LabVIEW Based Automatic Measuring System for Fresh Water Aquaculture Parameters

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Abstract- This paper presents the development of a LabVIEW based automatic measuring system for fresh water aquaculture parameters measuring four water parameters optimized by appropriate algorithms. LabVIEW virtual instrument platform, high performance PC system along with multi channel sampling chamber, DAS card, Opto-isolated I/O card, solenoid valves, sensors with transmitters and ½ HP pump are used to monitor the pond water parameters like dissolved oxygen, pH, conductivity and temperature which determines the stress factors of fish. The software was developed in the LabVIEW platform for logging the acquired data in Microsoft Access Database and to control sampling chamber operations. Initial Field Trials were conducted at Bhubaneswar and data was collected in March 2010 to July 2010. The result indicated that the measured values of pH and DO were compared to the data of standard meters used at CIFA. It is found that the pH, DO and temperature reading of the sampled water was consistent with the standard meter readings.

Keywords: Dissolved Oxygen, LabVIEW, monitoring system, pH, stress parameters, sensors, Temperature.

1 Introduction

Initially developed systems determine the freshwater parameters in the ponds only or by the chemical method. Chemical testing kits of pH, dissolved oxygen and temperature measurement "[1]" are used to determine the water parameters in the ponds.The other method is to determine the water parameters of the pond by putting sensors directly into the concrete pond "[2]". These types of systems are costlier and stagnant to the ponds in the fields or in the labs. The basic idea was to develop this system is to make the fully automized and portable system, which can be used in the field ponds to determine the freshwater parameters which effects on the aquaculture and in the mean time determine the parameters in the lab also.

Water quality is critical to the beneficial use of ponds, but the parameters and levels of concern will vary depending on the intended use of the pond. Water quality also plays a critical role in determining the types and number of fish species that can live in all ponds, as well as their growth and survival rates "[3]". For the fish farming in the coastal region in India, aquaculture production systems must be capable of maintaining proper levels of water quality parameters like temperature, dissolved oxygen, pH, un-ionized ammonia, nitrite and carbon dioxide "[4],[5],[6]". LabVIEW has become a vital tool in today's emerging technologies and widely adopted throughout academia, industry, and government laboratories as the standard for data acquisition, instrument control and analysis software "[7]". The main target is to achieve better fish production annually so the water quality should be maintained. The objective of this work was to develop dedicated computer-based online monitoring system for measurement, data logging, and data analysis of critical water quality parameters. Application software is developed in LabVIEW for data logging of water parameters like dissolved oxygen, temperature and pH from the sensor through a data acquisition interface card "[8]". The acquired data are recorded in a Microsoft Access database as well as in a text file that can be locally queried as desired. The operator can log into the system and follow the real-time variations of a specific water quality parameter. In the designed system multichannel sampling chamber is used to acquire the water directly from different ponds. The respective obtained data can be analyzed using various tools (statistical, graphical, etc.) and validation.

2 Materials and Method

The initially developed system which is having a rectangular sampling chamber, sensor assembly, solenoid valves act as on/off switches, a pump and the common node or sucking area of pump made up with the perspex sheet "[9]". In this system air leakage problem occurs at the time of sucking water directly from the pond via tubes and the rectangular sampling chamber acquires the environmental air which was further mixed into the water.

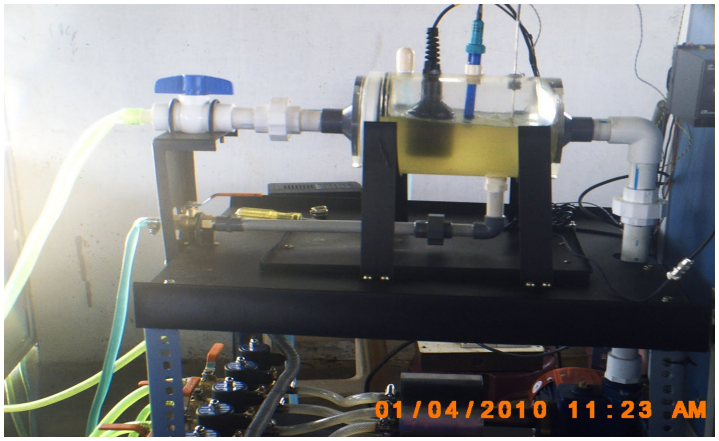

Fig. 1: Sampling chamber of the developed system

This chamber is having a drainage pipe in the middle of the

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bottom which is also controlled by the manually or automatically (by software) and having the water inlet and water outlet at the same height for the continuous flow of water "[10]". The sampling chamber (Fig. 1) is equipped with pH sensor, RTD temperature sensor and Dissolved oxygen sensor with the transmitter.

