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Remote Heart Rate Monitoring System Using IoT

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Abstract-*The heart Diseases cause millions of death worldwide because of the increase in the aging population and the rising of healthcare costs. There is also a demand of quality healthcare from remote locations. Technological advancements in the field of medical electronics and communication can help decreasing the cost of healthcare. . In this paper a real-time heart disease monitoring system is introduced. This paper is based on the monitoring of the patient that is done by the doctor continuously without actually visiting the patient. In this paper, IoT is becoming a major platform for many services & applications, also using Raspberry Pi not just as a sensor node but also a controller here. Paper propose a generic health monitoring system as a step forward to the progress made in this department till now. The heart rate of the patient can be monitored by the doctor or by the guardian without actually visiting the patient. Taking this into consideration, we have developed a prototype for a bracelet that is portable, wearable remote heart rate monitoring device. As a result, doctors can provide quick services from remote place or in case monitored by the guardian, he can take necessary steps to save the patient's life immediately through the email or SMS notification that they receive. The system is implemented using pulse rate sensor, Arduino UNO, Raspberry Pi 3 and ThingSpeak cloud.*

Keywords— Raspberry Pi, IoT, Health Condition, E Bracelet, Heart Attack, Notification.

I. INTRODUCTION

Now-a-days health problems like cardiac failure, lung failures & heart related diseases are arising day by day at a very high rate. Due to these problems time to time health monitoring is very essential. A modern concept is health monitoring of a patient wirelessly. It is a major development in medical arena. Health professionals have developed a brilliant and inexpensive health monitoring system or providing more comfortable living to the people suffering from various diseases using leading technologies like wireless communications, wearable and portable remote health monitoring device. As visits of doctors to the patients constantly are decreased as the information regarding patient's health directly reaches to doctor's monitor screen from anywhere the patient resides[1]. Also, based on this doctors can save many lives by imparting them a quick & valuable service.

According to the recent statistics, nearly two million people suffer from heart attack every year and one person dies every 33 seconds in India. World Health Organization (WHO) reports that heart disease rate might increase to 23.3% worldwide by the year 2030. The treatment of such chronic disease requires continuous and long term monitoring to have proper control on it. IoT helps to move from manual heart rate monitoring systems to remote heart rate monitoring systems A doctor may not be present all the time to provide medication or treatment to the patients or a guardian may not be present all the time to take the patient to the hospital. Hence, our proposed system is the right solution for this problem. The remote heart rate monitoring system is used to monitor physical parameter like heart beat and send the measured heart rate directly to a doctor through Email or SMS.

In today's era, health problems are increasing day-by-day at a a high pace. The death rate of 55.3 million people dying each year or 151,600 people dying each day or 6316 people dying each hour is a big issue for all over the world. Hence it is the need of hour to overcome such problems. We, therefore, proposing a change in wireless sensors technology by designing a system which included different wireless sensors to receive information with respective human body temperature, blood pressure, saline level, heart rate etc. that will be undoubtedly further transmitted on an IoT platform which is accessible by the user via internet. An accessible database is created about patient's health history which can be further monitored & analyzed by the doctor if necessary[2].

This paper proposes a health monitoring system which is capable of detecting multiple parameters of our body such as blood pressure, temperature, heart rate. A continuous record of body health parameters can be used o detect the disease in a more efficient manner. Now-a-days, people pay more attention towards prevention & early recognition of disease. In addition to it, new generation mobile phones technologies.

Proposed system consists of a pulse rate sensor, Arduino Uno and Raspberry Pi 3. This system is able to measure heart rate of an infant to an elderly person. The low cost of the device helps to provide appropriate portable remote based effective

heart rate monitoring system. The system is based on advanced wireless and wearable sensor technology. The rapid growth in technology has remarkably enhanced the scope of remote health monitoring systems. Thus in such environment proposed system serves to be of effective cost with ease of application.

Satisfactory work is done in health monitoring by using raspberry pi as well as IoT, but this paper gives embedded concept of both the platform. By using combination of these, the proposed structure will be more effective. In this paper, we investigated recent papers related to health monitoring systems IoT. IoT is nothing but an advanced concept of ICT (Information Communication Technology). IoT is the interconnecting of devices and services that reduces human intervention to live a better life. This paper as showing the advancements in health care management technology, it would save patients from the future health problems that would arise and would also help doctors to take an appropriate measure or action at a proper time regarding patient's health.

