Implementation and control of patient monitoring system using Bluetooth technology

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Abstract— **This paper presents invention for monitoring the physical conditions of patient in a room and helps in mon- itoring the surrounding conditions as well. Wireless remote patient monitoring(RPM) is a very helpful and efficient tool for monitoring of elderly and disabled patients in their home environment. It can help the patient and the doctor or their relatives to continuously keep a track of the patient's health parameters like heart rate and body temperature. It can also help in detecting fall in case the patient has fallen down from the wheel chair. It can also help in monitoring the room temperature and humidity to check whether the surrounding conditions are favourable for the patient. Key of the design is the involvement of other health care services such as social care, emergency department, out of hour general practitioners and involvement of patient's and their caretakers.**

Index Terms— **remote patient monitoring, Bluetooth, Tele-monitoring, Heart rate, App-based.**

I. INTRODUCTION

Health monitoring is a very serious issue in the present scenario. The lack of proper health monitoring can pose as a serious issue for the elderly and disabled persons. Monitoring systems are drawing a lot of attention as it can prove to be very helpful to keep a track of the patient's physical status and their surrounding conditions as well.[1]

The technical brilliance and the growing use of technology as proved to have an impact in our daily lives and has efficiently improved the living conditions. The advances in the technology can help us to provide a better lifestyle for the patients without worrying about drastic changes in their health conditions as this device will keep a track of their physical conditions and keep their relatives and the doctors posted.The device will provide with real-time values and will be helpful to the physicians in analyzing the patient's conditions.

This device will help in monitoring the patient's health status by sensing the following parameter- heart rate, body temperature, fall detection and room conditions. Nowadays, fall detection is also an serious issue as it is widely increasing in numbers and has affected the lives of many elderly and disabled patients.

For the purpose of this project, we formally define a fall as an unintentional, sudden and uncontrolled movement of the human body causing it to end up lying on the ground. This kind of sudden fall can cause physical as well as mental disturbance for the elderly patients.

II. PROBLEM DEFINITION

Since there a lot of elderly in our country and it is nearly impossible to take of them at all times. Thus, we are aiming to work on this problem and design a system which will help their relatives and physicians to keep a track of their health and take care of them. The problem here is that before the monitoring systems were used the physicians had the personally visit their patient's to check their status and someone has to be present near them at all times. This project is aimed at reducing the efforts and still keep a track of the status of the patient at all times.[3]
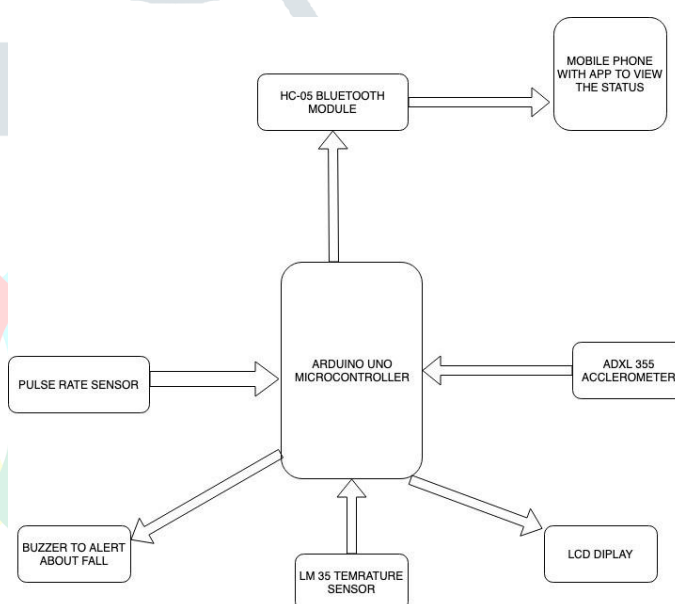
III. BLOCK DIAGRAM

Fig. 1. Patient monitoring system using Bluetooth module

The above diagram shows us the block representation of our system. In this diagram we can clearly see a Arduino Uno micro-controller in the middle of the whole system, this micro-controller will act as the brains of the system. This micro-controller is responsible for the proper working of all the other components of this system. In the other blocks we can see components like accelerometer which is responsible for finding the body status of the body that is the current co-ordinates of the body and will be responsible in determining fall of the body. The LM35 is a transistor based temperature sensor and will be responsible for determining the body temperature of the patient. The pulse rate sensor will detect the heart rate of the patient and will forward its input to the micro-controller. A HC-05 Bluetooth module is used to connect to the mobile of patient, doctor or caretaker througha mobile app. The liquid crystallized display (LCD) will display the para metes like heart rate and body temperature on it. A buzzer is which will make sound when a fall of body is detected by the accelerometer.

