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Acquiring Bio potentials and displaying them in Real Time on an Android device

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Abstract

In this paper an attempt has been made to acquire two bio potential signals from the human body and display them on an Android device in real time. The bio potential signals that are acquired are the Body Temperature and the Pulse rate. The acquired signals are then transmitted to the Android device via Bluetooth technology. An android application has also been developed in accordance with the system that has been proposed so that the app can directly communicate with the system in real time and display the signals in a graphical way. The signals are given to the Arduino board which is then interfaced with Android so as to provide communication between the two. The proposed system is low cost, portable and compact and hence anyone who owns an Android device and the system can check their Body Temperature and Pulse rate comfortably and in an effective way.

Key Words:

Android, Real time, Android app, Arduino, Bluetooth

Introduction

In today's world the health of an individual is of the utmost concern around the globe. Health issues and problems are always on the rise due to a variety of factors such as the population, the changing lifestyle, pollution, lack of basic facilities etc. Due to this a number of people around the world fall prey to their untimely death and this number is also increasing day by day. This is a major problem in the developed, developing and the poor nations in the world. The poor nations lack the medical technology to detect and cure the diseases and disorders of the people which further complicate and reduce their chance of getting better. In this paper the two parameters that have been used for detecting changes in the human body are the Body Temperature and the Pulse rate.

Measuring one's body temperature is one of the oldest techniques to find out if something is wrong with the individual or not. Even though it's still old it is still used now today for medical purposes. It is one of the most important vital sign of the human body and it is very important that one must measure the body temperature very accurately. The normal temperature range of an individual is between 36.1ºC – 37.5ºC (97F – 99.5 F) although this temperature range depends on various factors such as the age of the person, what activity they are doing, the time of the day and most importantly where they measure the body temperature from. Measuring body temperature is of significant importance for both monitoring and diagnostic purposes [1]. The temperature of the body can be affected by a variety of changes by both the internal and external factors. The internal factors include the metabolic activity of the cells thus

generating a heat in varying amounts throughout the body. The core body temperature maybe affected by this process but it is only to a certain extent and does not cause much variation as the external factors. The external factors include exercise, environment and diseases. The physical activity that is done during exercises can affect one's body temperature. During an exercise there is an increase in the metabolic activity of the cells which are necessary to produce more energy which results in an increased heat production within the body. Sweating occurs during exercise because the internal heat that is produced is then transferred to the skin via the blood to the skin surface which is a way of balancing the normal body temperature.

However, if the temperature regulation and control during the exercise is compromised it can cause heat exhaustion or even a deadly heatstroke. When a disease inhibits the body, several changes can be observed on both the outside and the inside of the body. Monitoring the body temperature can alert us to specific diseases and by identifying these diseases the treatment can be modified accordingly. Hence by taking into account how much the body temperature has changed and the noticeable changes on both the outside and the inside of the body the specific disease, virus, bacteria or fungus can be identified and the individual can be given the proper treatment. Depending upon the climatic conditions the body adjusts its temperature accordingly [2]. In hot and humid conditions, it is very difficult for the body to dissipate the heat away from the body because of the high amount of moisture in the air and the small difference in the temperature between the skin and air which ultimately results in an elevated temperature of the body. On the other hand in cold conditions a great amount of energy is necessary to produce body heat so that it does not leave the body which results in a drop in the core body temperature. Hence if the temperature rises or falls beyond the normal temperature range it is of serious concern for the health of the individual.

Pulse rate can be simply defined as the rate at which one's heart beat in a minute. Measuring one's pulse rate is important because it gives us information about the strength and the rhythm of the heartbeat [3]. Checking one's pulse rate is crucial due to the following reasons:

- Helps in finding the cause of symptoms such as chest pain, fainting, dizziness, irregular or rapid heartbeat.
- In case of accidents the pulse rate is checked to see if the heart is pumping enough blood or whether a blood vessel maybe blocked or not as a result of the injury.
- Can be used to identify diseases or medicines which cause irregular, slow or fast heartbeat thus changing the medications and the treatments accordingly.

