Using Mobile-Enabled Devices for Engagement and Monitoring of Patient with Chronic Disease: Hypertensive Case

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Abstract

Handling of chronic disease in Nigeria health care system is perfunctory as illnesses that require long-term monitoring get very little or no attention due to lack of proper facilities to handle such cases. Use of traditional mode of patient monitoring system where patient visit hospital to see doctor is still order of the day in our hospitals. Hence result to bad management of chronic diseases and long queue in the various hospital across the nation. This research addressed the problems associated with the use of the traditional mode of engagement of patient with chronic diseases. The research is focused on design a Remote Patient Monitoring System for monitoring patients with chronic condition by healthcare provider. The system will supports and allows for greater care of patient with chronic disease like hypertension.

Keywords: chronic disease, digital technologies, mobile device, hypertensive, remote monitoring.

I. INTRODUCTION

"Any human health disease that is tenacious in its effects that comes with time is refer to as chronic condition, it includes Arthritis, Asthma, Hypertension, Cancer, COPD, Diabetes, Viral diseases such as hepatitis and HIV/AIDS, these categories of diseases constitute a major cause of mortality" Wadinga Audu. (2009). Monitoring and managing of chronic diseases patient is very essential to deter or reduce mortality rate. Manual monitoring and management of chronic condition patient is not effective as it reduce efficiency, enhance mortality rate, and also dangerous to the patient and healthcare officers. In this era of computer and Information and Communication Technology (ICT) proliferations, the use of mobile technology unit of ICT innovation can be deployed to manage and monitor patient with chronic conditions, "ICT in health care is the processing of data between computers and the movement of data between computers today" (Gitta, Cosmas & South David, 2011). "Remote patient monitoring (RPM), allows a patient to use a mobile medical device to perform a routine test and send the test data to a healthcare professional" (Shaw, Donald, 2009; Alexander et al 2007). Remote Patient Monitoring System Technology otherwise known as e-monitoring or e-health is currently becoming sin-qua-non in healthcare system. This RPMS will be of importance to elderly and chronically ill people that require closely monitoring and intervention of medical practitioners. In recent time handling of chronic condition patient by Nigerian healthcare system is very unfortunate as the patient get little or no attention due to manual and traditional method of operation. The focus of this research are: to integrate mobile technology into healthcare service; and to design and develop a user-centric home monitoring system to mend prolonged ailment managing. The scope of the research work will be limited to hypertensive case. The output of this work will be of benefit to patients with chronic condition of hypertensive case as it will supports real-time interventions, prevent emergencies and re-admissions, and reduced hospital stays and queue.

II. LITERATURE REVIEW

A. Evolution of Mobile Technology and Healthcare System

"Mobile technology affords users ubiquitous access to information and applications, hence providing flexibility with communication, collaboration and information sharing" **(**Banjoko S.O, Banjoko N.J, & Omoleke, 2010**).** "Since mobile phones are readily available even in remote rural areas, governments and development agencies view them as a potential Information and Communication Technology (ICT) tool for developing and improving livelihoods in developing countries for healthcare and public health in promoting health, disease prevention and management" **(Davies, 2008).**

B. Nigerian Healthcare System Challenges

"Nigerian health care system is poorly developed and has suffered several backdrops, especially at the Local Government Levels. No adequate and functional surveillance systems are developed and hence no tracking system to monitor the outbreak of communicable diseases, bioterrorism, chemical poisoning, etc" Inadequate facilities and low salary of public sector healthcare workers is also one of the numerous challenges of Nigeria health care system **(Nasir, 2011).**

C. Remote Monitoring of Chronic Disease

"The problem of chronic diseases continues to rise and places a huge strain on health system, many health care systems are now seeking innovative methods to improve the quality of care and curtail costs**"** Lai Khin Wee, Yeo Kee Jiar, Eko Supriyanto. 2009**)**. "In recent time health care providers are seeking new ways to engage their patients using seamless, continuous remote patient health monitoring" (Coye, Haskelhorn & Demello, 2009).

