Healthcare Monitoring of Chronic Diseases

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Abstract - The proposed system is an intensified version of monitoring the health condition of a person and making the information visible anywhere in the world. The technology used is the Internet of Things (IoT), is an advanced as well as the efficient solution for connecting the things to the internet and entire world of things in a network, which is possible by using Espressif (ESP8266 12E) along with ARDUINO UNO and its platform ARDUINO Integrated Development Environment(IDE). It is further interfaced with a blood pressure module, pulse rate and temperature sensor to obtain the data. Using web server programming the data is loaded into the Thing Speak platform. The ThingSpeak.com stores data in the form of charts of different styles like bar chart or even a line graph. This system is developed to produce a prototype of a web based patient monitoring system that allows the user to continuously monitor the patient's condition. The enhancement of this system from the existing method on monitoring the patients' health will allow the data to be monitored anytime and anywhere from the Internet. It consists of both the hardware and software modules. The hardware part involves building the blood pressure module, interfacing of the temperature sensor and the pulse sensor to the Arduino and the software section involves programming codes based on the C language.

Indexed Terms - Internet of Things (IOT), Sensors to Cloud System, Arduino UNO, Arduino IDE, ESP8266 12E.

I. INTRODUCTION

Monitoring is employed in various applications based on the requirement. Web-Based patient monitoring system is one among the health recorders that monitors several parameters and stores the data into a database and display the current health condition on the website through a web server [6]. The main advantage of this monitoring system is that it can be accessed anywhere and anytime by having stable internet connection. The user can monitor the patients' health condition from anywhere which could save the human expenses. The patient monitoring is widely used in medical field for which the data has to be saved and analyzed [1]. Proposed system design is to have the data acquisition system to measure and log some parameters. The main purpose of the system model is to make it easy for the user to view current health condition and having a user friendly interface [2]. The literature survey of the people who suffer from diabetes concludes that around millions of people in the U.S have diabetes but remain undiagnosed. In the recent survey dated on Nov 2018 the percentage of U.S adults with high blood pressure raised from 32% under the old definition to nearly 46% due to hypertension. The existing systems possess long term and secure energy efficient monitoring system. The system was evaluated under various schemes with the help of eight biomedical sensors and large storage requirements have been used [5]. Among that CS-based scheme provided the most computational energy savings. Also the above mentioned system uses sensors like heart rate, blood pressure, oxygen saturation, body temperature, glucose, accelerometer, electrocardiogram, Electro Encephala Gram (EEG), which continuously monitors the health parameters and transmits to the base station and the storage unit [8].Also the ZigBee systems were also employed in the area of medical electronics[4].The progressive growth in the evolution of the bio medical sensors, low power electronics and wireless communication have brightened this vision to the verge of reality [3].Usage of Wireless sensors came into existence than the existing large experimental setups [9]. Constrained size insinuates that the designs are of very limited storage and battery capacities. Therefore there is a strong necessity for the efficiency in data collection analysis, storage and communication [7].

II. PROPOSED METHODOLOGY

The proposed system includes two fundamental parts that forms continuous health monitoring system. The first part involves bio medical sensors and controller section .The second part is about the communication protocol which can be used to connect them together.

Bio medical sensors have been used for health monitoring of the people who suffer from severe chronic diseases. Thus the monitoring module includes the pulse sensor, temperature sensor, blood pressure module, glucose measurement using the non-invasive methods. They have the thermal, chemical and other signals which are converted to electrical signals that extract information and indicate the patient's health condition. It is based on the IOT technology which has grown rapidly in the era of various fields. In addition to the biomedical sensors, an important component of the health monitoring system is the controller Unit. Controller used in this monitoring system is Arduino UNO and ESP8266 Node MCU. The measured information from the bio sensors is controlled by the Arduino UNO that converts analog to digital signal. Also the ESP8266 Node MCU has the feature of inbuilt Wi-Fi. The master and slave communication is established by using the I2C protocol wherein the master is Node MCU and the slave is Arduino UNO.A key consideration in the design of this system is the communication technology used to connect the medical sensors with the web service. Here Node MCU is used to transmit the information to the web application using IOT. Due to privacy and safety concern in the medical system, security is also considered in the system design.

