines.

Because the Earth's tides are ultimately due to gravitational interaction with the Moon and Sun and the Earth's rotation, tidal power is practically inexhaustible and classified as a renewable energy resource.

A tidal generator uses this phenomenon to generate electricity. Greater tidal variation or tidal current velocities can dramatically increase the potential for tidal electricity generation.

The movement of the tides causes a continual loss of mechanical energy in the Earth–Moon system due to pumping of water through the natural restrictions around coastlines, and consequent viscous dissipation at the seabed and in turbulence. This loss of energy has caused the rotation of the Earth to slow in the 4.5 billion years since formation. During the last 620 million years the period of rotation has increased from 21.9 hours to the 24 hours we see now; in this period the Earth has lost 17% of its rotational energy. While tidal power may take additional energy from the system, increasing the rate of slowdown, the effect would be noticeable over millions of years only, thus being negligible.

2.1 Generating methods

Tidal power can be classified into three generating methods: Tidal stream generator, Tidal barrage, Dynamic

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tidal power.

3 Tidal StreamGenerator

A tidal stream generator is a machine that extracts energy from moving masses of water, or tides. These machines function very much like underwater wind turbines, and are sometimes referred to as tidal turbines.

Tidal stream generators are the cheapest and the least ecologically damaging among the three main forms of tidal power generation.

Fig. 1. The world's first commercial-scale and grid-connected tidal stream generator.

3.1 Types of tidal stream generators

Since tidal stream generators are an immature technology, no standard technology has yet emerged as the clear winner, but large varieties of designs are being experimented with, some very close to large scale deployment. Several prototypes have shown promise with many companies making bold claims, some of which are yet to be independently verified, but they have not operated commercially for extended periods to establish performances and rates of return on investments.

3.2 Energy calculations

Various turbine designs have varying efficiencies and therefore varying power output. If the efficiency of the turbine "ξ" is known the equation below can be used to determine the power output of a turbine.

The energy available from these kinetic systems can be expressed as:

$$P = \frac{\xi \rho A V^3}{2}$$

Where:
ξ = the turbine efficiency
P = the power generated (in watts)
ρ = the density of the water (seawater is 1025 kg / m³)
A = the sweep area of the turbine (in m²)
V = the velocity of the flow

Relative to an open turbine in free stream, depending on the geometry of the shroud shrouded turbines are capable of as much as 3 to 4 times the power of the same turbine rotor in open flow.

3.3 Resource assessment

While initial assessments of the available energy in a channel have focus on calculations using the kinetic energy flux model, the limitations of tidal power generation are significantly more complicated. For example, the maximum physical possible energy extraction from a strait connecting two large basins is given to within 10% by:

$$P = 0.22\,\rho\,g\,\Delta H_{max}\,Q_{max}$$

Where
ρ = the density of the water (seawater is 1025 kg/m³), g = gravitational acceleration (9.81 m / s²), ΔH_{max} = maximum differential water surface elevation across the channel, Q_{max}= maximum volumetric flow rate though the channel.

4 Tidal Barrage

A Tidal barrage is a dam-like structure used to capture the energy from masses of water moving in and out of a bay or river due to tidal forces.

Instead of damming water on one side like a conventional dam, a tidal barrage first allows water to flow into the bay or river during high tide, and releasing the water back during low tide. This is done by measuring the tidal flow and controlling the sluice gates at key times of the tidal cycle. Turbines are then placed at these sluices to capture the energy as the water flows in and out.

4.1 Generating methods

The barrage method of extracting tidal energy involves building a barrage across a bay or river that is subject to tidal flow. Turbines installed in the barrage wall generate power as water flows in and out of the estuary basin, bay, or river. These systems are similar to a hydro dam that produces Static Head or pressure head (a height of water pressure). When the water level outside of the basin or lagoon changes relative to the water level inside, the turbines are able to produce power.

The basic elements of a barrage are caissons, embank-

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ments, sluices, turbines, and ship locks.

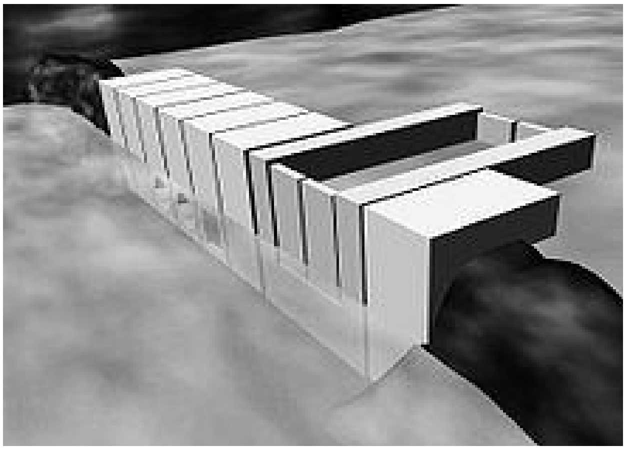

Fig. 2. An artistic impression of a tidal barrage, including embankments, a ship lock and caissons housing a sluice and two turbines.

4.2 Ebb generation

The basin is filled through the sluices until high tide. Then the sluice gates are closed. (At this stage there may be "Pumping" to raise the level further). The turbine gates are kept closed until the sea level falls to create sufficient head across the barrage, and then are opened so that the turbines generate until the head is again low. Then the sluices are opened, turbines disconnected and the basin is filled again. The cycle repeats itself. Ebb generation (also known as outflow generation) takes its name because generation occurs as the tide changes tidal direction.

4.3 Flood generation

The basin is filled through the turbines, which generate at tide flood. This is generally much less efficient than ebb generation, because the volume contained in the upper half of the basin (which is where ebb generation operates) is greater than the volume of the lower half (filled first during flood generation). Therefore the available level difference — important for the turbine power produced — between the basin side and the sea side of the barrage, reduces more quickly than it would in ebb generation. Rivers flowing into the basin may further reduce the energy potential, instead of enhancing it as in ebb generation. Of course this is not a problem with the "lagoon" model, without river inflow.

4.4 Pumping

Turbines are able to be powered in reverse by excess energy in the grid to increase the water level in the basin at high tide (for ebb generation). This energy is more than returned during generation, because power output is strongly related to the head. If water is raised 2 ft (61 cm) by pumping on a high tide of 10 ft (3 m), this will have been raised by 12 ft (3.7 m) at low tide. The cost of a 2 ft rise is returned by the benefits of a 12 ft rise. This is since the correlation between the potential energy is not a linear relationship, rather, is related by the square of the tidal height variation.

4.5 Two-basin schemes

Another form of energy barrage configuration is that of the dual basin type. With two basins, one is filled at high tide and the other is emptied at low tide. Turbines are placed between the basins. Two-basin schemes offer advantages over normal schemes in that generation time can be adjusted with high flexibility and it is also possible to generate almost continuously. In normal estuarine situations, however, twobasin schemes are very expensive to construct due to the cost of the extra length of barrage. There are some favorable geography, however, which are well suited to this type of scheme.

4.6 Tidal lagoon power

Tidal pools are independent enclosing barrages built on high level tidal estuary land that trap the high water and release it to generate power, single pool, around 3.3W/m2. Two lagoons operating at different time intervals can guarantee continuous power output, around 4.5W/m2. Enhanced pumped storage tidal series of lagoons raises the water level higher than the high tide, and uses intermittent renewable for pumping, around 7.5W/m2 i.e. 10 x 10 km delivers 750MW constant output 24/7. These independent barrages do not block the flow of the river and are a viable alternative to the Severn Barrage.

4.7 Energy calculations

The energy available from a barrage is dependent on the volume of water. The potential energy contained in a volume of water is:

$$E = \tfrac{1}{2} A \rho g h^2$$

Where:
h is the vertical tidal range,
A is the horizontal area of the barrage basin,
ρ is the density of water = 1025 kg per cubic meter (seawater varies between 1021 and 1030 kg per cubic meter) and g is the acceleration due to the Earth's gravity = 9.81 meters per second squared.

The factor is half due to the fact that the basin flows empty through the turbines; the hydraulic head over the dam reduces. The maximum head is only available at the moment of low water, assuming the high water level is still present in the basin.

4.8 Example calculation of tidal power generation

Assumptions:

Let us assume that the tidal range of tide at a particular place is 32 feet = 10 m (approx)

The surface of the tidal energy harnessing plant is 9 km² (3 km × 3 km) = 3000 m × 3000 m = 9 × 106 m2

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Density of sea water = 1025.18 kg/m^3

Mass of the sea water = volume of sea water × density of sea water

= (area × tidal range) of water × mass density

= $(9 \times 10^6 m^2 \times 10 m) \times 1025.18 kg/m^3$

= 92×10^9 kg (approx)

Potential energy content of the water in the basin at high tide =

½ × area × density × gravitational acceleration × tidal range squared

= $½ \times 9 \times 10^6 m^2 \times 1025 kg/m^3 \times 9.81 m/s^2 \times (10 m)^2$

=4.5×10^{12} J (approx)

Now we have 2 high tides and 2 low tides every day. At low tide the potential energy is zero.

Therefore the total energy potential per day = Energy for a single high tide × 2

= 4.5×10^{12} J × 2

= 9×10^{12} J

Therefore, the mean power generation potential = Energy generation potential / time in 1 day

= 9 × 1012 J / 86400 s

= 104 MW

Assuming the power conversion efficiency to be 30%: The daily-average power generated = 104 MW * 30% / 100%

= 31 MW (approx)

Because the available power varies with the square of the tidal range, a barrage is best placed in a location with very high-amplitude tides. Suitable locations are found in Russia, USA, Canada, Australia, Korea, and the UK. Amplitudes of up to 17 m (56 ft) occur for example in the Bay of Fundy, where tidal resonance amplifies the tidal range.

5 Dynamic Tidal Power

Dynamic tidal power or DTP is a new and untested method of tidal power generation. It would involve creating large damlike structure extending from the coast straight to the ocean, with a perpendicular barrier at the far end, forming a large 'T' shape. This long T-dam would interfere with coast-parallel oscillating tidal waves which run along the coasts of continental shelves, containing powerful hydraulic currents

5.1 Description

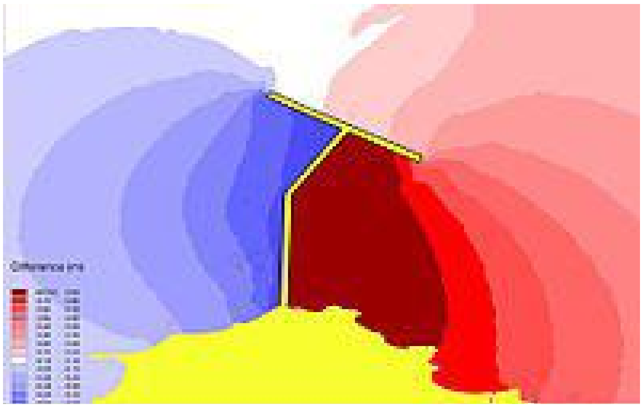

Fig. 3. Top-down view of a DTP dam. Blue and dark red colors indicate low and high tides, respectively.

A DTP dam is a long dam of 30 to 60 km which is built perpendicular to the coast, running straight out into the ocean, without enclosing an area. The horizontal acceleration of the tides is blocked by the dam. In many coastal areas the main tidal movement runs parallel to the coast: the entire mass of the ocean water accelerates in one direction, and later in the day back the other way. A DTP dam is long enough to exert an influence on the horizontal tidal movement, which generates a water level differential (head) over both sides of the dam. The head can be converted into power using a long series of conventional low-head turbines installed in the dam.

5.2Benefits

A single dam can accommodate over 8 GW (8000 MW) of installed capacity, with a capacity factor of about 30%, for an estimated annual power production of each dam of about 23 billion kWh (83 PJ/yr). To put this number in perspective, an average European person consumes about 6800 kWh per year, so one DTP dam could supply energy for about 3.4 million Europeans. If two dams are installed at the right distance from one another (about 200 km apart), they can complement one another to level the output (one dam is at full output when the other is not generating power). Dynamic tidal power doesn't require a very high natural tidal range, so more sites are available and the total availability of power is very high in countries with suitable conditions, such as Korea, China, and the UK (the total amount of available power in China is estimated at 80 - 150 GW).

5.3Challenges

A major challenge is that a demonstration project would yield almost no power, even at a dam length of 1 km or so, because the power generation capacity increases as the square of the dam length (both head and volume increase in a more or less linear manner for increased dam length, resulting in a quadratic increase in power generation). Economic viability is estimated to be reached for dam lengths of about 30 km. Other concerns include:

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shipping routes, marine ecology, sediments, and storm surges. Amidst the great number of challenges and few environmental impacts the method of utilizing tidal power to generate electricity has great potential and is certainly a technology most of the countries will try to harness in near future.

Acknowledgment

We would like to thank Prof. Sekh Abdur Rob for helping us with his valuable ideas and supporting us throughout. We would like to thank him for motivating us to work on tidal power.

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Design and Development of Fault Tolerent Control system for an Infant Incubator

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Abstract— This paper proposes the design and implementation of real time monitoring of an infant incubator, based on sensor fault tolerant control system, using a PIC microcontroller. Temperature and humidity are two parameters considered for the design infant incubator. The purpose of a Fault tolerant control systems (FTCS) scheme is to ensure that faults do not result in malfunctioning and system failure and to achieve the of best performance even with minimum number of sensors working. Fault tolerant control systems (FTCS) have ability to detect sensor fault automatically and to isolate faulty sensor which leads to system failure. The fault detection and the isolation (FDI) problem is an inherently complex one and for this reason the immediate goals are to preserve the stability of the process and, if is possible, to control and continue the process in a slightly degraded manner. The role of the FDI algorithms is that the control equipment must automatically isolate the faulted area, to adopt the correct attitude, to generate, to choose and to validate the correct decision. Prototype of infant incubator using FTCS was implemented by using redundant sensor with Build in self test (BIST) facility.

Index Terms— Sensor fault tolerant control, real time based, microcontroller, FTCS.

1 INTRODUCTION

THE objective of a fault tolerant control system (FTCS) is to maintain system availability when fault occurs, to improve the reliability of the control system and to minimize the effects on the system performance and safety [1].

Fault is a kind of malfunction in the system, which may lead to system degradation or any unacceptable performance of the system. The output of the Sensor should be constrained between the lower and upper limits, if it crosses these bounds then it is said that the senor is failed.

Fault tolerant control (FTC) has been increasing in the last few years because FTC system has the ability to increase complex systems reliability and performance requirement in the events of faults. The design of a FTC system requires knowledge of advanced control mechanism [3]. Systems mostly are very complicated. Designing a FTC system could also be very challenging. Different types of faults such as actuators, sensors, and system faults can occur. Each type of fault requires different approach to work with. A fault tolerant control system must be able to perform, fault detection, fault isolation, and fault diagnosis [3]. FTC should also have the ability to detect faults and provide correction. Fault tolerant control system results on two approaches: active and passive. The active approach relies on fault detection and isolation (FDI) scheme to detect the occurrence of faults in the system and to identify the source and severity of the faults. Secondly, in passive FTC, potential component faults are known a prior and are all taken into consideration in the control system design stage [5].

Infant incubator provides a controlled environment for newborns needing special care, such as those born prematurely. By placing an infant in an incubator, doctors and nurses can set and monitor different aspects of the child's environment in order to create ideal conditions for survival and moreover it protect infants from pollutants and infection[2].

This paper proposes the design and development of microcontroller based temperature and humidity controller for an infant incubator monitors and controls these two parameters constantly which are very critical for the normal growth of the new born (premature) babies. Infant incubator is used mainly to keep a baby's care temperature stable at 37˚Celsius and the relative humidity is maintained at (45 to 55)%RH.This system can automatically control the infant's temperature at optimum level and to maintain high relative humidity so as to minimize the thermal loss. The developed system must be user friendly, cost effective and accurate.

2 SENSOR FAULT TOLERANT CONTROL SYSTEM

Infant incubators and other advances in medical technology have made it possible for small or premature babies to survive in higher numbers than they did in the middle of the 20th century. An incubator is an infant-stimulating system used for intensive care of the new born, premature or sick baby. It provides a safe and clean environment, which has fresh air, clean and sterile am-

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bient conditions for the babies. In addition to these, the incubator environment provides a homogeneous and stable temperature, a relative humidity (RH) level that are needed especially for intensive care of the premature baby.

The sensor fault tolerant control was implemented for an infant incubator system. The system mainly consists of the microcontroller along with two temperature sensors, two humidity sensors, switches connected on either side of the sensors, a relay board with fan and heater, an LCD and LED's for display purpose. The block diagram of an infant incubator is shown in the figure 1.

The input of the sensor ambient condition of infant incubator and the output of the sensor is connected to the analog to digital converter (ADC) of the microcontroller. The microcontroller gets the value from the sensors and then displays in LCD display. The control action is taken by the micro controller to detect which sensor is failed or working properly according to the values taken by the sensors. The LED's, LCD display and the relay board are connected to the I/O ports of the microcontroller. The heater and fan are connected to the relay board.

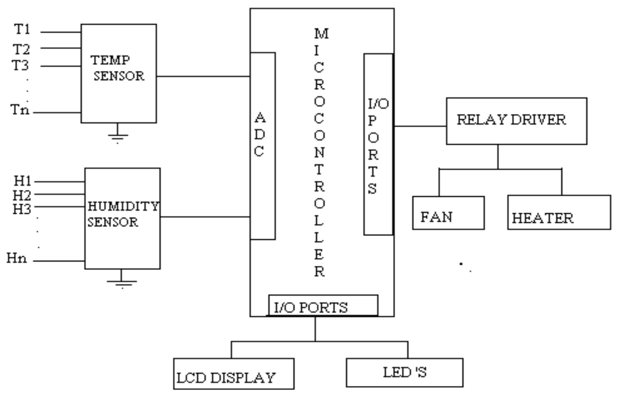

Fig. 1. Block Diagram of an infant incubator.

3 IMPLEMENTATION OF FTCS

Temperature and humidity are two very important parameters that need to be monitored continuously in the infant incubator chamber. Similar environment can be replicated for the pre-term infant or new born baby. Temperature can be displayed in terms of degree Celsius (0C) and humidity in terms of relative humidity which is expressed as % Relative Humidity (%RH).

3.1 Hardware Implementation of FTCS

The PIC16F877A microcontroller chip selected for the purpose of realizing the plant model. The model mainly consists of two LM35 temperature sensors, two CHR-01 humidity sensors, power supply circuitry, Switching board with 8 LED'S (4 red and 4 green), 8 switches connected, each on either side of the 4 sensors, and a relay board for connection of a fan and a heater. The implementation blockdiagram was shown in the figure 2.

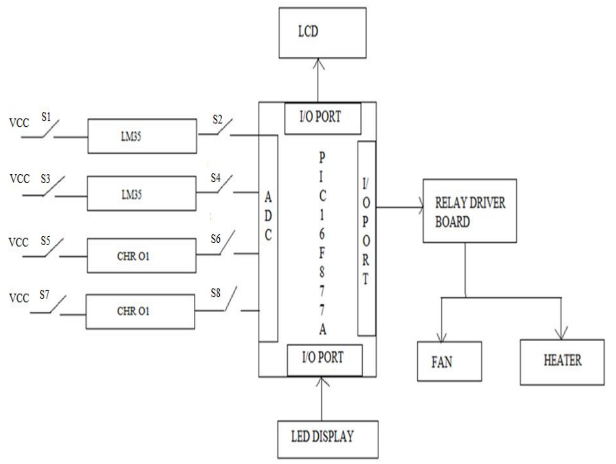

Fig.2: Implementation block diagram of an infant incubator

LM35 is an integrated circuit temperature Sensor and CHR01 is an Impedance type humidity sensor are shown in the figure 3 (a), (b). The three pins of LM35 sensors are input pin (is connected to VCC power supply), the output is connected to the ADC of the microcontroller and the ground pin is connected to the ground. ULN2002 used as driver to relay. Through relay load terminals the heater and fan are connected as shown in the figure 4 (a).