D. Related Works

Celler, Lovell & Basilakis, 2003 in a research entitled Mobile Patient Monitoring, designed a mobile patient monitoring application software that was assembled on the incorporation of wireless communications into medical mobile health care system to revolutionize personal healthcare delivery system. The objective their work was "to build a wireless patient monitoring system using mobile Technology, which could potentially be an integral part of a suite of personal healthcare appliances for a large-scale remote patient monitoring system equipped with a feature of sending SMS to doctor and patients relative in event of emergency". In 2013, Agarwal designed and developed system for monitoring patients remotely using wireless communication system, His design is called Automatic Wireless Health Monitoring System, and it is used to monitor body temperature of the patient and display the same to the doctor through Radio Frequency (RF) Technology. Omolase, Ihemedu, Ogunleye & Omolase, 2010 designed an image based technique system that acquire and analyze a constant streaming of Electrocardiogram (ECG) signal through digital camera for image capturing information extraction and analysis performed using MATLAB tools as well as data sending system based on internet network.

III. Methodology and Design

A. Description and Analysis of Proposed System

The propose system architecture and the basic flow diagram is as shown in figure 1, the system is made up of an embedded body sensor that will send information of the patient's blood pressure to the Analog to Digital Converter (ADC) which converts the signals and sends it to the microcontroller (MCU). The MCU then processes the signal and sends it to the detection module which then sends it to the receiver. In the processes, information about the patient's health is gathered from the sensor, MCU then processes the signal and sends it to the detection module, while detection module then sends the information to the receiver

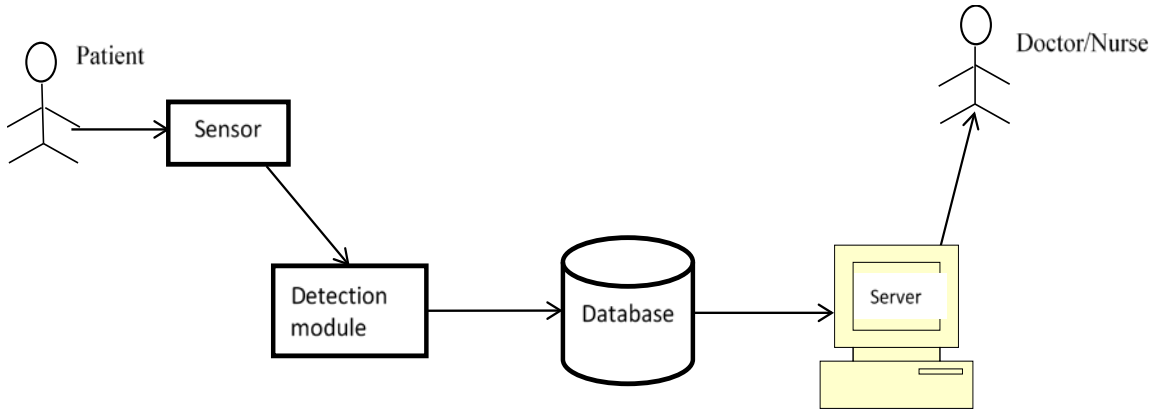

Figure 1. Proposed System Architecture

B. System Design

Modular design approach will be adopted in designing of the proposed system. The proposed system is alienated into three sub systems: blood pressure (bp) reader; device aid; and Web Medical Portal. Figure 2 represents the block diagram and flow of information for the Sending and receiver circuit of blood pressure reader.

