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Design and Implementation of Wireless Sensor Network for Health Care Monitoring in Hospitals via Mobile

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Abstract: Health monitoring is one of the emerging areas for computing technologies. Health monitoring via mobile is using the application of mobile computing technologies for amending communication between doctors and patients. As mobile devices have efficaciously become part of our life it can incorporate health care more seamlessly to our everyday life. There have been many recent advances in sensor technologies which enable us to integrate low- power, low-cost devices with emerging intelligent health monitoring systems.. Wireless Sensor Networks (WSN) have attracted much attention in recent years. The applications of Wireless Sensor Network are immense. Applications of Wireless sensor network in healthcare leads to an area called Body Area Network (BAN) or Body sensor Networks. Here we are building a wireless sensor network for health monitoring in hospitals with the use of mobile application. So in the proposed system a central server will be able to read patient's incoming data from the sensors and send it to the mobile application and it will also send alert SMS in case of emergency.

Keywords: Health monitoring, Wireless Sensor Networks (WSN), Body Area Network (BAN), Mobile application.

I. INTRODUCTION

The expeditious development of wireless networks has led to the exigency of new integrated mobile health care system which provides medical treatment remotely on time. These health care systems incorporate the use of wearable health sensors and mobile computing technology to provide effective treatment at real time basis. The system is convenient and advantageous since it can deliver health information of patients remotely directly to doctors. For doctors, after receiving the information from the patients, appropriate treatment can be made.

Recent technology advances in integration and miniaturization of physical sensors, embedded microcontrollers and radio interfaces on a single chip; wireless networking; and micro-fabrication have enabled a new generation of wireless sensor networks suitable for many applications. For example, they can be used for habitat monitoring , machine health monitoring and guidance, traffic pattern monitoring and navigation, plant monitoring in agriculture , and infrastructure monitoring. One of the most exciting application domains is health monitoring.

A number of physiological sensors that monitor vital signs, environmental sensors (temperature, humidity, and light), and a location sensor can all be integrated into a Wearable Wireless Body/Personal Area Network (WWBAN)]. The WWBAN consisting of inexpensive, lightweight, and miniature sensors can allow long-term, unobtrusive, ambulatory health monitoring with instantaneous feedback to the user about the current health status and real-time or near real-time updates of the user's medical records. Such a system can be used for computer-supervised rehabilitation for various conditions, and even early detection of medical conditions. For example, intelligent heart monitors can warn users about impeding medical conditions or provide information for a specialized service in the case of catastrophic events. Accelerometer-based monitoring of physical activity with feedback can improve the process of physical rehabilitation..

II. RELATED WORK

"SPOC: A Secure and Privacy-Preserving Opportunistic Computing Frameworkfor Mobile-Healthcare Emergency Rongxing Lu, Member, IEEE, Xiaodong Lin, Senior Member, IEEE, and Xuemin (Sherman) Shen, Fellow, IEEE"

In this paper, they proposed a secure and privacy-preserving opportunistic computing framework, called SPOC, for m-Healthcare emergency. With SPOC, smart phone resources including computing power and energy can be opportunistically gathered to process the computing-intensive personal health information (PHI) during m-Healthcare emergency with minimal privacy disclosure. In specific, to leverage the PHI privacy disclosure and the high reliability of PHI process and transmission in m-Healthcare emergency, we introduce an efficient user-centric privacy access control in SPOC framework, which is based on an attribute-based access control and a new privacy-preserving scalar product

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computation (PPSPC) technique, and allows a medicaluser to decide who can participate in the opportunistic computing to assist in processing his overwhelming PHI data. Detailed security analysis shows that the proposed SPOC framework can efficiently achieve user-centric privacy access control in m- Healthcare emergency. In addition, performance evaluations via extensive simulations demonstrate the SPOC's effectiveness in term of providing high-reliable-PHI process and transmission while minimizing the privacy disclosure during m-Healthcare emergency [1].

