*International Journal of Applied Engineering and Technology ISSN: 2277-212X (Online)*
*An Open Access, Online International Journal Available at http://www.cibtech.org/jet.htm*
*2017 Vol. 7 (2) April-June, pp.7-11/Swarnima and Rubina*
***Research Article***

# SMART SYSTEM FOR MONITORING OF PHYSIOLOGICAL PARAMETERS USING ANDROID APPLICATION

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## ABSTRACT
The main focus of the paper is to implement a model for the real time patient monitoring system. The proposed system is used to measure the physical parameters like body temperature, heart rate, ECG, blood sugar and oxygen level with the help of biosensors using arm microcontroller. There are number of techniques available for health monitoring of ICU patients with wired communication technology. In this novel system the patient's vital parameters are continuously monitored and the acquired data can be transmitted to an advanced reduced instruction set computing machine (ARM) server using wireless sensor networks. Here, Bluetooth wireless sensor networks are being used. The embedded processor supports analysis of inputs from the patient and the results of all the parameters can be stored in the database. If any abnormality is perceived in the data, an alarm will be raised and a message will be automatically sent to the doctor's mobile using global system for mobile communication (GSM) module.

***Keywords:*** *ARM Processor, Sensors, Bluetooth, GSM, Biomedical Monitoring System*

## INTRODUCTION
Technology has entered almost all aspects of daily life and the medical field is no longer an exception. In today's competitive world physical and emotional stress is a part of life leading to increased mortality and morbidity. The need of technologically well equipped hospitals is there. Patients are spread over a large area in such hospitals and continuous monitoring of all the patients is challenging for a doctor. Keeping all these aspects in the mind we have developed "biomedical data transmission system" which can be used efficiently to get rid of these problems.

With this system we can continuously monitor a patient's different parameters such as body temperature and transmit the data to the doctor's personal computer (PC)/ mobile continuously. A PC interface has been provided in our system to view the records of different patients situated at different places on a PC.

In this way it is beneficial for the larger hospitals to use this system. By employing this system they can reduce their manpower. By this the workload on doctors can be reduced and ensure efficiency. The data can be monitored accurately and human error can be significantly reduced, thus the health care scenario may be significantly improved.

Recently, wireless sensors and sensor networks have played a vital role in the research and technology. But there are different forms of traditional wireless networks as well as computer networks. Today, the progress in science and technology offers speed, intelligence, sophistication resulting in the development of various high-performance smart sensing systems. Many new researches have focused on improving quality of human life in terms of health by designing and fabricating sensors which are either in direct contact with the human body (invasive) or indirectly (noninvasive)[Singh C]. With this proposed system the patient's vital parameters are continuously monitored by the patient monitoring system and the acquired data is transmitted to a centralized arm server using wireless sensor networks. A Bluetooth node is connected to every patient monitoring system that consumes very low power and is extremely small in size.

This paper builds an independent system that automatically logs vital parameters of patients for easy access. The data is accessible to doctors through mobile device for convenience. Data of all the patients is stored in a common database. The host computer stores the data, which can be used to analyze the patient's overall health condition. When the patient is in an emergency situation with altered vital parameters, the host computer automatically alerts the situation to the health care staff by an alarm sound

and also a message will be sent to the doctor through GSM module. This systems for continuous health monitoring is a key technological advancement for transition to more practical and affordable healthcare. It not only allows the user to closely monitor changes but also provide emergency assistance to doctors (Kamal, 2008). The fundamental problem with this system is that when medical emergencies happen to a user, they are often unconscious and unable to press an "emergency alert button." There is no product presently available which does not require manual activation of the alarm and monitors a user's vital signs smartly, though research is currently undergoing (Purnima *et al.*, 2014). This is a novel design presented in this paper. The reported device consists of a wrist strap and a finger ring (circuitry). This allows the sensors to be mounted around the wrist, finger and the arm unit connected via ribbon cable.

***Literature Review***

There are many systems for remote monitoring and control designed as commercial products or experimental platforms. It is noticed that most of the work carried out belongs to the following categories

a. GSM-SMS protocols using GSM module individually or in combination with other wireless Technologies (Brajendra and Jain, 2015).

b. Internet based Monitoring using GPRS modems, Servers, etc. with different approaches (Priya *et al.*, 2009).

c. Monitoring using Wireless Sensor Networks (Purnima *et al.*, 2014).

d. Wireless Monitoring using Bluetooth, Wi-Fi, Bluetooth and RF (Shahriyar *et al.*, 2009).

e. Applications have varied widely like Home Automation, Security Systems, Bio-medical applications, Agriculture, Environment, Reservoir, Bridge health monitoring, etc. Before understanding the proposed model we have to understand a system and embedded system.