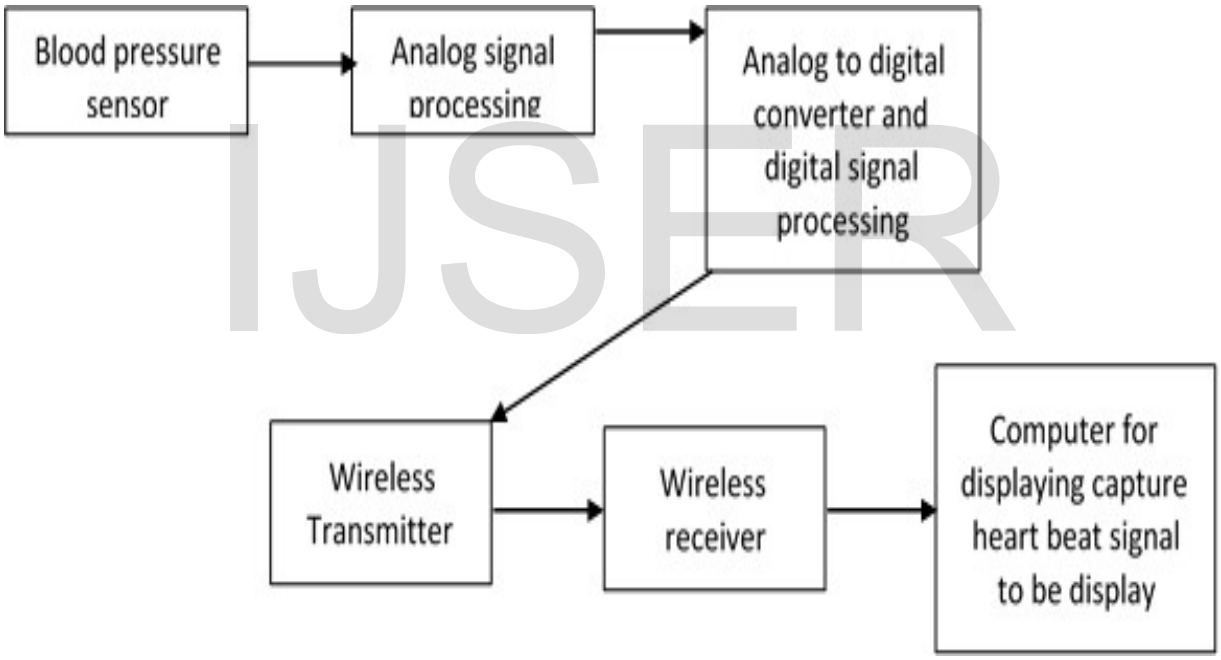

Figure 2. Block Diagram and information flow of the Sending and receiver circuit

C. Device Aid

The device aid will be developed with Microsoft Vb.Net, it gets the blood pressure from the receiving device and enables the user to see it on the computer. The result being displayed will be saved to the database by simply clicking a button which will append the result to the user record. For security reasons and to set session for each user, the patient is required to login with his or her email and password which must have been initially generated by the administrator. Operational algorithm is as follows.

Start
Enter login details
If correct
Select user full name and id
Open the BP result interface

Listen on serial interface for B.P readings
If B.P readings
Enable Submit
IF Submit
Insert = new record

The algorithm is then transformed into the flowchart shown in figure 3, and it will then be coded with appropriate programme.

