REMOTE HEALTH MONITORING USING NON INVASIVE MOBILE TECHNOLOGY

Ankita Gosavi[1], Harshvardhan Kariwala[2], Rohini Kaninde[3], Nilesh Rathod[4]

[1 2 3]Student, Information Technology, Rajiv Gandhi Institute of Technology, Maharashtra, India
[4] Faculty, Information Technology, Rajiv Gandhi Institute of Technology, Maharashtra, India

ABSTRACT

Abstract—   Keeping track of the health status of a patient at home is a difficult task. Especially old age patients and patients recovering from Malaria and Pneumonia should be periodically monitored and their loved ones need to be informed about their status from time to time. For this purpose,we put forward an innovative system that automates this task with ease. Our system puts forward a patient health tracking system that uses sensors to track patient health and uses internet to inform their loved ones in case of any issues. Our system uses temperature as well as heartbeat sensing to keep track of the patient's health.

If the system detects any abrupt changes in the patient's heartbeat or body temperature, the system automatically alerts the user/family member about the patients' status... The system we propose focuses on the measurement of health parameters based on a sensor network connected to a web application .Using internet we can overcome the problems of health monitoring systems. The implementation of the project is based on the portability of the sensors and a mobile device. This paper presents the design and implementation of one such system, Remote Health Monitoring System.

Keywords: *Patient monitoring system, Web Server,Internet of Things (IoT), Wi-Fi.*

1. INTRODUCTION

Health monitoring systems are gaining importance since the world wide senior citizens population increases the demands for monitoring. In Intensive Care Unit(I.C.U) there should be continuous monitoring of the patient's health condition. In majority of the cases,malaria and pneumonia infected patients released from the hospital are advised to rest and be under observation for a certain time period. When the family members of the patients are out of their home any mishap may happen which could prove to be disastrous. Calling up the patient to check on them, is definitely not an option since there may be times when the patient is not near their mobile phones. Hence,the family members of the patients always have to be there at home because to which their work is affected.

In this paper,we propose an innovative system that automates this task with ease. Our system puts forward a smart patient health tracking system which tracks a patient's vitals and alerts the medical supervisor and care takers in case of issues. It has three major parts: the sensors, the microcontroller and the Web application. The system uses a temperature sensor (LM35) as well as a heartbeat sensor to keep track of the patient's health. These sensors are are worn by the patient. The sensors will be connected to a Microcontroller which will transmit the live heart rate and body temperature wirelessly to the web application using Wi-Fi technology.

The web application will perform some calculations in the background. These calculations are based on predefined parameter values that are unique for each patientand are set by the doctor. In case of any abrupt changes in the vitals, the application can alert the patient's relatives and doctor of the patient by sending an SMS. Thus Remote Health Monitoring system effectively uses wireless technology to monitor the patient's health status and helps in saving precious minutes in emergency situations.

2. LITERATURE REVIEW

Margadu Anil Kumar et al focused on measuring and monitoring various parameters of the patient's body like heart rate, oxygen saturation level in blood and temperature using a web server and an android application, Their system uses Bluetooth to connect to the android application[1]. On the other hand Meria M George et al,focused on monitoring by using sensors which is connected to the circuit board that has the Adruino. And the sensor's data is sent to the remote web server by using an Ethernet shield. They used An ECG Sensor,Accelerometer and a Temperature sensor.[2]. Prabhakaran R et all,in their paper titled "REMOTE HEALTH MONITORING USING INTERNET OF THINGS (IOT)" suggested a system where they used 3 modules,the first is the Remote Node(slave node), which has the PIC16F877A processor, temperature sensor, heartbeat sensor and a Zigbee unit. The second module called the central node has the ARM LPC2368, an Ethernet Controller and a Zigbee unit via serial port.The data that is received by the master sensor node is uploaded to the web server using an Ethernet shield. [3]. Moeen Hassanalieragh et all in their paper titled "Health Monitoring and Management using Internet of Things Sensing with cloud based processing:opportunities and challenges" used wearable body sensor network and a concentrator to send data to the cloud storage.In the cloud the data is visualised and analysed by healthcare professionals. [4] Ramin Fallahzadeh et al suggested a system that keeps track of ankle edema based on the circumference of the ankle,using a circumferential sensor. [5]. T. Baranidharan et al proposed a system where they used heart rate sensor,blood pressure sensor,PIC micro-controller and used a gateway to send the information the server,where the doctor can sit in his clinic and see the data. [6] Yunzhou Zhang,et al in their paper titled "Remote Mobile Health Monitoring System Based on Smart Phone and Browser/Server Structure" suggested a system where they used a motion sensor to check if the patient is doing physical activities .Heart rate sensors is used to test if the patient's body status is normal.If the status is not normal and alarm will be sent[7]. Bhoomika.B.K. et al in their paper titled "Secured Smart Healthcare Monitoring System Based on Iot" ,suggested a system to monitor patients and alert the caretakers in case of abrupt changes in heart rate.To achieve this they used PIC18F46K22 microcontroller, Temperature Sensor (DS18S20),pulse oximeter sensor TCT1000 GSM module,MAX 232,L.C.D Disply, wi-fi module and piezo electric buzzer to alert the care takers.[8]. Alexandru Archip et al in their paper titled "An IoT Based System for Remote Patient Monitoring" suggested a system that helps monitor patients who have had a surgery and helps care takers to monitor a patient's movement.It uses a sensor node that have the following nodes:ECG node,Sp02 node,temperature and accelerometer node. Which is used to measure skin temperature and detect abnormal movements like seizures.ECG node has 50 samples per second.Sp02 node has 50 samples per second. They used JSON and REST to make a web service[9]