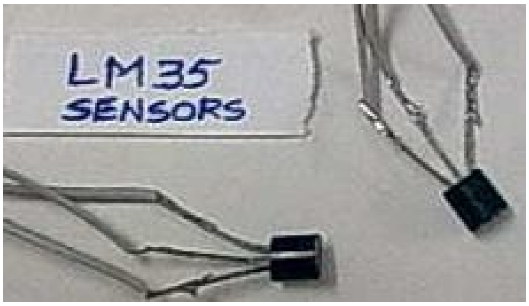

Fig.3 (a) LM35 Temperature Sensors

Fig.3 (b) CHR-01 Humidity Sensor

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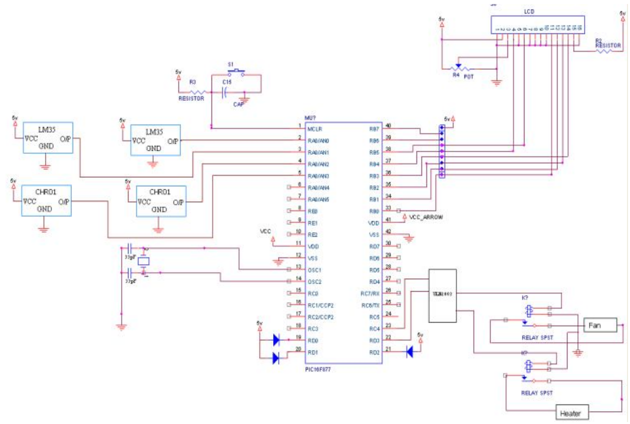

Fig.4 (a) Circuit diagram of the hardware components in the infant incubator.

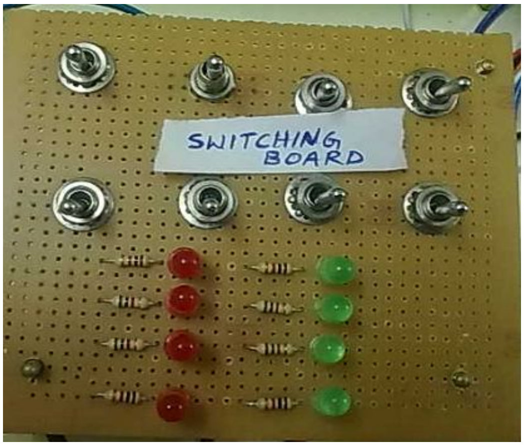

Fig.4 (b) Switching Board practice

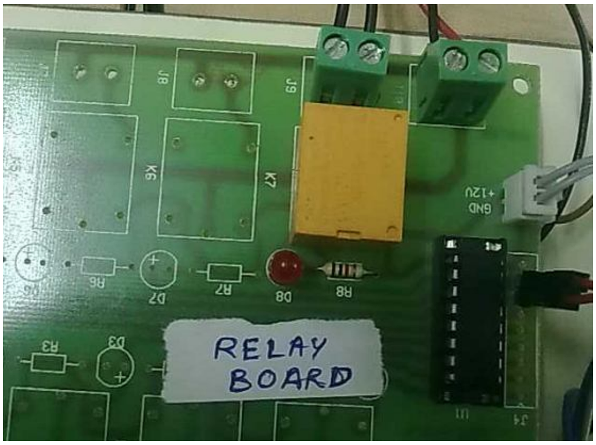

Fig.4 (c): Relay Board.

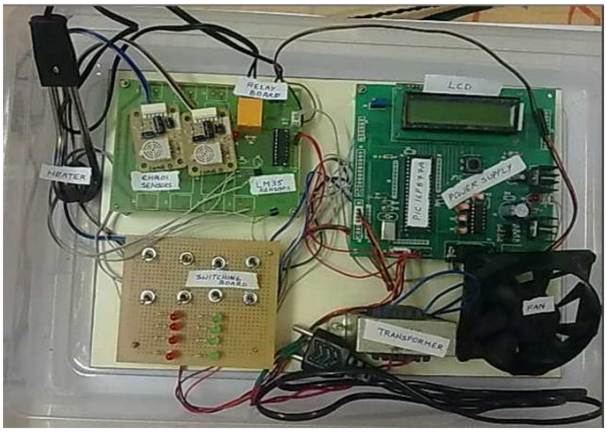

Fig 4 (d) Hardware Implementation of the FTCS for Infant Incubator

The switching board consists of 8 ON/OFF switches and 8 LEDs used to do self test of FTCS system. Of these 8 LEDs 4 are red LEDs and 4 are green LED's. Red LED glows, indicate the failure operation and the green LED-glows, indicate the correct and the safe operation and their component layout are shown in the figure 4 (b), (c).

Figure 4 (d) shows the complete hardware implementation of the FTCS Infant incubator system.It has micro-controller module, sensors module (two temperature and two humidity sensors), BIST module (sensor switching board), Power supply module, and Load driver module with fan and heater.

3.2 Software implementation of FTCS

Consider,

T1 is the value from the temperature sensor1
T2 is the value from the temperature sensor2
H1 is the value from the humidity sensor1
H2 is the value from the humidity sensor2

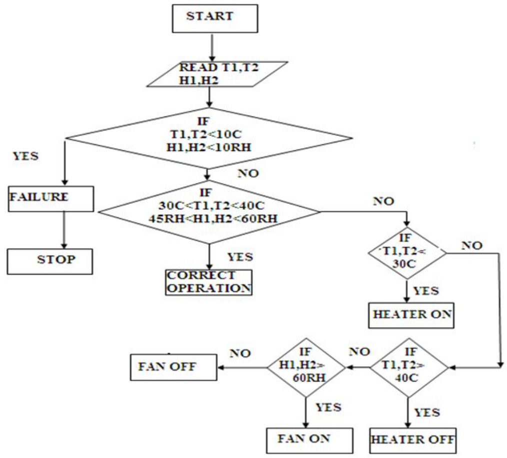

Fig.4(e) Flow chart of the operation of the Infant Incubator system.

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TABLE 1
Analysis of the Sensor Fault Tolerant Control System

T1	T2	H1	H2	RELIABLE	OPERATION
1	1	1	1	100%	No Fault has occured. The system works without any warnings
0	1	0	1	50%	Fault occured.The system works with some warnings
1	0	1	0	50%	Fault occured.The system works with some warnings
0	0	0	0	0%	Failure . The system stops working
0	0	1	1	50%	Fault occured. The system operation is disturbed
1	1	0	0	50%	Fault occured. The system operation is disturbed
1	0	0	0	25%	Fault occured. The system operation is disturbed
0	0	1	0	25%	Fault occured. The system operation is disturbed

Table 1 shows the sensor conditions for FTCS. The flowchart shown in the figure 4 (e) explains the operation of the sensor fault tolerant control of an infant incubator system. The T1, T2, H1, H2 values are taken from the sensors, the microcontroller reads the values and then compares them with the upper and lower limits. If it is not within the limit then the heater or fan operations are handled. If the values read by the sensors are less then 10°C or 10RH then the sensors are said to be failed. If all the sensors show the error value then the system is said to be a failure one and the operation should be stopped.

4 RESULTS AND DISCUSSION OF FTCS

Figure 5(a) shows the Simulation results of complete circuit carried out using Proteus software. The results obtained from the PIC16F877A microcontroller interfaced with two temperature sensors, two potentiometers as humidity sensors, an LCD and LED's. The LCD is used to monitor the sensor readings. The LED's are also connected for identification of the sensor working properly.

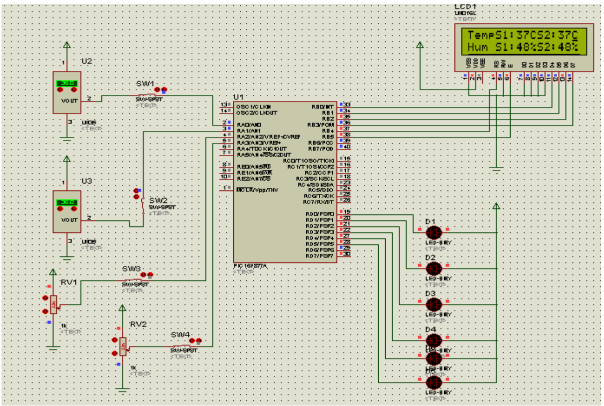

Fig.5(a) Simulation result showing Temperature sensors and Humidity sensors are working effectively.

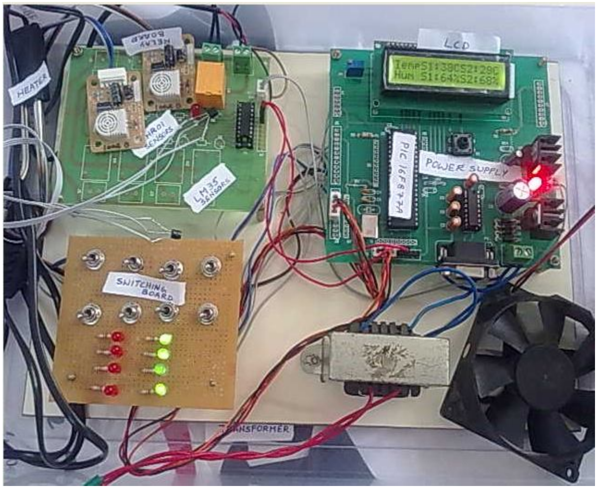

Fig.5(b) Hardware of FTCS showing Temperature sensors and Humidity sensors are working effectively.

The figure 5 (b) shows that the two LM35 temperature sensors and the two CHR01 humidity sensors are working correctly and the system is said to be 100% reliable. The LED's glowing indicates the sensors are working properly and there is no malfunction in the system. The LCD display shows both the temperature and the humidity sensors values are within the specified range.

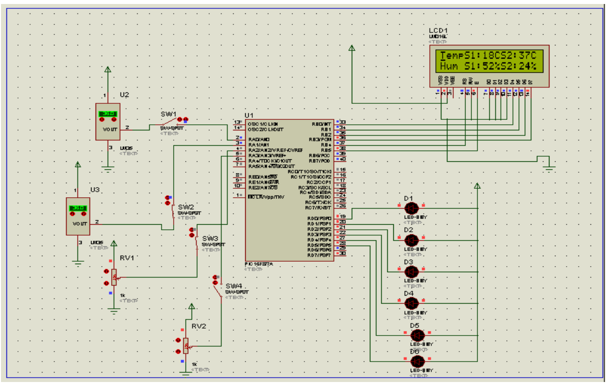

Fig.5(c) FTCS Showing One humidity sensor and one temperature senor are isolated.

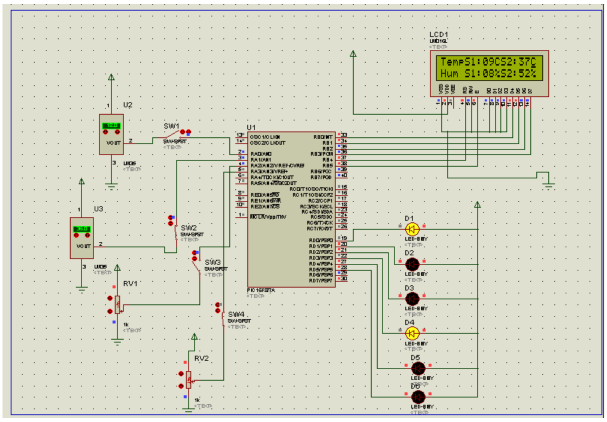

Fig.5(d) One humidity sensor and one temperature senor are failed.

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Figure 5 (c) shows that the only one LM35 temperature sensor and the only one CHR01 humidity sensor are working correctly. In that case the system is said to be 50% reliable. If one of the LED was not glowing indicates the system operation continues with some warnings. The LCD display shows one temperature sensor value and the one humidity sensor value are within the specified range and one temperature sensor value and the one humidity sensor value are not within the range since they are isolated.

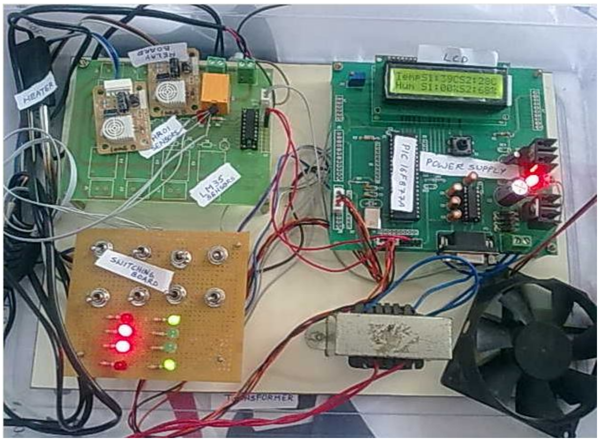

Fig.5 (e) FTCS showing one humidity sensor and one temperature senor are failed.

The figure 5 (d), (e) shows that the only one LM35 temperature sensor and the only one CHR01 humidity sensor are working correctly and one temperature sensor and one humidity sensor are failed. The system is said to be 50% reliable. The LED's are not glowing indicates the system operation is not disturbed but some warnings are arised. The LCD display shows one temperature sensor value and the one humidity sensor value are within the specified range and one temperature sensor value and the one humidity sensor value are not within the range since they are failed.

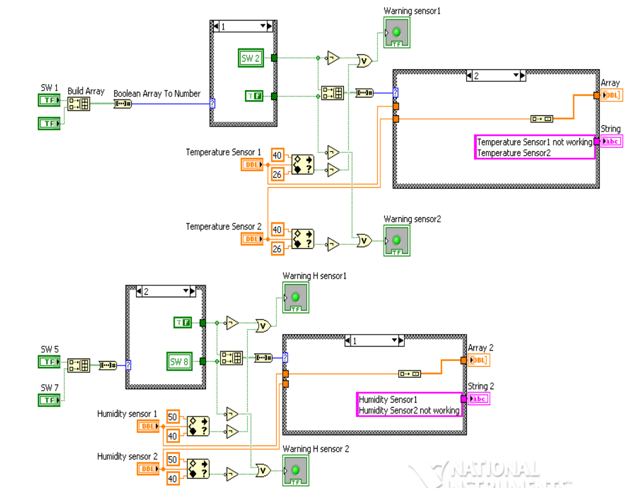

Fig.5(f) Block diagram of the switching operation using LABVIEW

The figure 5 (f), (g) shows the implementation of FTCS infant incubator in LABVIEW environment, that the all the sensors are working effectively and the value displayed also is within the desired range. So the system works correctly without any error or warnings. The LED glowing indicates the error or failure operation.

Fig.5 (g) Front Panel view of switching operation using LABVIEW.

The results are analyzed for different conditions of sensor. If they are not within the desired upper and lower limits then the LED indicating the specific sensor glows as the alarm to inform that the sensor is failed or an error is occurred to the sensor.

6 CONCLUSION

A suitable and realistic sensor fault tolerant control system for real-time implementation on an infant incubator for parameters like temperature and humidity is implemented according to the specifications given in Table:1 using the PIC16F877A microcontroller. The system uses the redundancy technique, i.e., if one sensor is failed then the microcontroller considers the value from the other sensor. The FTCS oeration represented by the flowcharts are then translated into equivalent C language and compiled using MPLAB IDE, the PIC16F877A software development tool. MPLAB IDE then translates the C files into corresponding hex files which are uploaded onto the PIC16F877A microcontroller. The microcontroller embedded with the proposed FTCS for real time implementation. Software Simulation using proteus IDE and circuit was implemented with hardware and tested. Test result shows PIC microcontroller is capable of realizing the FTCS operation.By simulation results were obtained for various input conditions manually, by ON and OFF of the switches connected in series andparallel to the sensors. Using LABVIEW, the operation BIST implemented with the switches is explained for how the LED glows and indicates the safe and error and failure operation. The different sensor condition are considered and tested. For each and every condition and the output is determined. By various tests infant incubator with FTCS was working effectively and it is observed that the overall system has a

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reliabity of 50%.

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Behavior of Eight Bus System with TC-IPC

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Abstract— Environmental, regulatory and economic constraints have restricted the growth of electric power transmission facilities, and the topologies to enlarge the levels of power transmission and enhance stability through existing transmission lines have become greatly needed. Many approaches have been proposed for solving the stability problems found in power system operations. Considering the diversity of both, the solutions and the problems, it is often difficult to identify the most suitable solution. The main purpose of this paper is to demonstrate the capability of Inter Phase Power Flow (IPC) Controller as a mean for stability improvement in power systems. In this paper 8 bus system is used as a test bed, the results are shown with and without TC-IPC. The results indicate the robustness of this Flexible AC Transmission System (FACTS) controller to the variation of system operating conditions.

Index Terms— Controlled Series Compensator (CSC), Eight Bus System, Flexiable ac transmission system (FACTS), Interphase power controller, Static phase shifting transformer, TC-IPC, UPFC

1 Introduction

The basic operating requirements of an AC power system are that the synchronous generators must remain in synchronism and the voltages must be kept close to their rated values. The capability of a power system to meet these requirements in the face of possible disturbance is characterized by its transient (or first swing), dynamic (or power oscillation), and voltage stability. Transient stability may be defined as the ability of an electric power system to remain in synchronism after being subjected to a major system disturbance (such as a short circuit). According to equal-area criteria transient stability of a power system is maintained if the accelerating area equals the decelerating area during the first rotor swing following the fault clearance.

To avoid stability problems a fast power flow control within the first swing of the generator is required. This can be achieved by different means, such as high performance excitation systems and high ceiling voltage, breaking resistors usage, superconducting magnetic energy storage systems and etc.

The recent availability of solid-state power switching devices with controlled turn off capability has made possible further advances in power conversion and control, leading to the development of a new generation of FACTS devices. FACTS (Flexible AC Transmission Systems) devices, as discussed in references , are first of all, effective tools for dynamic power flow control. On the other hand power flow is clearly related to a system's transient stability problems. As a result FACTS devices,
such as UPFC (Unified Power Flow Controller), SPS (Static Phase Shifting Transformers) , CSC (Controlled Series Compensator) , are presented as an effective tool to mitigate transient stability problems in electric power systems. These devices are power electronic based controllers, which can influence transmission system voltages, currents, influence transmission system voltages, currents, impedances and/or phase angle rapidly. Thus FACTS devices (or controllers) can improve both the security and flexibility of a power system. This paper presents the capability of IPC (Interphase Power Controller) as a mean for power stability improvement. Concerning this matter, it is necessary to replace the conventional PST (Phase Shifting Transformer) with the static PST (SPS). The result of these changes is a new FACTS device, which is referenced to it as Thyristor Controlled IPC or TC-IPC.