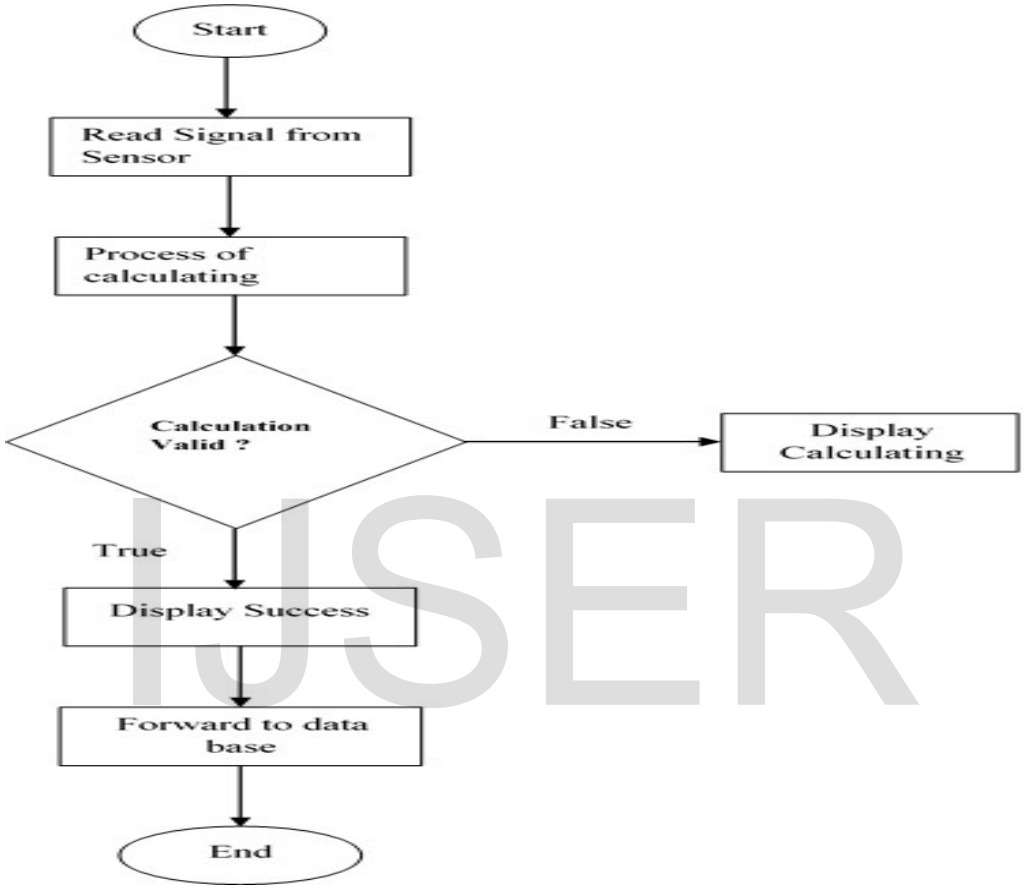

Figure 3. Flowchart of the proposed system

D. Patient Monitoring Portal

The Patient management portal is a web based system that will connect the patients and the medical personnel, it will assigning doctors to patients, doctor will then be able to monitor patient blood pressure record remotely, schedule appointment and prescribe drug. Chronic condition patient will use the device to read the B.P, view the result on the computer and also send it to the database through the reader aid, he or she can always login anytime to view an appointment or if there is a prescription.

E. Implementation and Testing

The Blood Pressure reader device is fitted with various components which make up the whole construction. The components are as follows: The blood pressure was measured with the temperature sensor LM35. PIC16F72 microcontroller contains in-built Analog to Digital Converter (ADC). Consequently extra Analog to Digital Converter device is not necessary. The data will be managed with microcontroller and sent to the remote end wirelessly by using RF transmitter and received at the remote end by using RF receiver. The received data were processed in the microcontroller and the data measured was displayed successfully on the Computer at the remote end. Visual Studio.NET was used for programming the system. Figure 4 to 12 shows output of various stages of implementation and testing.

