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IoT Based Healthcare Monitoring system With Alert And Notification System

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Abstract--: To ensure the safety of patient in todays world, there are lots of factors and aspects that should be taken into account. Two of the major reasons which affect the patient's health are man-made errors which are done by medical staff in measuring the body parameters and unavailability of medical attention at the proper time. As a remedy of this, the body parameters should be monitored in real time. To pursue this purpose, we had made a sincere attempt to make IOT (Internet of Things) based smart healthcare monitoring system with alert and notification feature. In this paper, we present the prototype of smart healthcare system that provides the provision to monitor the vital signs like blood pressure, heartrate and body temperature in real time. To convey the data remotely from the device to the gateway section we have used IEEE 802.15.4 wireless standard which works on low power and low data rate. Through the gateway, this data is uploaded to cloud which can be accessed from all around the world. Moreover to it, our system provide the provision of Alert system and Email notification feature.

***Keywords**-- Healthcare, Sensor Networking, IoT, Zigbee,Raspberry Pi.*

I. INTRODUCTION

In today's world, there are several highly qualified medical equipments, and healthcare and medical field are emerging at a very high rate. Technology is much more ahead in this field, which can simply turn around the condition. It gives a very strong support to doctor by which they can save a patient's life and also can provide positive results in unexpected situations too.

In spite of having emerging technology and latest equipment, Healthcare is somewhat not achievable as it should be. In our medical system and various hospitals, patients got to die and face severe consequences because of some certain reasons, in which, proper medical attention is not being given to patient at a critical time, moreover to it man-made errors create a drastic difference. In some cases wrong measurements are noted by the medical staff, which results in severe outcomes.

In our designed prototype, we take care of the human body's vital signs or basic vital parameters. Vital signs like blood pressure, heartrate and body temperature is taken into account. The values of this parameter are always considered for every clinical checkup. From the out of range values of this signs, critical situations can be identified and we can rescue it by proper treatment at appropriate time. 50 to 80 bpm is the normal range of heartbeat. If it exceeds the limit of 120bpm or below the range of 40bpm, it can be considered as symptoms of heart attack. body temperature above 37 degree centigrade can be considered as fever. In addition, the normal range of blood pressure is 80 to 120.

There are many systems[1]-[7]exist which provides some solutions to prevent this kind of condition, but these system consists some bugs which are solved by our system. To overcome these problems, our prototype provides the solution by real time access of these parameters. In our system, wearable sensors collect the value of vital parameters which is further conveyed remotely to the Raspberry pi, which provides gateway to make it available cloud so that it can be seen and accessed anywhere around the world. To pursue this we are using concept of IoT. The internet of things has been heralded as one of the major development to be realized throughout the internet portfolio of technologies [8]. The Internet of Things (IOT) is concerned with interconnecting communicating objects that are installed at different locations that are possibly distant from each other [9].

With the help of this effort we can get productive results like we can avoid man-made errors during taking measurements, also we can reduce the required manpower. Furthermore, it is a very low cost system in comparison with costly medical equipments. So that, it is also reliable for small hospitals in rural areas. Also one can buy it as a personal health monitor for home use.

We can expand this concept for city level monitoring, too. Furthermore, It can be made for particular dieses, and the required parameters can be taken into account with the help of respective sensors.

The following sections are going to present implemented methodology in our prototype. In this paper, we have presented sensor networking, gateway section and very important Client - Server socket programming.

II. METHODOLOGY

Healthcare Monitoring System provides real time monitoring of patient. In this system three vital parameters of Human body are getting monitored. With the help of proper sensors, Blood pressure, Heart rate and Body temperature are sensed and measured.

