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Heart Beat Sensor with Arduino, Heart RateMonitor System

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Abstract

This paper shows the Heartbeat Sensor is an electronic device that is used to measure the heart rate. i. e. speed of the heartbeat, monitoring body temperature, heart rate and blood pressure are the basic things that we do in order to keep us healthy. In order to measure the body temperature, we use thermometers and a sphygmomanometer to monitor the Arterial Pressure or Blood Pressure.

Keywords: Monitoring body temperature, Arterial pressure monitor, heart rate, accurate value.

1. Introduction

Heartbeat Sensor is an electronic device that is used to measure the heart rate i.e speed of the heartbeat. Monitoring body temperature, heart rate and blood pressure are the basic things that we do in order to keep us healthy. In order to measure the body temperature, we use thermometers and a sphygmomanometer to monitor the Arterial Pressure or Blood Pressure. Heart Rate can be monitored in two ways: one way is to manually check the pulse either at wrists or neck and the other way is to use a Heartbeat Sensor. In this project, we have designed a Heart Rate Monitor System using Arduino and Heartbeat Sensor. You can find the Principle of Heartbeat Sensor, working of the Heartbeat Sensor and Arduino based Heart Rate Monitoring System using a practical heart beat Sensor. In recent years the mortality rate has increased through heart attack is occurred in the human being, so the heart rate analysis is very important to reduce the mortality rate in the world. The heart rate is monitoring with help of the real time sensors like heart beat sensor is used to fix on human chest and monitor. Every second, and the sensed data is sent to the controller if any variation is occurred in the data the alert signal is send to the medical person. The heart rate is varied with respect to the human age, like the normal person having 72 bpm (beats per minute), the aged person having 90 bpm and the child having 120 bpm. In that heart rate is increasing when the human doing an exercise and the rest of the time it is going to a normal condition, but the heart rate is lower when compared to the normal range is called has a bradycardia and higher range is called as tachycardia.

2. Aim And Objectives

The aim of this project was two-fold: Develop and implement a biofeedback procedure within a rotator cuff rehabilitation regimen to quantify shoulder rehabilitation progression. Design and validate a bio-mechanical shoulder rehabilitation device to aid in the transition from an in-office to remote physical therapy modality due to the altering conditions created by the COVID-19 pandemic/rural people.To accomplish this aim, we are going to develop to formulate an experimental rehabilitation procedure. To confirm that the procedure could be safely performed, human models were created using IOT to monitor the desired procedure. It is a smaller and more portable version of the original design, capable of assisting in rotator cuff rehabilitation and confirmed that this was the optimal design suited to fulfill the second aim of the project.

3. Existing System

There have been many methods developed in order to ensure that the heartbeat rate of a human is under control. All these methods have the similar drawback of accuracy. it can cause a life to death. To overcome this many methods have been proposed in this field as follows:

• A journal paper on “fingertip based heart beat monitoring system using embedded systems” got published in 2017 where the heart beat rate is counted based on the ECG device.

• A paper on “smart heart rate monitoring system” predicts the heart rate using infrared transmitter and receiver circuits where Photoplethysmography (PPG) implemented.

• another paper on “Arduino based wireless heart-rate monitoring system with automatic SOS message and/or call facility using sim900a gsm module” uses Arduino lily pad as the main governing microcontroller to transmit circuit whereby.

4. Proposed System

The project holds to overcome the disadvantage of previous system the technique proposed system to avoid over timing and increased speed of measure heartbeat. Heart is the most wanted part of human being to live in a world, at the same time the heart rate analysis is increased in medical field and the heart analysis is important parameter of human health. The various heart rate analysis methodsis available in medical field like ECG and pulse sensing system this pulse analysis is depends on the blood force of heart artery. This artery is closed to the skin in that reason the pulse is identified easily. The proposed system analysis the pulse rate in the way of fingertip using Arduino controller, and it’s based on photo plethysmography principle.This method to analysis the blood pressure difference and identified the variations of the value of blood pressure and send to the controller. The function of heart beat is occurring the whole-body blood is pumping, so it depends upon the fingertip blood artery is also change.

This type of changes is identified with help of the heart beat sensor is placed in the finger to measure the value, and the signal is sent to the controller via serial communication system it is help to monitoring the heart beat range. The photo diode and infra-red led is placed in the sensor to detect the blood volume, the infrared diode is transmitting the infrared light to the fingertip, this light passing over the blood inside arteries of finger. The photo diode is analysis the light signal and reflected back to the device, so the difference between the light signals the value is send to the controller. It is continuously processed in every circulation of blood in the fingertip region, and sends the variation of changes in the light signal to the controller via serial communication.