3. COMPARISON OF VARIOUS TECHNOLOGIES FOR HEALTH MONITORING SYSTEMS

The table 1 given,gives a comparison of the various technologies used in Health Monitoring Systems and highlights the drawbacks such as ,the accuracy of the sensor's readings, latency in arrival of alerts due to network delay, and efficiency. These flaws can be overcome by using Wi-FI technology as theconnection technology.A Web based application is developed in ASP.Net in C Sharp as a user interface for the doctors, Internet and SMS Gateways as the mode of connection to send a S.M.S alert to the doctors and the relatives.Wi-Fi will be used as a mode for transmitting the vitals collected by the sensors to the Web server. Our system also allows the doctor to view the historic data of the patient which includes the heart beat and body temperature in the past.

Table 1: Comparison of various technologies for Health Monitoring Systems

Name of paper	Authors	Journal of publication	Year and month of publication	Technology used	Drawbacks
Android Based Healthcare Monitoring	Maradugu Anil Kumar Y. Ravi Sekhar	International Conference on Innovations in Information Embedded and Communication Systems ICIIECS'15	March 2015	Android,LM35 temperature sensor,ATMEGA8L microcontroller,Bluetooth technology	Bluetooth has less range

Patient Health Monitoring system using IoT and Android	Meria M George,Nimy Mary Criac,Sobin Mathew,Tess Antony .	Jorunal for research	March 2016 Vol 2,Issue 1	Android,Adruino,Ether net shield	Ethernet shield is costly.
REMOTE HEALTH MONITORING USING INTERNET OF THINGS (IOT)	Prabhakaran R,Jili k p	International Journal on Engineeering Technology and Sciences.	September 2015, Vol 02, Issue 09	PIC16F877A processor, temperature sensor,heartbeat sensor,buzzer, Zigbee unit, ARM LPC2368	System is very complex with various devices used and hence costly.
Health Monitoring and Management Using Internet-of-Things (IoT) Sensing with Cloud-based Processing: Opportunities and Challenges	Moeen Hassanalieragh, Alex Page, Tolga Soyata, Gaurav Sharma, Mehmet Aktas, Gonzalo Mateos Burak Kantarci, Silvana Andreescu	IEEE International Conference on Services Computing	August 2015	Wireless Body sensor network,ZigBee/Blueto oth,	The system is more costly.
Context-Aware System Design for Remote Health Monitoring	Ramin Fallazadeh,Yuchao Ma,Hassan Ghasemzadeh	IEEE transactions on mobile computing	March 2016, Vol 00, Issue 0	Circumferential sensor,motion sensor,Bluetooth Module	The system is complex and Bluetooth has limited range.
Health Monitoring using Internet of Things	T.Baranidharan,S.Abipriy a, C.Jeyakanthsevlan,D. Suganya,L.Venkatapraka sh	International Journal for Science and Research in Technology	March 2016 Vol 02, Issue 03	Heart rate sensor,Blood pressure sensor, PIC microcontroller,wi-fi module,USB Modem	PIC Microcontroller has low speed
Remote Mobile Health Monitoring System Based on Smart Phone and Browser/Server Structure	Yunzhou Zhang, Huiyu Liu, Xiaolin Su, Pei Jiang and Dongfei Wei	Journal on Healthcare Engineering	June 2015 Vol 06, No 4	Motion sensor,Heart rate sensor,Bluetooth Module	System was good.
Secured Smart Healthcare Monitoring System Based on Iot	Bhoomika.B.K, Dr. K N Muralidhara	International Journal on Recent and Innovation Trends in Computing and Communication	May 2016 Vol 3, Issue 7	PIC18F46K22 microcontroller,Tempe rature Sensor(DS18S20),puls e,oximetersensor-TCT1000GSMmodule, MAX 232,L.C.D Disply, wi-fi module an piezoelectric buzzer	The system is complex and costly.