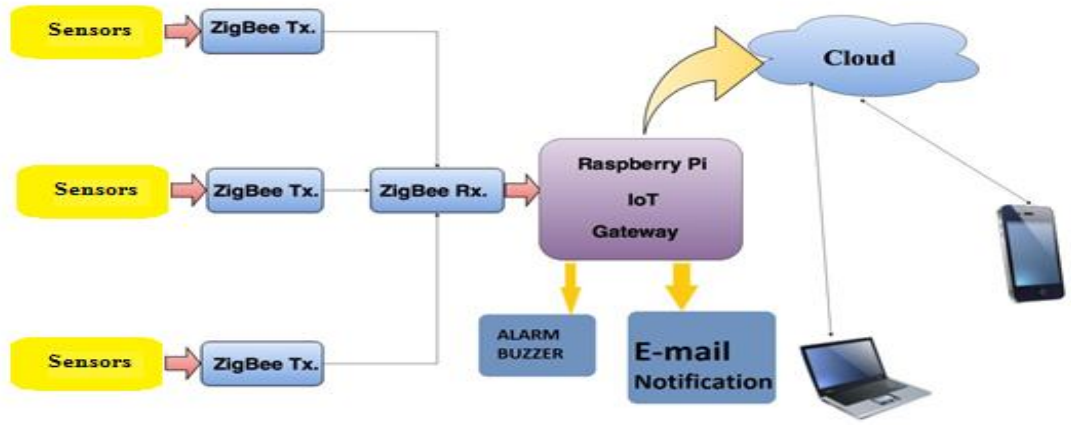

Figure 1. System Architecture

For the processing of collected data, the ranges of vital parameters are followed, which are as mentioned before.

These measured data are then transmitted to Raspberry pi via Zigbee. We are using IEEE 802.15.4 wireless standard because of certain important reasons. Zigbee provides low power consumption and provides a range about 100m. Zigbee is supposed to do what Wi-Fi or Bluetooth which do not provide both way communication between multiple devices over a simple network using very low power and at very low cost [10].

Raspberry pi is used as a core controller. Here, all the collected data from different devices are gathered and processed. A gateway is created for IoT. With the help of this gateway, data is forwarded to a remote server for further processing and use. The brief introduction of IOT gateway is discussed in [11]. It is uploaded to the cloud. Cloud computing provides the access of applications as utilities, over the internet. The cloud computing characteristic and development approaches are explained in [12]-[14].

In addition, with real time monitoring, we have also providing ALARM and Notification system. In which for the critical conditions the alarm will be generated with the help of Buzzer and also providing E-mail notification directly to doctor or present medical staff.

our system provides below listed features:

- The proposed system is reliable and efficient.
- This Healthcare monitoring system is very cost effective in comparable to other healthcare system and various instruments .
- The system provides real time monitoring of vital parameters using wireless data communication standard.
- The system is user friendly, that provide a browser application to the user which is helpful to reduce man power and saves time.
- In this system various sensors are used for measuring of vital parameters and based on which Alert system is designed for critical situations.
- Electronic buzzer is set for the alert of the critical situation and also we set the E-mail notification system for alert.
- Moreover to it, with the help of web application an authority can able to control the Alert system and other GPIOs.

There three main phases of this healthcare monitoring system, (i) sensor networking (ii) Gateway (iii) Web Application, which are described below:

A. Sensor Networking

In our "Healthcare Monitoring System", we are measuring four various and very important vital parameters of human body namely Heartrate, Temperature and Blood pressure. Moreover to it Blood pressure contains its two ranges which are: Systolic and Diastolic. The circuit diagram for this networking is shown below:

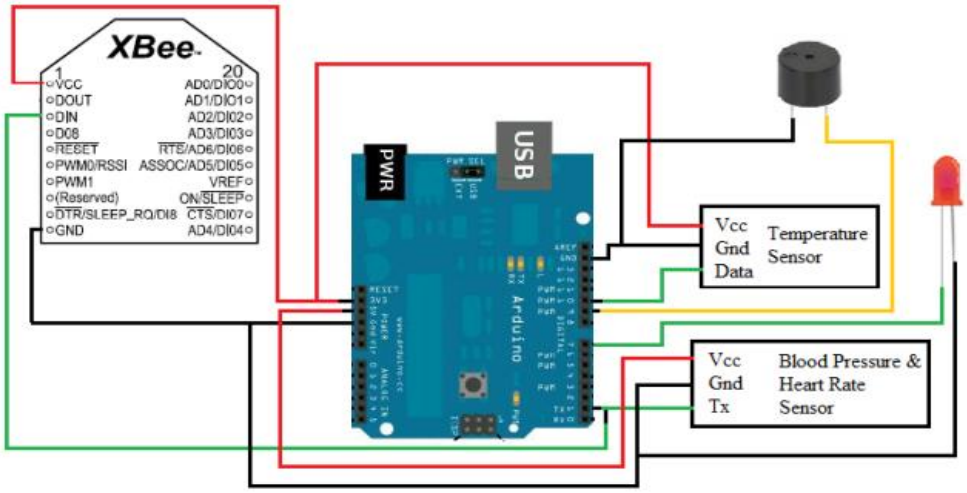

Figure 2. Sensor Networking

To fulfill this purpose, we are using two different sensors. From which, the first one provides values of Systolic, Diastolic and Heartrate serially at the baud rate of 9600bps. On the other hand, we have a waterproof Temperature sensor from the Dallas group of manufacturers of DS18b20 family, which works on one wire protocol. As its name suggests, it provides the value of temperature by only single data line which is used as command line too as per the requirement.

Sensor Networking is the very first and a base stone step for our system. Sensor Networking is described in brief in [16]-[18]. In the first half of our system we have collected all the measured data and put it in a well structured string which is conveyed to the other end for the further processing. Here, we have used the Arduino board as a central controller to tie up all the sensors.

The sensor networking topology is shown in the given figure. From which we can see that the serial data out pin of Blood pressure and Heartrate sensor is connected to the UART Receive pin, so that when it gets available at Rx pin the data is being read serially. Simultaneously, DS18B20 is connected on the Arduino board. Temperature is being read as per the one wire protocol:

(1) Reset the one wire bus. (2) Select one wire slave device. (3) Start reading scratchpad.

For which it requires a minimum of 750ms of delay. All these measured values are conveyed to the raspberry pi end remotely via Zigbee.

Addition to this we have established an ALERT SYSTEM at the device end, in which buzzer gets started buzzing and LED light turns ON for the defined critical range of all the four vital parameters.

Zigbee works on radio standards and 2.4 GHz, 900 MHz, 868 MHz unlicensed band frequency. Due to low power and low data rate its range is limited from 10 to 100m. Its having data rate of 250kbps. Due to energy efficiency, it provides long battery life. Moreover to it, Zigbee provides "Mesh Networking Topology" and the convenience of "Personal Area Network". Zigbee adds network structure, routing, and security to complete the communication suite [15].

B. Gateway

In the first half of the Healthcare Monitoring System, All the value of different vital parameters measured by respective sensors and combined data is conveyed to the Raspberry Pi for the further processing via Zigbee wireless communication standard.

To use the collected data for IoT purpose, we need to do is Gateway creation and Socket programing. A gateway is a network point that acts as an entrance to another network. The brief introduction of IOT gateway is discussed in [19] [20].

