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IoT Based Heart Rate and Oxygen Monitoring System

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Abstract - IoT based Heart Beat and Oxygen Monitoring System is developed with an objective of detecting the heartbeat of patients in order to monitor the risk of heart disease such as heart attack and also the patients in need of regular checkups. The usage of temperature sensor helps to monitor the temperature of patients. Body health monitoring is very important to us to make sure that our health is in excellent condition. In this project we describe the design of low-cost heart beat monitoring and health monitoring device using IoT technology. This system is comprised of several parts such as Heart Rate module, Pulse Rate module, Temperature module, Android application module, Wi-fi module. The Heart Rate (HR) module picks up heart rate signal by a non-invasive technique photoplethysmography. The Pulse rate module picks up pulse for monitoring oxygen saturation level of the patients and temperature sensor is used to picks up temperature from patients and these data are sends it to android application using Wi-fi module. The buzzer unit in this system provides an alarm when heart rate or oxygen level becomes above or below the threshold. The result from this device prototype can be utilized for various clinical investigations.

Key words: Heart Rate, Oxygen Saturation level, Photoplethysmography, Wi-fi.

1.INTRODUCTION

In recent years, demands for vital sign monitoring has been increased in the field of health care. The heart is one of the most important organs in the human body. It acts as pump for circulating oxygen and blood throughout the body, thus keeping the functionality of the body intact. A heartbeat can be defined as a two-part pumping action of the heart which occurs for almost a second. Heart diseases are one of the most important causes of death among men and women. Therefore, heart rate monitoring is crucial in the study of heart performance and thereby maintaining heart health. The sensor which is used in our project to detect heart beat precisely, the use of IOT makes the project more effective and efficient. Different types of sensors such as heart rate sensor (heart rate sensor module), Pulse oximetry sensor (TCRT sensor) and temperature monitoring sensor (4 pin digital thermal thermistor sensor) are used combinedly in order to monitor heart rate and oxygen saturation level in the blood. The buzzer system used in this project can help caretakers to identify that there is a critical condition in health of the patients. IoT based system is very useful in this aspect as it replaces the conventional monitoring systems with a monitoring system with a more efficient scheme, by providing critical information regarding the condition of the patients. In addition, if the patient is in home, the caretakers can monitor the heart rate of the patient in the serial monitor through the real-time monitoring system.

The proposed approach consists of sensors which measures heartbeat and body temperature of a patient which is controlled by the microcontroller. Both the readings are displayed in LCD monitor. Wireless system is used to transmit the measured data from the remote location. The heartbeat sensor counts the heartbeat for specific interval of time and estimates Beats per Minute while the temperature sensor measures the temperature and both the data are sent to the microcontroller for transmission to receiving end"[1]. For monitoring the athletes' heart rate during training or exercise session. A bracelet with different color code of Light Emitting Diode (LED) is designed as a wrist heart rate monitor. Our work investigates the usage of Zigbee and ANT+ as a transmission medium from transmitter (chest strap) to receiver (bracelet)[2].The raw heart-rate signals were collected from finger using IR TX-RX (Infrared Transmitter and Receiver pair) module which was amplified in order to convert them to an observable scale. The inherent noise signal was then eliminated using a low pass filter. These signals were counted by a microcontroller module (ATmega8L) and displayed on the LCD panel [3]. Unit Gashaye Lewtie Hailu's the selected headphones can be easily replaced by any other over-ear headphones due to the modular structure of the system and custom 3D printed ear pads. Dry contact conductive textile removes any discomfort and the need for preparation for electrodes or the user's skin. Evaluated 4.4% R-R interval detection error makes the proposed method a perfect candidate for continuous heart rate monitoring for daily use [4]. Abnormal deviation in the values of any of these parameters from their set point values will be immediately sensed and local help is sought from the nearby people. If no such help is available, this system sends SMS directly to home, doctor or care taker's mobile phone. Heart rate is the number of heat-beats per unit of time, typically expressed as beats per minute (bpm) [5]. Heart Rate (HR) module picks up heart rate signal by a non-invasive technique (Photoplethysmography) from the subject (patients) and sends it (signal) wirelessly to computer or android application using Bluetooth module[6].The device consists of which are used to measure heartbeat as well as body temperature of a and it is controlled by a central unit. The readings from these sensors are further processed and sent via GSM module to a remote location where it is displayed on cell phone. The optical heartbeat sensor counts the heart beat per minute and temperature sensor measures the temperature from the body and both the measured data are sent to a receiving end utilizing wireless technology where the data is displayed in a cell phone for further processing and patient care [7].