An IoT Based System for Remote Patient Monitoring	Alexandru Archip,NicolaeBotezatu, Elena S¸ erban, Paul-Corneliu Herghelegiu and Andrei Zala	Carpathian Control Conference (ICCC),2016 17th International	June 2016	ECG node,sensor node,temperature sensor,accelerometer.REST,JSON	The system is complex.

4. PROPOSED SYSTEM

In this project, we aim to develop a system that wirelessly monitors patients and proves to be user friendly.
The main idea of the designed system is the continuous monitoring of the patients over internet. Our system puts forward a smart patient health tracking system that uses Sensors to track the patient's health and uses SMS to send alerts. Our.. In this system, Microcontroller ATmega16 collects the data from the sensors and sends the data through Wi-Fi Protocol to the web server. The data sent can be accessed anytime by the doctors by typing the corresponding unique IP address in any Internet Browser at the end user device.
 If the web application detects any abrupt changes in the patient's heartbeat or body temperature, the system automatically alerts the user/family member about the patients' status by sending an SMS to the mobile phone numbers stored in the database The patient's name, three relatives and the doctor's phone numbers will be stored in the database at the server side During this time when the heart beat and temperature readings cross a limit the SMS alert is sent using an S.M.S gateway to the contact numbers stored in the database. And the user interface html webpage will automatically refresh for every 15 seconds hence patient health status is continuously sent to the doctor. Hence continuous monitoring of patient data is achieved.

In this project data is to be transmitted to the remote web application as per our main requirement. There are different communication technologies that are used for data transmission these are WiFi, Zigbee, GPRS, GSM and Bluetooth. Because of Low cost and error correction meachanism in this project we use Wi-Fi.
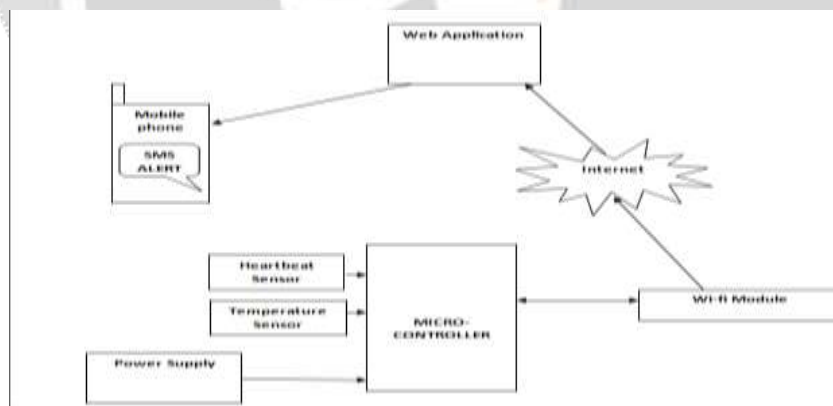

FIG 1:Block diagram for Remote Health Monitoring System using Non Invasive mobile technology.

Our system works in three steps as shown in the Fig 1 :
The proposed system main object is to monitor the patient health status in real time and notify relevant doctor or nurse instantly if the patient is in risk.The complete project methodology is explained below in steps

Step 1-
Connecting all the sensors to the patient and transferring that collected data through ATMEGA16.

Step 2-
In this phase, Once all the parameters are received by the application, parameters are updated into database.

Step 3-
Web application fetches these parameters for every change and sends an SMS alert to the smart phone.

5. IMPLEMENTATION

The actual working of the project includes the hardware specifications and sensors, power supply, microcontroller, and software are Visual Studio IDE, Microsoft SQL server.

5.1 Parameters used are shown in Table 2
Table 2: Parameters used in the project

Integrated Development Environment	Visual Studio 2013
Micro controller	ATmega16
Clock Speed	16 MIPS
Digital Communication Peripherals	1-UART
Input Voltage	5 volts
Programming Language	Embedded C,C#

5.2 Hardware components
Hardware components include the ATmega16 Microcontroller ,LM35 temperature sensor ,Heart beat sensor and ESP8266 Wi-Fi module.

5.2.1 ATmega16
The ATmega16 Microcontroller is a 8 bit micro controller.It is a high performance low power consumption AVR Micro controller.The ATmega16 has the following advantages it has 4 times the ROM and 4 times the RAM and EEPROM which is byte addressable and non volatile as compared to 8051. ATmega16 has a clock speed of 20MHz and they run at near 20 MIPS. Other micro controllers run at 5 MHz with a 20 MHz oscillator frequency.ATmega16 has better RISC instruction set while 8051 has CISC instruction set.ATmega16 instructions are executed in a single instruction cycle whereas 8051 instructions are executed in multiple cycles.