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2 Introduction to IPC

One of the problems for interconnected power systems is overrating of circuit breakers and associated substation equipment due to short circuit level. Conventional options to decrease the short circuit levels are splitting existing bus into two or more sections, addition of series reactors in transmission lines and using transformers with high impedance or replacing over-duty substation circuit breakers and associated equipments. However, none of the above methods provide additional transmission capability or ability to control and redirect the power flow.

Splitting an existing bus into more than one section decreases the substation fault problem in a relatively costeffective manner, but operating flexibility and reliability will be decreased. In practice, it may be difficult to obtain permission to change the existing bus configuration. Series reactors can neither completely eliminate the fault current contributions nor efficiently reduce the transmission constraints. At normal conditions, series reactors absorb reactive power. Under heavy loading conditions, this solution can make more problems for voltage regulation. Replacing the underrated circuit breakers and associated substation equipments with higher interrupting devices, is another method to overcome the fault duty problem . Depending on voltage levels, the number of circuit breakers involved and desired new rating for the breakers, the replacement of breakers can be expensive. In addition, scheduling large number of circuit breaker replacements imposes planning and engineering challenges.

Some new techniques for fault limitation such as series compensation, flexible alternative current transmission systems (FACTS), phase shifting transformer (PST) or Inter phase Power Controller (IPC) in an existing substation can be very attractive options. In the present thesis, the role of IPC is discussed .

3 IPC Description

The basic design goal in IPC technology is to find passive solutions to fundamental frequency problems. Power electronics modules can be added in situations where rapid control action is required to damp oscillations or prevent excessive voltage variations. Hence, basic IPC solutions utilize only conventional equipment, such as capacitors, inductors and phase-shifting transformers. They generate no harmonics and have no commutation losses. Robustly built, they require much less maintenance than power electronics-based devices.

The IPC does not have a fixed configuration, being more a technology for creating different and innovative power flow controllers with diverse characteristics and configurations. Generically, it is a seriesconnected device consisting of two parallel branches, each with an impedance in series with a phase-shifting element (Figure 1). The four design parameters (two impedances and two phase shifts) allow enormous design flexibility and make a wide variety of applications possible. Because of the different characteristics these IPC applications can have, they have their own specific names.

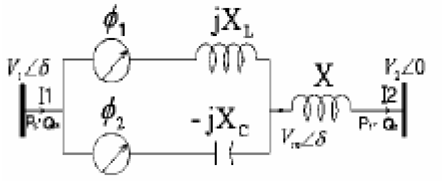

Fig 1: The Single diagram of Generic IPC

IPCs can be adapted to specific operating conditions. In general, the adaptation also results in an optimization. For example, the removal of the phase shift in one of the two branches of the IPC reduces the amount of equipment and relocates the control characteristic to a more favorable position in the power-angle plane. The adaptability of the IPC technology is also demonstrated by the various ways in which the internal phase shifts can be implemented. Conventional phase-shifting transformers (PST) are the first obvious choice, but the IPC characteristics can also be obtained using conventional transformers which have auxiliary windings added to create the desired internal phase shift by injecting series voltages from other phases.

4 Thyristor Controlled Interphase Power Controller (TC-IPC)

In this paper a 8 bus system is implemented with thyristor controlled interphase controller. Based on this model it is demonstrated that the TC-IPC can be very effective to damp power systems oscillations. Simulation results indicate the robustness of this Flexi-

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ble AC transmission system (FACTS) controller to the variation of system operating too, IPC system is shown in the fifure 2(a). Real and reactive powers with α=144^0 and 153^0 are shown in figure 2(b) & 2 (c) respectively.

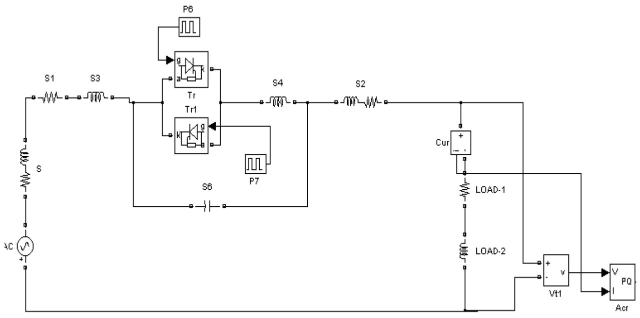

Fig2 (a): Interphase controller with Thyristors

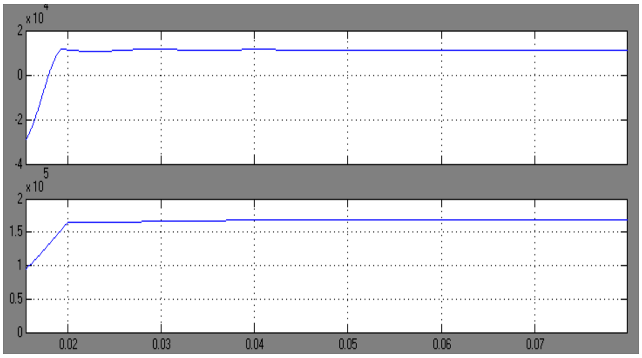

Fig 2(b) : Real and Reactive Power at Alpha =144 Degree

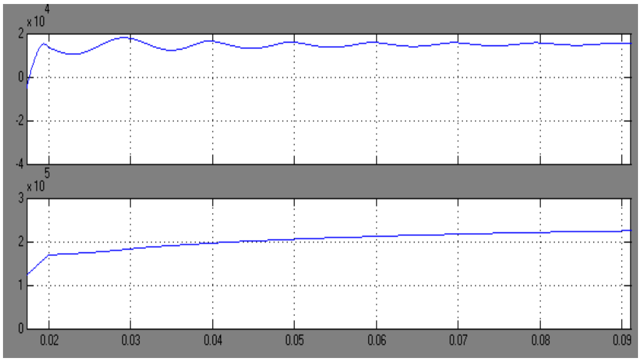

Fig 2(c) : Real and Reactive Power at Alpha =153 Degree

It have been shown that real and reactive power could be controlled by Varying "alpha" in Thyristor controlled-Inter phase power controller.

Eight bus system without TC-IPC is shown in figure 3(a). Real and reactive powers are shown in figure 3(b), current and voltage at bus 3 is shown in figure 3(c).

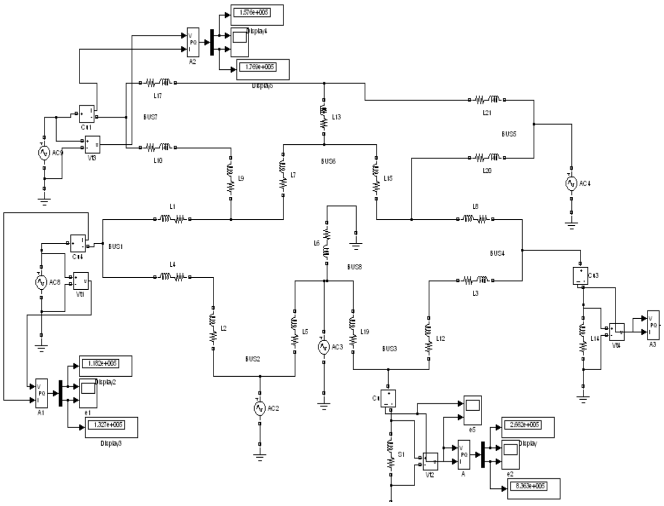

Fig 3(a): 8 Bus System without TCIPC

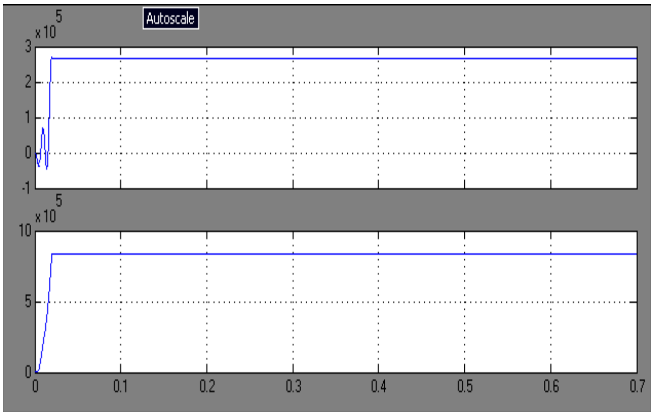

Fig 3(b): Real and reactive power across bus-3

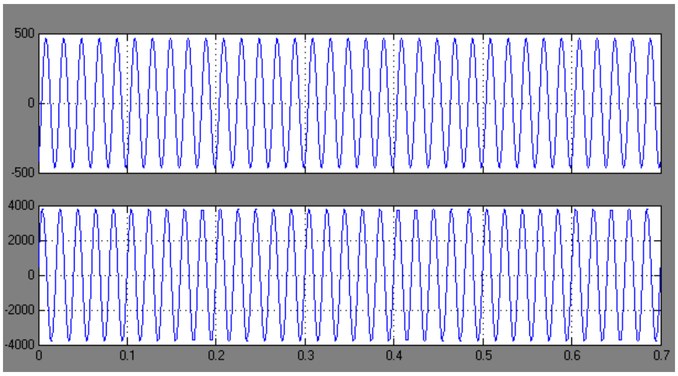

Fig 3(c): Current and volatge across bus-3

Eight bus system with TC-IPC is shown in figure 4(a). Real

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and reactive power at busses 7,1,3 & 4 are shown in figure 4(b) to 4(e), voltage and current at bus 3 are shown in figure 4(f). Reactive power with and without TC-IPC are shown in Table-1.

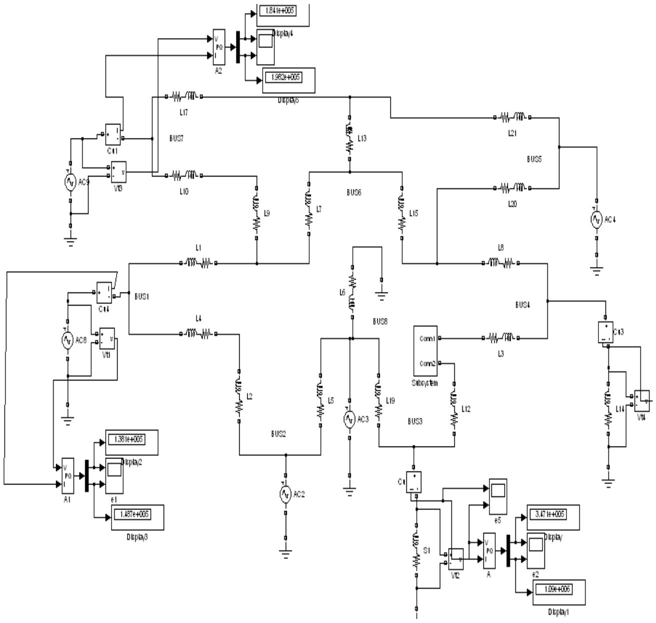

Fig 4(a): Bus System with TCIPC

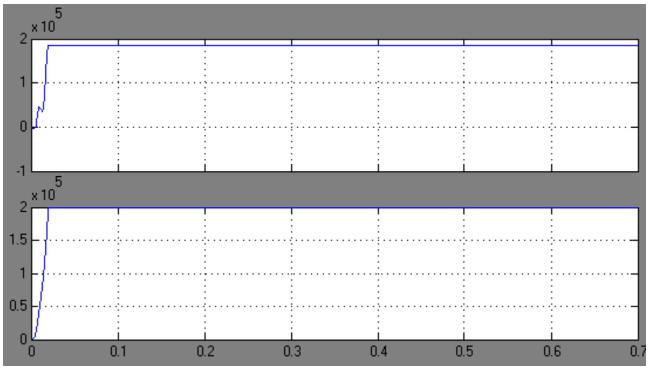

Fig 4(b): Real and reactive power across bus-7

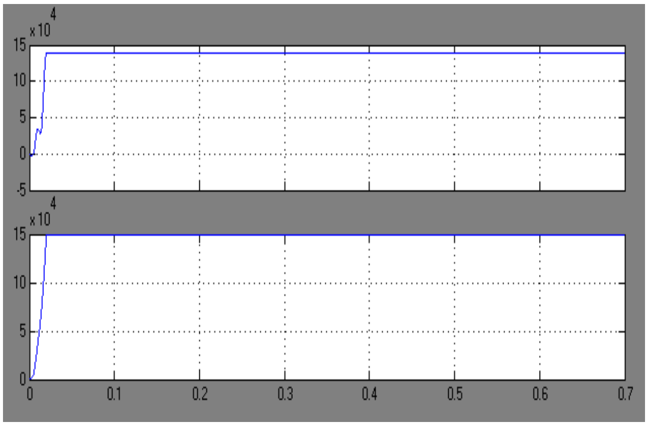

Fig 4(c): Real and reactive power across bus-1

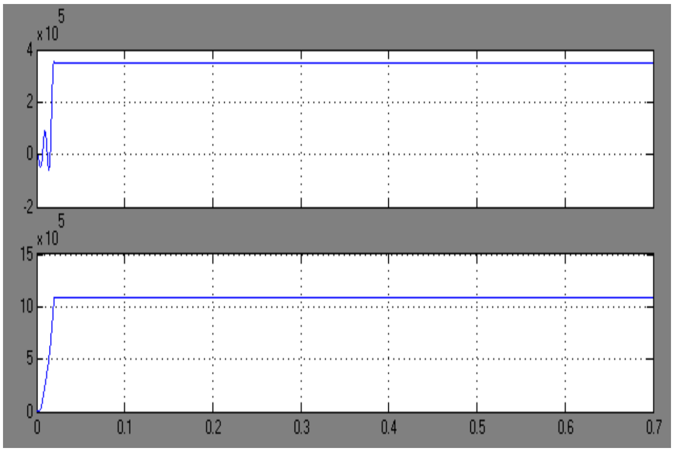

Fig 4(d): Real and reactive power across bus-3

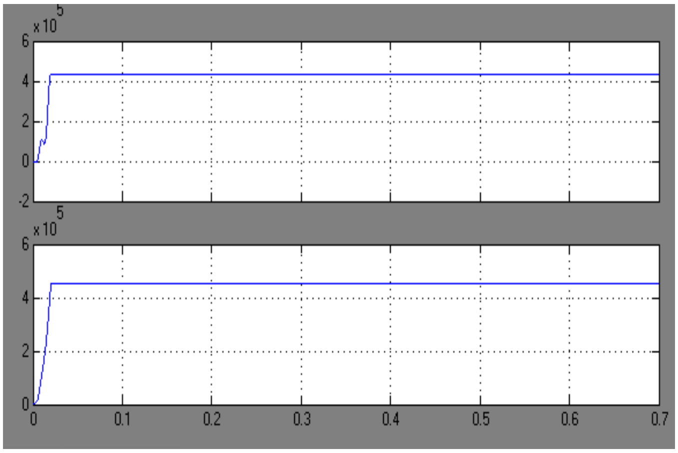

Fig 4(e): Real and reactive power across bus-4

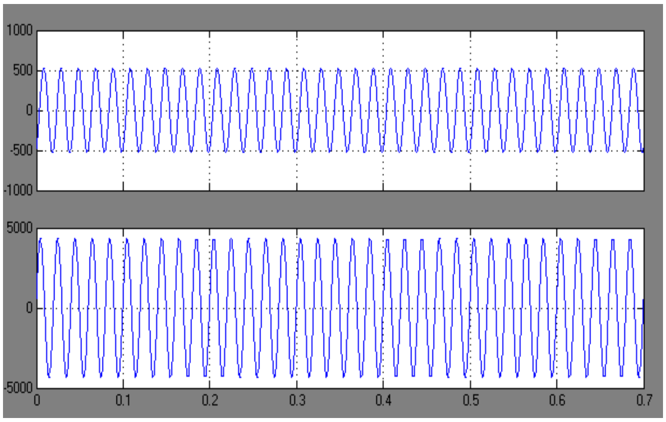

Fig 4(f): Current and volatge across bus-3

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Table1: Reactive Power with and without TC-IPC

BUS NO:	REACTIVE POWER (MVA) WITHOUT TCSC	REACTIVE POWER (MVA) WITH TCSC
BUS-7	0.174	0.198
BUS-1	0.133	0.148
BUS-3	0.836	1.090
BUS-11	0.663	0.456

6 Conclusion

This paper presents the simuation resuts of 8 bus system with and without TC-IPC, simuation resuts shows that TC-IPC can improve the system stabiity and mean while preserved the merits of conventiona IPC, simuation resuts indicate that TC-IPC as a FACTS controller can improve the dynamic performance of the system. Simuation results indicate that TC-IPC can increase the real and reactive powers in the line.

Acknowledgement

We are thankful to Department of Electrical and Electonics Engineering of SCSVMV University and Jerusalem College of Engineering, Chennai, India with whom we had useful discussions regarding FACTS Performance of transmissions lines. Any suggestions for further improvement of this topic are most welcome.

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Implementing Anti Collision Algorithm for Multiple Tag Identification

Sindhura kodali, Eswaran.P

Abstract— RFID is core technology in the area of ubiquitous computing.To identify the objects begins with the reader query to the tag attached to the subject. When multiple tags exist in the reader's interrogation zone, these tags simultaneously respond to the reader's query, resulting in collision. This kind collision makes the reader to take long time to identify tags within the reader's identification range and impossible to identify even one tag.In RFID system, the reader needa the anti-collision algorithm which can quickly identify all the tags in interrogation zone. This paper proposes a design methodology with two different RF modules, 433.92MHz and 315 MHz are interfaced into microcontroller, encoder, decoder IC's are used.According to query technique, the reader sends the query signal to all tags with one frequency and the tag corresponding to the query will respond to reader with another frequency, likewise anti-collision algorithm is implemented to avoid collision and number of query reponses can be reduced.

Index Terms— Anti collision Algorithom, Active tag, multiple tags, query technique RFID, RF modules, Tag collision.

1 Introduction

RFID (Radio Frequency Identification) is a technology that deciphers or identifies the tag information through a reader (or interrogator) without contact. RFID have become very popular in many service industries, purchasing and distribution logistics, industry, manufacturing companies and material flow systems. Automatic Identification procedures exist to provide information about people, animals, goods and products in transit [1],[2].

The reader receives required information from the tags by sending and receiving wireless signals with the tag. Since the communication between the readers and the tags shares wireless channels, there exist collisions. The collisions can be divided into the reader collision and the tag collision. The reader collision occurs when multiple readers send request signals to one tag, and the tag receives the wrong request signal due to signal interference between readers. The tag collision occurs when more than two tags simultaneously respond to one reader and the reader cannot identify any tags. This kind of collision makes the reader take long time to identify tags within the reader's identification range and impossible to identify even one tag [3]- [6].

Therefore, the collision is a crucial problem that must be resolved in RFID systems, so many studies to resolve this problem have been carried out as well as are ongoing.

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This paper focuses on the tag collision problem which occurs in the case where one reader identifies multiple tags. A design methodology is implemented in reader and tag module to avoid collision problem and an anti-collision algorithm is implemented in RFID reader .

2 RFID System For Multiple Tag Identification

RFID systems typically use small, low-cost, battery free devices called TAGs, which use the radio signal from a specialised RFID reader for power and communication. When queried, each TAG responds with a unique identification number by reflecting energy back to the reader with a technique called backscatter modulation. Usually TAGs are application specific, fixed function devices that have an operating range of 10–50 cm for inductively coupled devices and 3–10 m for UHF TAGs. Traditionally, RFID TAGs have been used as a replacement for barcodes in applications such as supply-chain monitoring, asset management, and building security [8].