IV. WORKING AND CIRCUIT DIAGRAM

To understand the working of this Patient monitoring system we need to understand the working of each of the components used in this system, so we have listed the components used in the system as follows and we will explain each component further in the paper, and the circuit diagram with each of the components in the patient monitoring system is below.
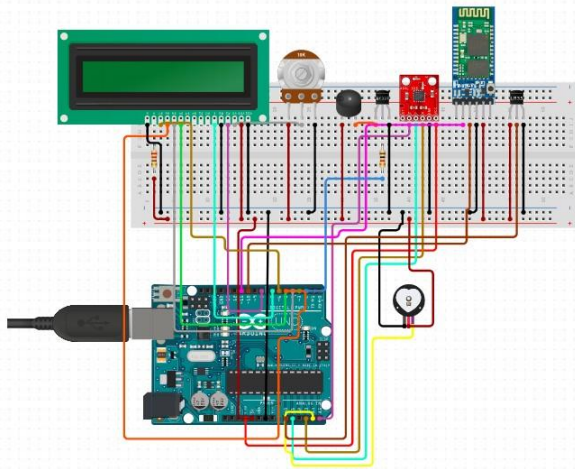

Fig. 2. Circuit Diagram of Patient monitoring system implemented with Bluetooth technology

A. Arduino Uno

The Arduino Uno is a micro-controller based circuit board. This board has 14 digital pins, 6 analog pins and is programmable by Arduino IDE using a type B USB cable. In this system we are using we will use 9 digital pins for connecting the HC-05 Bluetooth module, liquid crystallized display (LCD) and the heart rate monitor. All the other components are connected through the analog pins. The power(5 volts) and GND are also given by the Arduino Uno to the whole circuit.

B. LM 35 Temperature Sensor

The LM35 is an integrated circuit sensor that is used for temperature measurement with electrical output proportional to sensor(in degree Celsius). It has output voltage that is proportional to the Celsius temperature.

C. Pulse Rate Sensor

The Pulse rate sensor in this project is used to read the heart rate of the patient. The heart rate is a crucial parameter of the Human body as early detection of abnormal heart rate can help prevent from serious diseases. Heart rate monitoring is needed is need to determine the range of heart rate. The
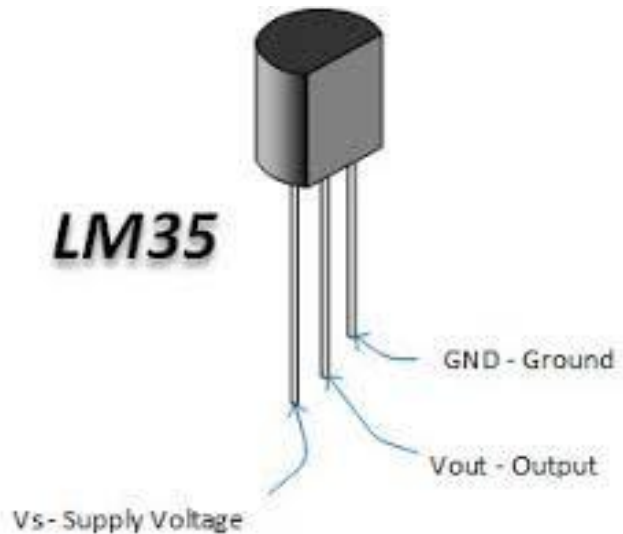

Fig. 3. Arduino Uno

Fig. 4. LM35 Temperature sensor

pulse rate sensor used in this system has an operating range of 3.3 Volts to 5 Volts. It works with a current value of 4 milli amperes. This sensor makes a direct contact with the skin of the patient. This pulse rate monitor has an ambient light sensor like the one used in cell phones, laptops and tablets to adjust the brightness of the screen. The Light emitting diode(LED) shines the light into the finger tip, ear lobe or other capillary tissues, and the sensor reads the light which is reflected back. In this manner the heart beating rate is measured by the sensor.