"Resource-Aware Secure Ecg Healthcare Monitoring Through Body Sensor Networks by Honggang Wang, University Of Massachusetts, Dartmouth Dongming Peng, Wei Wang, And Hamid Sharif, University Of Nebraska-Lincoln Hsiao-Hwa Chen, National Cheng Kung University Ali Khoynezhad, University Of Nebraska Medical Center, IEEE Wireless Communications • February 2010"

In this paper they proposed a secure and resource-aware BSN architecture enabling realtime healthcare monitoring, especially for secure wireless electrocardiogram (ECG) data streaming and monitoring. A cross-layer framework is developed based on unequal resource allocation to support biomedical data monitoring applications. In this framework important information (e.g., major ECG data) is identified, and extra resources are allocated to protect its transmission. Furthermore, BSN resource factors are
exploited to guarantee a strict requirement of real-time performance. In this work we integrate biomedical information processing and transmission in one framework, where secure data trans-mission in a BSN proceeds with energy efficiency and minimum delay.

"Intelligent Mobile Health Monitoring System (IMHMS) Rifat Shahriyar1, Md. Faizul Bari, Gourab Kundu, Sheikh Iqbal Ahamed, and Md. Mostofa Akbar International Journal of Control and Automation Vol.2, No.3, September 2009"

In this paper they present a bio-sensor based mobile health monitoring system named as "Intelligent Mobile Health Monitoring System (IMHMS)" that uses the Wearable Wireless Body/Personal Area Network for collecting data from patients, mining the data, intelligently predicts patient's health status and provides feedback to patients through their mobile devices. The patients will participate in the health care process by their mobile devices and thus can access their health information from anywhere any time. Moreover, so far there is no automated medical server used in any of the work related to mobile health care. To maintain the server a large number of specialist are needed for continuous monitoring. The presence of a large number of specialists is not always possible. Moreover in the third world countries like ours specialist without proper knowledge may provide incorrect prescription. That motivates us to work for an intelligent medical server for mobile health care applications that will aid the specialists in the health care. As a large amount of medical data is handled by the server, the server will perform mine and analyze the data.

III. PROPOSED WORK

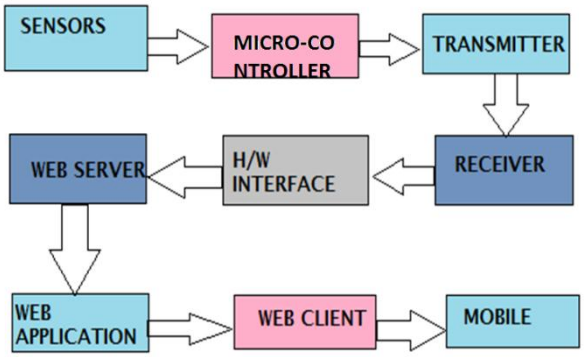

Fig 1: System Block Diagram

The above figure shows the detailed working of proposed system where it shows the wearable wireless sensor module, having sensors to monitor patients statistics like Heart beat and temperature. This module is then connected to a microcontroller. Data obtained from microcontroller will then be sent by RF transmitter and received by RF receiver connected to the serial port and then to the server side. This data will be transmitted to the smartphone which will have a web application which can be accessed through android like mobile device in order to provide patients details to the doctors or the users. If there is a case of emergency such as increase in heart beat or temperature or decrease in heart beat or temperature then the message will be sent to the doctor's mobile via GSM modem which will help the doctor to take the necessary steps.

The below figure displays the overall structure of the proposed system. The proposed system has been divided in to three main phases of development and implementation. Let's see the each phase in brief.

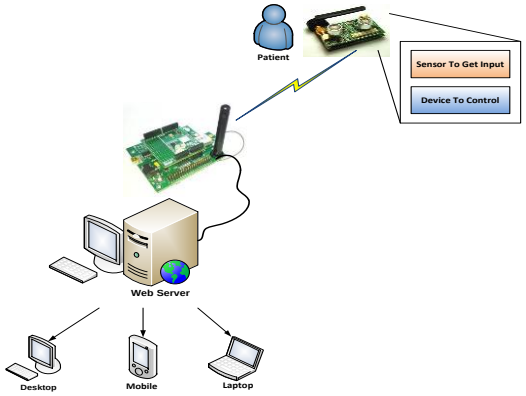

Fig 2: System architecture

Patients Monitoring Device*:* This device is connected to the patients and alL the sensors attached to patients body. Figure shows the sample circuit with the Heart beat and temperature sensor connected to device. The main device where all sensors are connected will transfer sensors values to central server through RF module.