When multiple tags are present in readers interrogation area,all tags try to access the reader at a time as a result the reader cannot notify a single tag or take long time for identification as shown in fig[1]

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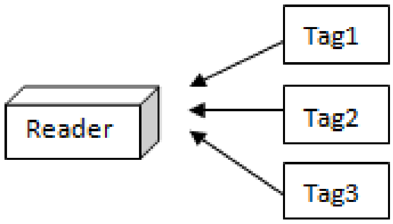

Fig 1: Tag collision problem in RFID system

The tag collision is avoided by implementing an anti-collision algorithm in reader[8][9].In RFID an anticollision algorithm is implemented suchthat The Reader continuously queries the tags one by one for the identifications. Whenever the tag is identified then the data will be processed through RF signals from tag to reader. In the reader module the data is decoded and stored in EEPROM of the controller. The controller sends the data to PCfor display purpose as shown in fig [2]. In this way multiple tags can be identified by reader query and data can be retrieved.

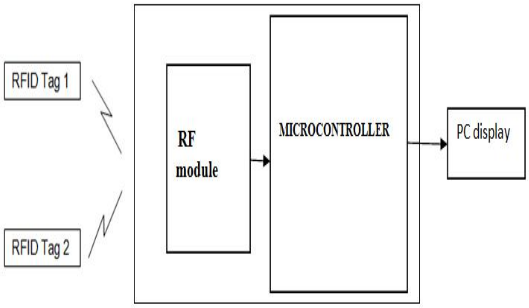

Fig. 2 Block diagram of RFID system for multiple tag identification.

The hardware modules are divided into these categories

- RFID tag module
- RFID Reader module

2.1 Active RFID Tag Module

Active tags are powered by an internal battery and are typically read / write. The life of an active tag is limited by the life of the battery. The data within an active tag can be rewritten or modified. An active tag's memory can vary from a few bytes to 1MB. The battery-supplied power of an active tag generally gives it a longer read range. The trade off is, greater the size the greater cost, and a limited operational life. Depending upon the battery type and temperatures, the life of such tags could be 10 years. Some active tags can also be smart and do not send their information all the time. In a typical read / write RFID system, a tag might give a machine a set of instructions, and the machine would then report its performance to the tag. This encoded data would then become part of the tagged part's history. This data can be detailed about the port of transit with dates.

The RFID transponder is sometimes called the RFID tag or an inlay. The transponder is usually made of an antenna that is bonded to an integrated circuit (IC) chip. The IC chip contains the RF circuit, encoders, decoders, and memory as shown in fig [3].

Active transponders are woken up when they receive a signal from a reader. Active tags have a read range of up to 300 feet (100 meters) and can be read reliably because they broadcast a signal to the reader . This active RFID tag module consists of a transmitter with a encoder and receiver with decoder to interpret the data, and microcontroller programmed with information. The RF provides a means of communicating with the interrogator. Active tag consists of transmitter, receiver and for data security encoder and decoder modules are used. Whenever the query from the reader comes to tag then the query will stored in the receiver buffer and then it is processed to microcontroller and the relative data operations will be done. Then the ancknowledgement signal is transmitted to reader via transmitter

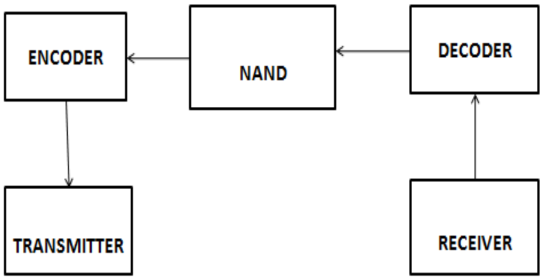

Fig.2. Block diagram of Active RFID tag.

2.2 RFID Reader Module

RFID technology explaining how an RFID chip interacts with a reader through different radio wave frequencies. A Reader is also called interrogator, is comprised of a transmitter, receiver, control module and PC connection for data display [6]. The query response is sent through the RF-transmitter to tag RF-receiver for tag identification .once the tag is identified, the tag sends encoded data through RF-transmitter. The reader receives data through RF-receiver and data is decoded and checks whether queried tag is identified or not. Data is displayed on PC dis-

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play through serial communication interface.The RFID reader modulu shown in the fig [4]

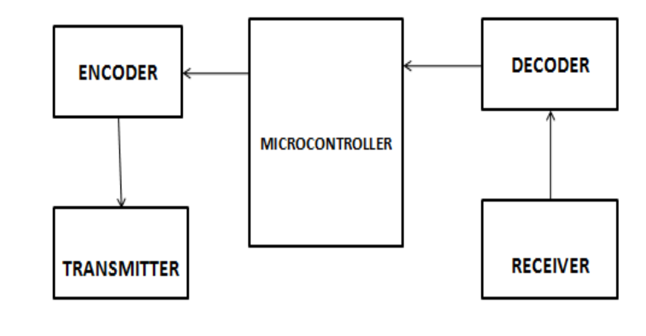

Fig.4. Block diagram for RFID reader module.

3 SOFTWARE IMPLEMENTATION

Tag collision in RFID systems happens when multiple tags reflect the signal back to the reader. This problem is often seen whenever a large volume of tags must be read together in the same RF field. The reader is unable to differentiate these signals from all; tag collision confuses the reader.

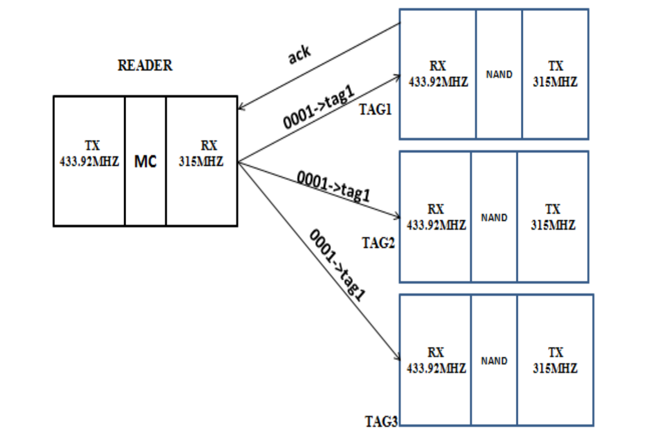

Fig.4. Showing the functionality of RFID system

To avoid the collision two different frequencies of RF module are interfaced with microcontroller. With one frequency (433.92MHz RF TX) module the reader sends query to all tags. All tags receive signal with 315MHz RF-Rx module and check for match of data and address of the received signal .Then Corresponding tag transimitter module is enable and sends the acknowledgement signal with another frequency,suchthat the remaining tags don't receive the acknowledgement signal of corresponding query tag. In this way the reader sends simultaneous queries to tags and acknowledgement is retrieved from each tag separately as per query as shown in fig [5].

3.1 Algorithm for Multiple Tag Identification

Step1: Reader initialization
Step2: Sends the query to all the active tags
Step3: Decoder of each tag checks for corresponding query
Step4: If match occurs then (valid transmission) VT=1
Step5: If VT=1 then (transmission enable) TE=0 for transmitter to send acknowledgement
Step6: Then VT bit of reader will be active high and data will be sent
Step7: Goto step2

3.2 FLOW CHART OF RFID SYSTEM

The reader sends query signal to all the tags. For example if 0001 is the data related to the tag1 ,the data is encoded and send to all the tags present in the readers interrogation area. All tags will decode the data and checks whether the data and address are correct or not. If match occurs then VT (valid transmission) of the corresponding tag will be high which makes the TE (transmission enable) low of the encoder for sending acknowledgement signal to reader. once the acknowledgement signal is received then it send data serially to PC for display purpose and again start querying for next tag and continue the process until all tags are identified as flowchart shown in fig[6].

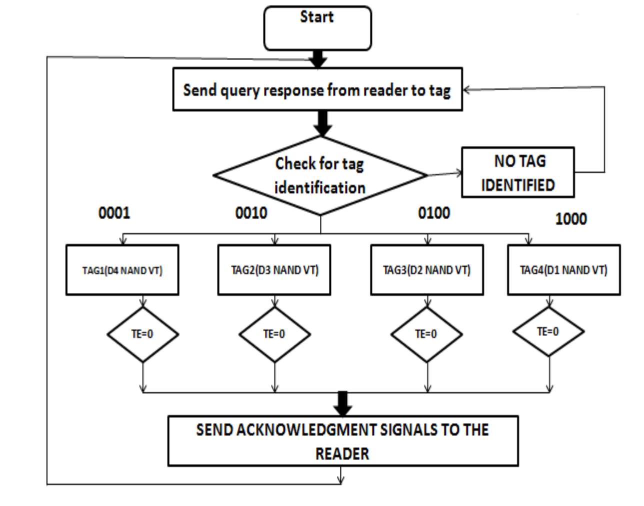

Fig.6. Flow chart of RFID system.

4 HARDWARE IMPLEMENTATION RFID SYSTEM

4.1 RFID Tag Module

The tag module as shown in fig [7] consist of RF transmitter (433.92MHz) and receiver module (315MHz), data security encoder and decoder modules. Tag receives

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query signal from the reader through RF receiver and data is decoded by HT12D decoder. Then the corresponding tag VT (transmission) will be high in decoder, which makes the RF transmitter enable (TE=0) . Tag sends the acknowledgement signal to the reader module through RF transmitter.

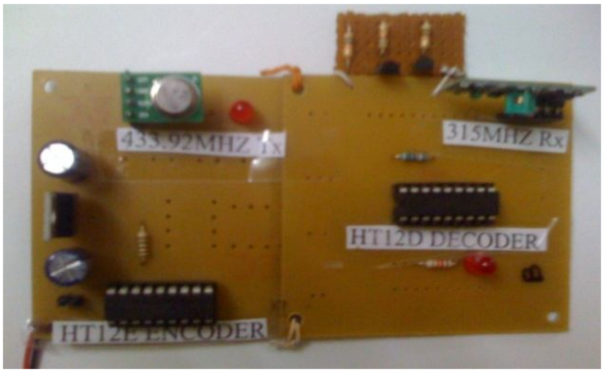

Fig. 7. RFID Tag module.

4.2 RFID READER MODULE

The reader module as shown in fig[8] consist of microcontroller,RF transmitter (315MHz),RF receiver (433.92MHz) , HT12E encoder and HT12D decoder IC's and serial port for PC serial data transfer. Once the reader is power up, then microcontroller starts querying each tag one by one. The encoded data is sent to all tags through RF transmitter [10] and corresponding tag will sent acknowledgement signal to the reader and data is sent through serial port from controller to the PC for display purpose.

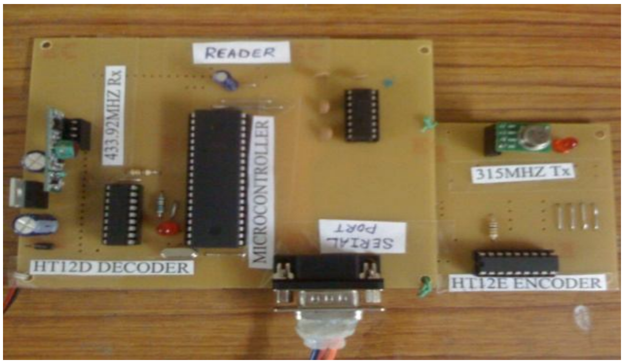

Fig.8. RFID Reader module.

4.2 PROPOSED RFID SYSTEM

The RFID reader is connected to laptop through USB to serialport converter as shown in fig [9].Hyperterminal window is launched in PC by configuring with serial port and setting the properties of port. All the tags are made active by powerup in interrogation area .once the reader is powerup then the microcontroller start sending query signals to all the tags and identified tag data is displayed on the screen.

Fig.9. proposed RFID system.

5 RESULTS AND DISCUSSIONS

When the reader is active, then microcontroller runs and in hyper terminal it asks to press any key to scan as show in fig [10]. If any key on keyboard is pressed then it start scaning all tags which are present in reader's interrogation area and identified tags are displayed on screen.

If tags are not present in the reader's interrogation area then it again ask to press any key to start scanning for tags.It is as shown in fig [11].

The tags which are active in reader's interrogation area are identified and displayed on the screen as shown in the following figs [12][13][14].

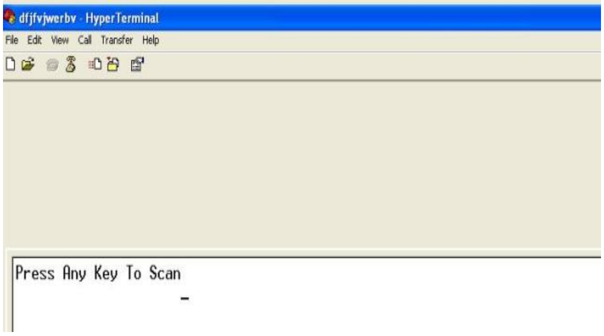

Fig.10. Reader initialization

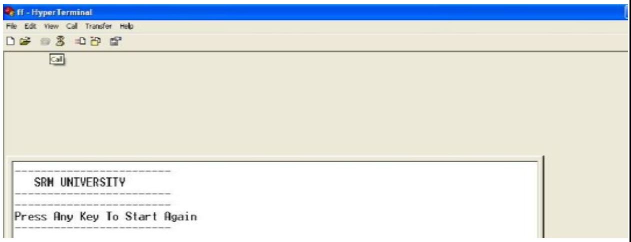

Fig.11. No tag is identified

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Fig.12. Two tags are present in reader's interrogation area

Fig.13. Three tags are present in reader's interrogation area,

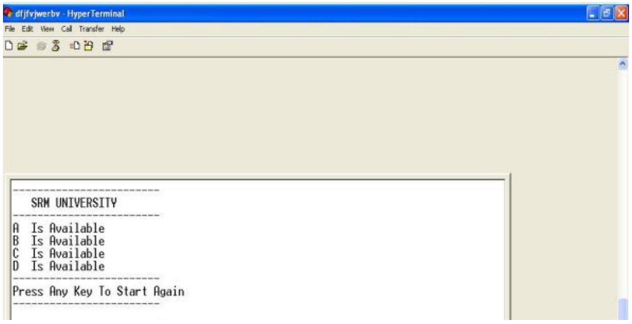

Fig.14. Four tags are present in readers interrogation area.

7 Conclusion

In RFID system, the tag collision problem occurs in multitag environment where multiple tags have to be identified. The anticollision algorithm is necessary to arbitrate the collision and to identify all the tags faster.

When multiple tags exist in the reader's interrogation zone, these tags simultaneously respond to the reader's query, resulting in collision. To avoid the collision two different frequencies of RF module are interfaced with microcontroller. With RF transmitter module the reader sends query to all tags in interrogation area. Once the corresponding tag is identified, the tag transfers data with another frequency, so that only required tag can be identified. In this way the reader sends simultaneous queries to tags and data is retrieved from each tag. By using this design methodology multiple tags can be identified in efficient mannerand number of query responses from reader are reduced.

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Face Recognition using Neural Network and Eigenvalues with Distinct Block Processing

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Abstract –Human face recognition has been employed in different commercial and law enforcement applications. It has also been employed for mug shots matching, bank-store security, crowd surveillance, expert identification, witness face reconstruction, electronics mug shots book, and electronic lineup. A face recognition system based on principal component analysis and neural networks has been developed. The system consists of three stages; preprocessing, principal component analysis, and recognition. In preprocessing stage, normalization illumination, and head orientation were performed. Principal component analysis is applied to obtain the aspects of face which are important for identification. Eigenvectors and eigenfaces are calculated from the initial face image set with the help of distinct block processing. New faces are projected onto the space expanded by eigenfaces and represented by weighted sum of the eigenfaces. These weights are used to identify the faces. Neural network is used to create the face database and recognize and authenticate the face by using these weights. In this paper, a separate network was developed for each person. The input face has been projected onto the eigenface space first and new descriptor is obtained. The new descriptor is used as input to each person's network, trained earlier. The one with maximum output is selected and reported as the equivalent image.

Index Terms - Eigenface, eigenvector, eigenvalue, Neural network, distinct block processing, face recognition, face space.

I. INTRODUCTION

THE face is our primary focus of attention in social intercourse, playing a major role in conveying identity and emotion. Although the ability to infer intelligence or character from facial appearance is suspect, the human ability to recognize faces is remarkable. We can recognize thousands of human faces[1,2,3] learned throughout our lifetime and identify familiar faces at a glance even after years of separation. This skill is quite robust, despite large changes in the visual stimulus due to viewing conditions, expression, aging, and distractions such as glasses or change in hairstyle or facial hair. As a consequence, the visual processing of human faces has fascinated philosophers and scientists for centuries.

Computational models of face recognition [5,7,8,9,10,11], in particular, are interesting because they can contribute not only to theoretical insights but also to practical applications. Computers that recognize faces could be applied to a wide variety of problems, including criminal identifications, security systems, image and film processing and human – computer interaction. For example, the ability to model a particular face and distinguish it from a large number of stored face models would make it vastly improve criminal identification. Even the ability to merely detect faces, as opposed to recognizing them can be important. Detecting faces in photographs[20], for instance, is an important problem in automating color film development, since the effect of many enhancement and noise reduction techniques depends on the picture content.

Unfortunately, developing a computational model of face recognition is quite difficult, because faces are complex, multidimensional and meaningful visual stimuli. Thus unlike most early visual functions, for which we may construct detailed models[28] of retinal or striate activity, face recognition is a very high level task for which computational approaches can currently only suggest broad constraints on the corresponding neural activity.

We, therefore, focused my paper towards implementing a sort of early, pre-attentive pattern recognition[11,42] capability that does not depend on

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having three-dimensional information or detailed geometry. Our goal is to develop a computational model of face recognition which would be fast, reasonably simple, and accurate in constrained environments such as an office or a household. In addition, the approach is biologically implementable and in concern with preliminary findings in the physiology and psychology of face recognition. The scheme is based on an information theory approach that decomposes face images into a small set of characteristics feature images called “eigenfaces”[12,23,24,34,36], which may be through of as the principal components of the initial training set of face images. Recognition is performed by projecting a new image into the subspace spanned by the eigenfaces (“face space”) and then classifying the face by comparing its position in face space with the positions of known individuals.

II. BACKGROUND AND RELATED WORK

Much of the work in computer recognition[9,44] of faces has focused on detecting individual features[5,9,43] such as the eyes, nose, mouth, and head outline, and defining a face model by the position, size, and relationships among these features. Such approaches have proven difficult to extend to multiple views and have often been quite fragile, requiring a good initial guess to guide them. Research in human strategies of face recognition, moreover, has shown that individual features and their immediate relationships comprise an insufficient representation to account for the performance of adult human face identification. Nonetheless, this approach to face recognition remains the most popular one in the computer vision literature.

Bledsoe[16,17] was the first to attempt semi-automated face recognition with a hybrid human-computer system that classified faces on the basis of fiducially marks entered on photographs by hand. Parameters for the classification were normalized distances and ratios among points such as eye corners, mouth corners, nose tip, and chin point. Later work at Bell Labs developed a vector of up to 21 features, and recognized faces using standard pattern classification techniques.

Fischler and Elschlager[40], attempted to measure similar features automatically. They described a linear embedding algorithm that used local feature template matching and a global measure of fit to find and measure facial features. This template matching approach has been continued and improved by the recent work of Yuille and Cohen. Their strategy is based on deformable templates, which are parameterized models of the face and its features in which the parameter values are determined by interactions with the face image.