A. Temperature Sensor:

The LM35 series are accurate IC's which consists of the temperature sensors. The output voltage of LM35 is linearly proportional to the Celsius or Centigrade temperature. The other temperature sensors are calibrated in Kelvin. LM35 provides more accuracy when compared to other sensors. The pin configuration of temperature sensor is given as follows.

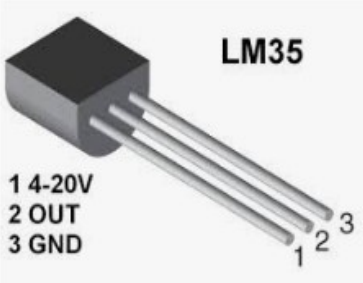

Fig. 2.1: Pin diagram of LM35

The temperature sensor results in linear output and output impedance, which provides accurate inbuilt calibration so that the circuit can be easily controlled. Only single power supply is required to operate this temperature sensor. For measuring the body temperature the left pin of LM35 is connected to power (5V) and the right pin is connected to ground. The middle pin of the sensor results in the analog voltage and is directly proportional to the temperature. Body temperature is acquired by holding the sensor with the finger and the corresponding changes in temperature is converted into analog voltage. The collected data is then fed to the Arduino from the middle pin which is also known as signal pin of Temperature sensor.

B. Pulse Rate Sensor:

The pulse sensor is a plug and play heart rate sensor for the Arduino compatibles. It is an integrated optical amplifying and noise eliminating circuit sensor and is amped works with either 3V or 5V and is connected with Arduino power supply Three pins in pulse sensor is connected with Arduino. Signal pin is connected with any of the Arduino digital pin. By Clipping the Pulse sensor to the fingertip and plugging it into the Arduino, the pulse rate can be read. The image of Pulse rate sensor is in Figure 2.

Fig. 2.2: Pulse Sensor

C. Blood Pressure Module:

Blood pressure monitoring is based on various methods. This project involves the oscillometric method takes the advantage of the pressure pulsation taken during measurement. An occluding cuff is wrapped around the left arm and is connected to the air cuff and a pressure sensor. The cuff is expanded until a pressure greater than the typical systolic value is reached and then the cuff is gradually deflated. As the cuff flattens the systolic pressure value is obtained and the pulsations start to appear. These pulsations refer the pressure change due to heart ventricle contraction and can be used to calculate the heart beat

rate. Figure 3 is the block diagram to measure the blood pressure of the patient. This pulsation will be given to pressure transducer and then fed to the Arduino. If the pressure is given to the hand cuff the systolic pressure change when the blood is flowing through the blood vessel and the pressure gets minimum while the arterial pressure are loosened and widened. The normal range of blood pressure more than 120 over 80 and less than 140 over 90 (120/80-140/90) or 120/80 mmHg.

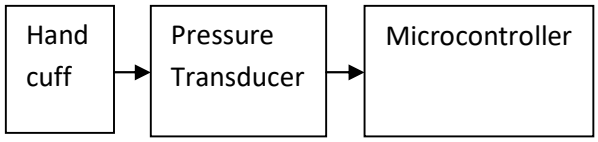

Fig. 2.3: Blood Pressure Module

D. Glucose Measurement

Tear/Sweat/Urine is a body fluid which is used as clinical sample. The measurement of glucose level is done by non-invasive method, to easily obtain the data and to realize real time monitor compared to others. Sweat rate is detected from human body to obtain the pH concentration of sweat which is as same as that of the blood glucose level. pH meter is used to measure acidity or alkalinity present in a solution. The pH scale ranges from 0 to 14.The pH indicates the concentration of Hydrogen $[H]^+$ ions present in certain liquid samples. It can accurately be obtained from the pH sensor that measures the potential difference between two electrodes reference electrode(silver/silver chloride) and a glass electrode that is sensitive to hydrogen ion, which forms the probe. This sensor can also be used with the microcontroller such as Arduino which the gives the measure of the glucose content in our body.