II. SYSTEM DESIGN

The system is classified into two parts, viz. Hardware & Software. Here we discuss IoT applications that are useful to health monitoring. Fig. 2.1 depicts the IoT application stages The general operation stages of an IoT application include

1) Data acquisition,

2) Data processing,

3) Data storage,

4) Data transmission.

The first and last stages exist on every application, while the processing and storage may or may not exist in some applications [3]. Here data acquisition is used as real-time raw data transmission, raw data transmission and real time on-board process. The energy consumption of data acquisition can be reduced with MEMS technology. Many IoT applications have the data sparsity property and can exploit the compressed sensing paradigm. In health monitoring applications and wireless body sensor network, compressed sensing has been investigated and studied extensively . Energy efficiency in a processing unit can be achieved by

1) Ultra-low power processors and

2) Efficiently threshold processor.

Alongside with a high performance processor in addition to a task scheduling framework brings energy efficiency for IoT applications. Energy reduction in memory has received significant industrial and academic attention in embedded system design community, but there are some characteristics specific to IoT applications that can be exploited for further improvements in energy efficiency of memory in IoT embedded devices. Data transmission can be improved by integrating radio transceivers into SoCs, providing low power multi-radio chips, etc. In order to reduce the amount of data to be stored or transmitted, new data compression techniques, especially for the streams of data, are needed.

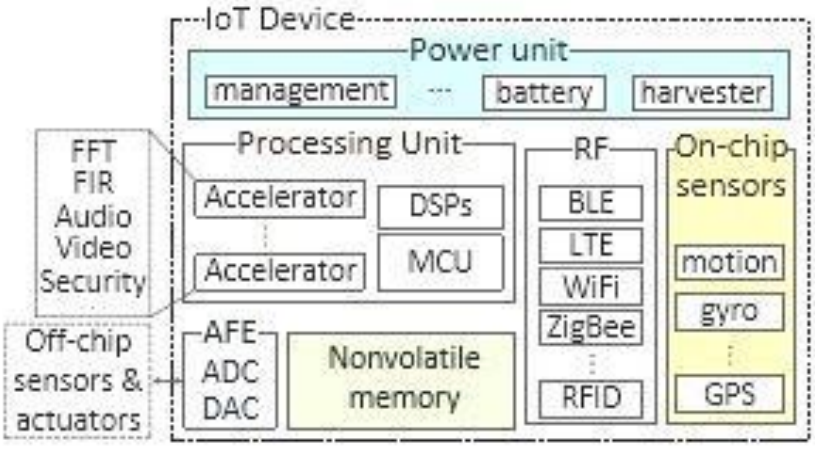

Fig. 2.1 Architecture of IoT device

III. COMPONENTS USED IN IMPLEMENTATION

For implementing the health diagnosis system, there is a need of essential components that are suitable and manipulate health problems. The components use generally includes

A. ARDUINO UNO
B. RASPERRY PI 3
C. PULSE RATE SENSOR
D. LEDS
E. Wires to connect

Arduino UNO

Arduino is an open-source electronics platform based on easy to use hardware and software. Arduino boards are able to read inputs from different sensors and redirect the output to the mentioned output pins. Fig. 3(a) shows the example of one type of Arduino i.e. ARDUINO UNO which is used in proposed system.

Fig. 3(a) Arduino UNO

In the proposed system Arduino UNO reads the rate of heart pulses from Pulse rate sensor and directs the output i.e. normal pulse rate or abnormal pulse rate to RaspberryPi 3. If the heart rate read from the sensor by Arduino is abnormal(less than 60 or greater than 100) for a specified predefined interval of time then the Arduino forwards abnormal heart rate to Raspberry Pi 3 shown in Fig. 3(b).