Connectionist approaches to face identification seek to capture the configurationally nature of the task. Kohonen and Lehtio[30,31] describe an associative network with a simple learning algorithm that can recognize face images and recall a face image from an incomplete or noisy version input to the network. Fleming and Cottrell[19] extend these ideas using nonlinear units, training the system by back propagation.

Others have approached automated face recognition by characterizing a face by a set of geometric parameters and performing pattern recognition based on the parameters. Kanade's face identification system[20] was the first system in which all steps of the recognition process were automated, using a top-down control strategy directed by a generic model of expected feature characteristics. His system calculated a set of facial parameters from a single face image and used a pattern classification technique to match the face from a known set, a purely statistical approach depending primarily on local histogram analysis and absolute gray-scale values.

Recent work by Burt[26] uses a smart sensing approach based on multiresolution template matching. This approch to fine strategy uses a special purpose computer built to calculate multiresolution pyramid images quickly, and has been demonstrated identifying people in near real time.

III. METHODLOGY EMPLOYED

A. Eigen Face Approach

Much of the previous work on automated face recognition has ignored the issue of just what aspects of the face stimulus are important for face recognition.

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This suggests the use of an information theory approach of coding and decoding of face images, emphasizing the significant local and global features. Such features may or may not be directly related to our intuitive notion of face features such as the eyes, nose, lips, and hair.

In the language of information theory, the relevant information in a face image is extracted, encoded as efficiently as possible, and then compared with a database of models encoded similarly. A simple approach for extracting the information contained in an image of a face is to somehow capture the variation in a collection of face images, independent of any judgment of features, and use this information to encode and compare individual face images.

In mathematical terms, the principal components of the distribution of faces, or the eigenvectors of the covariance matrix of the set of face images, treating an image as point (or vector) in a very high dimensional space is sought. The eigenvectors are ordered, each one accounting for a different amount of the variation among the face images. These eigenvectors can be thought of as a set of features that together characterize the variation between face images. Each image location contributes more or less to each eigenvector, so that it is possible to display these eigenvectors as a sort of ghostly face image which is called an "eigenface".

Sample face images, the average face of them, eigenfaces of the face images and the corresponding eigenvalues are shown in Figure 1, 2, 3, 4 respectively. Each eigenface deviates from uniform gray where some facial feature differs among the set of training faces. Eigenfaces can be viewed as a sort of map of the variations between faces.

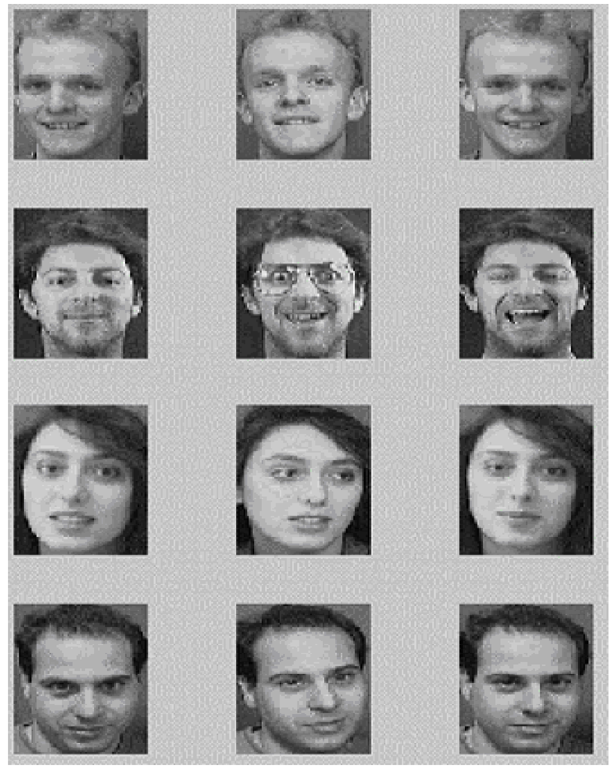

Fig 1 Sample Faces

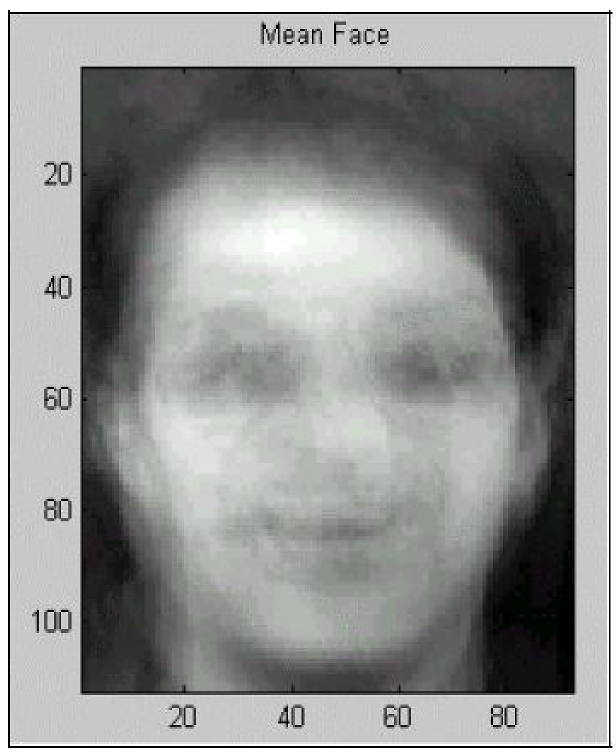

Fig. 2 Average face of the Sample face

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Each individual face can be represented exactly in terms of a linear combination of the eigenfaces. Each face can also be approximated using only the "best" eigenfaces, those having the largest eigenvalues, and which therefore account for the most variance within the set of face images. As seen from the Figure 3.4, the eigenvalues drops very quickly, that means one can represent the faces with relatively small number of eigenfaces. The best M eigenfaces span an M-dimensional subspace which we call the "face space" of all possible images.

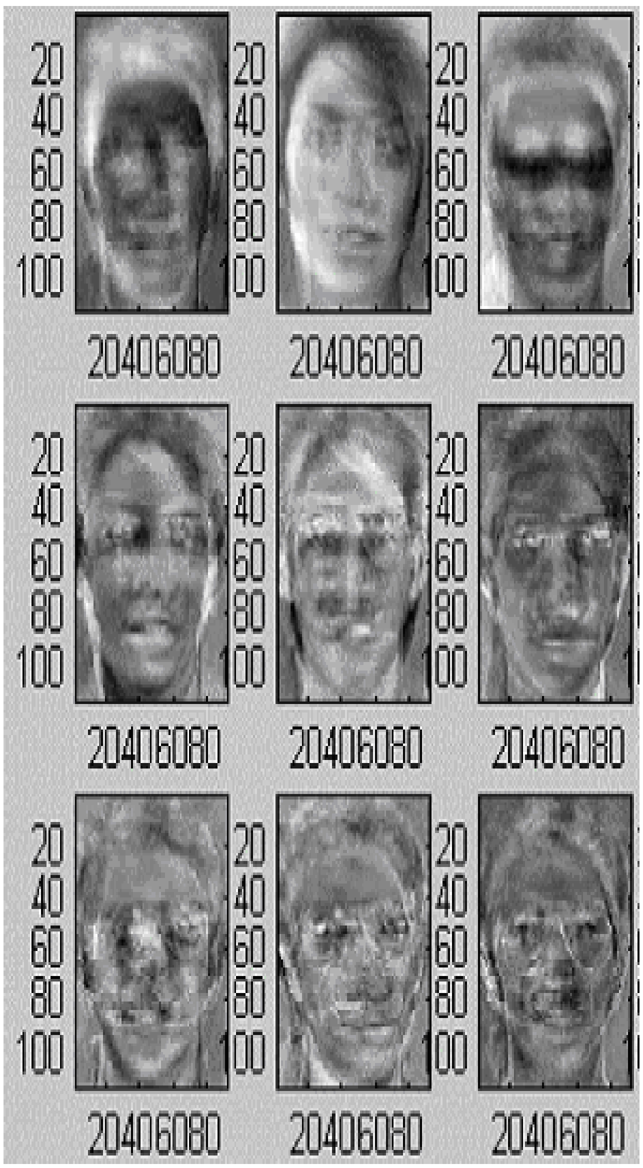

Fig. 3 Eigen face of the Sample face

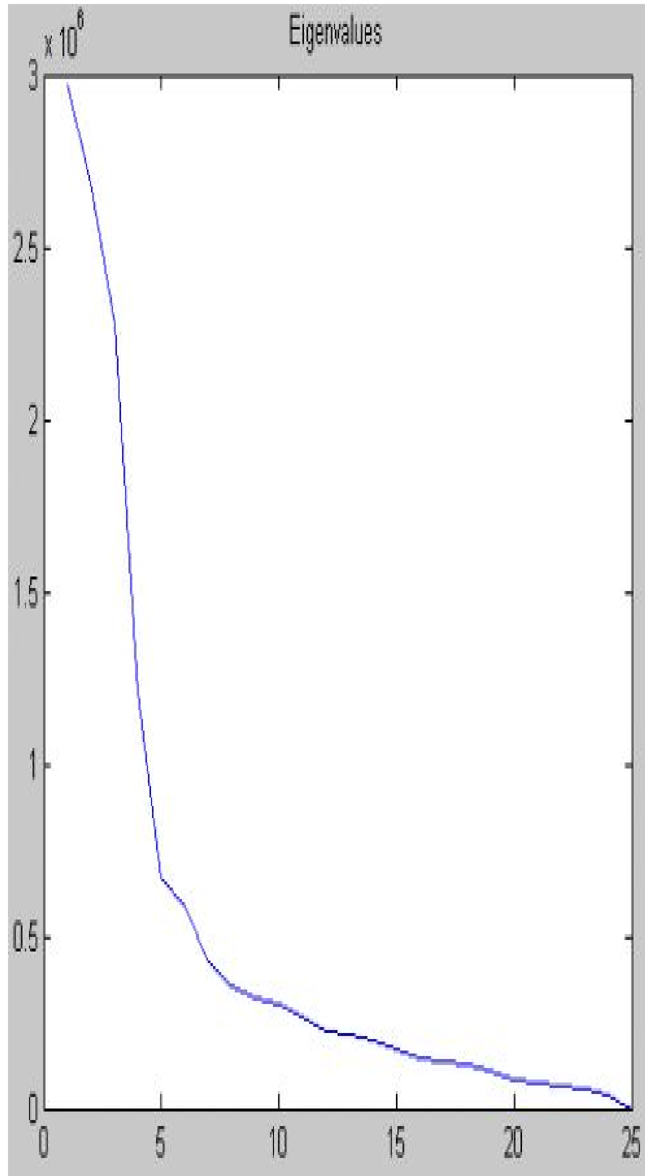

Fig. 4 Eigen values corresponding to Eigenfaces

Kirby and Sirovich[3,25] developed a technique for efficiently representing pictures of faces using principal component analysis. Starting with an ensemble of original face images, they calculated a best coordinate system for image compression, where each coordinate is actually an image that they termed as "eigen picture". They argued that, at least in principle, any collection of face images can be approximately reconstructed by storing a small collection of weights for each face, and a small set of standard pictures (the eigen pictures).

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Fig 5 Reconstruction of first image with the number of Eigen Faces

The weights describing each face are found by projecting the face image onto each eigen picture.

Turk and A. Pentland[12] argued that, if a multitude of face images can be reconstructed by weighted sum of a small collection of characteristic features or eigen pictures, perhaps an efficient way to learn and recognize faces would be to build up the characteristic features by experience over time and recognize particular faces by comparing the feature weights needed to approximately reconstruct them with the weights associated with known individuals. Therefore, each individual is characterized by a small set of feature or eigenpicture weights needed to describe and reconstruct them. This is an extremely compact representation when compared with the images themselves. The projected image of the Face1 with a

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number of eigenvalues is shown in Figure 5. As seen from the figure among the 25 faces database (25 eigenfaces), 15 eigenfaces are enough for reconstruct the faces accurately. These feature or eigenpicture weights are called feature vectors.

If a multitude of face images can be reconstructed by weighted sums of a small collection of characteristic features or eigenspaces, an efficient way to learn and recognize faces would be to build up the characteristic features by experience over time and recognize particular faces by comparing the feature weights needed to reconstruct them with the weights associated with known individuals. Each individual, therefore, would be characterized by the small set of feature or eigenspace weights needed to describe and reconstruct them – an extremely compact representation when compared with the images themselves.

This approach to face recognition involves the following initialization operations:

(i) Acquire an initial set of face images (training-set).
(ii) Calculate the eigenfaces from the training set, keeping only the M images that correspond to the highest eigenvalues. These M images define the face space. As new faces are experienced, the eigenvalues can be updated or recalculated.

These operations can also be performed from time to time whenever there is free excess computational capacity. Having initialized the system, the following steps are then used to recognize new face images.

(i) Calculate a set of weights based on the input image and the M eigenfaces by projecting the input image onto each of the eigenfaces.
(ii) Determine if the image is a face at all by checking to see if the image is sufficiently close to “face image”.
(iii) If it is a face, classify the weight pattern as either a known person or unknown.

B. Face Space Visited

Calculate the set of all possible images, those representing a face, make up only a small fraction of it. It has been decided to represent images as very long vectors, instead of the usual matrix representation. This makes up the entire image space where each image is a point. Since faces however possess similar structure (eye, nose, mouth, position) the vectors representing them will be correlated. We will see that faces will group at a certain location in the image space. We might say that faces lie in a small and separate region from other images. The idea behind eigen images is to find a lower dimensional space in which shorter vectors well describe face images, and only those.

In order to efficiently describe this cluster of images, we have chosen the set of directions in the image space along with the variance of the cluster is maximum. This is achieved through the standard procedure of Principal Component Analysis. A direction defined in terms of the coordinates of its extremity is in the image space actually an image. Transforming coordinates amounts to projection onto new coordinates and expressing an image as a linear combination of base images. The identified directions, thus, are images or more precisely eigen-images, and in this case it will be called them eigenfaces because faces are being decribed.

Let a face image I(x,y) be a two-dimensional N x N array of 8-bit intensity values. An image may also be considered as a vector of dimension N^2, so that a typical image of size 256X256 becomes a vector of dimension 65,536, or equivalently a point in 65,536-dimensional space. An ensemble of images, then, maps to a collection of points in this huge space.

Images of faces, being similar in overall configuration, will not be randomly distributed in this huge image space and thus can be described by a relatively low dimensional subspace. The main idea of the principal component analysis is to find the vectors that best account for the distribution of face images within the entire image space.

These vectors define the subspace of face images, which will be called as "face space". Each vector is of length N^2 describes an NXN image, and is a linear combination of the original face images. Because these vectors are the eigenvectors of the covariance matrix corresponding to the original face images, and they are face-like in appearance, it will be refer to them as "eigenfaces".

Recognizing similar faces, is equivalent to identifying the closest point to the query in the newly defined face-space. If a person is represented in the database more than once, the problem is to decide to which group of images the query is most similar to. Finally, if the input image is not a face at

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all, it's projection into the face space will give inconsistent results, so this case will also be identified.

IV. ROLE OF NEURAL NETWORKS

Neural networks[10,32,42] are composed of simple elements operating in parallel. The neuron model shown in figure 6 is the one which is widely used in artificial neural networks with some minor modifications on it.

The artificial neuron given in this figure has N input, denoted as $u_1, u_2, \ldots u_N$. Each line connecting these inputs to the neuron is assigned a weight, which is denoted as $w_1, w_2, \ldots, w_N$ respectively. The threshold in artificial neuron is usually represented by Φ and the activation is given by the formula:

$$a = (\sum_{j=1}^{n} w_j u_j) + \Phi$$

The inputs and weight are real values. A negative value for a weight indicates an inhibitory connection while a positive value indicating excitatory one. If Φ is positive, it is usually referred as bias. For its mathematical convenience (+) sign is used in the activation formula. Sometimes, the threshold is combined for simplicity into the summation part by assuming an imaginary input u_0 = +1 and a connection weight w0 = Φ. Hence the activation formula becomes

$$a = (\sum_{j=1}^{n} w_j u_j)$$

The vector notation

$$A = w^T u + \Phi$$

is useful for expressing the activation for a neuron. The neuron output function f(a) can be represented as:

Linear:

$$f(a) = K(a)$$

Threshold:

$$f(a) = \begin{cases} 0 & a \le 0 \\ 1 & 0 < a \end{cases}$$

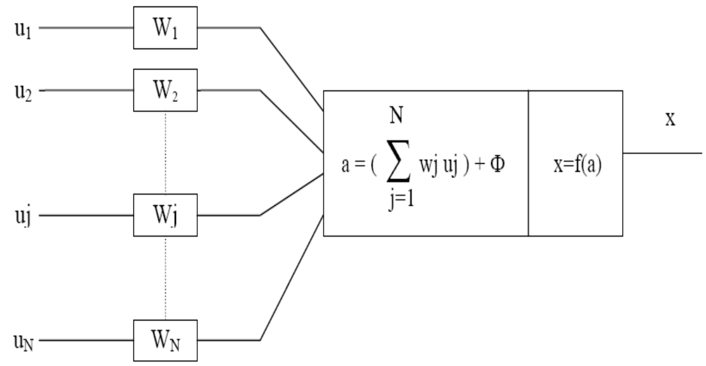

Fig. 6 Artificial Neuron

Ramp:

$$f(a) = \begin{cases} 0 & a \le 0 \\ a / K & 0 < a \\ 1 & K < a \end{cases}$$

Sigmoid:

$$f(a) = 1/(1 + \exp(-Ka))$$

Functional implementations can be perfprmed by adjusting the weights and the threshold of the neuron. Furthermore, by connecting the outputs of some neurons as inputs to the others, neural network will be established, and any function can be implemented by these networks. The last layer of neurons is called the output layer and the layers between the input and output layer are called the hidden layers. The input layer is made up of special input neurons, transmitting only the applied external input to their outputs. In a network, if there is only the layer of input nodes and a single layer of neurons constituting the output layer then they are called single layer network. If there are one or more hidden layers, such networks are called multilayer networks. There are two types of network architecture: recurrent and feed forward neural network.

The eigenfaces approach to face recognition can be summarized in the following steps:

- Form a face library that consists of the face images of known individuals.

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- Choose a training set that includes a number of images (M) for each person with some variation in expression and in the lighting.

- Calculate the M x M matrix L, find its eigenvectors and eigenvalues, and choose the M' eigenvectors with the highest associated eigenvalues.

- Combine the normalized training set of images according to produce M' eigenfaces. Store these eigenfaces for later use.

- For each member in the face library, compute and store a feature vector.

- Create Neural Network for each person in the database

- Train these networks as the faces will be used as positive examples for their own networks and negative examples for all other networks

- For each new face image to be identified, calculate its feature vector

- Use these feature vectors as network inputs and simulate all networks with these inputs

- Select the network with the maximum output. If the output of the selected network passes a predefined threshold, it will be reported as the host of the input face. Otherwise it will be reported as unknown and adds this member to the face library with its feature vector and network.

V. METHODOLOGY PROPOSED

A. Distinct Block Processing

In this section, a basic yet novel method of face recognition is presented. The technique integrates the concepts of distinct block processing and relative standard deviations. Faces can be encoded in a block wise fashion wherein the standard deviation for each block is encoded.