D. ADXL355 Accelerometer

The ADXL355 accelerometer is used in this system for fall detection purposes of the patient's body. This accelerom- eter also needs to attach with the patient's body. This accelerometer has an operating range of 2.25 Volts to 5 Volts. Accelerometer measures the acceleration due to motion of the body. However when it is fixed only the gravity pulling down is sensed. This device measures linear acceleration along three perpendicular axis. In ideal conditions the value

Fig. 5. Pulse rate Sensor

of the 2 axis must be 0 and the value of the third axis must be maximum, if this condition is not matched then we come to know that there is condition of fall. When these conditions are not matched and there is a condition of fall of the body a buzzer attached to the system will start to make sound so that any person in the nearby surroundings gets his attention towards the patient.[7]
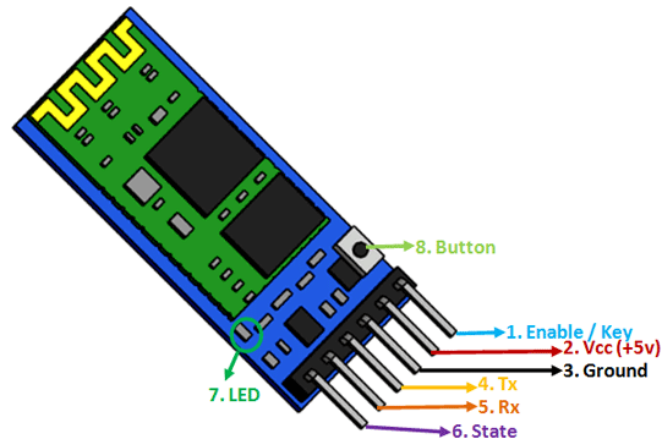

Fig. 6. ADXL355 Accelro-meter

E. HC-05 Bluetooth module

In this system we have used a HC-05 Bluetooth module which connects to the smart-phone of the doctor, patient, or his/her caretakers. Through their smart-phones the parameters of the patient's health can be monitored through a mobile app which is freely available on the Android play store called "Bluetooth terminal HC-05". The HC-5 is a Serial port protocol(SPP) module designed for transparent serial connection setup. The Bluetooth module is Master/Slave module but by default the factory setting is Slave. This module can only accept connections and cannot establish them on its own. The operating range of this module is 3.3 Volts to 5 Volts. The slave default baud rate is 9600. Auto pairing pin-code is "1234" by default. The voltage of 5 Volts of this system is supplied to the Vcc pin of this Bluetooth module. The GND pin connected to the ground. The TXD and RXD pin acts as USART interface for communication.[8],[10]
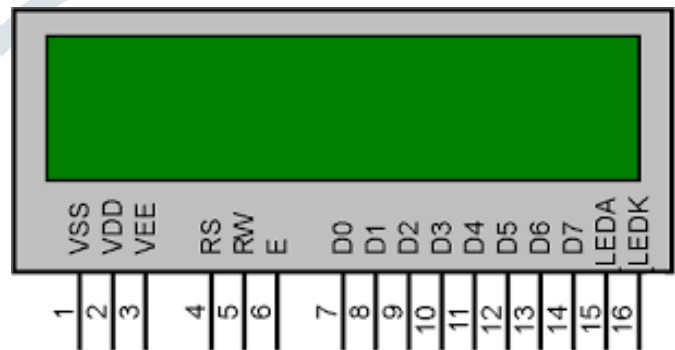

Fig. 7. HC-05 Bluetooth Module

F. Liquefied crystallized display

The Liquefied crystallized display(LCD) used in this system a 16x2 LCD which will display the parameters like heart rate and body temperature in it. This device will work when an output command is given by the LCD to print the suitable data. The supply voltage for this LCD is 5 Volts and it is supplied through the Vcc or Vdd pin of the LCD. The ground connection is done to the GND pin of the LCD. The Vee pin is used for contrast adjustment of the LCD. The RS pin is the Register select pin. R/W pin is used for reading and writing of data to and from the LCD. EN is the enable pin which will send data to the data pin. The LCD has 8 data pins from DB0 to DB7. The Led+ and Led- pins are used to activate the backlight of the LCD and the Led+ pin must be connected to the Vcc of 5 volts and Led- pin must be connected to GND of 0 volts. When suitable connects are made between this 16x2 LCD and the Ardiono Uno then the display will be visible on the LCD. The LCD can be of many sizes like 8x1, 8x2, 16x1, 16x2, 16x4, etc., but we are using a 16x2 LCD because firstly this LCD is cost effective and secondly this LCD is most suitable for our system as this LCD will have the least cutter on the display screen and the display will be easily readable by the user.

Fig. 8. 16x2 Liquefied Crystallized Display

V. APPLICATIONS

The patient monitoring system has a wide range of applications associated to it. All the applications of this system can prove to life saving for a lot of patients. Some of the applications of this system are listed below.