Raspberry Pi 3

Raspberry Pi 3 as shown in Fig. 3(b) is a pocket sized minicomputer which provides all the functionalities like personal computer. On receiving the abnormal heart rate from Arduino Uno directs the appropriate message "Heart rate of your Concerned Person is Abnormal Please take Appropriate Actions Soon" to the Doctor or Guardian of the Patient who is wearing the remote heart rate monitoring bracelet. Raspberry Pi
It is a powerful, low cost, and a small card sized device which is a perfect platform for interfacing with many devices. The board contains a processor, graphics chip, RAM memory, interfaces to other devices and connectors for external devices, of which some are necessary and some are optional.

There are much versions of Raspberry Pi but the CPU (BCM2835) of all the models of Raspberry Pi remains same. The CPU is somewhat cheap, powerful and efficient and it does not consume a lot of power. It works in the same way as a standard PC requiring a keyboard for giving commands, a unit and power supply. Here, in Raspberry Pi, SD card is used in the same way as the hard disc in the computer. The connectivity of raspberry pi to the internet may be via a LAN (Local Area Network) cable / Ethernet or via a USB modem.

The main advantage of Raspberry Pi is that it has a large number of applications.

Fig. 3(b) Raspberry Pi 3

Pulse Sensor

The Pulse Sensor is a plug-and-play heart rate sensor for Arduino. It can be used by students, artists, athletes, makers, and game & mobile developers who want to easily incorporate heart rate data into their projects. In the proposed system we clip the pulse rate sensor to bracelet and plug it into 3 or 5 Volt Arduino pin.

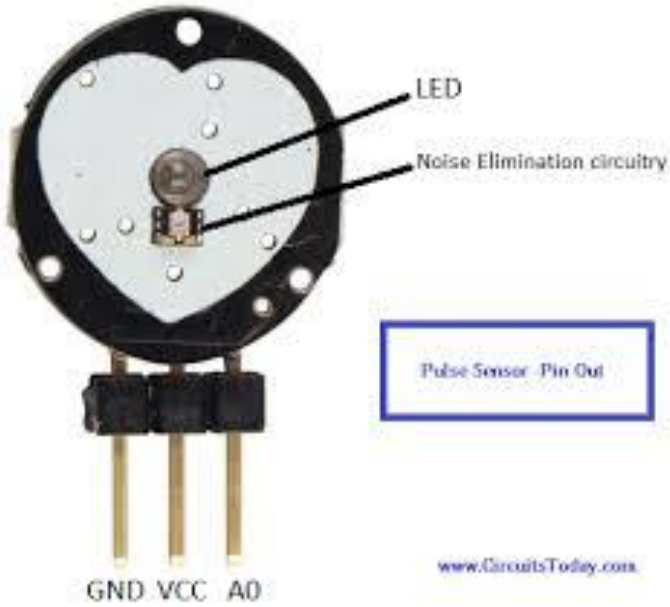

Fig. 3(c) Pulse sensor

LEDS

Two LEDS red and green are used to indicate normal and abnormal heart rate. When heart rate is normal green LED is blinking and when heart rate is abnormal red LED is blinking. In the proposed system we have attached the LEDs to the breadboard but as an extension to this system we can attach small LEDs to bracelet that can help patient determine if their heart rate goes abnormal.

Fig. 3(d) LEDS

Wires to connect

Wires are used to connect all these components they play an important role as connectors in the proposed system[4], [5]. In health monitoring system, wireless network is used to forward measurement through a gateway towards cloud. The main network used here is IoT. The meaning of IoT is Internet of Things, simply called as Internet of everything. Different wireless communication technologies can be used for

(i) Connecting the IoT device as local networks, and
(ii) Connecting these local networks (or individual IoT devices) to the Internet.

IV IMPLEMENTATION

For implementing the health diagnosis system, there is a need of essential components that are suitable and manipulate health problems includes using pulse rate sensor, Arduino UNO, Raspberry Pi 3 and ThingSpeak cloud.The detailed steps of implementing the proposed system for remote heart rate monitoring are as follows:

4.1 Circuit Connections

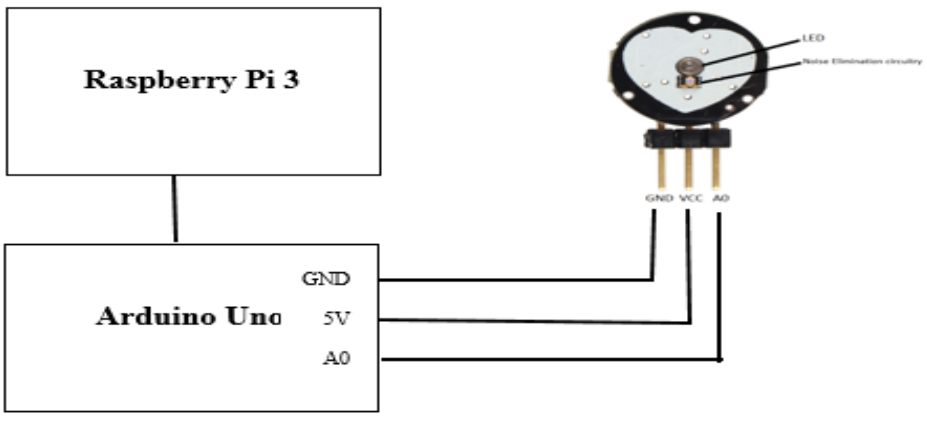

Fig. 4(a) Block diagram

Steps to do connections for the proposed system are as follows:

1. Open remote desktop in your laptop and add your Raspberry Pi 3's static IP address and connect (Assumption: Raspberry is made static priorly).

2. Connect Arduino with raspberry through USB cable.
3. Connect pulse rate sensor to Arduino UNO. Pulse rate sensor has three pins:

   S-pin- Connect it to analog 0 of Arduino UNO,

   Vcc Pin-Connect it to 5V/3.3V of Arduino UNO.

   Ground pin- Connect it to GND pin of Arduino UNO.
4. Connect two LEDs to the Arduino UNO using breadboard. A green color LED to indicate normal heart rate and a Red color LED to indicate abnormal heart rate.
5. Connect cathode end of two LEDs to any of the two pins you select to be the output pins.
6. Connect anode end of both the LEDs to Ground.
7. Integrate the sensor with Bracelet.
8. Run the code and see the heart beat on serial monitor[6].

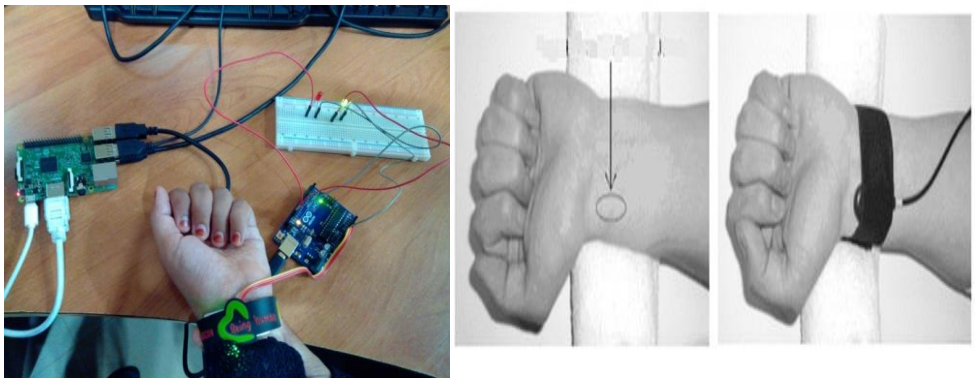

Fig. 4(b) Circuit connections with bracelet and green LED blinking.

The Proposed system collects the data of heart rate using the pulse rate sensor which should be placed on the wrist of the person. This sensor detects the heart rate of the person and sends data to the Arduino UNO where it is analyzed to detect abnormalities. If any fluctuation in the heart beat from the normal rate is found, then an alerting message is sent to the concerned person in the form of an email[7],[11].

4.2 Sending Data to the Cloud

The data that is collected from the pulse rate sensor is stored in the cloud. Cloud used for this purpose is ThingSpeak. ThingSpeak is an IoT application and API to store and retrieve data from different sensors or devices in the system through internet. It allows creating channels which can be used to store data related to a project. It produces graphs with the collected data and hence provides an efficient way to analyze and monitor the data of interest. Read and write API keys are generated for each channel through which data can be read from or written to the channel[12]. ThingSpeak also facilitates the use of Matlab functionalities by integrating Matlab from MathWorks within it. This eliminates the need of purchasing the Matlab license from MathWorks. To use the services of ThingSpeak, it is required to have an account in it.