Karandeep *et al.*, (2012) developed a Bluetooth based smart, noninvasive, wearable physiological parameters monitoring device. The system can be used to monitor physiological parameters, such as temperature and heart rate, of a human subject. The system consists of an electronic device which is worn on the wrist and finger, by an at risk person. Using several sensors to measure different vital signs, the person is wirelessly monitored within his own home. An impact sensor has been used to detect falls. The device detects if a person is medically distressed and sends an alarm to a receiver unit that is connected to a computer. This sets off an alarm, allowing help to be provided to the user.

Shaikh (2012) designed a module for monitoring of remote patients, after being discharged from the hospital. We have designed and developed a reliable, energy efficient remote patient monitoring system that sends parameters of patient in real time. It enables the doctors to monitor patient's parameters (temp, heartbeat, ECG) in real time. Here, the patient parameters are measured continuously and wirelessly transmitted using Bluetooth.

Sirisha *et al.*, (2013) described a solution for enhancing the reliability, flexibility by improving the performance and power management of the real-time multi-patient monitoring system (MPMS).

Pantelopoulos and Bourbakis (2010) describe specifications of various wearable sensor and from there paper description of various sensors is given.

Yuce *et al.*, (2007) presented a recently developed wireless body sensor network hardware, which uses the recently allocated medical implant communication service (MICS) band. The system prototype consists of a pulse rate and a temperature sensor, a central control unit (CCU), and a receiver station at a medical center.

*Existing System:* The patient is monitored in ICU and the data transferred to the PC is wired. Such systems become difficult where the distance between System and PC is more. The available systems are large in size. Regular monitoring of patient is not possible once he/she is discharged from hospitals. These systems cannot be used at individual level. The other problem with these systems is that it is not capable of transmitting data continuously also range limitations of different wireless technologies used in the systems. Our system is able to transmit the parameters of patient continuously and over long distance in wireless medium. Bluetooth is Wireless Networking Technology and is an established set of specifications for wireless personal area networking (WPAN), i.e., digital radio connections between computers and related devices. This kind of network eliminates use of physical data buses like Universal

Serial Bus (USB) and Ethernet cables. We are using ZNet 2.5 (Series 2) modules. The XBee ZNet 2.5 modules from Digi are more advanced than the popular XBee Series 1modules. Therefore, by developing a system that can constantly measure the important parameters of a patient's body and alert the doctor any time about patient's condition we wish to serve humanity.

***Proposed System Description***

The proposed system is designed for monitoring patients at any place. The system would constantly monitor important physiological parameters like temperature, heart rate, ECG, blood oxygen saturation, and would compare it against predetermined values and if these values cross a particular limit it would automatically sound an alarm and alert the doctor via a SMS. This system will provide a continuous health monitoring. The data processed is transmitted by Bluetooth. Finally, the received data is sent to the PC. The graphical user interface programs on the PC are coded using Keil C software, Using GSM modem message is transmitted to the doctor's mobile when the measured parameters are abnormal. GSM modem has a slot for inserting SIM (Subscriber Identity Module). GSM network contains Mobile Station, Base station subsystem and Network subsystem. Mobile station contains IMEI number and SIM has IMSI number. Base station subsystem contains Base Transceiver Station which has antennas for communication and Base Station Controller which controls multiple base stations. Network subsystem contains VLR (Visitor Location Register), HLR (Home Location Register), AuC (Authentication Center) and EIR (Equipment Identity Register). MSC (Mobile Switching Center) is the major part which is the gate way for communication between mobile station and PSTN. HLR stores the information about the subscriber and the current location of subscriber. VLR provides the services to the subscribers of HLR who are visitor users. AUC gives the security of the user and to identify the location of the subscriber. EIR is also for security purpose and to identify the mobile station. MAX232 is connected to GSM modem so that it is useful for serial data transmission. OSS (Operation Support System) is used to control the traffic of users.

## MATERIALS AND METHODS

***Methodology***

The backbone of this project is to develop the hardware and software with the wireless connection that is Bluetooth. The whole system is shown as Figure 1 below. The system design begins with a construction of circuit concept including data acquisition from ECG. In this study, a voltage regulator circuit is assumed as the patient's data originally collected from ECG machine. AT89S52 microcontroller (Kamal, 2008) and XBee module are used as the tools for transmitting the data from transmitter to the receiver. To configure the XBee modules, X-CTU software is required to be installed.

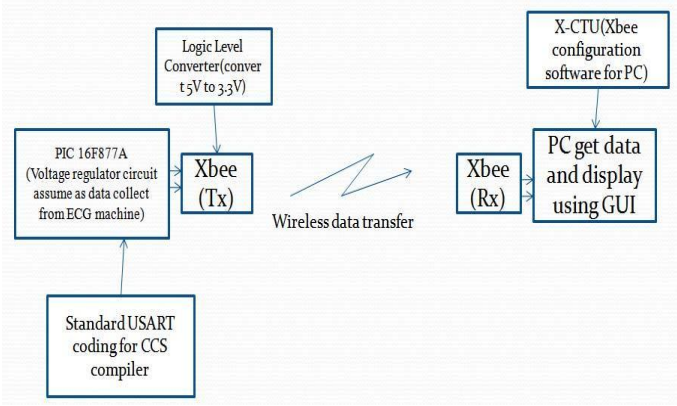


**Figure 1: Block Diagram of the System**

The both transmitter and receiver XBee Pro series use the same installer to be communicated each other successfully. Data communications between two XBee modules are tested individually to ensure the

functionality by entering a simple word to be send to the receiver. Data communications of all the parts involved in this study are tested individually to ensure the functionality.