A. *In home environment*

This patient monitoring system proves to be very helpful in monitoring vital body parameters of the patient in its house hold conditions. The parameters such as heart rate and body temperature prove to be vital when he patient is elderly and needs to monitored on a regular basis, many people cannot go to a hospital or to a clinic every time they need themselves to be monitored so the most efficient and the most effective solution is given by this system which we propose in which a patient is able to monitor his/her body parameters by himself/herself and does not need to go anywhere outside his/her house. Many elderly people have problems going to the hospitals and want their checkup to be done at their homes, with this system a more efficient readings of the elderly patients can be taken at their own home.[1]

B. *Wireless Monitoring*

It is not possible for a person to be present with a family member who is ill all the time, as in today's world no one have the ability to leave their daily jobs and look after their family members for the whole day. With this patient monitoring system a family member can check the parameters of the patient through his/her smart-phone. With the shortage of doctors in present day condition it is not possible for doctors to monitor his/her patients all the time again the doctors can monitor their patients through this patient monitoring system using their smart-phones and whenever they find something is wrong in the received body parameters they can immediately attend their patient.[9]

C. *ICU care*

The patient monitoring system can be a very useful is the Intensive care units(ICU) of the hospitals as patients admitted in the ICU needs constant monitoring which is provided by this patient monitoring system. This patient monitoring system can be attached to the patients in the ICU and the in-charge of the ICU can monitor the body parameters of the patient through his/her smart-phone.[3]

VI. FIGURE AND GRAPHS

Positioning Figures and Graphs: The below attached figures and graphs are very help-full in supporting the results of the patient monitoring system. The graphs shows the variation in the readings of the body parameters of the patient. The figures are the snapshots of the device that was made and the deployment of the device with all the sensors. The graphs attached are for variation in body temperature and heart rate of the patient, as well as a graph shows the out put of the accelerometer which indicates the body position of the patient with varying time. All the graphs show their parameters with respect to time.
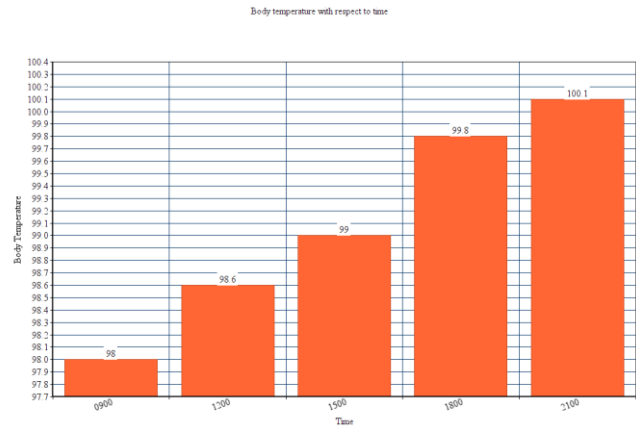

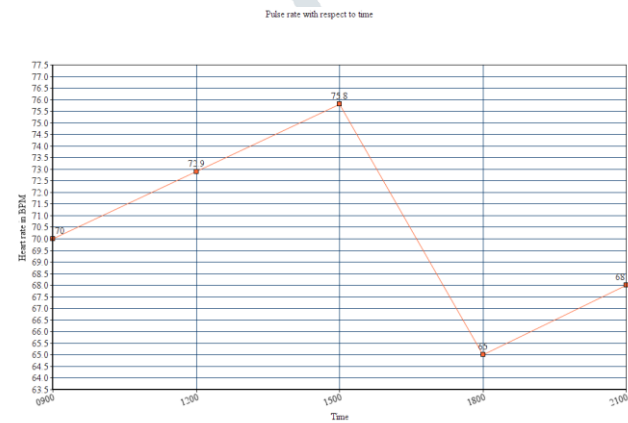Fig. 9. Graph of body temperature with respect to time