Fig. 2: Fully developed system

To avoid the air mixing along with water 1/2 HP centrifugal pump is used to suck the water directly from the pond and send it to the sampling chamber through the solenoid valves and air tight stainless steel common node. The software is developed in LabVIEW to monitor record and display the data of the fish pond's water into the text file as well as in graphical form to show the history curve and trend curve of the parameters. This developed software control the operation of a pump, solenoid valve and pond water parameter acquisition through interface with the hardware using DAS and Opto-isolated I/O cards (PCL 818HG and PCI 1730). The fully developed system is shown in Fig. 2 and main operational menu of the developed system is shown in Fig. 3.

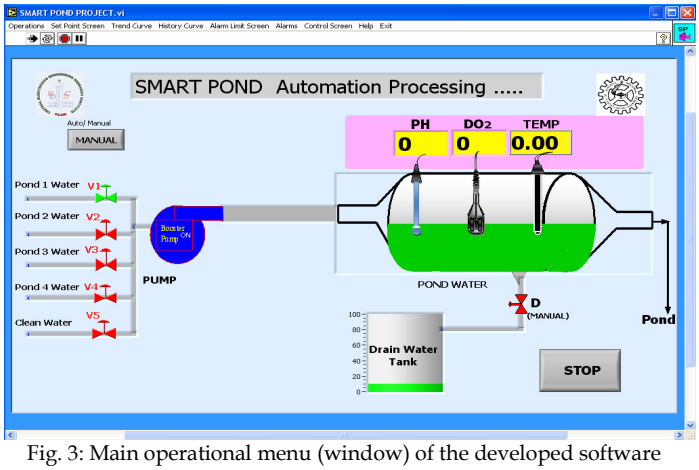

Fig. 3: Main operational menu (window) of the developed software

The data are recorded in the text file as well as into the Microsoft Access Database in a way that it can be easily exported for the further treatment and analysis. The values from the sensors are acquired at predefined intervals and the respective maximum and minimum values displayed with the information from existing sensors. The operation of the software for multi-sensor automatic controlled system is shown in the flowchart in Fig 4.

