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IOT Based Heart Rate Monitoring System Design for Heart Attack Detection

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Abstract— In recent days, the human demise has increased due to heart attack. An IOT based sensor system is proposed to detect the heart rate of a person to increase their lifespan. To measure the heart rate, the heart beat sensor is interfaced with a microcontroller. The threshold levels of heart beat is set by the user with the help of a proposed mobile application. Based on the patient age, heart beat limit is set and then the system starts monitoring. When the heart beat goes beyond the range an alert message is sent to the care taker or Physician. Thus an alert of abnormal condition of the patient is sent immediately to the Physician. So, the immediate care is taken and the person life is saved. The developed system is tested and works well for all the age groups.

Keywords— Heart rate, Sensor, Heart attack, Alert

I. INTRODUCTION

In recent days, heart related problems are common. There are approximately 1 million deaths every year due to heart diseases. Around 800 million people spend 10% of their family expense for their healthcare. An increasing cardiovascular disease rate poses a serious problem in rural populations. The major parameter used to identify heart functioning is heart rate, which is normally measured with the help of Electrocardiogram (ECG). From the ECG signal, pulse and heart boundaries can be easily derived. When the data set is imbalanced ECG then an intelligent IOT based health care device (called iKardo) is used [1]. With the help of the above said IOT device, imbalanced data are converted into balanced data and the disease detection accuracy is 99.58%.

An automatic RF based heart rate measuring system is proposed[2]. In this, a piezoelectric sensor generates voltage equivalent to the heart beat of a person and it is filtered by an active bandpass filter (ABF). ABF is designed to match with the RFID and it transmits the signal.

The system is developed to detect heart beats using pulse width-locked loop (PWLL) from ECG which is powered by the human body heat[3]. In the developed system, the thermoelectric generator(TEG) is charged by human body heat. TEG is connected with a boost converter and power management system since it needs 20 μW.

The IoT based wearable system for monitoring sleep and stroke prediction is discussed[4]. Due to the technology development, wearable based bracelet is introduced to monitor heart rate in remote area[5]. To obtain better accuracy, AI based decision tree, baysian classifier and KNN network are used in the prediction of coronary heart disease [6]. An IoT based hardware system is implemented to monitor the heartbeat. Further, an alert system is added [7] to send the alert message to the physician through a mobile phone when heart beat goes low or high than the permissible level. This can be accessed by the doctors or nurses from any location.

A noninvasive photoplethysmography (PPG) is used for measuring the heart rate [8]. Here, an optical sensing mechanism is used to detect the fluctuation of blood inside our body. The continuous wireless monitoring system is developed for diagnosing tachycardia and bradycardia of cardiac patients [9]. In emergency situations, physician received the alert message facility is added in the above proposed system. For remote monitoring of heart rate, wireless technique is introduced for emergency situation [9]. IOT plays a vital role for remote monitoring in telemedicine applications [10].Today's human life style the heart attack problem is becoming predominant due to eating habits, irregular daily routines. So, it is important to provide medical facilities as soon as possible by early detection of heart attack.

Mostly heart attack occurs due to reduction of blood flow to the heart muscle. Whenever, a person may get a heart related issue that is considered as a serious medical emergency to lead their life. Many existing systems lack IOT features. Also there is no option for setting the upper limit and lower limit of heart rate as per the patient needs and as per our requirement. Thus, a new system is required to monitor performance of the heart.

II. METHODOLOGIES

This system is especially developed for measuring heart rate using heart beat sensors in remote places. Heart beat sensor and microcontroller are interfaced to measure the heartbeat of a person. The system alerts doctors as well as concerned

users when the heart rate is abnormal. The live heart rate of the patient displays whenever the user logs on for monitoring. Thus, an alert of an abnormal condition of the patient is sent immediately to the Physician.