5. Design Methodology System

5.1 Main Module

The device consists of a Grove-Heart rate sensor and LM35 IC sensor as inputs, Arduino Uno, Bluetooth module (HC-05), laptop to display the heart rate and temperature of the respondent and LEDs as indicators. The heart rate data is detected by using Grove-Heart Rate sensor that is clipped on the fingertip. While, for measuring the body temperature in degrees Celsius, LM35 IC is used [3]. This LM35 IC is placed and strapped at the armpit of the respondent. Both sensors are connected to the Arduino Uno and programming is required to ensure the sensors are functioning well and well-integrated. Bluetooth is a short-range radio link and low-power technology [5] allowing the data from both sensors to be transferred wirelessly between the monitoring system to the laptop for every minute. The data is displayed using Tera Term software. Any abnormal reading or rate can be identified easily either from the active LEDs or warning messages displayed on Tera Term window.

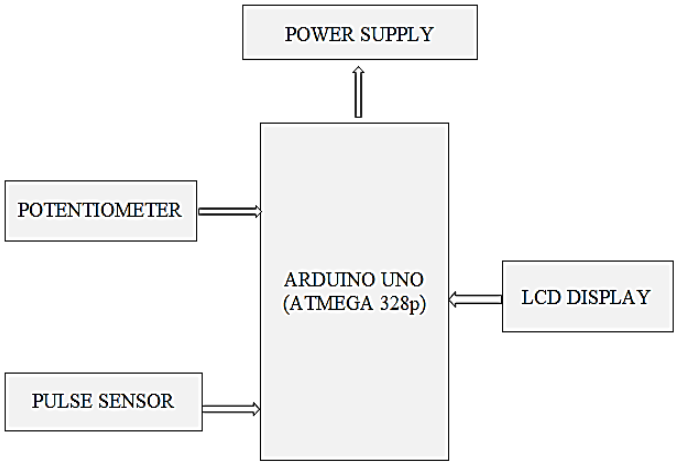

Figure 1 Diagram of Proposed System

5.2 Heartbeat Sensor

Practical heartbeat Sensor examples are Heart Rate Sensor (Product No PC3147). It consists of an infrared led and an LDR embedded onto a clip-like structure. The clip is attached to the organ (earlobe or the finger) with the detector part on the flesh. Another example is TCRT1000, having 4 pins- Pin1: To give the supply voltage to the LED Pin2 and 3 are grounded. Pin 4 is the output. Pin 1 is also the enable pin and pulling it high turns the LED on and the sensor starts working. It is embedded on a wearable device that can be worn on the wrist and the output can be sent wirelessly (through Bluetooth) to the computer for processing.

Figure 2 Heartbeat Sensor

As described above regarding the principle of a heartbeat sensor, when the finger tissue or the earlobe tissue is illuminated using a light source, the light is transmitted after getting modulated i.e., a part getting absorbed by the blood and the rest being transmitted. This modulated light is received by the light detector. Here a Light Dependent Resistor (LDR) is used as a light detector. It works on the principle that when light falls on the resistor, its resistance changes. As the light intensity increases, the resistance decreases. Thus, the voltage drops across the resistor decreases. The principle behind the working of the Heartbeat Sensor is Photoplethysmography. According to this principle, the changes in the volume of blood in an organ are measured by the changes in the intensity of the light passing through that organ. Usually, the source of light in a heartbeat sensor would be an IR LED and the detector would be any Photo detector like a Photodiode, an LDR (Light Dependent Resistor) or a Phototransistor. With these two i.e., a light source and a detector, we can arrange them in two ways: A Transmissive Sensor and a Reflective Sensor. In a Transmissive Sensor, the light source and the detector are placed facing each other and the finger of the person must be placed in between the transmitter and receiver. Reflective Sensor, on the other hand, has the light source and the detector adjacent to each other and the finger of the person must be placed in front of the sensor. A simple Heartbeat Sensor consists of a sensor and a control circuit. The sensor part of the Heartbeat Sensor consists of an IR LED and a Photo Diode placed in a clip. The output of the photodiode is given to the non – inverting input of the first op – amp through a capacitor, which blocks the DC Components of the signal.

The first op – amp acts as a non – inverting amplifier with an amplification factor of 1001. The output of the first op – amp is given as one of the inputs to the second op – amp, which acts as a comparator. The output of the second op – amp triggers a transistor, from which, the signal is given to a Microcontroller like Arduino. The Op – amp used in this circuit is LM358. It has two op – amps on the same chip. Also, the transistor used is a BC547. An LED, which is connected to a transistor, will blink when the pulse is detected.