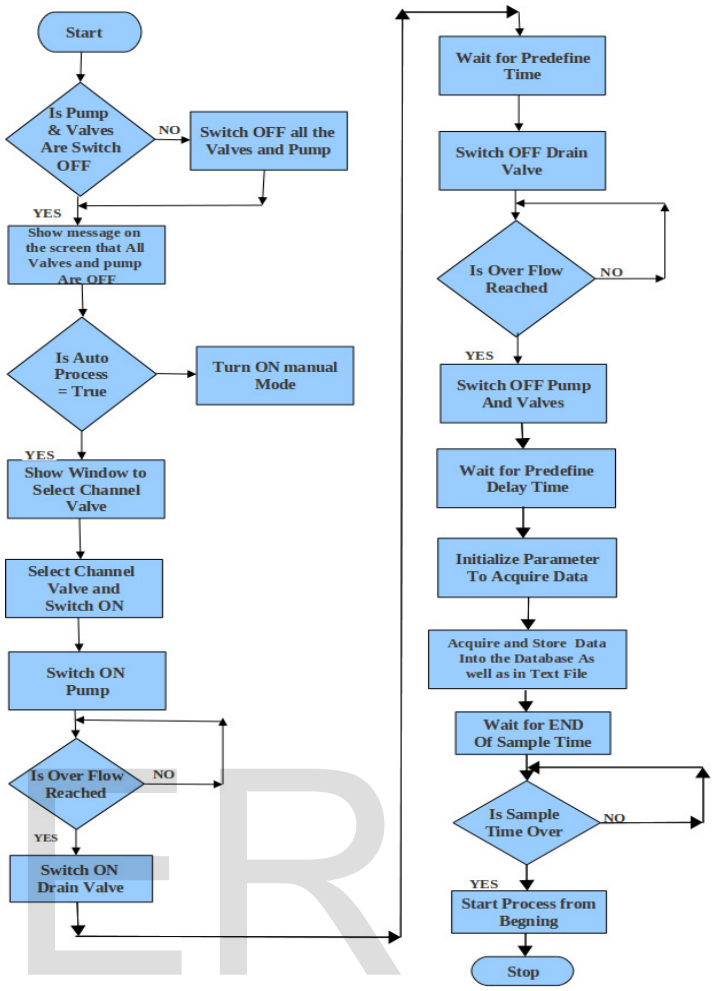

Fig.4: Flow chart of the system software developed under LabVIEW

3 Results and Discussion

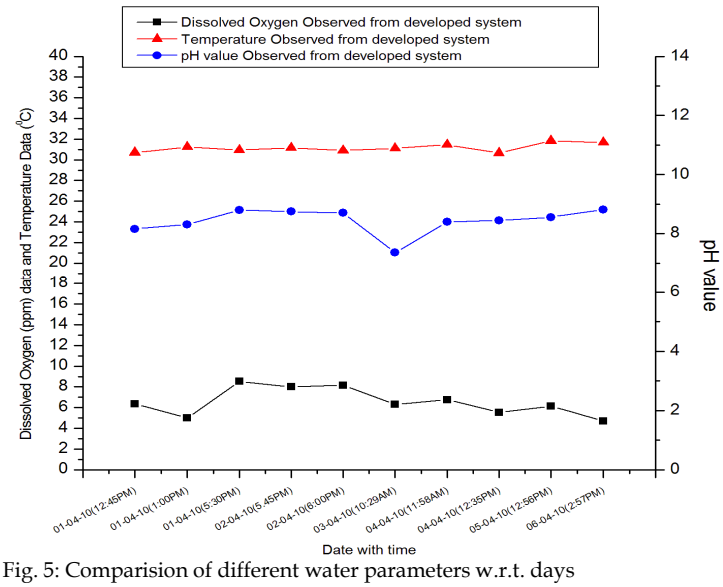

Fig. 5: Comparision of different water parameters w.r.t. days

The developed system is connected with the pH sensor, RTD temperature sensor and the Dissolved Oxygen sensor

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through the interfacing unit DAQ cards. The sensors transmit data in the form 4 to 20 mA current output which is further converted into the Voltage form to acquire through DAS card. The data are stored in the text file as well as into the database. At the same time pH sensor, RTD temperature sensor and the Dissolved Oxygen sensor were placed into the concrete ponds with the reference/standard measurement system for the standard data of the water parameters.

Date with time	Dissolved Oxygen (mg/l)		Temperature (^{0}C)		pH	
	Developed system data	Standard system data	Developed system data	Standard system data	Developed system data	Standard system data
01-04-10(12:45PM)	6.36	5.73	30.7	30.8	8.16	8.62
01-04-10(1:00PM)	5	4.59	31.25	31.1	8.31	8.82
01-04-10(5:30PM)	8.53	8.74	30.95	31	8.8	8.69
02-04-10(5.45PM)	8	7.68	31.17	31.2	8.75	8.89
02-04-10(6:00PM)	8.17	8.12	30.9	31	8.7	8.79
03-04-10(10:29AM)	6.3	5.69	31.1	30.9	7.36	7.85
04-04-10(11:58AM)	6.76	6.24	31.46	31.5	8.4	8.56
04-04-10(12:35PM)	5.55	5.39	30.65	30.79	8.45	8.6
05-04-10(12:56PM)	6.13	5.71	31.83	31.8	8.56	8.75
06-04-10(2:57PM)	4.69	4.3	31.67	31.8	8.82	9.23

Table 1: Acquired data of Temperature, pH and Dissolved Oxygen at different time on different dates

Month	Dissolved Oxygen (mg/l)	Temperature (^{0}C)	pH
March, 2010	4 - 7.78	29 - 33	7 - 9.4
April, 2010	3.3 - 8.9	28 - 33.84	6.9 - 9.33
July, 2010	4.45 - 8.53	28.5 - 34.9	6.5 – 9

Table 2: Acquired data of temperature, pH and Dissolved Oxygen during March to July, 2010

The results of the data acquired day wise (01/04/2010 to 06/04/2010) are shown in Table 1.In the comparison of month, the average acquired data of various water parameters shown in Table 2. Fig. 5 shows dissolved oxygen values ranged from 7mg/l to 10 mg/l in day time, as the temperature ranged from 29 ^{0}C to 33 ^{0}C and pH range varies from 7.5 to 9. From the combined study of dissolved oxygen, temperature and pH all the 3 parameters depends upon each other as temperature varies oxygen and pH also varies. As temperature increases dissolved oxygen decreases and pH value also decreases with the temperature.