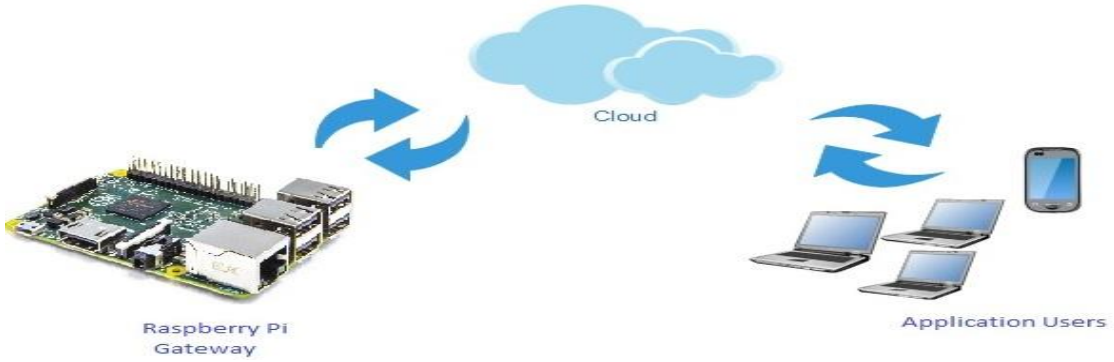

Figure 3. Gateway Process

Zigbee co-ordinator module is attached to the raspberry pi board via USB 2.0 port. Which can be detected at Pi console:

[5.710534] usbserial: USB Serial support registered for cp210x
[5.719118] cp210x 1-1.2:1.0: cp210x converter detected
[5.728666] usb 1-1.2: cp210x converter now attached to ttyUSB0

From the above statements, we can see that Zigbee module is connected to ttyUSB0 port of Raspberry pi.

At the Raspberry pi, data which is sent remotely is collected. For the further processing, We have to read this data from the USB port, to do so we perform serial read operation. All of these four vital signs values are stored in the .txt files for its further processing and IoT purpose. Following to it, all the text files are sent out to the server for the cloud computing. It is done by File Transfer Protocol (FTP). FTP is used to establish connection between client and server computer. It mostly used in downloading file from the world wide web (WWW). In our system we use FTP to send the data stored in .txt file to the server. So that it can be displayed on web application. This can be done by following statement:

system("wput -u data1.txt data2.txt data3.txt data4.txt ftp://username:password@ip_address/")

In our healthcare monitoring system we have also attached ALERT SYSTEM to provide emergency alarm. To control it, we have provided the provision in our web application. An authorized person can control GPIOs of raspberry pi and can provide an alert. To control this we have to control client device. To achieve this we have to create sockets for both client and server. Here we are using a connection oriented protocol which uses TCP for the communication. So, for that we have described socket programming below:

Sockets are used to establish connection between client and server. On the server side, first of all, the socket is created by socket() and following to it bind() is executed. Bind function is used to bind various attributes of sockets like address, port number, etc. With the help of this it can create the proper environment for it. Server side's socket is always in listening mode by listen(). Simultaneously, on the other side client's socket is trying to connect with the server. As a result, the server connects to the client by accept() if there is space for it. Once the connection gets established then they start conveying data. When the communication is completed, then socket gets closed by close(). After which connection gets dismantled.

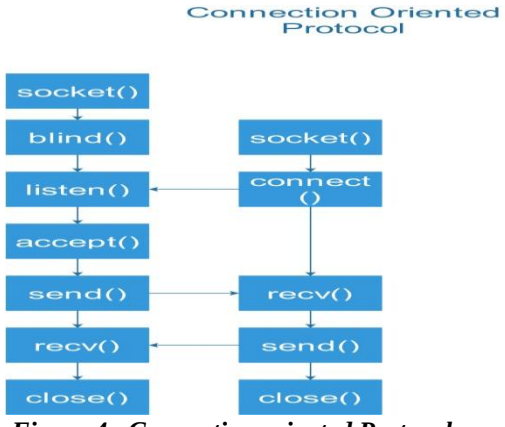

Figure 4. Connection oriented Protocol

At the client side, first we create socket and the descripter is stored in sock as shown below:

sock = socket(AF_INET , SOCK_STREAM , 0)

Following to it define ip address, port number and internet protocol. After which connect() is executed and it tries to connect with server. Once its get connected client can receive the command to control GPIO of raspberry pi. The command string which is received is written in the .txt file. With the help of this we can change the value and direction of GPIO.