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Fig 3: Patient's module

Central Server Application: This is the main web application responsible for monitoring and managing the entire operation of the proposed system. First part of this module will deal with patient's device and get all the reading and store it to database for further utilization. Second part of the module will be a web application which let the doctors view the patient's statistics over the mobile device

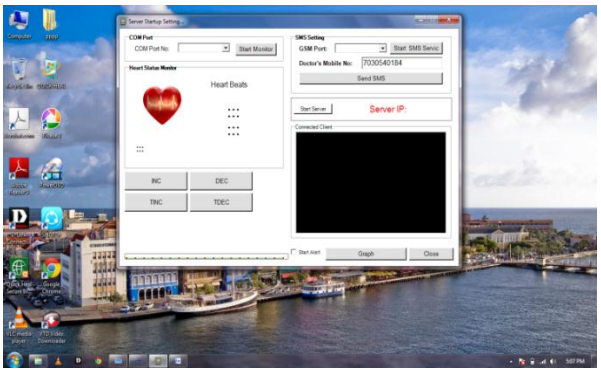

Fig 4: Server Application

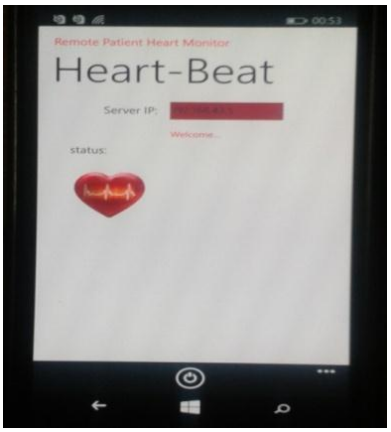

Fig 5: Mobile Application

Mobile application: Mobile application has been designed by keeping the idea of remote statistics monitoring of patients connected to the monitoring device and alert generation for doctor in case of emergency Figure Shows the sample view of the GUI of mobile application where we can see how doctor can monitor the patient's state.

IV. IMPLEMENTATION OF PROPOSED METHODOLOGY

A.System Requirements

- RF transceiver modules
- Pulse sensor
- Temperature sensor
- Smartphone
- Atmega16 Microcontroller Module
- Battery power supply
- GSM Modem

RF Module:

An RF module (radio frequency module) is a (usually) small electronic device used to transmit and/or receive radio signals between two devices. In an embedded system it is often desirable to communicate with another device wirelessly. This wireless communication may be accomplished through optical communication or through Radio Frequency (RF) communication. For many applications the medium of choice is RF since it does not require line of sight. RF communications incorporate a transmitter and/or receiver.

Fig 6: CC2500 RF module

Pulse Sensor:

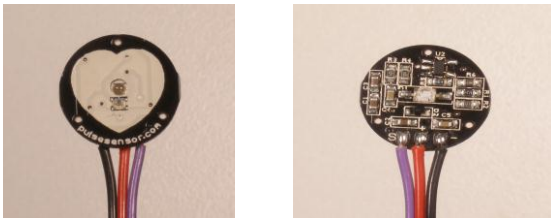

Fig 7: Pulse Sensor AMPED

Pulse Sensor AMPED makes pulse measurement very simple. Pulse measurement can be a very useful thing. Doctors have employed the use of pulse measurement for hundreds of years to determine stress, relaxation, physical fitness levels, medical conditions, and more. This information is easy to gather using tactile measurement; you can determine your pulse rate by touching your arteries in your wrist or neck. The Pulse Sensor measures subtle changes in light from expansion of the capillary blood vessels to sense your heartbeat. Gently place the sensor on any area of skin (such as a finger or earlobe) and it will transmit pulse data to your microcontroller for processing.

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Principle of Heartbeat Sensor

The heartbeat sensor is based on the principle of photo phlethysmography. It measures the change in volume of blood through any organ of the body which causes a change in the light intensity through that organ (a vascular region). In case of applications where heart pulse rate is to be monitored, the timing of the pulses is more important. The flow of blood volume is decided by the rate of heart pulses and since light is absorbed by blood, the signal pulses are equivalent to the heart beat pulses.