Pulse rate is very important for a person's wellbeing and since it is directly connected to the heart, it can give a great deal of information about the irregular heartbeats a condition called as 'Arrhythmia'. An Arrhythmia can be defined as a disorder of the heart rate where the heart beats too quickly a condition called as 'Tachycardia' where the heart rate is more than 60 – 100 beats per minute. When the heart rate is less than 60 – 100 beats per minute the condition is called as 'Bradycardia'. Common symptoms that occur during an Arrhythmia include sweating, shortness of breath, dizziness, and fainting and chest pain [4]. Hence if these symptoms are identified early, then the individual can be treated accordingly with the right treatment and medications which will save their lives. Arrhythmias can also be caused by some

factors such as smoking of cigarettes, drugs, steroids, caffeine and alcohol.

Hence it is of vital importance that both these parameters be measured accordingly so that an individual can become aware of the changes and the symptoms and contact the physician or the doctor and get the appropriate treatment and the medicines and avoid the loss of life. Further in this paper how the body temperature and the pulse rate have been measured is detailed and their values displayed on an Android screen.

Hardware Implementation

As stated before body temperature is a vital parameter that needs to be measured in determining the health of an individual, and hence there are three regions where the temperature is being measured namely oral, rectal and axillary. However, in this project an actual thermometer was never used, instead the temperature sensor LM35 was used for determining the changes in temperature. The LM35 is a precision IC temperature sensor which gives the values in ºC. It has an operating range from -55ºC - 150ºC and can be used for remote applications and has an operating range of 4V to 30V [5]. The LM35 is low cost and hence can be easily available. Figure 1 shows the LM35 precision IC temperature sensor:

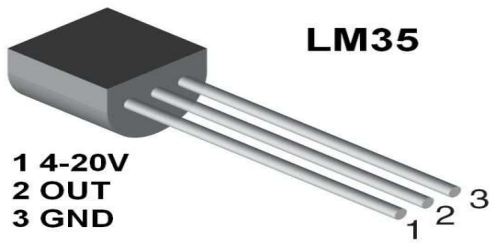

Figure 1: LM35 Precision IC Temperature Sensor

As shown above pin no 1 is connected to the VCC, pin no 3 I connected to the GND and the output is taken via pin no 2. In this paper the readings from the temperature sensor were taken by connecting the pins to the Arduino board. The Arduino board that was used in this project is the Arduino Mega 2560 board. Arduino is an open source software and hardware tool that can be used for sensing and reading the data from a variety of sensors and switches and can also be used to control them. The main advantage of using Arduino board is that the software is freely available and can be downloaded from the internet [6]. It is also compatible with most of the operating systems such as LINUX, MACINTOSH and WINDOWS and is also very low cost as compared to the other microcontrollers. The Arduino Mega 2560 board was used as compared to the Arduino Uno because the Arduino Mega has more number of Analog Input pins for reading the body temperature and the Pulse rate values rather than the Arduino Uno. The pin no 1 of LM35 was connected to the 5V pin with the help of connector cables. Pin no 2 and the pin no 3 were connected to the Analog Input pin A0 and the ground pin respectively.

The Arduino Mega 2560 is powered with the help of the USB cable attached to the computer. The green light on the board indicated that the device is powered up and ready to be used. A program was written in Arduino to read the temperature sensor values from pin no 2 and to be displayed on the serial monitor. By connecting the LM35 to the Arduino board the values were displayed on the serial monitor but since the readings were taken in a normal environment the readings were constant. Hence to verify if the readings are being properly displayed a lighter was lit and was moved around the temperature sensor so as to increase the heat around it and it was found that the values changed accordingly and correspondingly the values were displayed on the serial monitor too. However some calibrations had to be done to ensure that the values displayed are consistent with the values that are provided by a thermometer. The values observed on the

serial monitor were compared with the values observed on a digital thermometer and it was found that the values given by LM35 were nearly identical to the values shown by the digital thermometer.