III. RESULT AND PERFORMANCE ANALYSIS

A. Web Application

Internet of Things, is a technology by which we can access and control IT resources from all over the world. In our project the last part contains a web application by which we can see the different vital parameters and also control GPIO for ALERT SYSTEM. The browser application is shown in below figure:

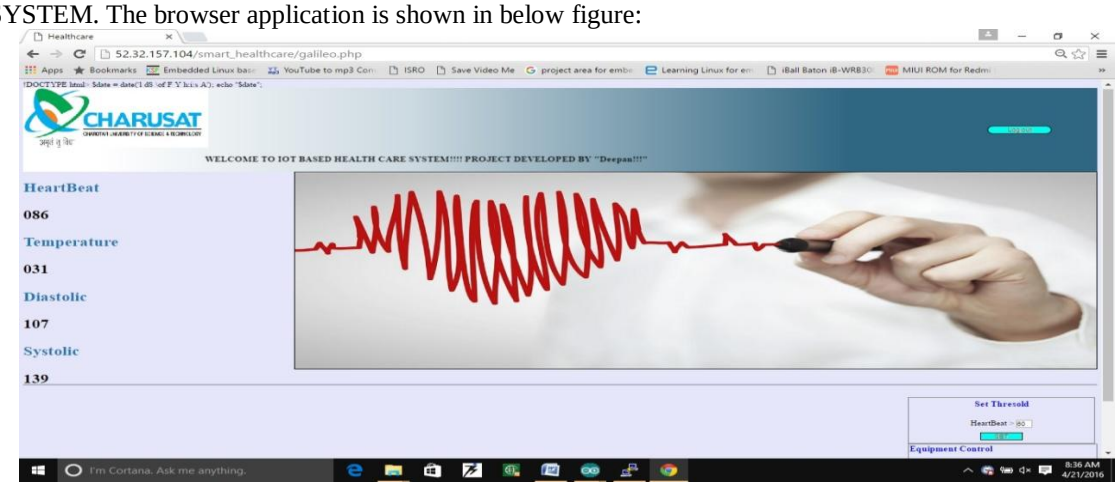

Figure 5. Web Application

Moreover to it, we have provide provision to set the threshold value from web application.

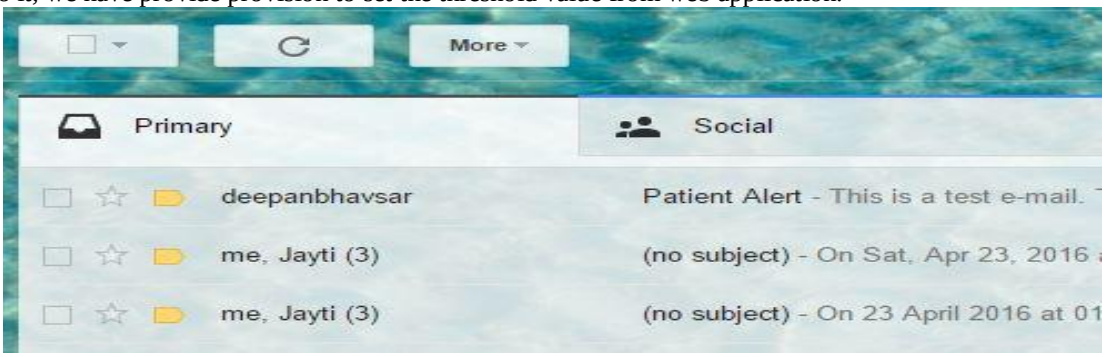

Figure 6. Email Notification

So that whenever value crosses the threshold limit an E-mail is sent to given email address.

Figure 7. Log In page

To prevent our application from unauthorized access and trespassing, we have applied a LOGIN page.