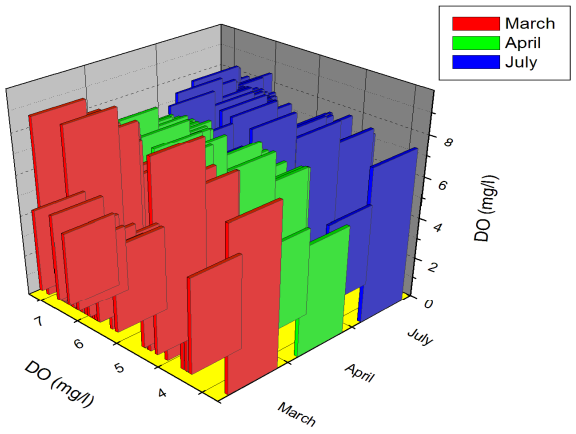

Fig. 6: 3D bar chart of Dissolved Oxygen

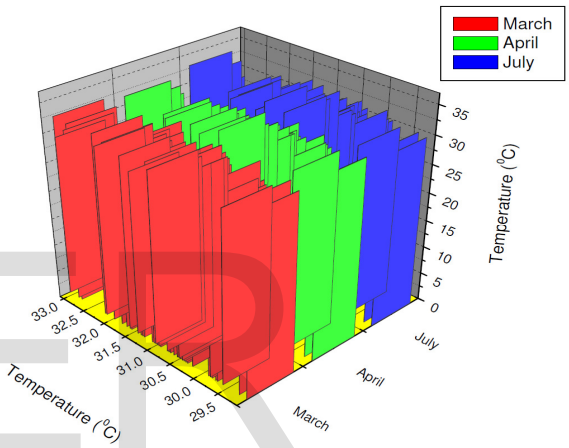

Fig. 7: 3D bar chart of Temperature

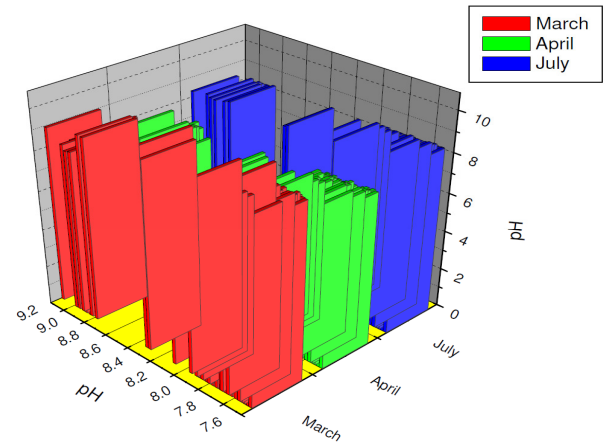

Fig. 8: 3D bar chart of pH

In comparison to months, Fig. 6 to Fig. 8 shows the 3d- Bar charts of the water parameters Dissolved oxygen, Temperature and pH, which shows the continuous variations in the ponds. Fig. 9 to Fig. 11 shows the comparison between the observed data of different parameters of the developed system and the reference/ standard system. In the present graph the

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observed values are almost equal to the reference values. The temperature profile of the dissolved oxygen values recorded in this study is almost match with the standard values (8.38mg/l and 7.64mg/l) quoted by Boyd and Lichktoppler "[6]" at the equivalent temperature range of 25°C to 33°C. The pH values recorded from this system were well within the preferred pH of 6.5 to 9.0 recommended for optimal fish production as reported by Boyd and Lichktopller "[6]".