To measure the pulse rate of the body a pulse sensor was used. The sensor that was used in this project is the 'Easy Pulse Sensor'. It consists of a plastic pocket where one has to place their index finger inside it [8]. The sensor is fabricated and has PIC16F877A which illuminates the finger from one side with the help of an Infrared and Red LED. The small variations in the transmitted light intensity are measured by the photo detector placed on the other side. The photo detector detects the variations corresponding to the changes in the blood volume inside the tissue which directly correlates to the pumping action of the heart. Figure 2 illustrates the Pulse Sensor as below:

Figure 2: Pulse Rate sensor

The index finger is inserted into the green pocket and the connection is made to the Arduino board. The Easy Pulse Sensor also contains three pins out of which the first pin is +5V, the second pin the GND and the third pin is the output which is connected to the A1 pin, since the temperature sensor is connected to the A0 pin as mentioned above. The connection between the temperature sensor, the Easy Pulse Sensor and the Arduino board is illustrated in Figure 3 as below:

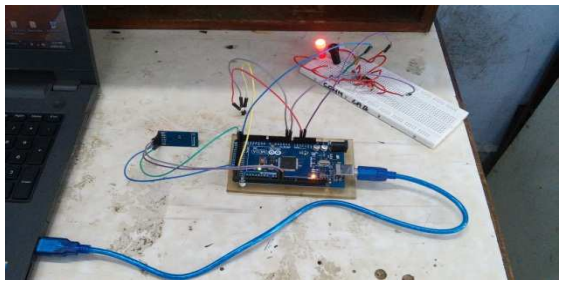

Figure 3: Interfacing between LM35, Pulse sensor and Arduino board

Software Implementation

As stated before the values had to be displayed in real time on an Android screen hence in order to display the values an Android application or more commonly known as an app was designed. The app was designed using the 'Eclipse' software which can be directly downloaded from the internet. The app has been designed in a simple and easy way so that everyone will be able to use it. The steps which are needed to display the values are simple to follow and hence anyone with an Android device and the system will be able to make the most of it. Another main aim behind designing this app is that there are many apps available in the Playstore for temperature and pulse rate; however most of the apps are unreliable in nature. There are many temperature apps available but most of these apps only measure the temperature of the mobile phone and of the surroundings. None of them measure the temperature of the human body and that too in real time. Also another problem with these apps is that it requires specific sensors to sense the temperature which unfortunately are not available in most of the phones. Hence the app only works in a few specific phones which possess the sensors. The pulse rate apps that are available measure the pulse rate by keeping the index finger over the camera of the phone for a limited amount of time. The problems with these apps are that the readings vary from app to app depending upon how much time they take and how the readings are taken. Also it has been

reported that the camera of the phone heats up extensively while taking the readings which is very inconvenient to the user and as a result an accurate and precise pulse reading is not possible. Hence to overcome all these disadvantages a proper app needed to be designed that would take the body temperature and the pulse rate readings correctly and display them in real time as accurately as possible. Hence in order to display the values both the Android app and the system is necessary to measure it. The view of the app is as shown in Figure 4 as below:

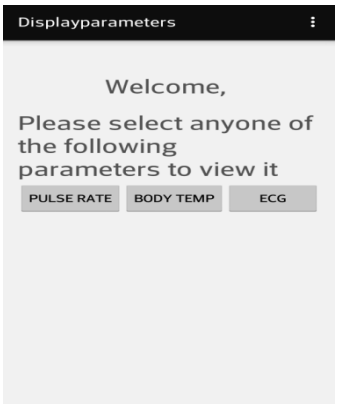

Figure 4: View of the app

In this paper only two parameters Body temperature and the Pulse rate have been discussed, however provisions can also be made for displaying the ECG also. The app was designed in Android and not in any other Operating Systems like iOS, Windows because Android is an open source Operating System and hence there are no restrictions in developing the app. Also all the material needed to develop the app like the 'Software Development Kit (SDK)' and 'Android Development Tool (ADT)' are also freely available hence helped in designing the app [10]. The tutorials are also available on the internet guiding the various steps required to design and build the app.