Fig. 2.4: pH sensor with probe

III. HARDWARE IMPLEMENTATION OF THE PROPOSED SYSTEM

A. Arduino IDE Setup And Installation:

Arduino allows installation of the third-party packages using Boards Manager.

- Install Arduino 1.6.8 from the Arduino website
- Start Arduino and open the preferences window
- Enter the following code

http://arduino.esp8266.com/stable/package_esp8266.comindex.json into additional board manager. We can also add multiple URL's separating them with commas.

- Open Board Manager from Tools and select Board Menu and install the ESP8266 platform
- Select the Board (Tools > Board > Node MCU)
- Install Libraries for ESP8266, Pulse sensor, PH sensor, Temperature sensor and Blood pressure module
- Now the program can be loaded to ESP8266 using Arduino IDE 1.6.8
- The status can also be viewed on serial window of Arduino

B. Arduino To Esp8266 Node MCU

Connecting all the Bio- Sensors to Arduino and to transmit the data to the user via Thing Speak, Wi-Fi module is needed. Here Node MCU ESP 12E model is used. This is done by I2C protocol which is called intra-board communication. It is employed for attaching low speed peripherals IC's to processors and microcontrollers for a short distance. This acts as serial bus protocol which includes signal lines such as SCL (clock line) and SDA (data line) lines which are used to communicate with the devices. SDA and SCL are deployed to synchronize the data transfers over the I2C bus. SDA is the data line. SCL is the clock line. The communication established between the master and the slave device is as shown in the Figure 4.

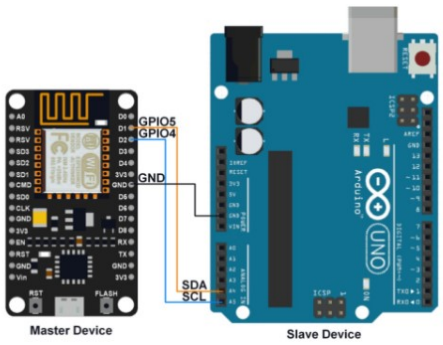

Fig. 2.5: Implementation of I2C protocol

C. UPLOADING DATA TO THINGSPEAK

Thing Speak is an open source platform (Application Program Interface) API used for "Internet of Things" applications. It also retrieves data from Thing Speak using HTTP over the internet or through the Local area network (LAN). Using Thing Speak platform the user can create sensor logging applications, Location tracking applications and social network of things along with status updates. In addition to the storing and retrieving the data from the sensors, the Thing Speak API also allows numeric data processing such as time scaling, averaging, median, summing and rounding and other mathematical applications. Thing Speak channel can bear data entries up to 8 data fields which includes the latitude, longitude, elevation and status. The channel supports JSON, XML and CSV formats to combine with applications. The elements of Thing Speak activity on creating a channel consists of data fields, location fields and status fields. The steps involved in this are as follows:

- Sign in to Thing Speak platform using Math Works account or Thing Speak account or create a new Thing Speak account
- Click Channels and select My Channels.
- On the Channels Page, click on to New Channel and the page will be redirected to create the field.
- Check the boxes next to fields 1-5. Enter these channel setting values.
- Name Medicheck
- Field 1: Pulse rate
- Field 2:Temperature
- Field 3:Blood Pressure
- Field 4: Glucose
- Field 5: Panic
- Click save channels at the bottom of the setting.