Heart beat rate is detected using photo plethysmo graph (PPG) technique. This signal is processed using PIC16F87 microcontroller to determine the heart beat rate per minute. Then, it sends SMS alert to the mobile phone of medical experts or patient's family members, or their relatives via SMS [8]. UsingESP8266 Node MCU Wi-Fi Module, DS18B20 Temperature sensor probe, MAX 30100 Pulse Oximetry sensor and DHT-11 Temperature and Humidity sensor [9]. Internet of

things (IoT) based smart health care system different sensors are placed at the respective locations on the human body and are connected to the Arduino board. For the temperature sensor output from LM35 is converted to digital form with the help of ADC pins of Arduino board. For the pulse rate sensor when the heart. The devices seamlessly gather and share the information with each other and also store the information, making it possible to collect record and analyze data [10]. This was implemented by using electro-optical sensor, an embedded electronic system, and Bluetooth enabled Hands-Free module. Software algorithm was employed to process the heartbeat signal detected though the finger. Results show that the system can detect abnormal cardiac rhythms in real-time. In addition, the system was able to contact an authorized clinician in a remote location during an emergency situation [11].

This project aims to develop a mobile application to help myocardial infarction patients to keep track of their heart rate and seek for emergency help with ease. Methodology for the development of this project, Rational Unified Process (RUP) was chosen because it is an iterative and incremental development methodology. Fully functioning system, along with the system's architecture and data design are the result for this project [12].

Monitors the heart rate of the patient with long term cardiovascular disease. Here the Arduino based microcontroller is used to communicate to the sensors such as pulse sensor and ECG Sensor. The system can analyze the signal, extract features from it, detect the normal or abnormal conditions with the help of Raspberry Pi and the results of the ECG signals is sent to the web server [13]. The project uses simple and low-cost IR transmitters and receivers for the calculation of heart rate. The user is required to place his fingertip gently on the IR transmitter and receiver. The sensors values acquired through photo plethysmography is sent to Arduino Uno [14]. HRV is determined by the time-series heartbeat peak-to-peak intervals using electrocardiography (ECG). To reduce patient discomfort, we designed a Doppler radar-based autonomic nervous activity monitoring system (ANMS) that allows cardiopulmonary monitoring without using ECG electrodes or spirometry monitoring [15]. The algorithm selects a constant scale factor during learning, then uses the selected scale factor to detect heart rate during test. In this paper, they proposed a method to improve the RMSE of R-R interval compared with the conventional one. During learning, we search for a scale factor interval corresponding to the heart rate obtained with the Doppler sensor. The average RMSE of R-R interval was improved by about 60 msec and 65 msec, respectively for all the subjects compared with the conventional one [16].

The proposed method contributes to detect the driver's heartbeat for the prevention of the accidents, or to observe the stress level of the subject while they are doing desk works. Unlike the conventional wavelet analysis-based works, they do not convert the pseudo frequency of the wavelet to the heart rate [17]. A novel CA-CFAR approach for improvement of doppler sensor-based heart rate variability estimation. This technique eliminated the undesired peaks with large amplitude, there is CA-CFAR (C Average-Constant False Alarm Rate) [18]. The HR and RR were calculated using a peak position detection method, which was carried out via LABVIEW. To evaluate the measurement accuracy, we measured the HR and RR of seven subjects in the laboratory. As a reference of HR and RR, the persons wore contact sensors i.e., an electrocardiograph (ECG) and a respiration band [19]. Proposed system detection algorithm of R-R intervals based on the spectrogram. As a result, the R-R intervals were detected with higher accuracy than the conventional algorithm. When they detected peaks on the integrated spectrum, peaks probably not due to heartbeats sometimes appeared [20].

2. PROPOSED SYSTEM

In this system we use the pulse oximeter sensor for monitoring oxygen saturation level (TCRT sensor) and heart beat sensor module for monitoring heart rate and temperature sensor (4 pin digital thermal thermistor sensor) for temperature monitoring, these sensors are connected to microcontroller when the finger is placed in the sensor and it measures the heart rate and also the pulse rate is measured by pulse sensor and temperature also measured and these data are send to android mobile application via wi-fi module. The average heart rate from new born baby to adult is shown in Fig-1.