Generally, by observing the heart rate of a person, a heart attack is detected. The block diagram and design of proposed work are shown in the figure 1 and figure 2 respectively. The system comprises mainly three units, processing unit, Rectifier unit and Sensing unit. In this design, Heartbeat sensor, ESP32 microcontroller (in-built Wi-Fi and Bluetooth), Buzzer – alert system, LCD Display

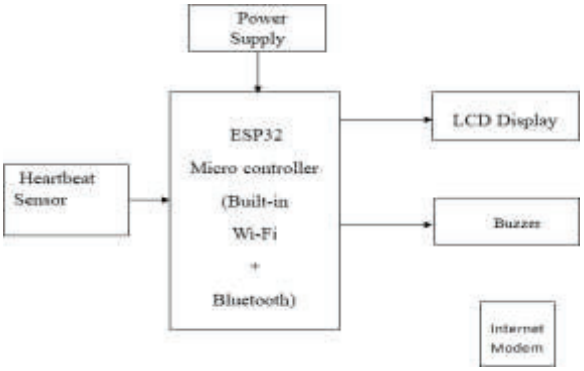

Fig. 1. Block Diagram for heart attack detection

– I2C based Interface and Power supply are used. The system measures the heart rate using an IR based heart rate sensor. This data is viewed in the LCD unit using I2C interface unit. The ESP32 microcontroller gets connected to the internet modem using a built-in wifi module. With the support of internet, the data is sent to the thing speak server. Suppose the heartbeat is not within the set limit, then the corresponding data is sent to the server and also buzzer produces alert. The ESP32 microcontroller can be connected to the Bluetooth of an android app Smartphone. The upper limit and lower limit can be set to the unit using Bluetooth android app using Smartphone. The live data can be monitored by the thingspeak server.

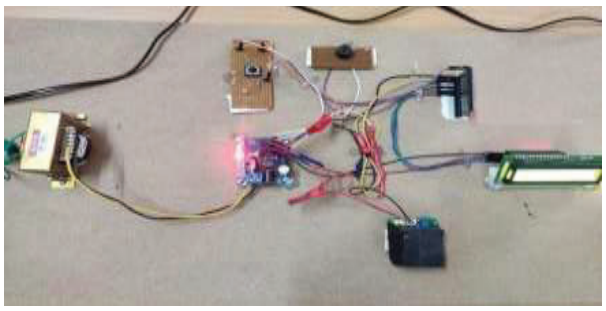

Fig. 2. Experimental Setup

Rectifier. The voltage Regulator LM7812 & LM7805 used to regulate voltage at 12V & 5V respectively. The upper limit and lower limit can be sent through a smartphone Bluetooth android app .The corresponding limit will be displayed in the microcontroller display. The heart rate normal and abnormal conditions are read from the sensor and corresponding values are updated to the thingspeak server using built in wifi and internet modem. If the heart rate exceeds the range, the buzzers start to give an alarm signal. This helps the health care monitor to assess the patient before it gets worse.

III. Results And Discussion

Step 1

When turning on the system by connecting to the power supply, the system is turned on and the corresponding LCD display is shown in the fig 3.

Fig. 3. LCD display

Step 2

After turning on the system, smartphone hotspot and Bluetooth are connected with the system to control the operation of the system. In the smartphone “Serial Bluetooth terminal” app is installed to config the upper and lower limits of heart rate. Fig 4 shows the LCD display after switching on the wifi in the smartphone

A. Experimental Setup

The system consists of sensors with its accessories like pads and sensors cable, ESP32, and number of sensors and Buzzer has been shown in fig 2. All the connections between sensors and ESP32 board can be clearly seen

When the power supply is turned on, the step-down transformer in the product converts the 230V to 20 V AC supply, which is then converted into DC supply by Bridge

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Fig. 4. Wi-Fi successfully connected

Step 3

The upper limit and lower limit can be sent through smartphone Bluetooth android app, shown in fig 5 .The corresponding limit will be displayed in the LCD monitor is shown in fig 6.