The tabs in the channel include:

- Private view: This tab displays information about the channel that only the user can see
- Public view: To make this channel view publically, use this tab to display the selected fields and it can also be used for channel visualization
- Channel Setting: This tab shows all the channel options that are set while creating. The channel can be edited, cleared and deleted from the channel tab
- API keys: This tab displays channel API keys. These keys are used to read from and write to your channel
- Data Import/Export: This tab enables the user to import and export channel data

D. APPLICATIONS

- To predict the patient's heart rate, blood pressure, temperature and blood glucose level before it reaches the critical stage and becomes hard to cure
- The high accuracy of the device is achieved by using the cost efficient electronic components
- It provides a user friendly platform such that the patient can be examined from the home
- The technology of IOT has been employed which enables the care taker as well as the doctor to monitor the patient's data from anywhere and at anytime
- The additional features include the patient to contact the caretaker/doctor through the panic button in case of emergency
- Non-invasive measurement technique (ie.tears, sweat, urine) is used so that the patient can be able to measure the glucose level according to their comfort

IV. RESULTS AND DISCUSSION

The experimental setup of the proposed system with all the necessary components is shown below.

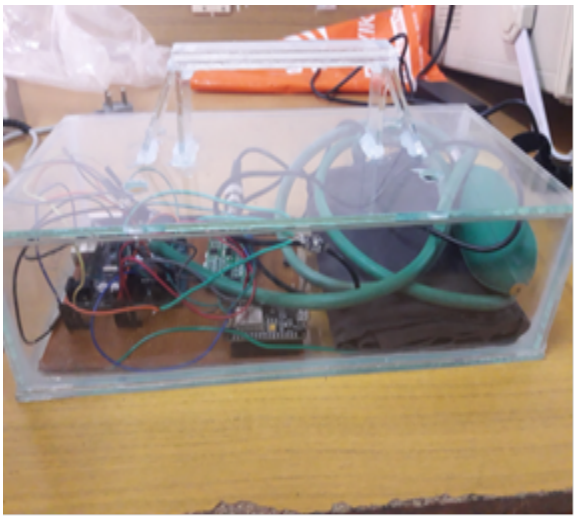

Fig. 4.1: Prototype Model

The simulation results obtained by monitoring the patient parameters like pulse rate, temperature, blood pressure, glucose level are represented in the following figures.

(i) Pulse rate:

The pulse rate obtained on observing patient usually ranged from 60-100

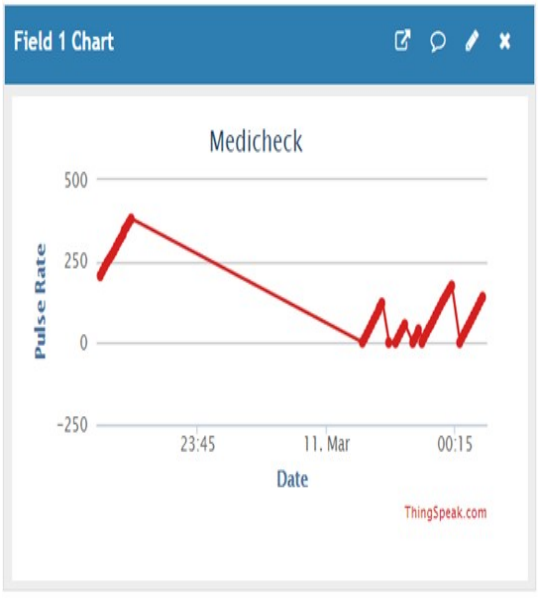

Fig. 4.2: Pulse Rate

ii. Temperature:

The body temperature of the patient ranges between 30-39 Fahrenheit.

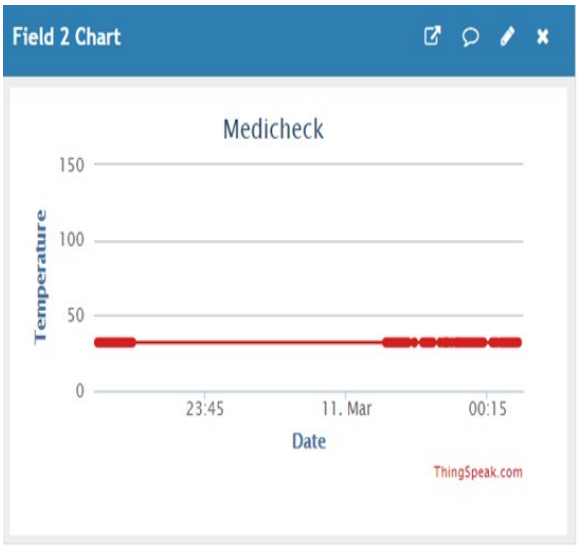

Fig. 4.3: Temperature

iii. Glucose Level:

The glucose level is monitored on observing the patient usually ranged from 6.84-7.82 from the sweat as a sample.