AGE	AVERAGE HEART-RATE
Newborn Baby	140
7 year	85-90
14 year	80-85
Adult	70-80
Athletes	60-100

Fig -1: Average Heart Rate according to age

3.BLOCK DIAGRAM

The block diagram for the proposed system is shown in Fig -2.

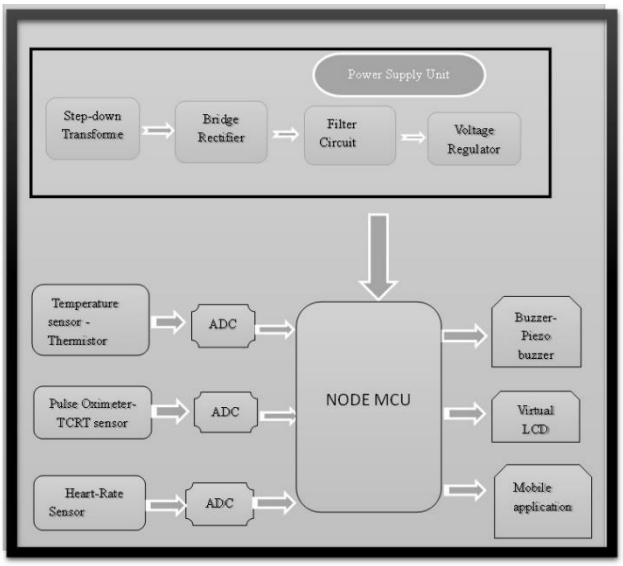

Fig -2: Block Diagram

The Block diagram consists of the following components

- Node MCU
- Heart Rate Sensor Module
- Pulse Oximeter Sensor
- Temperature Sensor
- Buzzer
- Power supply Unit

I.NODE MCU:

The microcontroller NODE MCU is shown in Fig-3.

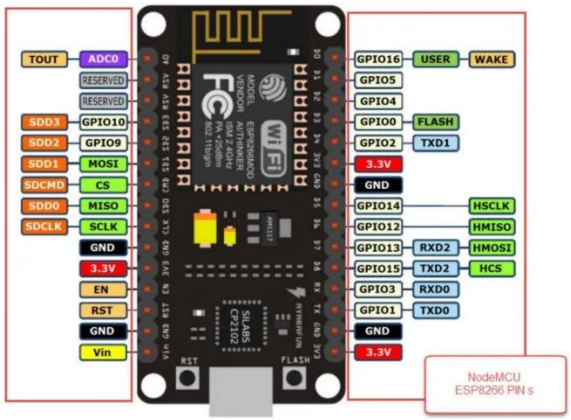

Fig -3: Microcontroller NODE MCU

Node MCU is an open source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC. It includes firmware which runs on the ESP8266 Wi-Fi SoC from Espressif Systems, and hardware, which is based on the ESP-12 module.

II.HEART RATE SENSOR MODULE

The Heartbeat Sensor Module is used to experiment with detecting the heart rate of an individual by detecting changes in infrared light shining through a fingertip. It is shown in FIG.4.The sensor measures the variation in blood volume in tissue. The sensor transmitter emit light in to the tissue and a light detector is placed nearby the transmitter which measure the reflected light from the tissue. If we are using our finger to measure heart rate, it is important that a proper finger holding mechanism must be used.

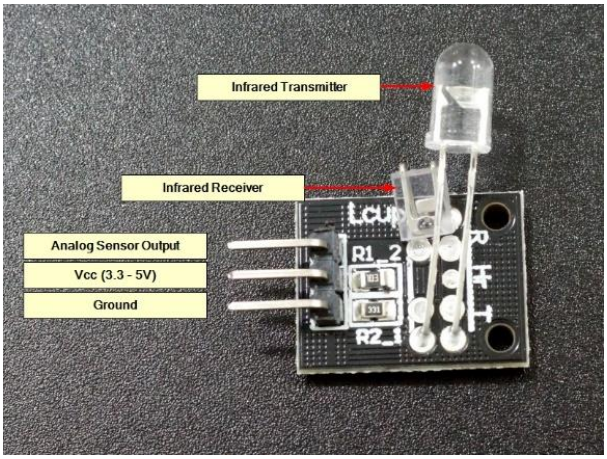

Fig-4: Heart Rate Sensor Module

The sensor modules can be used to try to detect the heart rate of an individual. It accomplishes this by shining an IR emitting LED on one side of a fingertip and detecting small changes in the received IR on the other side of the finger using a phototransistor. The fluctuations in the transmitted IR is caused by the blood being pumped through the finger. A fingertip is placed between the IR emitter and the detector and software running on the MCU filters out the electrical noise, parses the data and spits out the heart rate.