5.3 Potentiometer

A potentiometer is a three-terminal resistor with a sliding or rotating contact that forms an adjustable voltage divider. If only two terminals are used, one end and the wiper, it acts as a variable resistor or rheostat. Potentiometer. A typical single-turn potentiometer. A potentiometer is a passive electronic component. Potentiometers work by varying the position of a sliding contact across a uniform resistance. In a potentiometer, the entire input voltage is applied across the whole length of the resistor, and the output voltage is the voltage drop between the fixed and sliding contact as shown below. A potentiometer has the two terminals of the input source fixed to the end of the resistor. To adjust the output voltage the sliding contact gets moved along the resistor on the output side. The resistor has the uniform electrical resistance per unit length throughout its length. Hence, the voltage drop per unit length of the resistor is equal throughout its length. Suppose, by adjusting the rheostat we get v volt voltage drop appearing per unit length of the resistor. Now, the positive terminal of a standard cell is connected to point A on the resistor and the negative terminal of the same is connected with a galvanometer. The other end of the galvanometer is in contact with the resistor via a sliding contact as shown in the figure above. By adjusting this sliding end, a point like B is found where there is no current through the galvanometer, hence no deflection in the galvanometer.

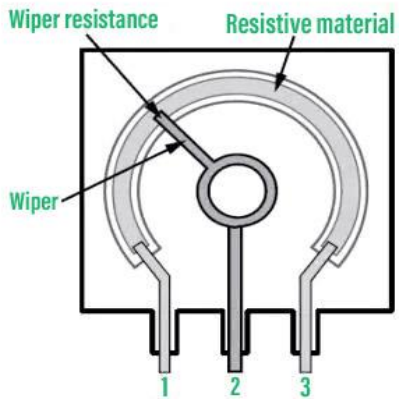

Figure 3 Potentiometer

The principle of measuring voltage across a branch of a circuit with the help of a potentiometer is also simple. Here first we have to adjust the rheostat to adjust the current through the resistor so that it causes a specific voltage drop per unit length of the resistor. Now we have to connect one end of the branch to the beginning of the resistor and the other end is connected to the sliding contact of the resistor through a galvanometer.

Now we have to slide the sliding contact on the resistor until the galvanometer shows zero deflection. When the galvanometer comes to its null condition, we have to take the reading of the position of the sliding contact tip on the resistor scale and accordingly we can find out the voltage across the branch of the circuit since we have already adjusted the voltage per unit length of the resistor.

5.4 Arduino Uno

Arduino UNO is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. You can tinker with your UNO without worrying too much about doing something wrong, worst case scenario you can replace the chip for a few dollars and start over again.

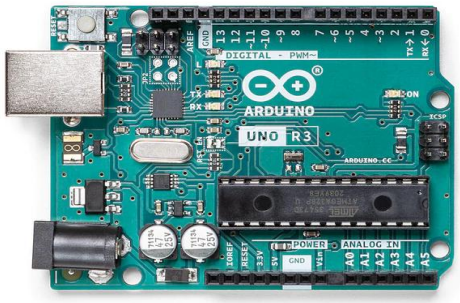

Figure 4Arduino Uno

5.5 LCD Display

LCD is used mainly for displaying the needed information about the project. Information like temperature and flame level can be displayed through LCD Emergency fire alert also will be displayed through LCD will be connected with the digital pins (RC0, RC1, RC2, RC3) of the controller as 4-bit mode or 8-bit mode In addition we also need to connect RS, EN, RW pins of the LCD with controller It is supplied with 5 volt dc and ground This word comes from the liquid crystal and 16X2 represents its screen size. In the Liquid crystal display 16×2, there are 2 rows and 16 columns. These devices are thinner as well and power consumption is extremely less. The LCD 16x2 working principle is, it blocks the light rather than dissipates.

Figure 5LCD Display

An LCD (Liquid Crystal Display) screen is an electronic display module and has a wide range of applications. A 16x2 LCD display is a very basic module and is very commonly used in various devices and circuits. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in a 5x7 pixel matrix. The 16 x 2 intelligent alphanumeric dot matrix displays is capable of displaying 224 different characters and symbols. This LCD has two registers, namely, Command and Data. Command register stores various commands given to the display. Data register stores data to be displayed. The process of controlling the display involves putting the data that form the image of what you want to display into the data registers, then putting instructions in the instruction register.