Fig. 4.4: Glucose Level Measurement

iv. Blood Pressure:

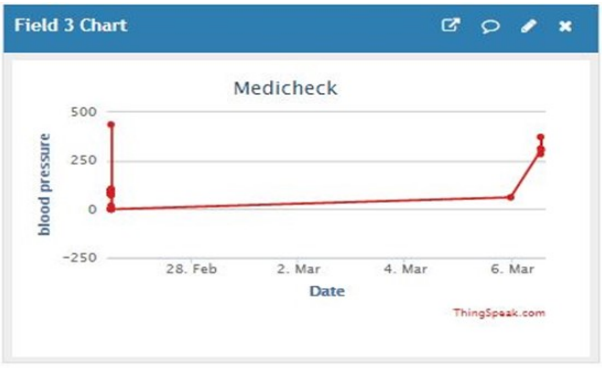

Fig. 4.5: Blood Pressure

v. Panic:

The message is sent to the care taker or the doctor when pressed in case of emergency.

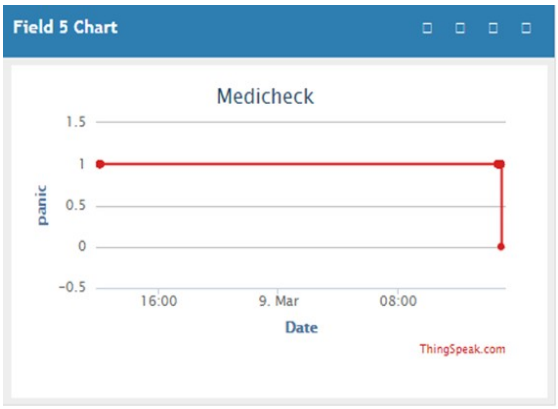

Fig. 4.6: Panic Situation

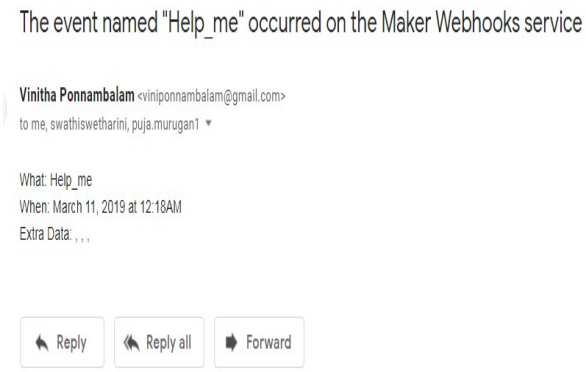

Fig. 4.6: Message sends at Panic Situation

V. CONCLUSION

Presently used health monitoring system occupies more space and measurement capacity is also very less. The proposed system is compact and will collect and transfer the information to the doctor as well as the caretaker at the earliest because of the IoT. It is easy for the doctor to analyse the health condition of the patient continuously. Using IoT, it is easy to retrieve the previous record which is used for analysing during the complicated conditions. Arduino along with ESP8266 Node MCU is used for the complete process which is cost efficient and the results are accurate and precise. The continuous long-term health monitoring system should be configured based on patient's needs and physician's recommendations.

A. Future work:

The proposed system measures the basic parameters like Heartbeat, Blood Pressure, Temperature and the Glucose level only. In future it can be added more parameters like oxygen saturation, accelerometer, EEG, ECG, vibration of the body, fall detection and Emotional Quotient can also be measured. This system displays the output in the webpage created and it can be replaced by the app to improve the better communication and understanding.

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