Temperature Sensor:

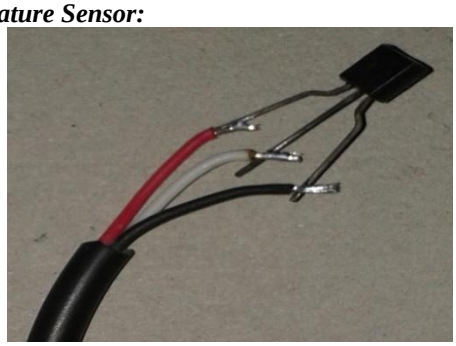

Fig 8: Temperature Sensor [LM 35]

General Description

The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The LM35 thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The LM35 does not require any external calibration or trimming to provide typical accuracies of ±1⁄4°C at room temperature and ±3⁄4°C over a full −55 to\ +150°C temperature range. Low cost is assured by trimming and calibration at the wafer level. The LM35's low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. It can be used with single power supplies, or with plus and minus supplies. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air.

B. Design Platform

An **embedded system** is some combination of computer hardware & software, either fixed in capability or programmable, i.e. specifically designed for a particular for a particular function. Industrial machines, automobiles, medical equipment, cameras, household appliances, airplanes, vending machines and toys (as well as the more obvious cellular phone and PDA) are among them yriad possible hosts of an embedded system. Embedded systems that are programmable are provided with programming interfaces, and embedded systems programming is a specialized occupation.

Microsoft Visual Studio 2010 is an integrated development environment (IDE) from Microsoft. It is used to develop computer programs for Microsoft Windows, as well as web sites, web applications and web services. Visual Studio uses Microsoft software development platforms such as Windows API, Windows Forms, Windows Presentation Foundation, Windows Store and Microsoft Silver light. It can produce both native code and managed code

C. Rf Communication Module

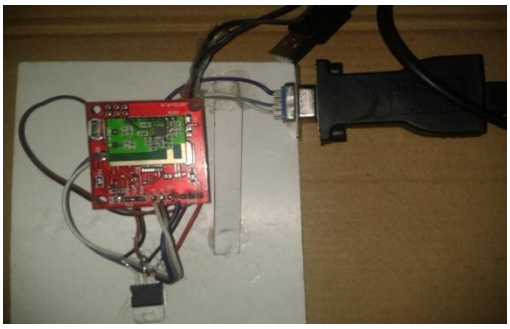

Fig 9: RF Module connected to Server

USB to TTL module having FT232 IC to convert microcontroller signals in to serial format. USB connector provides connection between FT232 serial to USB convertor board and USB port of computer system FT232 acts as transition state between USB and TTL/CMOS voltage levels thus allowing data to be read/write through USB port. It helps to interface USB or serial port device with module supporting UART. USB convertor interface PCs or laptop with UART(TTL/CMOS logic) supporting module/devices like microcontroller, Wi-Fi module, GPS(global positioning system) module, GSM(global system for mobiles)module, RFID(radio frequency identification)and finger print scanner module. FT232 IC is the one which convert TTL logic to USB logic so that devices works on TTL logic can share the data with devices connected through USB cables.

USART: The Universal Synchronous and Asynchronous serial Receiver and Transmitter (USART) is a highly flexible serial communication device.

The main **features** are:

- Full Duplex Operation (Independent Serial Receive and Transmit Registers)
- Asynchronous or Synchronous Operation
- Master or Slave Clocked Synchronous Operation
- High Resolution Baud Rate Generator
- Supports Serial Frames with 5, 6, 7, 8, or 9 Data Bits and 1 or 2 Stop Bits
- Odd or Even Parity Generation and Parity Check Supported by Hardware

D. Interfacing With Microcontroller

- It first Wait for some time (say 300 millisecond).
- Then Initialize USART of microcontroller. Initial baud rate should be 9600.
- Configure CC module for its own SELF ID & CHANNEL ID
- Also Configure CC module for baud Rate (if required). Default Baud rate is 9600.
- Then Transmit data after RID (receiver id). Here data can be a single Byte or packet of many bytes (max packet length is 64).