In the proposed method, each image is segmented into distinct blocks and the standard deviation of each of these is calculated. The difference in standard deviations of two images gives a measure for comparison. The system has been tested using varying facial conditions: controlled condition, varying facial expression, varying pose and varying illumination.

Certain image processing operations involve processing an image in sections called blocks, rather than processing the entire image at once. In a distinct block operation, the input image is processed a block at a time. That is, the image is divided into rectangular blocks, and some operation is performed on each block individually to determine the values of the pixels in the corresponding block of the output image.

Distinct Blocks are rectangular partitions that divide a matrix into m-by-n sections. Distinct blocks overlay the image matrix starting in the upper left corner, with no overlap. If the blocks don't fit exactly over the image, zero padding is added so that they do as needed.

In order to determine the optimal block size for block processing, a simple algorithm is used. Suppose the syntax of the function that runs the algorithm is given as below:

Size = bestblk ([m.n],k)

This function returns for an m-by-n image, the optimal block size for block processing, 'k' is a scalar specifying the maximum row and column dimensions for the block: if the argument is omitted, it defaults to 100. The return value 'size' is a 1-by-2 vector containing the row and column dimensions for the block.

The algorithm for determining 'size' is:

- If m is less than or equal to k, return m.
- If m is greater than k, consider all values between min(m/10,k/2) and k
- Return that value that minimizes the padding required

The same algorithm is then repeated for n, for example

Size = bestblk([640,800],72)

B. Proposed Technique

Proposed Face Recognition system consists of a face database that may store multiple face images of the same person. First of all, these images are not actual face images.

The face image before being stored into the database is first resized into a standard size. It has been taken this as 112 X

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92. Then the optimal block size is found for this image size; it comes out as 8 X 5. Then for every block, its standard deviation is calculated as follows:

$$S = \sqrt{\sum(X_i - X)^2/(n-1)}$$

Where X_i is the individual pixel value, X is the mean of all pixel values in that block and n is the number of pixels in that block.

After the standard deviation for the block is calculated, all the pixels in that block are assigned that value. This is done for all the blocks.

Then these values are stored as 112 X 92 matrix in the database. In case an additional image of the same person has to be stored, it is first converted into the above matrix form and its mean will be taken with the matrix stored in the database corresponding to that person. Then this new matrix is overwritten in the database.

Now to compare the input image, it is also processed in the above form. Then this image matrix is compared with every image matrix in the face database. The comparison is carried out as follows:

For a block in the test image, choose any pixel value. Take a pixel value from the corresponding block of the image matrix in the database, find their absolute differences. Repeat this for all the blocks.

Sum all the absolute differences obtained. This gives a measure to compare the difference between the two images. Perform this calculation for each image stored in the database. The image for which this difference is the least is the one that matches best to the input test image.

C. Training and Test Image Constraints

The only constraint that this technique has is that for all images of the same person, the size of the face in the frame and its relative position in the frame must be more or less same.

VI. EXPERIMENTAL RESULT AND ANALYSIS

This method has been tested on 10 pictures from an ORL Database. This database has one face images with different conditions (expression, illumination, etc.), of each individual. In the following section, detailed information for this database and their corresponding performance results for the proposed face recognition method are given.

The number of networks used for the ORL database are equal to the number of people in the database. The initial parameters of the neural networks used in these tests are given below:

- Type: Feed forward bacpropagation network

- Number of layers: 3 (input, one hidden, output layer)

  - Number of neurons in input layer : Number of eigen faces to describe the faces
  - Number of neurons in hidden layer : 10
  - Number of neurons in output layer : 1

A. Test Results for the Olivetti and Oracle Research Laboratory (ORL) Face Database

The Olivetti and Oracle Research Laboratory (ORL) face database is used in order to test this method in the presence of headpose variations. There are 10 different images of each of 40 distinct subjects.

For some subjects, the images were taken at different times, varying lighting, facial expressions (open / closed eyes, smiling / not smiling), facial details (glasses / no glasses) and head pose (tilting and rotation up to 20 degrees). All the images were taken against a dark homogeneous background. Figure 7 shows the whole set of 40 individuals, 10 images per person from the ORL database.

Since the number of networks is equal to the number of people in the database, forty networks, one for each person were created. Within the ten images, first 4 of them are used for tanning the neural networks, then these networks are tested and their properties are updated with the next 3 pictures for getting the minimum squared error function, and these networks will be used for later use for recognition purposes.

For testing the whole database, the faces used in training, testing and recognition are changed and the recognition performance is given for whole database. For this database,

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the mean face of the whole database, the calculated top 30 (with the highest eigenvalues) eigenfaces, and their corresponding eigenvalues are shown in Figure 8, Figure 9 and Figure 10 respectively. The recognition performance increases with the number of faces used to train the neural networks, so the recognition rates, with different number of faces used in training, are calculated and given in Table 1.

The number of eigenfaces that is used to describe the faces, and the number of neurons in hidden layer also affects the recognition rate, so the tests are done with different number of eigenfaces and neurons, and the results are given in Table 2.

Histogram equalization enhances the contrast of images by transforming the values in an intensity image so that the histogram of the output image approximately matches a specified histogram. Table 2 also shows the recognition rates with and without histogram equalization. Up to now, the recognition rates are calculated with neural networks only for first choice (largest output), The recognition rates with neural networks other choices are also given in Table 3

B. Computational Time

The images in the database were tested for 10 pictures that were trained with the help of Neural Network and a very small amount of time(<3 seconds) is required to compute the result.

VII. CONCLUSION AND FUTURE WORK

The Eigenfaces algorithm has been successfully implemented which is fast popular and practical, besides familiarizing the user with the basics of image processing and the various other approaches to the face recognition.

The Eigenface approach to face recognition was motivated by information theory leading to the idea of basing face recognition on a small set of image features that best approximate the set of known face images without requiring that they correspond to our intuitive notions of facial parts and features. Although it is not an elegant solution to the general recognition problem, the Eigenface approach does provide a practical solution that is well fitted to the problem of face recognition. It is fast, relatively simple and has been shown to work well in a constrained environment.

It important to note that many applications of face recognition do not require perfect identification although most require a low false-positive rate. For instance, in searching a large database of faces, it may be preferable to find a small set of likely matches to present to the user.

Subsequently a novel algorithm have been developed which integrates the concepts of "Distinct Block Processing" and Relative Standard Deviation. The work is still in progress and may be enhanced further.

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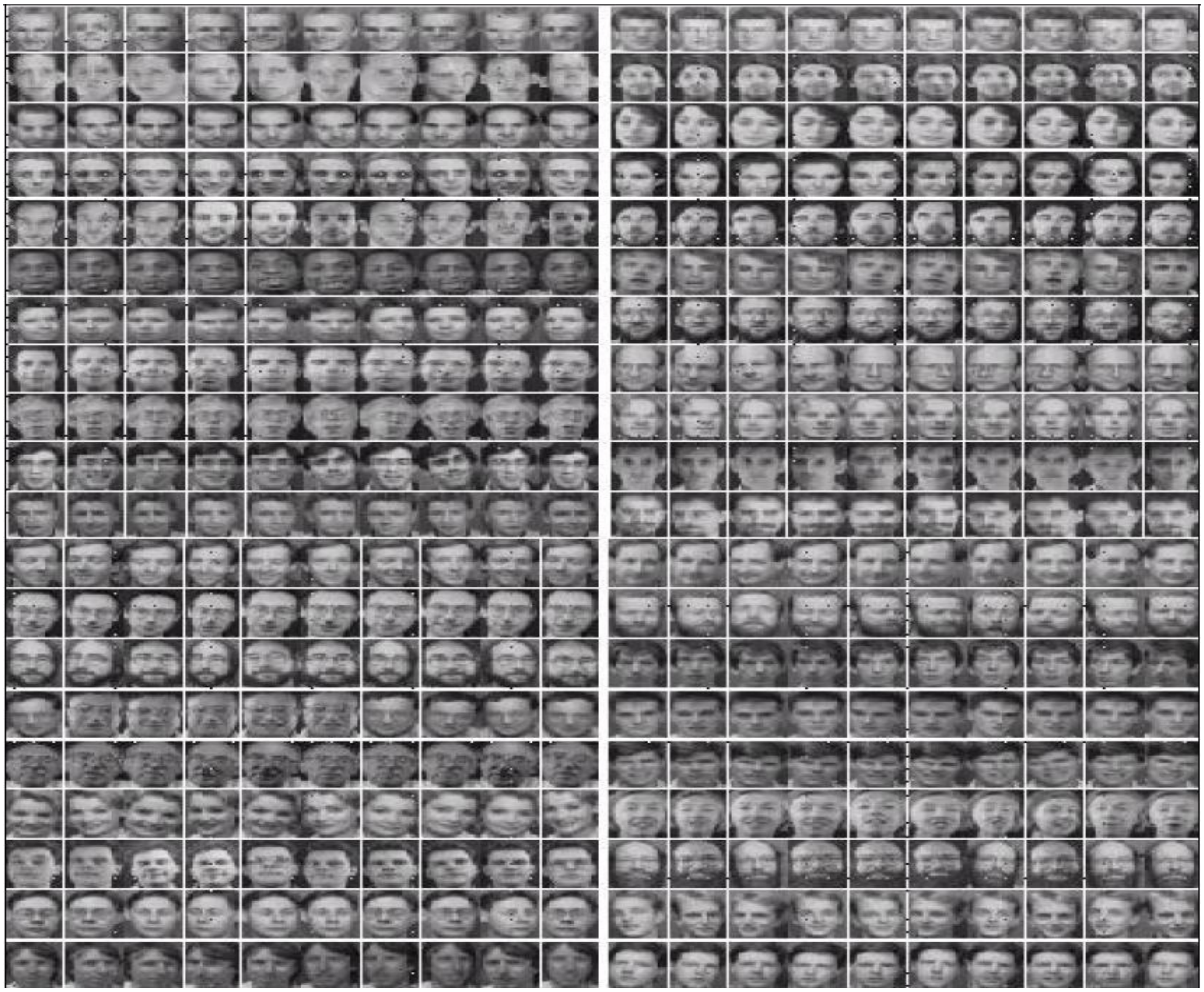

Figure 7 ORL Face Database

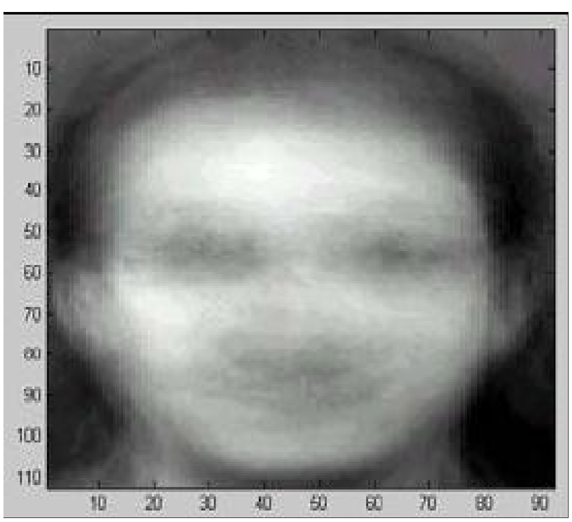

Figure 8 Mean face for ORL Face Database

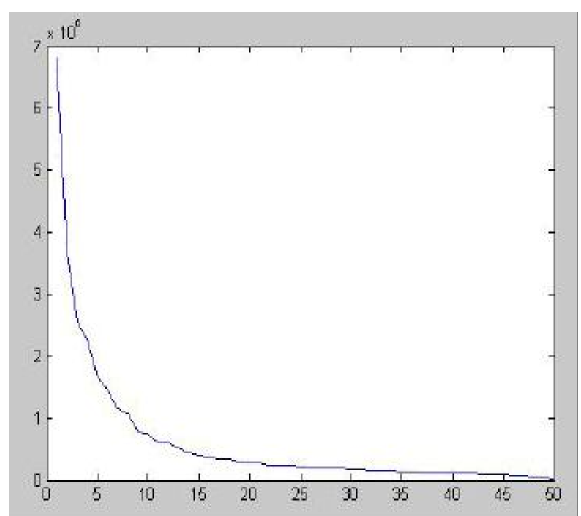

Figure 9 The eigen values for ORL Face Database

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Figure 5.4 The top 30 eigen faces for the ORL Face Database

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Number of Images used in Training (per individual)	***Number of Images used in Testing (per individual)***	***No of Eigen-faces***	***Hist. Equ.***	***Recogni -tion Rate (%)***
1	9	10	√	8.8
1	9	10	X	9.7
2	8	20	√	25
2	8	20	X	26
3	7	25	√	51.7
3	7	25	X	51.7
4	6	30	√	75
4	6	30	X	76.2
5	5	50	√	87.5
5	5	50	X	90
6	4	60	√	90
6	4	60	X	92.5
7	3	100	√	89.1
7	3	100	X	91.6
8	2	100	√	88.8
8	2	100	X	91.2
9	1	100	√	87.5
9	1	100	X	90

Table 1 Recognition Rate using different Number of Training and Test Images, and w/wo Histogram Equalization. Number of Neurons in Hidden Layer: 15

Number of EigenFaces	***Number of Neurons in Hidden Layer***	**RECOGNITION** ***Rate (%)***
40	5	40
	10	58.3
	15	72
	20	74.5
45	5	41
	10	73.5
	15	80.8
	20	88.5

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50	5	54.8
	10	73
	15	87.5
	20	90.8
55	5	50
	10	81.8
	15	88.5
	20	91.5
60	5	48.8
	10	81.3
	15	89.5
	20	92.8
65	5	52
	10	81.8
	15	91.5
	20	94.3
70	5	50
	10	86.3
	15	92.3
	20	93.3

Table 2 Recognition Rate using different Number of Eigen Faces and Neuron in hidden layer.
Number of Images used in Training : 5
Number of Images used in Testing : 5
Histogram Equalization : Done for all images

	Rank 1	Rank 2	Rank 3	Rank 4	Rank 5
Number of Correct Decision (Over 400 Images)	360	21	7	4	2
Recognition Rate	90%	95.2 %	97%	98%	98.5 %

Table 3 Recognition Rate with Neural Networks different choices.
Number of Testing Images: 5
Number of Eigenfaces: 50
Number of H. L. Neurons: 15

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Molecular Biocoding of Insulin – Amino Acid Gly

Lutvo Kurić

Abstract - The modern science mainly treats the biochemical basis of sequencing in bio-macromolecules and processes in medicine and biochemistry. One can ask weather the language of biochemistry is the adequate scientific language to explain the phenomenon in that science. Is there maybe some other language, out of biochemistry, that determines how the biochemical processes will function and what the structure and organization of life systems will be? The research results provide some answers to these questions. They reveal to us that the process of sequencing in bio-macromolecules is conditioned and determined not only through biochemical, but also through cybernetic and information principles. Many studies have indicated that analysis of protein sequence codes and various sequence-based prediction approaches, such as predicting drug-target interaction networks (He et al., 2010), predicting functions of proteins (Hu et al., 2011; Kannan et al., 2008), analysis and prediction of the metabolic stability of proteins (Huang et al., 2010), predicting the network of substrate-enzyme-product triads (Chen et al., 2010), membrane protein type prediction (Cai and Chou, 2006; Cai et al., 2003; Cai et al., 2004), protein structural class prediction (Cai et al., 2006; Ding et al., 2007), protein secondary structure prediction (Chen et al., 2009; Ding et al., 2009b), enzyme family class prediction (Cai et al., 2005; Ding et al., 2009a; Wang et al., 2010), identifying cyclin proteins (Mohabatkar, 2010), protein subcellular location prediction (Chou and Shen, 2010a; Chou and Shen, 2010b; Kandaswamy et al., 2010; Liu et al., 2010), among many others as summarized in a recent review (Chou, 2011), can timely provide very useful information and insights for both basic research and drug design and hence are widely welcome by science community. The present study is attempted to develop a novel sequence-based method for studying insulin in hopes that it may become a useful tool in the relevant areas.

Index Terms-Amino Acid Gly, Human Insulin, Insulin Model, Insulin Code.

1 Introduction

The biologic role of any given protein in essential life processes, eg, insulin, depends on the positioning of its component amino acids, and is understood by the „positioning of letters forming words“. Each of these words has its biochemical base. If this base is expressed by corresponding discrete numbers, it can be seen that any given base has its own program, along with its own unique cybernetics and information characteristics.

Indeed, the sequencing of the molecule is determined not only by distin biochemical features, but also by cybernetic and information principles. For this reason, research in this field deals more with the quantitative rather than qualitative characteristcs of genetic information and its biochemical basis. For the purposes of this paper, specific physical and chemical factors have been selected in order to express the genetic information for insulin.Numerical values are them assigned to these factors, enabling them to be measured. In this way it is possible to determine oif a connection really exists between the quantitative ratios in the process of transfer of genetic information and the qualitative appearance of the insulin molecule. To select these factors, preference is given to classical physical and chemical parameters, including the number of atoms in the relevant amino acids, their analog values, the position in these amino acids in the peptide chain, and their frenquencies.There is a arge numbers of these parameters, and each of their gives important genetic information. Going through this process, it becomes clear that there is a mathematical relationship between quantitative ratios and the qualitative appearance of the biochemical „genetic processes“ and that there is a measurement method that can be used to describe the biochemistry of insulin.

2 Methods

Insulin can be represented by two different forms, ie, a discrete form and a sequential form. In the discrete form, a molecule of insulin is represented by a set of discrete codes or a multiple dimension vector. In the sequential form, an insulin molecule is represent by a series of amino acids according to the order of their position in the chains 1AI0.

Therefore, the sequential form can naturally reflect all the information about the sequence order and lenght of an insulin molecule. The key issue is whether we can develop a different discrete method of representing an insulin molecule that will allow accomodation of partial,

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if not all sequence order information? Because a protein sequence is usually represented by a series of amino acids should be assigned to these codes in order to optimally convert the sequence order information into a series of numbers for the discrete form representation?

3 Expression of Insulin Code Matrix- 1AI0

The matrix mechanism of Insulin, the evolution of biomacromolecules and, especially, the biochemical evolution of Insulin language, have been analyzed by the application of cybernetic methods, information theory and system theory, respectively. The primary structure of a molecule of Insulin is the exact specification of its atomic composition and the chemical bonds connecting those atoms.

3.1 Model

The structure **1AI0** has in total **12** chains: A,B,C,D,E,F,G,H,I,J,K,L.

1AI0:A

G	I	V	E	Q	C	C	T	S	I	C	S	L	Y	Q	L	E	N	Y	C	N
10	22	19	19	20	14	14	17	14	22	14	14	22	24	20	22	19	17	24	14	17
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21

1AI0:B

F	V	N	Q	H	I	C	G	S	H	L	V	E	A	L
23	19	17	20	20	22	14	10	14	20	22	19	19	13	22
22	23	24	25	26	27	28	29	30	31	32	33	34	35	36

Y	L	V	C	G	E	R	G	F	I	Y	T	P	K	T
24	22	19	14	10	19	26	10	23	22	24	17	17	24	17
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51

etc.

Fig. 1. Group of chains A,B,C,D,E,F,G,H,I,J,K,L.

Notes: Aforementioned aminoacids are positioned from number 1 to 306. Numbers 1, 2, 3, n... present the position of a certain aminoacid. This positioning is of the key importance for understanding of programmatic, cybernetic and information principles in this protein. The scientific key for interpretation of bio chemical processes is the same for insulin and as well as for the other proteins and other sequences in biochemistry.