III.PULSE OXIMETRY SENSOR

The TCRT 5000 Sensor is used to experiment with detecting the pulse rate which is shown in Fig-5.

Fig-5: TCRT 5000

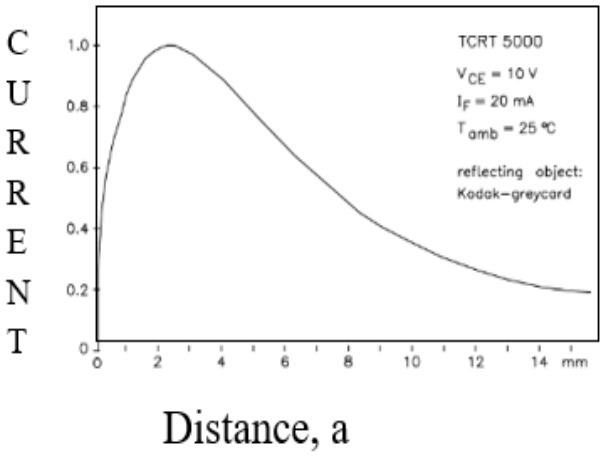

Fig-6: Working of TCRT Sensor

The reflex sensors TCRT5000 contain IR-emitting diodes as transmitters and phototransistors as receivers. The transmitters emit radiation of a wavelength of 950 nm. The spectral sensitivity of the phototransistors are optimized at this wavelength. In the TCRT5000, the concentration of the beam pattern to an angle of 16□ for the emitter and 30□ for the detector results in operation at an increased range with optimized resolution. The emitting and acceptance angles in the other reflex sensors are about 45□. This is an advantage in short distance operation. The working diagrams of the sensor (FIG.6) shows a maximum at a certain distance, Ao. Here the optical coupling is the strongest. For larger distances, the collector current falls in accordance with the square law. When the amplitude, I, has fallen not more than 50% of its maximum value, the operation range is at its optimum.

IV.TEMPERATURE SENSOR

The sensor for monitoring temperature is shown in Fig-7.

Fig-7. 4 Pin Digital Thermal Thermistor Sensor

The basic principle of working of the temperature sensors is the voltage across the diode terminals. If the voltage increases, the temperature also rises, followed by a voltage drop between the transistor terminals of base and emitter in a diode. A thermistor is basically a sensitive temperature sensor that reacts precisely to even the minute temperature changes. It provides a huge resistance at very low temperatures. This means, as soon as the temperature starts increasing, the resistance starts dropping quickly. Due to the large resistance change per degree Celsius, even a small temperature change is displayed accurately by the Negative Temperature Coefficient (NTC) Thermistor. Because of this exponential working principle, it requires linearization. They usually work in the range of -50 to 250 °C.

V.BUZZER

The buzzer is used for alarming purpose. In this system we use piezo buzzer. The frequency range is 3,300Hz. The Operating Temperature ranges from – 20° C to +60°C and Operating voltage ranges from 3V to 24V DC. The sound pressure level is 85dBA or 10cm.The supply current is below 15mA.

VI.POWER SUPPLY UNIT

The power supply unit is shown in Fig-8 which consists of Stepdown transformer, Bridge Rectifier, Filter Circuit and Voltage regulator.

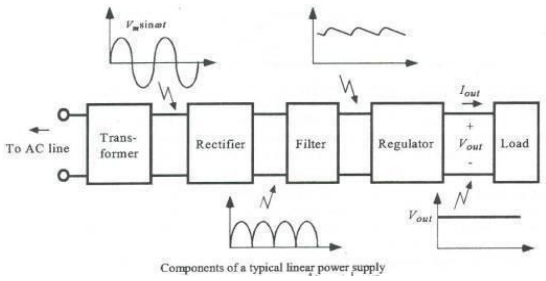

Fig-8: Power Supply Unit

4.CONSTRUCTION

The structure of the system that is used to collect heartbeat, pulse and temperature using sensors is used in this section followed by a description of device's main component which is shown in Fig-9. It is made up of input block, process unit and output block. The sensors in the chamber such as pulse sensor, temperature sensor and heartbeat sensor serve as input block which are connected to the NODE MCU serves as process unit and buzzer and display from NODE MCU serves as output block.