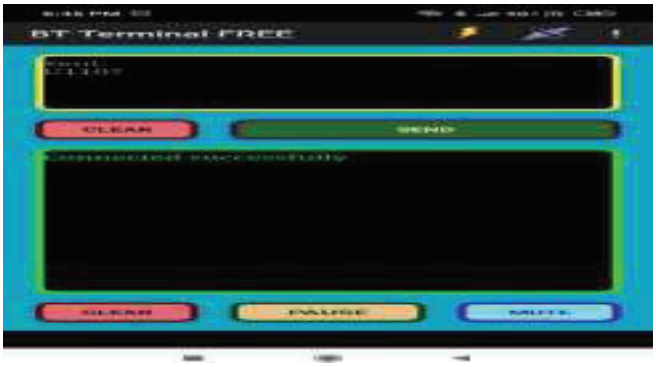

Fig. 5. Android app

Fig. 6. Display of heart rate limits in LCD

Step 4

Then the subject's finger is placed, shown in fig 7 and 8, on the sensor slightly pressed towards it. To save the data in the IoT Thingspeak push button is pressed, and it is recorded, and can be viewed anytime. During the transmission of recorded data the LCD displays like in the fig 9 and 10.

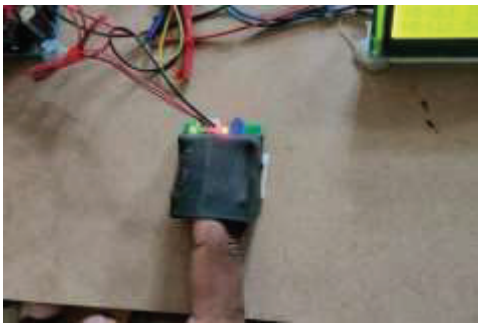

Fig. 7. Subject finger placed in the sensor

Fig. 8. System shows the heart rate

Fig. 9. Transmitting data

Fig. 10. Recorded data sending to IOT server

Step 5

When the heart rate is above or below the normal range the buzzer starts to alert. The data will be recorded on the Thingspeak simultaneously, shown in fig 11 and 12.

Fig. 11. Graph of heart rate (normal and abnormal condition)

Fig. 12. Detailed graph of subject 3 on

The normal range of heart rate is tabulated in the table 1and different subject's heart rate is recorded in the Table 2.

TABLE I. NORMAL RANGE OF HEART RATE

Age	Heart rate range
Below 3 years	80-150 bpm
3 to 15 years	80-130 bpm
15 years	60-160 bpm
20 years	100-170 bpm
30 years	95-162 bpm
40 years	90-153 bpm
50 years	85-145 bpm
60 years	80-136 bpm
65 years	78-132 bpm
Older than 65 years	75-128 bpm

TABLE II. OBSERVATION OF HEART RATE OF DIFFERENT AGE GROUPS

Name	Gender	Age	Medical History	Heart rate (bpm)	Inference
Subject 1	Male	16	Normal	84	Normal
Subject 2	Male	20	Normal	91	Normal
Subject 3	Male	21	Normal	97	Normal
Subject 4	Male	21	Normal	90	Normal
Subject 5	Male	21	Normal	85	Normal
Subject 6	Male	23	Normal	89	Normal
Subject 7	Male	47	Diabetic	79	Normal
Subject 8	Male	55	Blood pressure, Diabetic	92	Normal
Subject 9	Male	57	Diabetic	90	Normal
Subject 10	Female	18	Normal	86	Normal
Subject 11	Female	37	Normal	82	Normal
Subject 12	Female	42	Heart Patient	89	Normal
Subject 13	Female	67	Heart patient, Diabetic, Ruptured wall	88	Normal

IV. CONCLUSION

We have designed an IOT based heart rate monitoring system. ESP32 controller is coded to compare the heart rate of the person with the set value by the physician. The system can detect Heart rate abnormalities of the person based on the

principle of photoplethysmography and the heart rate displayed by the system is transmitted via the internet to the thingspeak server. System helps to monitor a patient's cardiac status of 24 hrs./day/week. In this work, the limit setting for heart rate is done by using an android app via Bluetooth. Patient Heart Rate Variability(HRV) is analyzed by continuous monitoring of the heart rate.

The EKG sensor can be integrated with our system to monitor the patients in the cardio-thoracic unit during the post-op period for Coronary Artery Bypass Graft surgery. CABG surgery may cause thrombosis in the arteries, so the patient needs to be monitored 24/7 by the nurses so our system specifically monitors the ST wave segment and by analyzing the ST wave abnormality the system alerts the physician and they can act in time and save the person's life.

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