Figure 4. Constructed Blood Pressure Reader

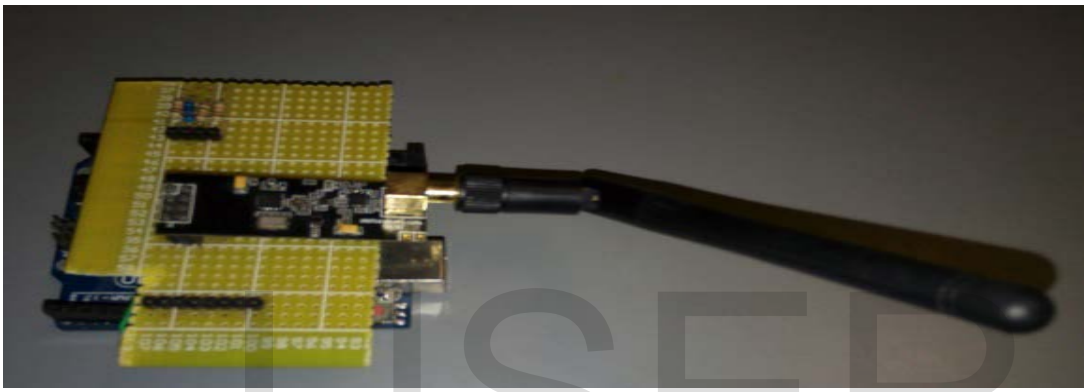

Figure 5. Pictures of the blood pressure receiver

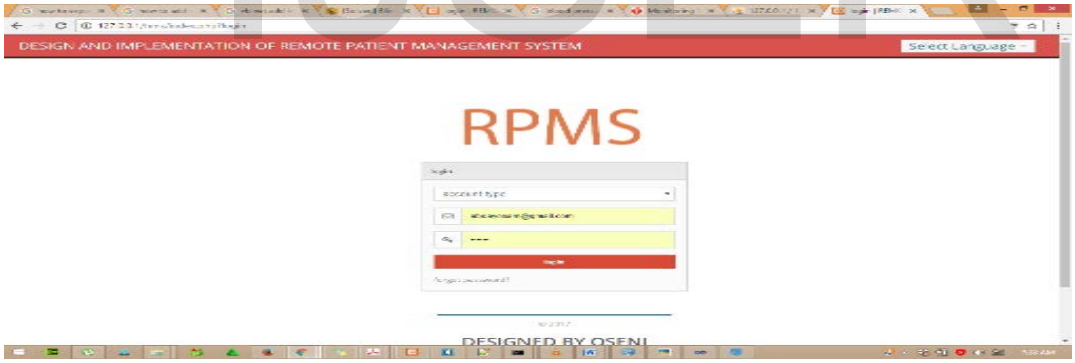

Figure 6. Web Portal Login shot

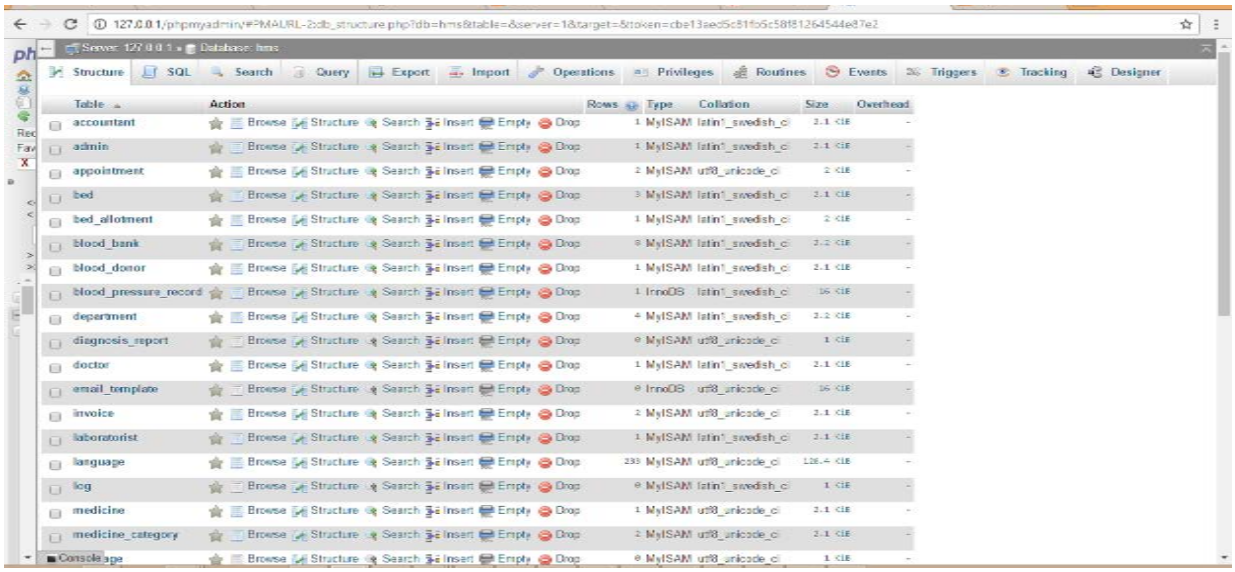

Figure 7. Database Table

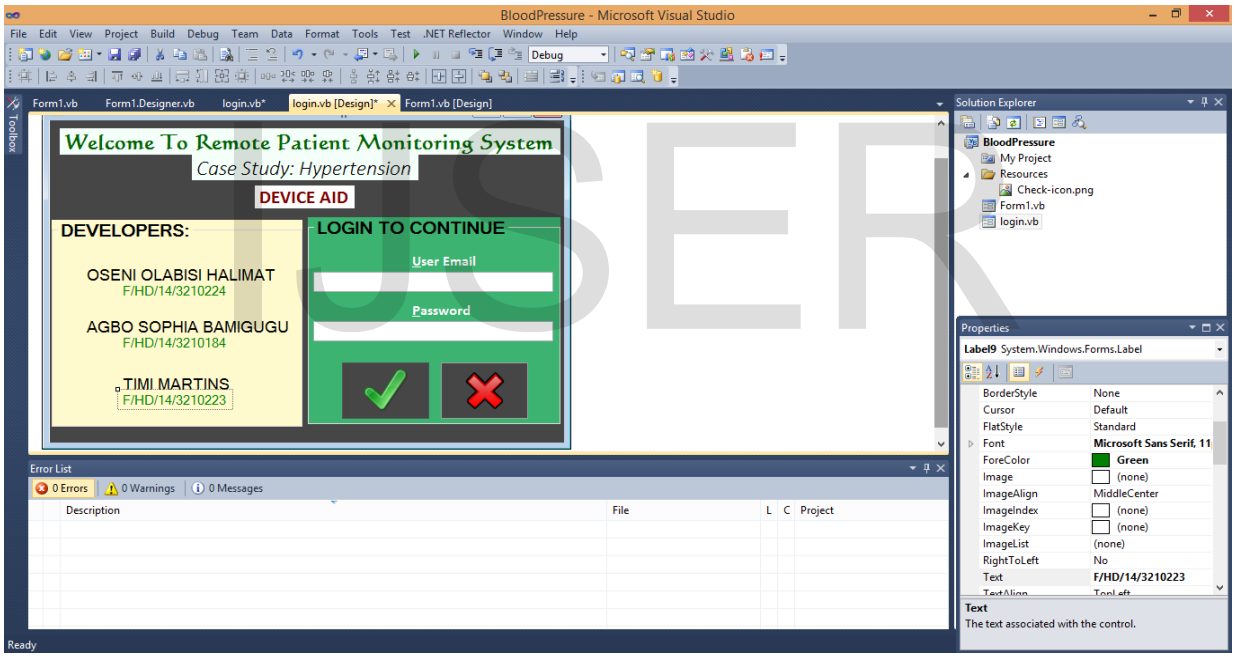