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E. Configuring Self Id And Channel Id

By sending the string using UART port microcontroller can communicate with CC2500 module i. e

- .'< 'Part of protocol (less than) ,
- '1' Self id,
- '2' Channel id,
- '>' Part of protocol.

The following figure shows the flow diagram of implementation. The sensor data collected is processed and sent to server application via Wi-Fi. Then the server monitors the data and displays it in the mobile application and also stores the data in the log file. In critical situations it sends the sms to doctor's mobile.

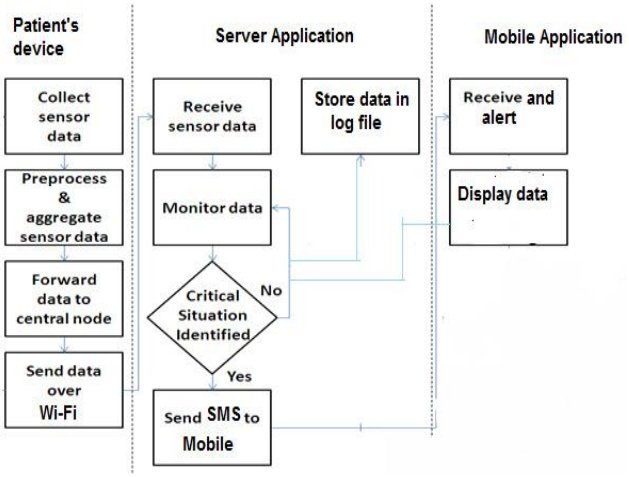


Fig 10: Flow Diagram of Implementation

V. RESULT ANALYSIS

A. Hardware Photos:

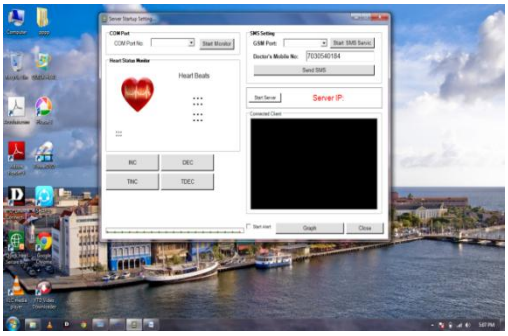
In this fig, there are wearable wireless sensor module, having sensors to monitor patients statistics like Heart beat and temperature. This module is then connected to a microcontroller. Data obtained from microcontroller will then be sent by RF transmitter and received by RF receiver connected to the serial port and then to the server side. This data will be transmitted to the smartphone which will have a web application which can be accessed through android like mobile device in order to provide patients details to the doctors or the users.

Step 1: Connect the hardware to the power supply. Open the file location and run the program. Now to obtain the pulse value put the sensor on your finger tip.

Step 2: To measure the temperature value take the any heat source near the sensor.

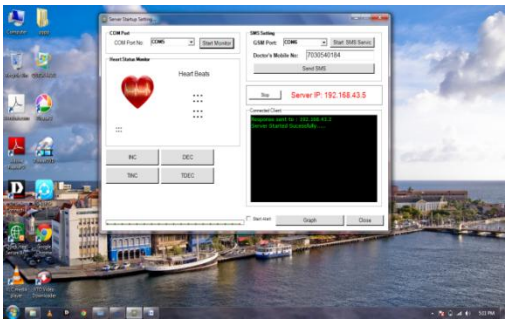
B: Software Photos:

Step 1: Open the program file. Click on the play button. The EXE will open.



Step 3: Select the COM port no as COM 5 as the serial port is connected to COM5 and select GSM port no as COM 6.

Step 4: Click on START SERVER. The server will start displaying the IP address. Then click on the START SMS and START MONITOR.



Step 5: Open the Mobile application and type the IP address in the box and click on the ON button. Now the mobile will be connected to the laptop through Wi-Fi.Then the appliation will start to receive data.