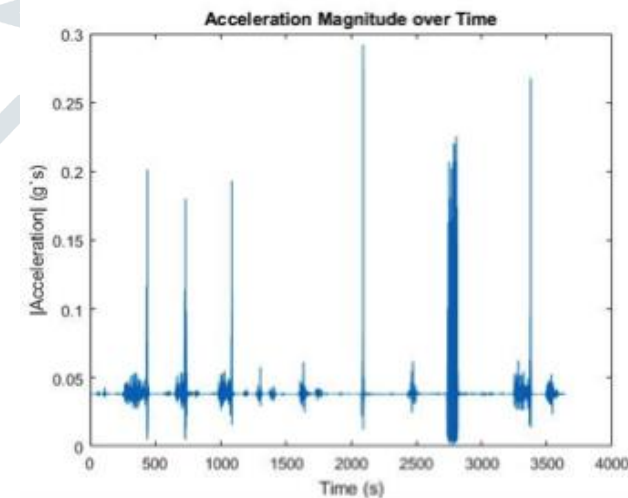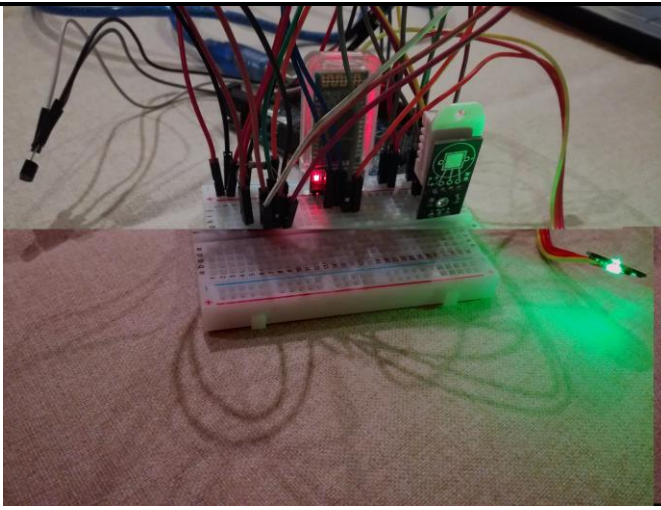Fig. 10. Graph of heart rate with respect to time

Fig. 11. Graph of body posture

Fig. 12. Snapshot of actual device

VII. CONCLUSIONS

The Patient monitoring system is designed to be lightweight, efficient and accurate. This system is easy to operate and can monitor several parameters of the human body. This system when integrated to a device will help the elderly and disabled or ill patients to monitor their health status in their home environment and they do not need to go to the hospitals or clinics for the same. Future works will focus on reducing the size and using better data transmission techniques between transmitter and receiver like Zigbee, ANT+, etc., it may also include using a smaller controller like Arduino mini or Arduino Nano other than these we can interface a Wi-Fi or a GSM module to interface our Mobile phones with this system which will make monitoring the patient's parameters even more easier. This device also gives advantage to doctors and care takers of the patient as if they use this system they are not required to constantly monitor the patient all the time but can do other daily tasks while remotely monitoring the patient's health parameters.

REFERENCES

[1] Tanja Bratan, Optimum design for patient monitoring system, Brunel research group of health and technologies(Bright), School of informa- tion systems, Computing and mathematics, Brunal University, United Kingdom. 2006.

[2] N.H.Mahmood, N.Uyop, N.Zulkarnain, F.K.Che Harun, M.F.Kamarudin and A.Linoby, LED indicator for heart rate monitoring system in sport application. University of technology(UTM), Malaysia. 2011

[3] Nitin P.Jain, Preeti N.Jain and Trupti P.Agarkar, An embedded, GSM based, multiparameter, realtime patient monitoring system and control-
An implementation for ICU patients. Navi Mumbai, India. 2012

[4] Neha R. Singh, P.R. Rothe and A.P. Rathkanthiwar, Implementation of safety alert system for elderly people using multi-sensors. Priyadar- shani college of engineering, Nagpur, Maharashtra, Indi .2017

[5] Bertrand Massot, Claudine Gehin, Ronald Nocua, Andre Dittmar and Eric McAdams, A wearable, low-power, health monitoring instrument based on programmable system-on-chip. 2009

[6] Shraddha D. Deshmukh and Swati N. Shilaskar, Wearable sensors and patient monitoring systems: A review,Vishwakarma Institute of technology, Pune, Maharashtra, India. 2015

[7] Artem Alesin, Ardeshir Osanlou and Sai Win Maw, A low budget multifunctional wearable device for motion and fall detection. Center of ultra realtic imaging, ASCE, Glyndwr University, Wrexham, Wales, UK. National research university of Electronic technology, Moscow, Russia. 2018

[8] Neeraj Rathi, Monika Kakani, El-Sharkawy and Meher Rizkalla, Wearable low power pre-fall detection system with IoT and Bluetooth technologies. Department of electrical and computer engineering, Indi- ana University Prudue University Indianapolis, Indianapolis, Indiana, USA. 2017

[9] T. Elakkiya, Wearable safety wristband device for elderly health monitoring with fall detection and heart attack alarm. Asst. Prof. Department of electronics and instrumentation, Jeppiaar Engineering college, Chennai, India. 2017

[10] Won-Jae Yi, Oishee Sarkar, Thomas Gannot, Ehsan Monsef and Jafar saniie, 6Lo-WPAN-enabled fall detection and health monitoring sys- tem with android smartphone. Department of electrical and computer engineering, Illinois indtitute of technology, Chicago, Illinois, United States. 2016