Figure 8. Device login page in Visual Studio development Environment

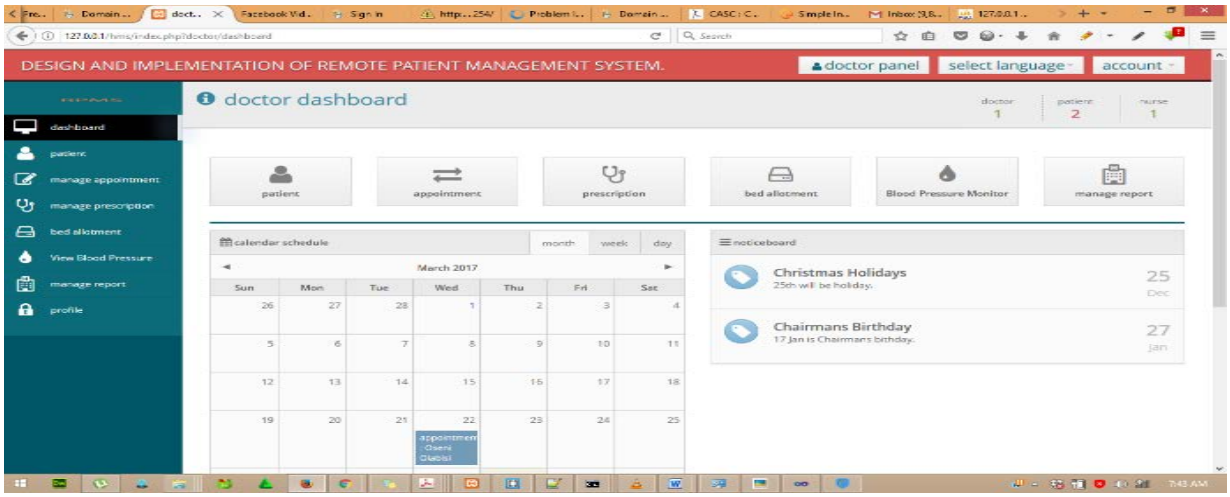

Figure 9. Doctors Dashboard

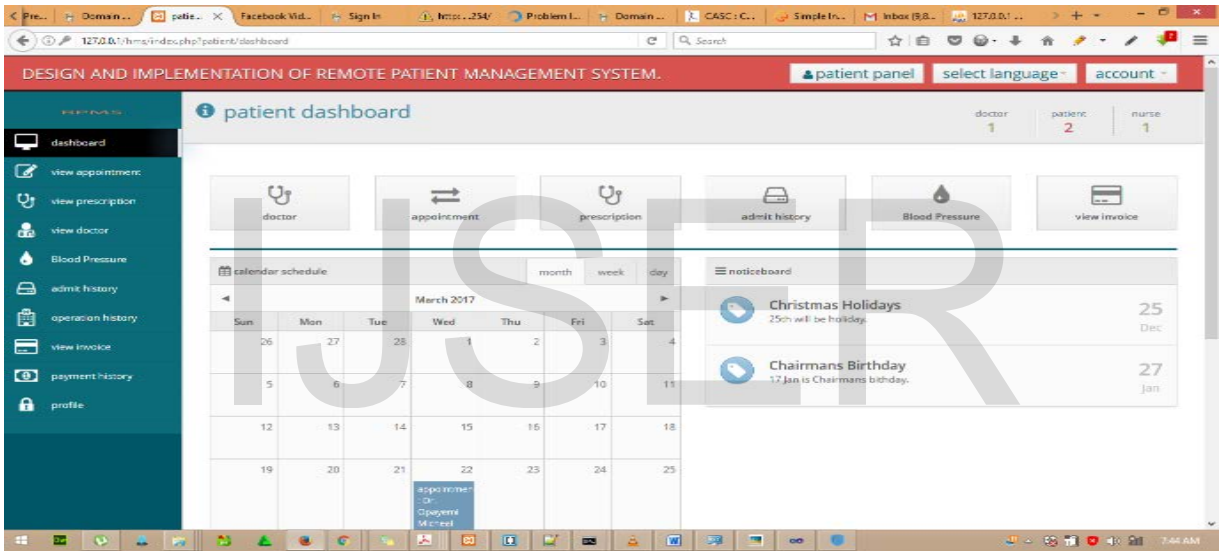

Figure 10. Patients Dashboard

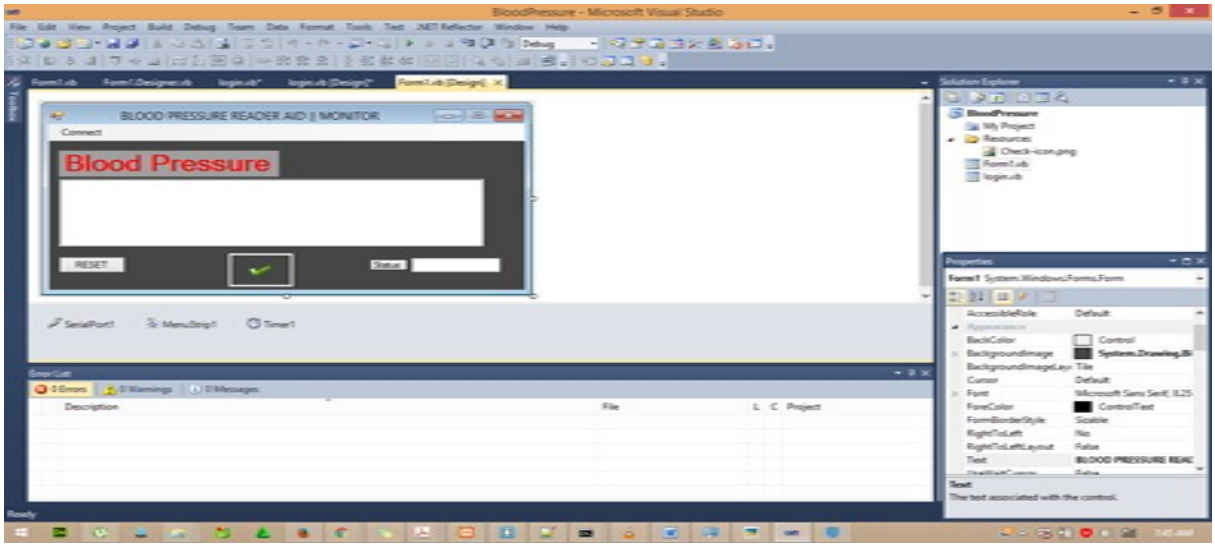

Figure 11. Blood pressure capture page

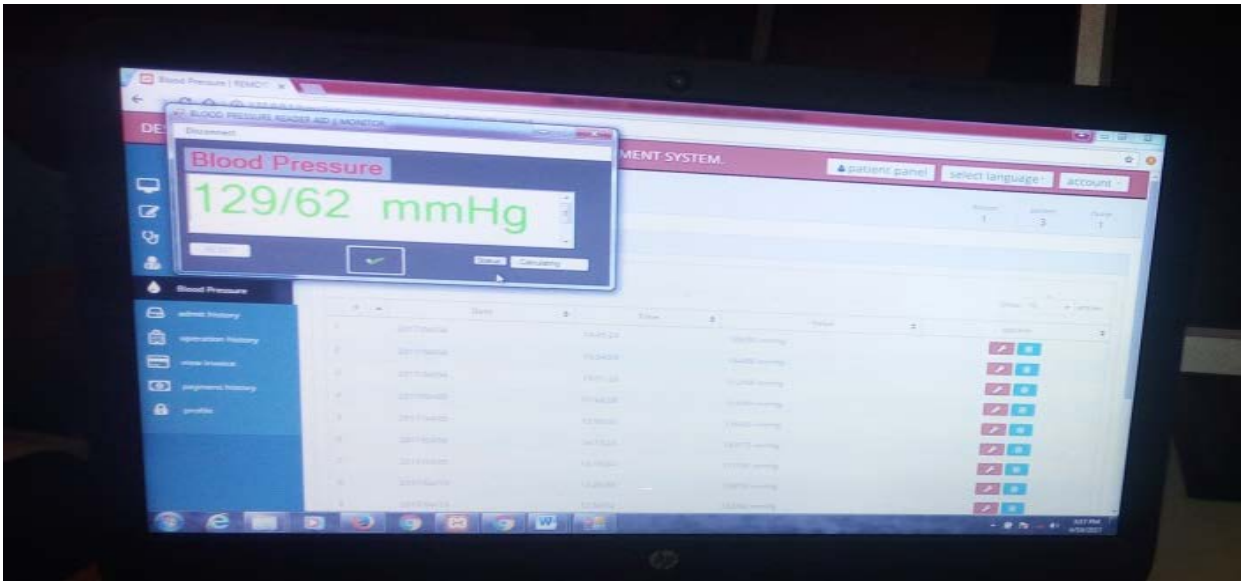

Figure 12. Activity Diagram of the Remote Patient Monitoring System

IV. CONCLUSION

There is no doubt that Nigeria healthcare system is still crawling in the rising wave of eHealth revolution globally. This proposed system: Mobile-Enabled Devices for Engagement and Monitoring of Patient with Chronic Disease will go a long way to solve problems related to management of chronic disease patients. The system will supports and allows for greater care of patient with chronic disease like hypertension. The output of this research can be modified to accommodate other chronic diseases for easy of monitoring and engagement patients with chronic condition.

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