5.2.2 LM35 Temperature Sensor

The LM35 sensors are precision integrated-circuit temperature sensors that has an output voltage that increases linearly with the temperature in centigrade. LM35 sensor doesn't need any external calibration to give an accuracy of ±0.25°C at room.LM35 sensor has very less self heating.LM35 temperature sensor gives an output in terms of voltage that is proportional to the Celsius temperature.LM35 requires only 35 micro amperes from its power supply.The output voltage is converted to temperature using a conversion factor.It has a sensitivity of 10mV/°C. Equation required to convert the ouput voltage into temperature is as follows:

$$Temperature(°C) = Vout * (100°C/V)$$
$$If\ Vout = 1V\ then\ Temperature\ is\ 100°C$$

Fig.2: LM35 temperature Sensor

5.2.3 Heart beat sensor

The heart beat sensor module combines a phototransistor and I.R L.E.D.When a finger is placed between the two a varying signal is received at the receiver.By reading this analog signal we can calculate the heart beats per minute(b.p.m).As the density of the blood passing through the finger changes the amount of light absrorbed changes.Using this we can calculate the heart beat per minute.

Pin description:

- S Analog output
- 3 to 5V DC input
- Ground

FIG 3: Heart beat sensor

5.2.4 Wi-fi Module ESP8266

ESP8266 is a low cost Wi-Fi module which is perfect for giving WiFi functions to a microcontroller via a UART serial connection. ESP8266 can also be programmed to be a stand alone Wi-fi module.ESP8266 requires a 3.3V power supply.It can serve as a Wi-fi adapter as well.ESP8266 operates in three modes:active mode,sleep mode and deep sleep mode.It can also be used to host wi-fi applications.ESP 8266 module is shown below in FIG 4.

Features of ESP8266 include:

- 802.11 b/g/n
- Integrated low power 32-bit MCU
- Integrated 10-bit ADC
- Integrated TCP/IP protocol stack
- Deep sleep power < 5uA
- Wake up and transmit packets in < 2ms

FIG 4:ESP 8266 Wi-fi module

5.3 Software Components

The web application was developed in c#.The web application is connected to a database.For the back end we have used Microsoft Sql server 2008.The web application has a module for the doctor to log in.Once the doctor is logged in ,he can check each patient's previous record as well as add and delete new patients from the database.The web application is shown below in FIG 5.
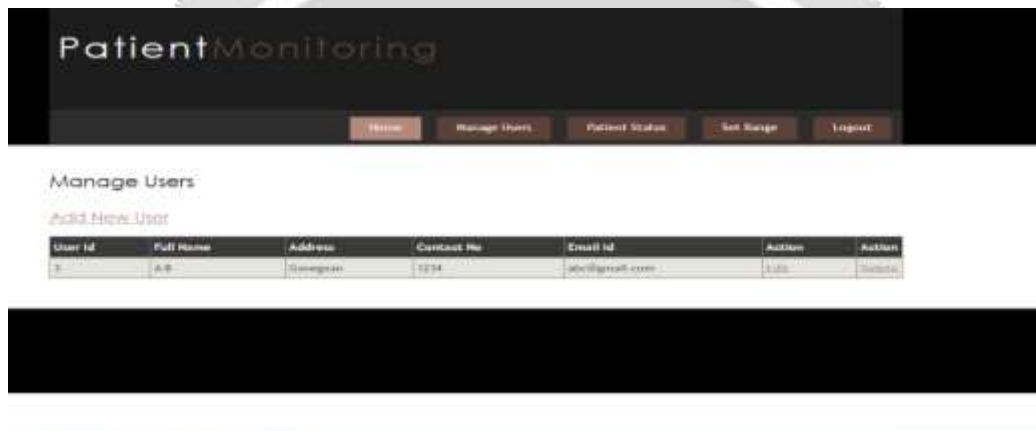

FIG.5: Web Application

6. RESULT

We have completed developing the software and integrating it with the hardware circuit board.This had led to a successful system where patients are monitored and their doctor and relatives are alerted automatically in case of an abnormal heart rate or too high or low body temperature.

7. CONCLUSION

The system that is developed has the ability to monitor patients throughout the day,in any environment whether that is at home or in a hospital. The sensor network and the easy to wear sensors are the important features of this project which when integrated with an IoT-based system where a machine interacts with another machine has been set up. The main objective of the project to wirelessly monitor the patients while not restricting the movement of the patients to their bed.Since the sensors are wearable devices patients can move around at home or in the hospital.. The Web based interface provides an ideal platform for doctors with non technical skills to use the system . Hence,the Remote Health Monitoring System using Non invasive mobile technology is a fit replacement for the manual monitoring of patients that requires a person to be present at all times.

8. REFERENCES

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