The first aminoacid in this example has 10 atoms, the second one 22, the third one 19, etc. They have exactly these numbers of atoms because there are many codes in the insulin molecule, analog codes, and other voded features. In fact, there is a cybernetic algorithm which it is „recorded“ that the firs amino acid has to have 10 atoms, the second one 22, the third one 19, etc. The first amino acid has its own biochemistry, as does the second and the third, etc. The obvious conclusion is that there is a concrete relationship between quantitative ratios in the process of transfer of genetic information and qualitative appearance, ie, the characteristcs of the organism.

3.2 Algorithm

We shall now give some mathematical evidences that will prove that in the biochemistry of hemoglob in there really is programmatic and cybernetic algorithm in which it is „recorded“,

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in the language of mathematics, how the molecule will be built and what will be the quantitative characteristics of the given genetic information.

3.2.1 Atomic progression

Step 1 (Amino acids from 1 to 306)

AC_1 = 10 atoms; AC_2 = 22 atoms; AC_3 = 19 atoms;... AC_{306} = 17 atoms;

$$[AC_1 + (AC_1 + AC_2) + (AC_1 + AC_2 + AC_3)..., + (AC_1 + AC_2 + AC_3..., + AC_{147})] = \mathbf{S_1};$$

$$AC_1 = APa1 = 10;$$
$$(AC_1 + AC_2) = (10+22) = APa2 = 32;$$

$$(AC_1 + AC_2 + AC_3) = (10+22+19) = APa3 = 51;$$
$$(AC_1 + AC_2 + AC_3..., + AC_{306}) = APa_{306} = 5640 \text{ atoms};$$
$APa_{1,2,3,n}$ = Atomic progression of amino acids 1,2,3,n

$$[APa_1 + APa_2 + APa_3)..., + APa_{306})] = (10+32+51..., + 5640) = \mathbf{S_1};$$

$$S_1 = 863\ 208;$$

Example :

Atomic progression 1 (APa)

G	I	V	E	Q	C	.	.	P	K	T	Sum
10	22	19	19	20	14	.	.	17	24	17	**5640**
1	2	3	4	5	6	.	.	304	305	306	46971

↓

G	I	V	E	Q	C	.	.	P	K	T	Sum
10	32	51	70	90	104	.	.	5599	5623	5640	**863 208**
1	2	3	4	5	6	.	.	304	305	306	46971

(0+10) = 10; (10+22)=32; (10+11+19) = 51; etc.

Fig. 2. Atomic progression 1 (APa) of amino acids from 1 to 306.

Notes: By using chemical-information procedures, we calculated the arithmetic progression for the information content of aforementioned aminoacids.

Step 2 (Amino acids from 306 to 1)

AC_{306} = 17 atoms; AC_{305} = 24 atoms; AC_{304} = 17 atoms;... AC_1 = 10 atoms;

$$[AC_{306} + (AC_{306} + AC_{305}) + (AC_{306} + AC_{305} + AC_{304})..., + (AC_{306} + AC_{305} + AC_{304}..., + AC_1)] = \mathbf{S_2};$$

$$AC_{306} = APb_{306} = 17;$$
$$(AC_{306} + AC_{305}) = (17+24) = APb_{306} = 41;$$

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$$(AC_{306}+ AC_{305}+ AC_{304}) = (17+24+17) = APb_{304} = 58;$$
$$(AC_{306}+ AC_{305}+ AC_{304}..., + AC_{1}) = APb_{1} = 5640 \text{ atoms};$$
$APb_{306,305,304,\ldots,1}$ = Atomic progression of amino acids 306,305,304,…1;

$$[APb_{306}+AP_{b305}+APb_{1304})..., + APb_{1})] = (17+41+58\ldots, + 5640) = 868\ 272;$$

$$S_2 = 868\ 272;$$

Example:

Atomic progression 2 (APb)

G	I	V	.	.	I	Y	T	P	K	T	Sum
10	22	19	.	.	22	24	17	17	24	17	5640
1	2	3	.	.	301	302	303	304	305	306	46971

↓

Sum	G	I	V	.	.	I	Y	T	P	K	T
868 272	5640	5630	5608	.	.	121	99	75	58	41	17
46971	1	2	3	.	.	301	302	303	304	305	306

(0+17) = 17; (17+24)=41; (17+24+17)=58; etc.

Fig. 3. Schematic representation of the atomic progression 2 from 306 to 1.

Within the digital pictures in biochemistry, the physical and chemical parameters are in a strict compliance with programmatic, cybernetic and information principles. Each bar in the protein chain attracts only the corresponding aminoacid, and only the relevant aminoacid can be positioned at certain place in the chain. Each peptide chain can have the exact number of aminoacids necessary to meet the strictly determined mathematical conditioning. It can have as many atoms as necessary to meet the mathematical balance of the biochemical phenomenon at certain mathematical level, etc. The digital language of biochemistry has a countless number of codes and analogue codes, as well as other information content. These pictures enable us to realize the very essence of functioning of biochemical processes. There are some examples:

Table 1. Atomic progression APa and APb (Amino acid Gly – position from 1 to 306 AA)

The structure 1AI0 – Amino acid Gly

	G	G	G	G	G	G	G	G
Number of atoms	10	10	10	10	10	10	10	10
Rank	1	29	41	44	52	80	92	95
APa	10	523	741	796	950	1463	1681	1736
APb	5640	5127	4909	4854	4700	4187	3969	3914
AP(a,b)	5650	5650	5650	5650	5650	5650	5650	5650

	G	G	G	G	G	G	G	G
Number of atoms	10	10	10	10	10	10	10	10
Rank	103	131	143	146	154	182	194	197
APa	1890	2403	2621	2676	2830	3343	3561	3616
APb	3760	3247	3029	2974	2820	2307	2089	2034
AP(a,b)	5650	5650	5650	5650	5650	5650	5650	5650

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	G	G	G	G	G	G	G	G
Number of atoms	10	10	10	10	10	10	10	10
Rank	205	233	245	248	256	284	296	299
APa	3770	4283	4501	4556	4710	5223	5441	5496
APb	1880	1367	1149	1094	940	427	209	154
AP(a,b)	5650	5650	5650	5650	5650	5650	5650	5650

Table 1. Schematic representation of the atomic progression APa and APb (Amino acid Gly – position from 1 to 306 AA).

Notes: Namely, having mathematically analyzed the atomic preogression model of Insulin Model (Table 1) we have found out that the protein code is based on a periodic law. This being the only to „read“ the picture, the solution of the main problem (concering an arrangement where each amino acid takes only one, precisely determined position in the code), is quite manifest:

Atomic progression model of insulin should, in fact, be „remodelled“ into a periodic system. Examples:

Atomic progression APa and APb

	G	G	G	G	G	G	G	G		
Rank	299	1	29	296	41	284	44	256	>	1250
APa	5496	10	523	5441	741	5223	796	4710	>	22940
R	-144	-144	314	314	314	314	-144	-144	>	680
APb	5640	154	209	5127	427	4909	940	4854	>	22260
	G	G	G	G	G	G	G	G		
Rank	1	299	296	29	284	41	256	44	>	1250

R > (5496-5640) = (-)144; (10-154) = (-)144; (523-209) = 314; etc.

	G	G	G	G	G	G	G	G		
Rank	52	248	80	245	92	233	95	205	>	1250
APa	950	4556	1463	4501	1681	4283	1736	3770	>	22940
R	-144	-144	314	314	314	314	-144	-144	>	680
APb	1094	4700	1149	4187	1367	3969	1880	3914	>	22260
	G	G	G	G	G	G	G	G		
Rank	248	52	245	80	233	92	205	95	>	1250

	G	G	G	G	G	G	G	G		
Rank	103	197	131	194	143	182	146	154	>	1250

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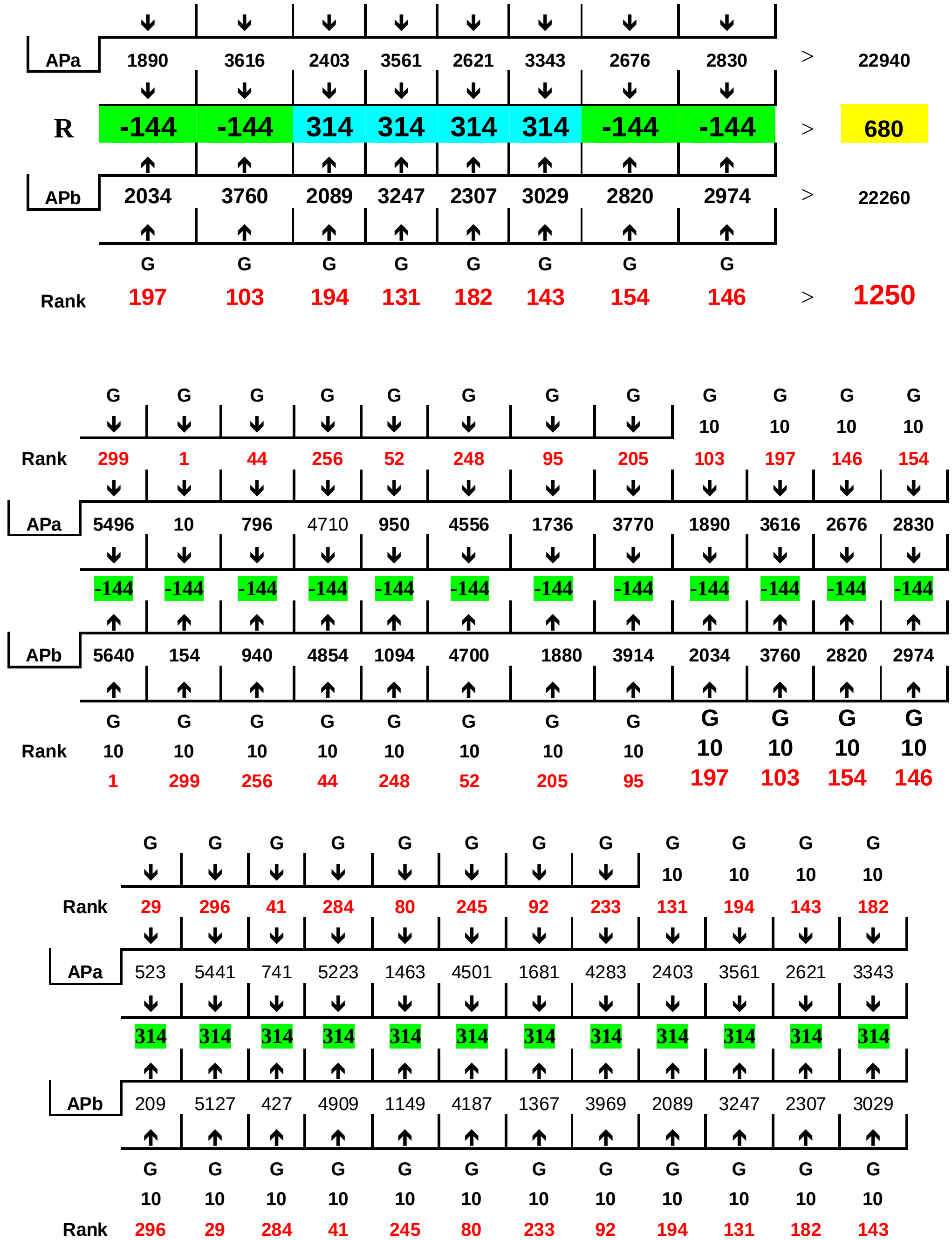

Fig. 4. Atomic progression APa and APb (Amino acid Gly – position from 1 to 306 AA).

In this example, the amino acids Gly atomic progression APa and APb as a result was given the codes 144 and 314th.

As we see, the insulin code is itself a unique structure of program, cybernetic and informational system and law.

The research we carried out have shown that atomic progression are one of quantitative characteristics in biochemistry. Atomic progression is, actually, a discrete code that protects and guards genetic information

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coded in bio-chemical processes. This a recently discovered code, and more detailed knowledge on it is yet to be discovered.

In a similar way we shall calculate bio codes of other unions of amino acids. Once we do this, we will find out that all these unions of amino acids are connected by various bio codes, analogue codes as well as other quantitative features. Examples:

Atomic progression APa and APb

	G	G	G	G	G	G	G	G
	◎	◎	◎	◎	◎	◎	◎	◎
APa	5496	10	523	5441	741	5223	796	4710
APa	950	4556	1463	4501	1681	4283	1736	3770
APa	1890	3616	2403	3561	2621	3343	2676	2830
APb	5640	154	209	5127	427	4909	940	4854
APb	1094	4700	1149	4187	1367	3969	1880	3914
APb	2034	3760	2089	3247	2307	3029	2820	2974
	◎		◎			◎		◎
		67800					67800	

	G	G	G	G		Sum
	◎	◎	◎	◎		
APa	5496	10	523	5441	>	11470
APa	950	4556	1463	4501	>	11470
APa	1890	3616	2403	3561	>	11470

	G	G	G	G		Sum
	◎	◎	◎	◎		
APa	741	5223	796	4710	>	11470
APa	1681	4283	1736	3770	>	11470
APa	2621	3343	2676	2830	>	11470

	G	G	G	G		Sum
	◎	◎	◎	◎		
APb	5640	154	209	5127	>	11130
APb	1094	4700	1149	4187	>	11130
APb	2034	3760	2089	3247	>	11130

	G	G	G	G		Sum
	◎	◎	◎	◎		
APb	427	4909	940	4854	>	11130
APb	1367	3969	1880	3914	>	11130
APb	2307	3029	2820	2974	>	11130

Fig. 5. Atomic progression APa and APb (Amino acid Gly – position from 1 to 306 AA).

Atomic progression presented in figure 2 are calculated using the relationship between corresponding groups of those rogressions. These are groups with different progression. There are different ways and methods of selecting these groups of progressions, which method is most efficient some We hope that science will determine which method is most efficient for this selection.

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3.2.2 Rank of atomic progression

	G	G	G	G	G	G	G	G	Sum
	◎	◎	◎	◎	◎	◎	◎	◎	
Rank	299	1	29	296	41	284	44	256	1250
Rank	1	299	296	29	284	41	256	44	1250
Rank	52	248	80	245	92	233	95	205	1250
Rank	248	52	245	80	233	92	205	95	1250
Rank	103	197	131	194	143	182	146	154	1250
Rank	197	103	194	131	182	143	154	146	1250
Sum	900	900	975	975	975	975	900	900	

	G	G	G	G		
	◎	◎	◎	◎		
Rank	299	1	29	296	>	625
Rank	1	299	296	29	>	625
Rank	52	248	80	245	>	625
Rank	248	52	245	80	>	625
Rank	103	197	131	194	>	625
Rank	197	103	194	131	>	625

	G	G	G	G		Sum
	◎	◎	◎	◎		
Rank	41	284	44	256	>	625
Rank	284	41	256	44	>	625
Rank	92	233	95	205	>	625
Rank	233	92	205	95	>	625
Rank	143	182	146	154	>	625
Rank	182	143	154	146	>	625

	G	G	G	G		Sum
	◎	◎	◎	◎		
Rank	299	1	44	256	>	600
Rank	1	299	256	44	>	600
Rank	52	248	95	205	>	600
Rank	248	52	205	95	>	600
Rank	103	197	146	154	>	600
Rank	197	103	154	146	>	600
Sum	900	900	900	900		

	G	G	G	G		Sum
	◎	◎	◎	◎		
Rank	29	296	41	284	>	650
Rank	296	29	284	41	>	650
Rank	80	245	92	233	>	650
Rank	245	80	233	92	>	650
Rank	131	194	143	182	>	650
Rank	194	131	182	143	>	650
Sum	975	975	975	975		

Fig. 6. Rank atomic progression APa and APb (Amino acid Gly – position from 1 to 306 AA).

In those examples, we have the mathematical balance in rows and columns in this figure.

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In fact, we have discovered the mathematical balance in distribution of sequences in figure 6 is achieved.

3.2.3 Correlation of atomic progression

Atomic progression of this amino acid to us as a result of its correlation give a variety of codes. Here are some examples:

	G	G				G	G				G	G		
	10	10				10	10				10	10		
	41	284	>	325		80	245	>	325		143	182	>	325
APa	741	5223	>	5964		1463	4501	>	5964		2621	3343	>	5964
APb	4909	427	>	5336		4187	1149	>	5336		3029	2307	>	5336
	◎	◎		◎		◎	◎		◎		◎	◎		◎
R	314	314		11300		314	314		11300		314	314		11300

	G	G				G	G				G	G		
	10	10				10	10				10	10		
	44	256	>	300		52	248	>	300		146	154	>	300
APa	796	4710	>	5506		950	4556	>	5506		2676	2830	>	5506
APb	4854	940	>	5794		4700	1094	>	5794		2974	2820	>	5794
	◎	◎		◎		◎	◎		◎		◎	◎		◎
R	314	314		11300		314	314		11300		314	314		11300

Fig. 7. Correlation of atomic progression and rank of APa and APb (Amino acid Gly – position from 1 to 306 AA).

In those examples we have the correlation of atomic progression and rank of APa and APb.

3.2.4 Odd and even progression

Progression of the APa and APb, in fact, odd and even numbers. These numbers are one of the keys to decoding and decoding molecules insulina. This decoding we can make this:

Steam progression

	G	G	G	G	G	G	G	G	G	G	G	G
	10	10	10	10	10	10	10	10	10	10	10	10
	1	44	52	95	103	146	154	197	205	248	256	299
APa	10	796	950	1736	1890	2676	2830	3616	3770	4556	4710	5496
APb	5640	4854	4700	3914	3760	2974	2820	2034	1880	1094	940	154
	5650	5650	5650	5650	5650	5650	5650	5650	5650	5650	5650	5650

etc.

Steam progression are:

APa = (10, 5640); (1736, 3914); (1890, 3760); etc.

Progression are the odd and even rank.

Odd rank

	G	G	G	G	G	G		
	10	10	10	10	10	10		
Rank	1	95	103	197	205	299	>	900

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APa	10	1736	1890	3616	3770	5496		16518
APb	5640	3914	3760	2034	1880	154	>	17382
	5650	5650	5650	5650	5650	5650		

Even rank

	G	G	G	G	G	G		
	10	10	10	10	10	10		
Rank	44	52	146	154	248	256	>	900
APa	796	950	2676	2830	4556	4710		16518
APb	4854	4700	2974	2820	1094	940	>	17382
	5650	5650	5650	5650	5650	5650		

Odd rank = Even rank = 900;
Odd APa = Even APa = 16518;
Odd APb = Even APb = 17382;

Fig. 8. Odd and even progression of aminoacid Gly.

Notes: Within the digital pictures in biochemistry, the physical and chemical parameters are in a strict compliance with programmatic, cybernetic and information principles. Each bar in the protein chain attracts only the corresponding aminoacid, and only the relevant aminoacid can be positioned at certain place in the chain. Each peptide chain can have the exact number of aminoacids necessary to meet the strictly determined mathematical conditioning. It can have as many atoms as necessary to meet the mathematical balance of the biochemical phenomenon at certain mathematical level, etc. The digital language of biochemistry has a countless number of codes and analogue codes, as well as other information content. These pictures enable us to realize the very essence of functioning of biochemical processes.