***Wireless Communication Part***

The XBee module needs to be set before it can be used as serial communication between hardware and software connection. This setting requires an installation of X-CTU software created to configure the XBee module by Digi Corp. Both XBee and XBee Pro series use the same installer. In this software, it has four tabs that have its own function:

i. PC Settings

Allow user to select the desired COM port and configure ports to fit the radio settings.

ii. Range Test

Allow user to perform a range test between two radios.

iii. Terminal

Allow access to the computers COM port with a terminal emulation program.

iv. Modem Configuration

Allow the ability to program the firmware settings via a graphical user interface.

For the configuration of XBee Pro module, it can be done by using X- CTU software. The software will automatically detect an available COM port to the user. By clicking the "Test/ Query" button the software began to interact with the module to test the selected COM port. Figure 3 shows the message box appears if the COM ports are OK.

At Modem Configuration, the specified information about the module can be modified according to user desired. To make a two ways connection between these modules, a few changes need to be done by modifying the selected properties as shown in Figure 2.

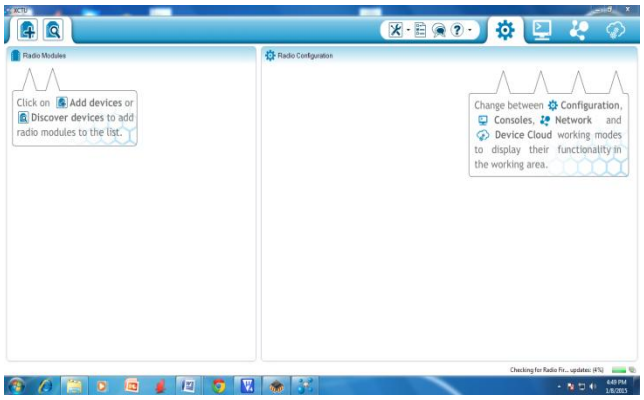


**Figure 2: Modem Configuration Using X-CTU**

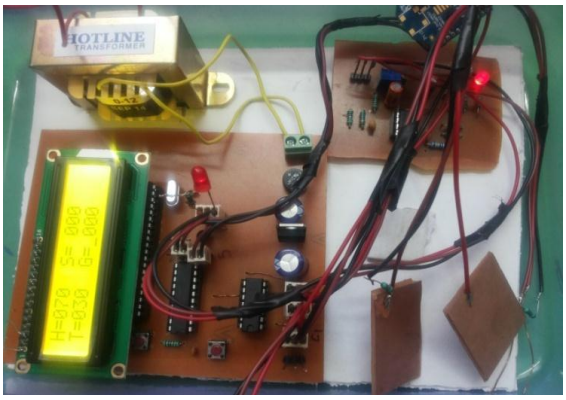


**Figure 3: Message Box**

As in Figure 2, four properties need to be modified in order to communicate all these modules with each other. The Destination Address High and Destination Address Low are set according to the user, as for this project it is set as 0. This address will be the receiving and transmitting address for the module. In other way, both modules need to use the same address. Basic configuration of a XBee involves setting XBee module self- address and destination address (the address of another XBee be transmitted to). Table 1 shows the basic configuration of two XBee modules (named XBee #1 and XBee #2) for wireless communication between the both transmitter and receiver.

## RESULTS AND DISCUSSION

***Results and Analysis***

In this proposed model of monitoring physiological parameters such as temperature, heart rate, ECG, blood oxygen saturation are more powerful than currently available system. Currently, available systems for monitoring physiological signals suffer from technical limitations. The proposed system is an enormous improvement over existing commercial methods. The present system can support up to twenty

patients with real-time, low-power, low-cost, long-distance, and dual-mode monitoring, from the above designed project. The keil C software is used for implementing the process and results are discussed. In future we can expand this system by using RFID technology; through this technology we can monitor the multiple numbers of patients. It may be a future work to develop another patient monitoring application code in that direction.

***Conclusion***

In this project, the Wireless Patient Monitoring System has been used to monitor the patient condition especially the heart rate. It also increases the efficiency of patient data monitoring. The data is successfully transmitted wirelessly to the receiver and is displayed on the PC. All the hardware design, data communication between hardware and software, wireless communication and GUI for the whole system is successfully function and can be used as a wireless patient monitoring system using Bluetooth as to replace the usage of Bluetooth, SMS through GSM are used as a mode of communication.

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