Steps to create an account are:

- Visit https://thingspeak.com/
- Click on Sign Up.
- Fill in the details asked and click “continue”.
- If the details are verified by the system, then a confirmation mail will be sent to the mail-id that we have provided while registering.
- Click on the verify link in the mail.
- Once verification is done, account will be created.
- Then create a new channel by clicking on New Channel.
- Provide name to your channel and select as many fields as you require.
- Check Make Public checkbox.

- Click on save channel.
- Now, navigate to API keys item in the menu.
- You will find two keys: Write API and Read API.
- Use the write API key in the program to connect the Raspberry Pi 3 to your channel[8].
- A code of "200 ok" indicates that data has been sent successfully to the cloud.
- Once the data is received by the cloud, graphs will be plotted for the received values.

Any abnormalities in the health conditions can be known directly and are informed to the particular person [9]. The graph that gets plotted in ThingSpeak in real time that will be shown to the guardian or doctor is shown in Fig 4(c)

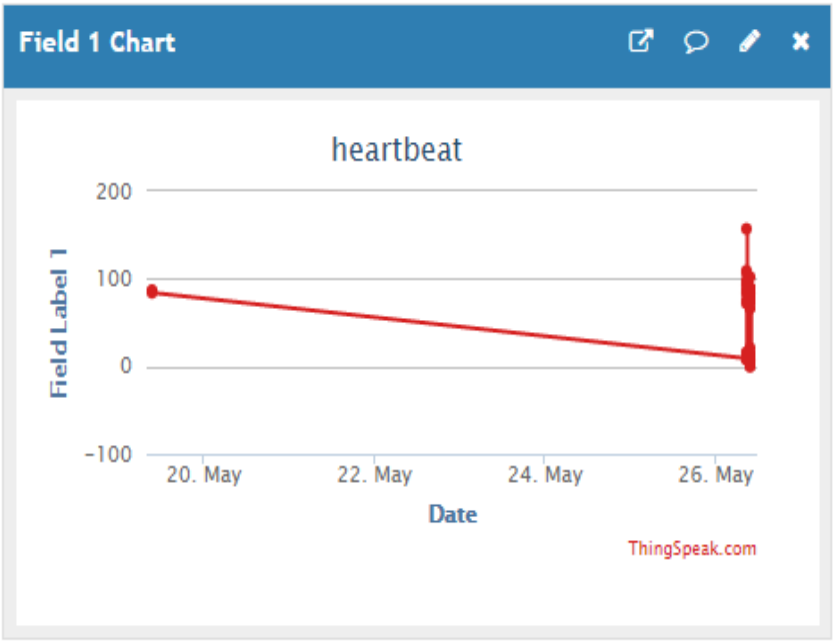

Fig 4(c) Graph plotted in ThingSpeak for sensed pulse rate.

V. RESULTS

The heart rate of monitored person can be seen on serial monitor of Arduino IDE. It can also be seen on Cloud in the form of Graph. Terminal on Raspberry will be printing "200 OK" which means data is successfully communicated from Arduino to Raspberry. The heart rate on Arduino IDE and the graph can be plotted in real time on cloud which is with the doctor or guardian for monitoring the patient regularly[10]. Hence, we used all means of communication to send notification to the concerned person about the patient to save the patient's life by sending the help to the patient on time[12].

VI. CONCLUDING REMARK

In this paper, we have analyzed Raspberry-Pi based health monitoring system using IoT. Any abnormalities in the health conditions can be known directly. The proposed system is simple, power efficient and easy to understand. It acts as a connection between patient and doctor. The hardware for the project is implemented and the output results are verified successfully. In this paper a real-time low cost heart disease monitoring system is introduced. If the system detects any of these abnormalities it will alert the doctor and hospital by sending email and SMS message. The system also implements an application based on Android platform for doctors and for patients.This system provides some sort of freedom to both doctor and patient since the results are shown at real-time The proposed system helps in remote heart rate monitoring of a person. It detects abnormalities if any in the monitored heart rate and reports the abnormalities to the concerned person through message, E-mail and Whatsapp. Information is stored in the cloud for future reference and analysis. The device can be extended to give Audio instructions to the person whenever the normal rates start fluctuating.

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