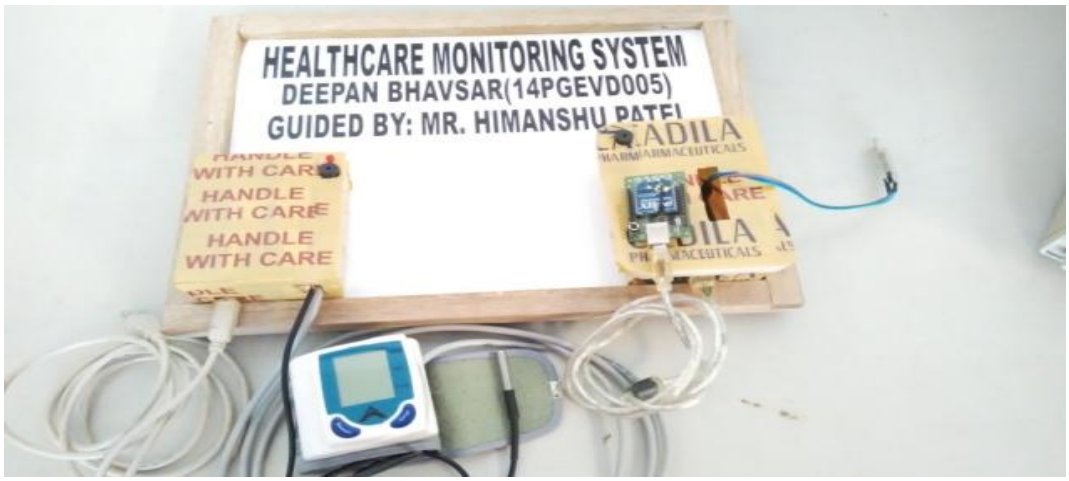

Figure 8. Hardware Implementation

To make any system better in performance and become more efficient and reliable, a module level testing, verification and analysis should be performed. So all the tested aspects of our system are described below.

B. Testing

1) Sensor Assessment

The sensor is wrist wearable, and it has defined a proper method to do so. But in very rare cases, when it is not worn properly, it produces an error instead of measured values. But in these cases, it provides the very previous values which are measured successfully.

2) Failure of Communication

The Internet is the essential stipulation to convey measured data to the cloud and receive fired commands from the cloud. In sum, we can say that internet loss results into system failure.

3) Web Application Security

We are using authentication method, in which you have to provide true username and password to access the application, which is full proof and prevent our system from the trespassers. Moreover, in our system only 5 clients can get connected simultaneously,

listen(sock, 5)

which reduces the risk of unauthorized usage of our web application.

C. Performance Analysis

1) Operation Delay

In our system, blood pressure sensor takes the maximum time, because to measure the blood pressure it has to perform the process of pumping which is time consuming. It requires minimum of 7-8 seconds, so that the count of operation delay is about 10 second.

2) Plug and Play

Our prototype performs all the operation as expected, but it is not a plug and play device. When we power on our system, it doesn't ready to perform the operation directly.

IV. CONCLUSION

One can do real time monitoring of body's vital parameters with the help of Healthcare Monitoring System. Based on a study of existing monitoring system and scenario of vital parameters we can say that proposed system is more suitable to monitor Human body's vital parameters in real time. So that doctor can see parameters of patients and can decide priority, that which patient need the medical attention first. Moreover, we can avoid manual errors made by medical staff.

Addition to this, the system has a powerful ALERT and Notification system. This system has alert at its both end. It is having provision of buzzer and led light at every device so that as per the defined range of parameters, it creates alert and necessary medical attention can be provided. Moreover to this we have GPIO control on web application so that Doctor can create alert if he finds any unusual situation. From the web application one can set the threshold for Vital sign and if the value goes beyond that range An email is sent to your email id. With the help of a technical person of proper this field, we can expand it to a number of possibilities.

We can expand it from casualty area to the hospital level or city level. Furthermore, we can make it for a particular disease like heart attacks or kidney problem. It can be made for physically handicapped people, in which system sends data to doctors and ambulance.It can be applied as Home healthcare monitoring system.

The system is low cost, faster, more efficient, real time and user friendly. Thus, we can fulfill aim and objective of the proposed system.

Conclusively, "Healthcare Monitoring System" provides monitoring efficiently and at very low cost. Furthermore, it provides remote access of data from anywhere in the world.

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