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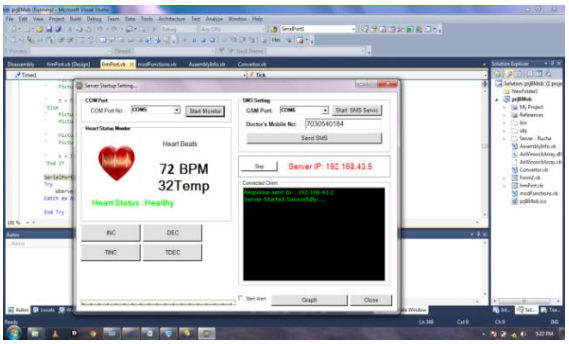
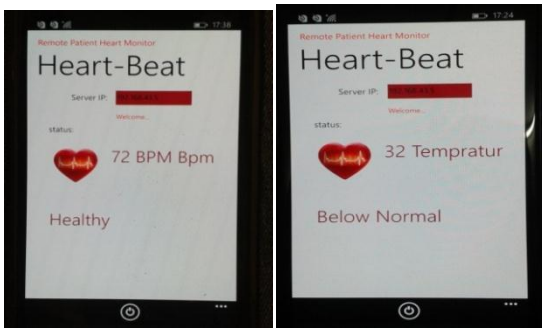
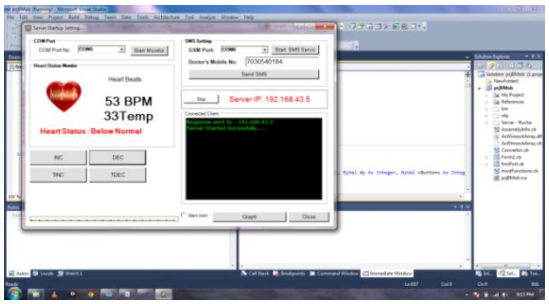
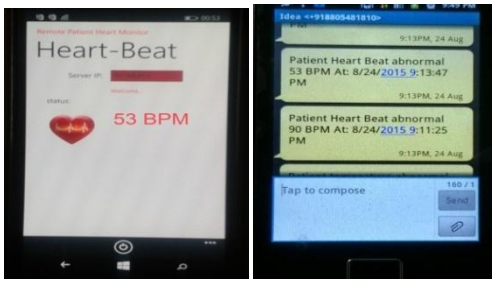
Step 6: Now as soon as pulse sensor is attached to the finger tip the data will be sent and displayed in the GUI as well as in the mobile application.

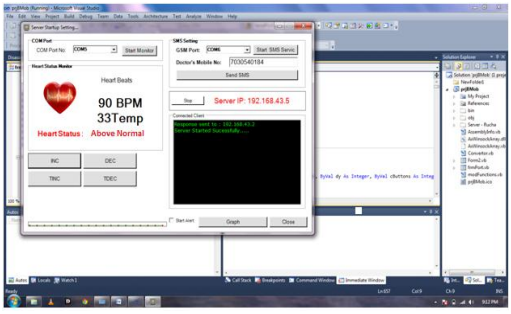


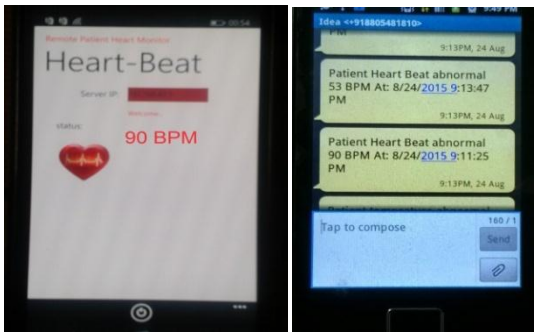


Step 7: If the pulse rate is decreased or increased then the GUI will display it and the SMS will be sent to the doctor's mobile.