Odd rank progression

	G	G	G	G	G	G		
	◎	◎	◎	◎	◎	◎		
Rank	1	299	95	205	103	197	>	900
	◎	◎	◎	◎	◎	◎		
APa	10	5496	1736	3770	1890	3616	>	16518
	◎	◎	◎	◎	◎	◎		
	-144	-144	-144	-144	-144	-144		
	◎	◎	◎	◎	◎	◎		
APb	154	5640	1880	3914	2034	3760	>	17382
	◎	◎	◎	◎	◎	◎		
	G	G	G	G	G	G		
Rank	299	1	205	95	197	103	>	900
	↘	↘	↘		↙	↙		
				34836				

(1+10+(-)144+154+299…+ 103) = 34836;

Even rank progression

	G	G	G	G	G	G		
	◎	◎	◎	◎	◎	◎		
Rank	44	256	52	248	146	154	>	900

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APa	796	4710	950	4556	2676	2830	>	16518
	-144	-144	-144	-144	-144	-144		
APb	940	4854	1094	4700	2820	2974	>	17382
	G	G	G	G	G	G		
Rank	256	44	248	52	154	146	>	900

34836

(44+796+ (-)144+940+256…+ 146) = 34836;

Fig. 9. Odd and even rank progression of aminoacid Gly.

Odd AP-a progression

	G	G	G	G	G	G	G	G	G	G	G	G
	10	10	10	10	10	10	10	10	10	10	10	10
	29	41	80	92	131	143	182	194	233	245	284	296
APa	523	741	1463	1681	2403	2621	3343	3561	4283	4501	5223	5441
APb	5127	4909	4187	3969	3247	3029	2307	2089	1367	1149	427	209
	5650	5650	5650	5650	5650	5650	5650	5650	5650	5650	5650	5650

Odd APa progression – Even rank

	G	G	G	G	G	G
Rank	80	296	92	284	182	194
APa	1463	5441	1681	5223	3343	3561
	1254	1254	1254	1254	1254	1254
APb	209	4187	427	3969	2089	2307
	G	G	G	G	G	G
Rank	296	80	284	92	194	182

Odd APa progression – Odd rank

	G	G	G	G	G	G
Rank	29	245	41	233	131	143

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APa	523	4501	741	4283	2403	2621
	-626	-626	-626	-626	-626	-626
APb	1149	5127	1367	4909	3029	3247
	G	G	G	G	G	G
Rank	245	29	233	41	143	131

Even rank and odd rank

	G	G	G	G	G	G
Rank par	80	296	92	284	182	194
Rank nepar	29	245	41	233	131	143
	51	51	51	51	51	51
Rank par	296	80	284	92	194	182
Rank nepar	245	29	233	41	143	131
	51	51	51	51	51	51

(80-29) = 51; (296-245) = 51; (92-41) = 51;

Even APa and odd rank

	G	G	G	G	G	G
APa rank even	1463	5441	1681	5223	3343	3561
APa rank odd	523	4501	741	4283	2403	2621
	940	940	940	940	940	940
APb odd	1149	5127	1367	4909	3029	3247
APb even	209	4187	427	3969	2089	2307
	940	940	940	940	940	940

(80-29) = 51; (296-245) = 51; (92-41) = 51;

Figure 10. Odd AP-a progression, odd APa progression–even rank, odd APa progression –odd rank, even rank and odd rank and even APa and odd rank

3.3 Bio frequency

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Insulin is composed of aminoacids with various numerical values. This numerical values are in an irregular order. For example, the first one has 10 atoms, the second one 22. Their frequency is X. Second amino acid has 22 atoms, and the third one 19. Their frequency is Y; etc... Frequency is the measurement for establishment of intervals of numerical values of amino acids in proteins. This value can be positive, negative or a zero value. These frequencies are showing us one completely new dimension of protein sequencing. Through these frequencies we can establish which of aminoacids are of primary, and which are of secondary significance in biochemical processes of insulin. Here is a concrete example:

	G	I	V	E	Q	C	C	T
	10	22	19	19	20	14	14	17
	1	2	3	4	5	6	7	8
10	12	-3	0	1	-6	0	3	-3

From 0 to 10 = 10; From 10 to 22 = 12; From 22 to 19 = (-) 3; From 19 to 19 = 0; etc

Schematic representation of the amino acid and frequency we will show in the fig.11.

G	G	G	G	G	G	G	G	G	G	G	G		
10	10	10	10	10	10	10	10	10	10	10	10		
1	29	41	44	52	80	92	95	103	131	143	146		
12	4	9	13	12	4	9	13	12	4	9	13	>	114;

G	G	G	G	G	G	G	G	G	G	G	G		
10	10	10	10	10	10	10	10	10	10	10	10		
154	182	194	197	205	233	245	248	256	284	296	299		
12	4	9	13	12	4	9	13	12	4	9	13	>	114;

◎◎

	G	G	G	G	G	G	G	G		
	◎	◎	◎	◎	◎	◎	◎	◎		
Rank	1	299	29	296	41	284	44	256	>	1250
	◎	◎	◎	◎	◎	◎	◎	◎		
Fr	12	13	4	9	9	4	13	12	>	76
	◎	◎	◎	◎	◎	◎	◎	◎		
	-1	1	-5	5	5	-5	1	-1	>	0
	◎	◎	◎	◎	◎	◎	◎	◎		
Fr	13	12	9	4	4	9	12	13	>	76
	◎	◎	◎	◎	◎	◎	◎	◎		
	G	G	G	G	G	G	G	G		
Rank	299	1	296	29	284	41	256	44	>	1250

	G	G	G	G	G	G	G	G		
	◎	◎	◎	◎	◎	◎	◎	◎		
Rank	52	248	80	245	92	233	95	205	>	1250
	◎	◎	◎	◎	◎	◎	◎	◎		
APa	12	13	4	9	9	4	13	12	>	76
	◎	◎	◎	◎	◎	◎	◎	◎		
	-1	1	-5	5	5	-5	1	-1	>	0
	◎	◎	◎	◎	◎	◎	◎	◎		
APb	13	12	9	4	4	9	12	13	>	76

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	G	G	G	G	G	G	G	G		
Rank	248	52	245	80	233	92	205	95	>	1250

	G	G	G	G	G	G	G	G		
Rank	103	197	131	194	143	182	146	154	>	1250
APa	12	13	4	9	9	4	13	12	>	76
	-1	1	-5	5	5	-5	1	-1	>	0
APb	13	12	9	4	4	9	12	13	>	76
	G	G	G	G	G	G	G	G		
Rank	197	103	194	131	182	143	154	146	>	1250

Figure 11. Schematic representation of the amino acid Gly and their frequency

Odd rank and frequency

G	G	G	G	G	G	G	G	G	G	G	G		
10	10	10	10	10	10	10	10	10	10	10	10		
1	29	41	95	103	131	143	197	205	233	245	299		
12	4	9	13	12	4	9	13	12	4	9	13	>	114;

Even rank and frequency

G	G	G	G	G	G	G	G	G	G	G	G		
10	10	10	10	10	10	10	10	10	10	10	10		
44	52	80	92	146	154	182	194	248	256	284	296		
13	12	4	9	13	12	4	9	13	12	4	9	>	114;

Figure 12. Schematic representation of the amino acid Gly and their odd-even rank and frequency

Therefore, there is a mathematical balance between the group of aminoacids with positive frequency and those of negative frequency. Aminoacids with a positive frequency have a primary role in the mathematical picture of that protein, and the negative frequencies have a secondary role in it. We assume that aminoacids with a positive frequency have a primary role in the biochemical picture of that protein, and the negative frequencies have a secondary role in it. If this really is the case and research on an experimental level proves it, a radically new way of learning about biochemical processes will be opened.

3.4 Analog bio code

Each numerical value has its analogue expression. For example: The analogue expression for number 19 is 91.

91 | | 19

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In a similar way we can calculate the analogue expression for any numerical value. Our research has shown that analog codes are quantitative characteristics in biochemistry. Analogue biocode is a discrete code that protects and guards genetic information coded in biochemical processes.

This a recently discovered code, and more detailed knowledge about it is necessary.

Odd rank and analog frequency

		G	G	G	G	G	G	G	G	G	G	G	G		
		10	10	10	10	10	10	10	10	10	10	10	10		
		1	29	41	95	103	131	143	197	205	233	245	299		
Frequencu	>	12	04	09	13	12	04	09	13	12	04	09	13	>	114;
		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎		
Analog frequency	>	21	40	90	31	21	40	90	31	21	40	90	31	>	546;

Even rank and analog frequency

		G	G	G	G	G	G	G	G	G	G	G	G		
		10	10	10	10	10	10	10	10	10	10	10	10		
		44	52	80	92	146	154	182	194	248	256	284	296		
Frequency	>	13	12	04	09	13	12	04	09	13	12	04	09	>	114;
		◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎	◎		
Analog Frequency	>	31	21	40	90	31	21	40	90	31	21	40	90	>	546;

Figure 13. Schematic representation of the amino acid Gly and their odd-even rank and analog frequency

Analogue code is , actually, a discrete code that protects and guards genetic information coded in biochemical processes.

In the previous examples we translated the physical and chemical parameters from the language of biochemistry into the digital language of programmatic, cybernetic and information principles. This we did by using the adequate mathematical algorithms. By using chemical-information procedures, we calculated the numerical value for the information content of molecules. What we got this way is the digital picture of the phenomenon of biochemistry. These digital pictures reveal to us a whole new dimension of this science. They reveal to us that the biochemical process is strictly conditioned and determined by programmatic, cybernetic and information principles.

From the previous examples we can see that this protein really has its quantitative characteristics. It can be concluded that there is a connection between quantitative characteristics in the process of transfer of genetic information and the qualitative appearance of given genetic processes.

4 DISCUSSION

The results of our research show that the processes of sequencing the molecules are conditioned and arranged not only with chemical and biochemical lawfulness, but also with program, cybernetic and informational lawfulness too. At the first stage of our research we replaced nucleotides from the Amino Acid Code Matrix with numbers of the atoms and atomic numbers in those nucleotides. Translation of the biochemical language of these amino acids into a digital language may be very useful for developing new methods of predicting protein sub-cellular localization, membrane protein type, protein structure secondary prediction or any other protein attributes.

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The success of human genome project has generated deluge of sequence information. The explosion of biological data has challenged scientists to accelerate the speed for their analysis. Nowadays, protein sequences are generally stored in the computer database system in the form of long character strings. It would act like a snail's pace for human beings to read these sequences with the naked eyes (Xiao and Chou, 2007). Also, it is very hard to extract any key features by directly reading these long character strings. However, if they can be converted to some signal process, many important features can be automatically manifested and easily studied by means of the existing tools of information theory (Xiao and Chou, 2007). The novel approach as presented here may help improve this kind of situation.

5 CONCLUSIONS AND PERSPECTIVES

The process of sequencing in bio-macromolecules is conditioned and determined not only through biochemical, but also through cybernetic and information principles. The digital pictures of biochemistry provide us with cybernetic and information interpretation of the scientific facts. Now we have the exact scientific proofs that there is a genetic language that can be described by the theory of systems and cybernetics, and which functions in accordance with certain principles.

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Electrical Power Generation Using Piezoelectric Crystal

Anil Kumar

Abstract- The usefulness of most high technology devices such as cell phones, computers, and sensors is limited by the storage capacity of batteries. In the future, these limitations will become more pronounced as the demand for wireless power outpaces battery development which is already nearly optimized. Thus, new power generation techniques are required for the next generation of wearable computers, wireless sensors, and autonomous systems to be feasible. Piezoelectric materials are excellent power generation devices because of their ability to couple mechanical and electrical properties. For example, when an electric field is applied to piezoelectric a strain is generated and the material is deformed. Consequently, when a piezoelectric is strained it produces an electric field; therefore, piezoelectric materials can convert ambient vibration into electrical power. Piezoelectric materials have long been used as sensors and actuators; however their use as electrical generators is less established. A piezoelectric power generator has great potential for some remote applications such as in vivo sensors, embedded MEMS devices, and distributed networking. Developing piezoelectric generators is challenging because of their poor source characteristics (high voltage, low current, high impedance) and relatively low power output. This paper presents a theoretical analysis to increase the piezoelectric power generation that is verified with experimental results.

Index Terms-Piezoelectric materials, piezoelectricity, power generation, PZT ceramics.

1 Introduction

Mechanical stresses applied to piezoelectric materials distort internal dipole moments and generate electrical potentials (voltages) in direct proportion to the applied forces. These same crystalline materials also lengthen or shorten in direct proportion to the magnitude and polarity of applied electric fields.

Because of these properties, these materials have long been used as sensors and actuators. One of the earliest practical applications of piezoelectric materials was the development of the first SONAR system in 1917 by Langevin who used quartz to transmit and receive ultrasonic waves [1]. In 1921, Cady first proposed the use of quartz to control the resonant frequency of oscillators. Today, piezoelectric sensors (e.g., force, pressure, acceleration) and actuators (e.g., ultrasonic, micro positioning) are widely available.

The same properties that make these materials useful for sensors can also be utilized to generate electricity. Such materials are capable of converting the mechanical energy of compression into electrical energy, but developing piezoelectric generators is challenging because of their poor source characteristics (high voltage, low current, high impedance). This is especially true at low frequencies and relatively low power output.

These challenges have limited the use of such generators primarily because the relatively small amount of available regulated electrical power has not been useful. The recent advent of extremely low power electrical and mechanical devices (e.g., micro electromechanical systems or MEMS) makes such generators attractive in several applications where remote power is required. Such applications are sometimes referred to as power scavenging and include *in vivo* sensors, embedded MEMS devices, and distributed networking.

Several recent studies have investigated piezoelectric power generation. One study used lead zirconate titanate (PZT) wafers and flexible, multilayer polyvinylidene fluoride (PVDF) films inside shoes to convert mechanical walking energy into usable electrical energy [2], [3]. This system has been proposed for mobile computing and was ultimately able to provide continuously 1.3 mW at 3 V when walking at a rate of 0.8 Hz.

Other projects have used piezoelectric films to extract electrical energy from mechanical vibration in machines to power MEMS devices [4]. This work extracted a very small amount of power (<5uW) from the vibration and no attempt was made to condition or store the energy. Similar work has extracted slightly more energy (70uW) from machine and building vibrations [5].

Piezoelectric materials have also been studied to generate electricity from pressure variations in micro hydraulic systems [6]. The power would presumably be used for MEMS but this work is still in the conceptual phase. Other work has used piezoelectric materials to convert kinetic energy into a spark to detonate an explosive projectile on impact [7]. Still other work has proposed using flexible piezoelectric polymers for energy conversion in windmills [8], and to convert flowin oceans and rivers into electric power [9].A recent medical application has proposed the use of piezoelectric materials to generate electricity to promote bone growth [10]. This work uses an implanted bone prosthesis containing a piezoelectric generator configured to deliver electric current to specific locations around the implant. This device uses unregulated (high voltage) energy and it is not clear if the technique has advanced beyond the conceptual phase. The

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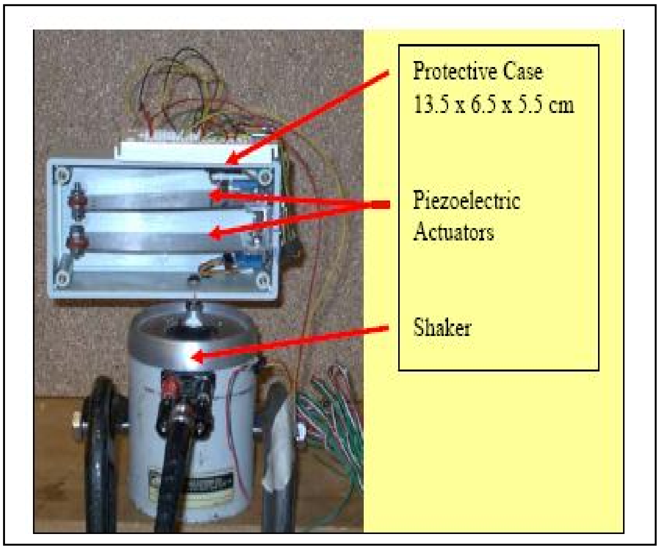
above studies have all had some success in extracting electrical power from piezoelectric elements. However, many issues such as efficiency, conditioning and storage have not been fully addressed.

This paper presents the idea to increase the power generation by the piezoelectric. A few researchers have used single off the-shelf piezoelectric devices to harvest electrical power, yet little has been done to overcome the main weaknesses associated with piezoelectric power harvesting. This research seeks to systematically overcome the weaknesses associated with cantilever-mounted piezoelectric used for mobile power harvesting to maximize the power from a piezoelectric device the load impedance must match the impedance of device. This is problematic for frequencies between 10-100 Hz because a single piezoelectric may have impedance in the range of several hundred thousand ohms to ten million ohms. Thus, little current can be produced, and battery charging is diminished due to low current production. To reduce the impedance and increase electrical current, two off-the-shelf actuators (8 piezoelectric totals) are connected electrically in parallel and tuned to resonate in the frequency range of an ambient vibration similar to that produced by a person walking. A picture of the experimental setup may be seen in Figure 1.

Figure 1: The mobile power harvester attached to a shaker for experimental testing



To demonstrate the power harvesting advantage, 40 and 80 mAhr Nickel Metal Hydride batteries are recharged with each individual actuator then charged with both actuators connected in parallel. For a 1.4 Hz frequency (a brisk walking pace), the parallel combination charges two 40 mAhr batteries in 3.09 hours, and two 80 mAhr batteries in 5.64 hours. The individual actuators require 16.1 hours to charge a 40 mAhr battery, and 22.7 hours to charge an 80 mAhr battery. Clearly, the parallel combination of multiple off-the-shelf piezoelectric actuators increases battery charge times, and adding more parallel devices could increase power production so long as the total voltage exceeds the charged voltage of the battery. Since most production piezoelectric devices are designed as actuators, research is being conducted to optimize piezoelectric for power harvesting. Specifically, the locations of each piezoelectric on the cantilevered structure is being studied and designs that reduce electrical cancellation due to out of phase motions are ongoing.

On october 6, 2009 the Hefer intersection along the old coastal road of Route 4 in Israel was the place where a piezoelectric generator was put to the test and generated some 2,000 watt-hours of electricity. The setup consists of a ten-meter strip of asphalt, with generators lying underneath, and batteries in the road's proximity. Being the first practical test of the system, the researchers still expect energetic and feasibility results. Technion was helped by Innowattech, a company from Israel to finish the pilot project The project manager, Dr. Lucy Edery-Azulay, explained that the generators developed by Innowattech are embedded about five centimeters beneath the upper layer of asphalt. "The technology is based on piezoelectric materials that enable the conversion of mechanical energy exerted by the weight of passing vehicles into electrical energy. As far as the drivers are concerned, the road is the same," she says Edery-Azulay added that expanding the project to a length of one kilometer along a single lane would produce 200 KWh, while a four-lane highway could produce about a MWh sufficient electricity to provide for the average consumption in 2,500 households.

CONCLUSION

As the results shows that by using double actuators in parallel we can reduce the charging time of the battery and increase the power generated by the piezoelectric device.In second research where a piezoelectric generator was put to the test and generated some 2,000 watt-hours of electricity. The setup consists of a ten-meter strip of asphalt, with generators lying underneath, and **batteries** in the road's proximity. So that it is clear by using parallel combination we can overcome the problems like of impedance matching and low power generation. The results clearly show that piezoelectric materials are the future of electric power generation.

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