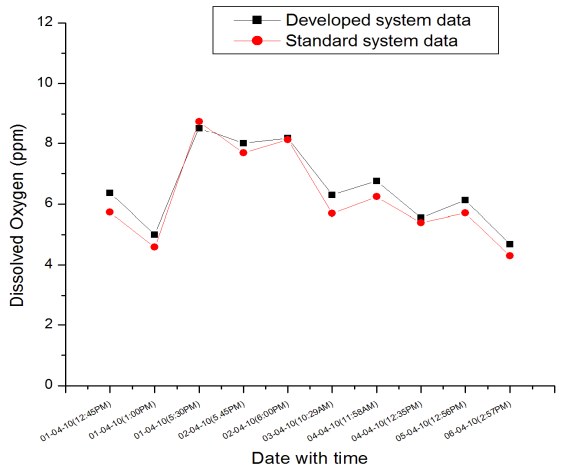

Fig. 9: Dissolved Oxygen w.r.t. different days

The pH range varies from 7.5 to 9 due to the effect of the other water parameters. Similarly measured dissolved oxygen concentration is found usually low in the morning and rises to a maximum in the afternoon as per the results quoted in "[6]". The values of temperature, pH and DO sensed through the system were compared to the data of standard meters used at CIFA, Bhubaneswar, India.

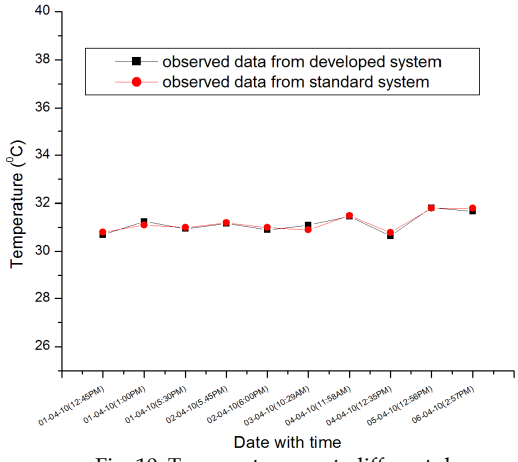

Fig. 10: Temperature w.r.t. different days

The pH, DO and temperature reading of the sampled water was consistent with the standard meter reading and shows the reliability towards the developed system.This system is running successfully into the CIFA, Bhubaneswar .

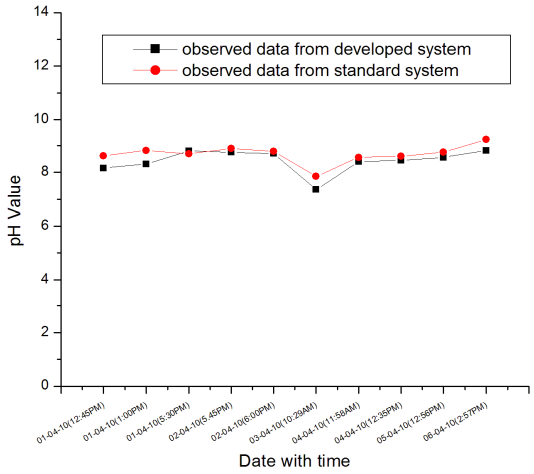

Fig. 11: pH w.r.t. different days

4 Conclusion

The development of the LabVIEW based automatic measuring system for fresh water aquaculture measuring four water parameters optimized by appropriate algorithms is presented. LabVIEW virtual instrument platform, high performance PC system along with multi channel sampling chamber, the DAS card, Opto-isolated I/O card, solenoid valves, sensors with transmitters and ½ HP pump were used to monitor the pond water parameters. The software developed in LabVIEW platform is used for logging the sensor data and storing in Microsoft Access Database and to control sampling chamber operations. Initial Field Trials were conducted at Bhubaneswar and data was collected in March 2010 to July 2010. The values of pH and DO sensed through the system were compared to the data of standard meters used at CIFA. The developed system is very rugged and shows the water parameter readings with the reliability factor. And the pond's acquired data from the developed system logging directly into the Microsoft Access database and as well as in the text file.

During the combined study of various water parameters in ponds (Fig. 6) shows that the developed system is having the correction factor +-0.5 %.

The average temperature among the different ponds varies from 29 °C to 33 °C as against 31 °C of the water. A minor variation of the temperature was recorded in all the ponds on different dates but theses variations were consistent in the morning and afternoon.

pH value of the ponds ranged between 6 to 9 during the study period. The water pH of the ponds varies from 7.63 to 9.23 (Table 1). During the period of pH study,pH did not change much among water ponds.

Dissolved oxygen in the pond varies from 4.3 mg/l to 8.74 mg/l according to the reference data investigation and according to the developed system dissolved oxygen varies from the 4.69 mg/l to 8.63 mg/l. The minimum value of the dissolved oxygen found in the early morning time and the maximum value of the dissolved oxygen was found in the afternoon

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time. During the investigation we found that the maximum dissolved oxygen occurs in the day time due to the photosynthesis process.

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