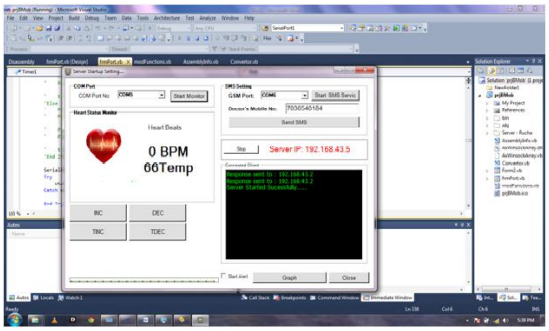


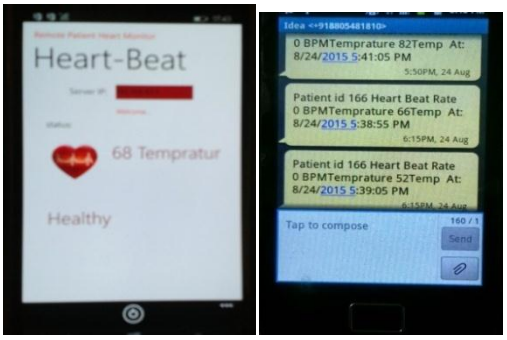


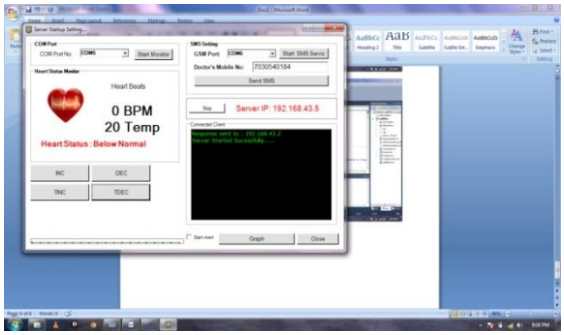


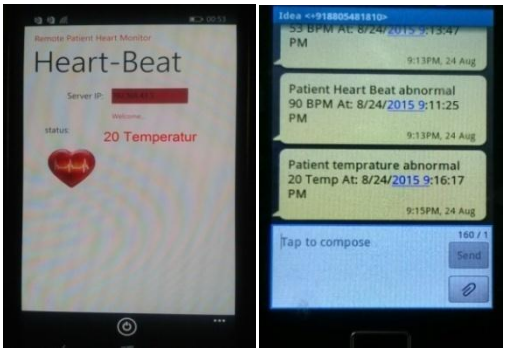


Step 8: If the temperture is increased or decreased then the GUI displays it and SMS is sent to the doctor's mobile.









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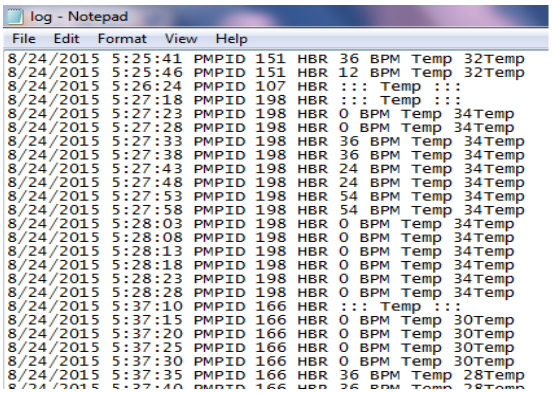
Step 9: This data will be saved as a log file in the bin folder as shown below.



VI. CONCLUSION

The potential benefits by deployment of Wireless sensor networks in healthcare applications are easy access of updated patient data at any time and from anywhere. It is wearable, portable , web based, real time system.Immediate response to emergency situations, provision of high quality healthcare with low cost individual health monitoring system. The system offers great conveniences to both patients and health care providers. This demonstrates an intelligent system for mobile health monitoring. Smart sensors offer the promise of significant advances in medical treatment. Networking multiple smart sensors into an application-specific solution to combat disease is a promising approach, which will require research with a different perspective to resolve an array of novel and challenging problems.

VII. FUTURE SCOPE

The system has great scope to improve in future for betterment of patients and doctors. The impact of these networks would be considerable and cover many aspects of daily life. The applications will not only lead to convenience but also lead to far reaching implications. The whole system of mobile health care using biosensor network places forward some future works such as finding the most effective mechanism for ensuring security in biosensors considering the severe restrictions of memory and energy, representing the collected data in the most informative manner with minimal storage and user interaction, modeling of data so that the system will not represent all the data but only relevant information thus saving memory. These are the generic works that can be done in future in the sector of mobile health care.

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