6. Applications

6.1 Developing your Heartbeat Sensor System

A basic Heartbeat Sensor system can also be built using basic components like an LDR, comparator IC LM358, and a Microcontroller as given below

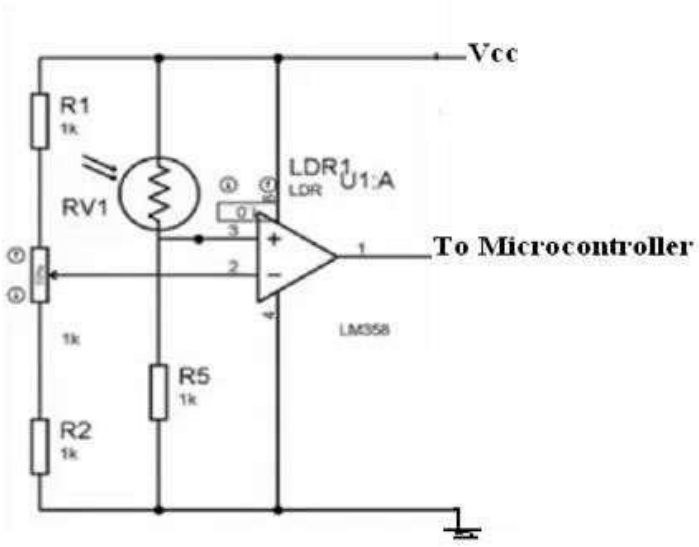

Figure 6Heartbeat Sensor System

As described above regarding the principle of a heartbeat sensor, when the finger tissue or the earlobe tissue is illuminated using a light source, the light is transmitted after getting modulated i.e., a part getting absorbed by the blood and the rest being transmitted. This modulated light is received by the light detector. Here a Light Dependent Resistor (LDR) is used as a light detector. It works on the principle that when light falls on the resistor, its resistance changes. As the light intensity increases, the resistance decreases. Thus, the voltage drops across the resistor decreases. Here a comparator is used which compares the output voltage from the LDR to that of the threshold voltage. The threshold voltage is the voltage drop across the LDR when the light with fixed intensity, from the light source, falls directly on it.

The inverting terminal of the comparator LM358 is connected to the potential divider arrangement which is set to the threshold voltage and the noninverting terminal is connected to the LDR. When human tissue is illuminated using the light source, the intensity of the light reduces. As this reduced light intensity falls on the LDR, the resistance increases and as a result of the voltage drop increases. When the voltage drops across the LDR or the noninverting input exceeds that of the inverting input, a logic high signal is developed at the output of the comparator and in case voltage drop being lesser a logic low output is developed. Thus, the output is a series of pulses. These pulses can be fed to the Microcontroller which accordingly processes the information to get the heartbeat rate and this is displayed on the Display interfaced with the Microcontroller

7. Resultsand Conclusions

In this research paper, the design and development of a microcontroller-based heartbeat and body temperature monitor using fingertip and temperature sensor is shown. The device consists of sensors Whitacre used to measure heartbeat as well as body temperature of a patient 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 a cell phone. In this research paper, it is shown that the heart rate can be measured by monitoring one's pulse using specialized medical devices such as an electrocardiograph (ECG), portable wrist strap watch, or any other commercial heart rate monitors. Despite its accuracy, somehow it is costly, involves many clinical settings and patients must be attended by medical experts for continuous monitoring. For a patient who is already diagnosed with fatal heart disease, their heart rate condition has to be monitored continuously. This paper proposed an alert system that is able to monitor the heart beat rate condition of patients. The heart beat rate is detected using photo plethysmography (PPG) technique. This signal is processed using a PIC16F87 microcontroller to determine the heart beat rate per minute. Then, it sends an SMS alert to the mobile phone of medical experts or patient’s family members, or their relatives via SMS. This will also alert the family members to quickly attend the patients. In this research paper implementation of heartbeat monitoring and heart attack detection system using Internet of things is shown. These days we see an increased number of heart diseases & heart attacks. The sensor is interfaced to a microcontroller that allows checking heart rate readings and transmitting them over the internet. The user may set the levels of heart beat limit. After setting these limits, the system starts monitoring and as soon as a patient heart beat goes above a certain limit, the system sends an alert to the controller which then transmits this over the internet and alerts the doctors as well as concerned users. Also, the system alerts for lower heartbeats. Whenever the user logs on for monitoring, the system also displays the live heart rate of the patient. Thus, concerned patients may monitor heart rate as well as get an alert of heart attack to the patient immediately from anywhere and the person can be saved on time. The prototype project is developed to monitor the patient's health if any changes occur in the sensor value the signal is sent to the controller, this controller gives the signal to the user via GSM module.

The use of the proposed system is measuring the patient's health every second and the data is noted to the record, so the patient has no need to go to the hospital in time. If the heart attack occurs in the patient side the message is passed through the mobile to the doctor, and this is done through a comparison of sensor value and threshold value if any variation is occurred to alert the user. Also, the monitoring of the patient is available everywhere so it is more helpful in rural areas, and the proposed system is given the accurate value and faster operation of this system.

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