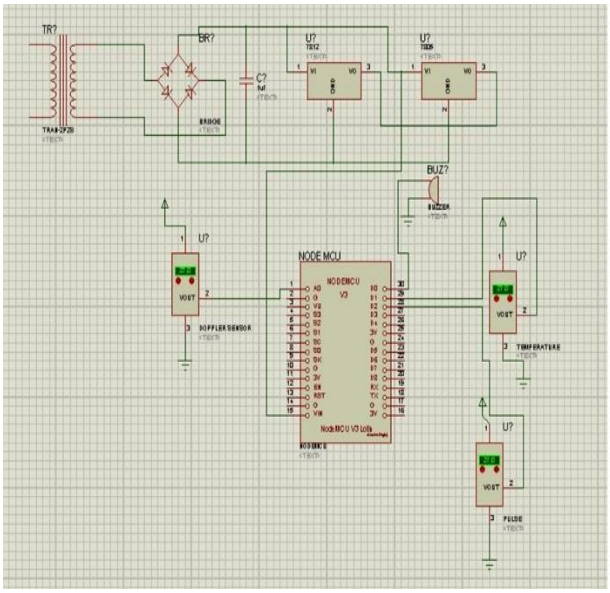

Fig-9: Simulation of the working system

5.WORKING METHODOLOGY

The proposed system works by collecting the data such as heart rate, pulse and temperature through sensors these data are processed and the output is shown in mobile application. Here we are using blynk app module which can control hardware remotely, it can display sensor data, it can store data, visualize it, and do many other cool things. Arduino IDE (Integrated Development Environment) is the software for ATMEGA 328. It is used for writing code, compiling the code to check if any errors are there and uploading the code to the ATMEGA 328. It is an open-source platform that is used in this system for development. The buzzer sound gets activated when the temperature reaches certain threshold value. The working of the pulse sensor with buffer storage is shown in Fig-10.By using this system the patient can be continuously monitored and can able to avoid running to the hospitals for regular checkups.

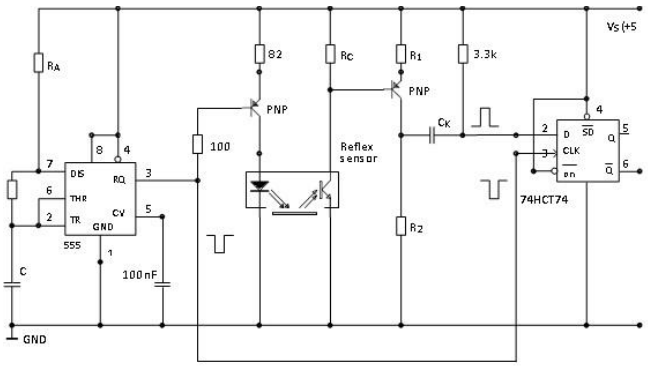

Fig-10: Working of Pulse Sensor with Buffer storage

6.RESULT AND DISCUSSION

Overall, a non- invasive IoT based heart rate and oxygen monitoring system is very helpful method for monitoring heart rate and oxygen saturation level. The sample snapshots of the results in mobile application is shown here in Fig-11.It should be understood, nevertheless, that this technology is currently in the research and development stage and requires additional

testing and validation before it can be extensively applied in clinical settings. In future, this system can be enhanced by involving camera and mic features for continuous monitoring and updation of patient's condition to the caretakers.

Fig-11: Output Indication of our Model

7. CONCLUSIONS

An IoT based human heart rate and oxygen monitoring system is developed. The human heart rate and oxygen saturation level is captured as data signals and processed by the microcontroller. The processed data are transmitted to the IoT platform for further analytics and visualization. IoT based system is very useful in this aspect as it replaces the conventional monitoring systems with a monitoring system with a more efficient scheme, by providing critical information regarding the condition of the patients. In addition, if the patient is in home, the caretakers can monitor the heart rate of the patient in the serial monitor through the real-time monitoring system.

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