Results

The temperature sensor LM35 was connected to the A0 pin and the pulse rate was connected to the A1 pin of the Arduino board. The Bluetooth module HC-05 [9] was also connected to the Arduino board. The Arduino board was given the supply by the USB cable attached to the computer. The Arduino program was burned into the board. The body temperature was first selected and the readings were seen on the serial monitor on the computer. On opening the app the Bluetooth dialog box appears which turns on the Bluetooth after clicking 'YES'. The app then pairs up with the Bluetooth module HC-05. After pairing the necessary details were entered and then the Body temperature button was clicked. Upon clicking the button the temperature sensor values were plotted in real time on an XY graph with the temperature values being plotted on the Y axis and the seconds being displayed on the X axis. . The readings were taken by lighting a candle and rotating it around the sensor. The graph of the body temperature is as shown in Figure 5 below:

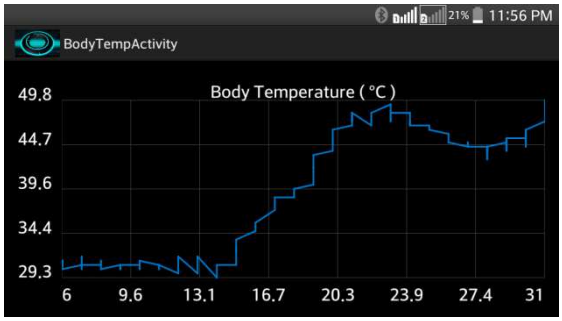

Figure 5: Body Temperature graph

In the next step the Pulse rate was selected and the corresponding values were observed on the serial monitor. Accordingly the pulse rate was button was clicked on the app and the pulse rate graph began to plot in real time. Here there were variations in the reading because of loose contact between the wires and the circuit due to which the pulse rate values are going beyond the normal range. The pulse rate graph is as shown below in Figure 6:

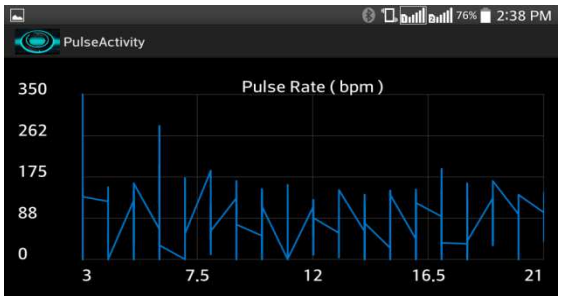

Figure 6: Pulse Rate graph

Conclusion

Thus two bio potentials Body temperature and Pulse rate were acquired and displayed on an Android screen in real time. The app designed is free and simple to understand and use. Since Android is open source and many people are using Android devices this system will be hugely beneficial to them thus converting their Android devices into their own health monitoring system. One can check their bio potentials in their home only without even going to the doctor. An expert in the medical field can see the readings and conclude whether the patient is suffering from a disorder or not.

Future Scope

The system that has been designed contains only two parameters and can be further modified to include more parameters as well. The signals are being transmitted via Bluetooth and further systems can also make use of the Wi-Fi for sending the signals to greater distances as the range of Bluetooth is limited. A centralized server system can also be created which will transmit and receive the signals sent over Wi-Fi so that the doctors can directly monitor the signals of the patients which are residing at home. The system that has been designed above is capable of only monitoring the signals and not diagnosing them in real time. Further systems can also include the diagnosing part which will be very helpful in alerting the people who don't have an intimate knowledge about the parameters. An emergency alert system can also be incorporated with the further modified system that will send alert messages to both the doctor and the patients or the persons who are residing in their homes. Ambulances can also be connected to this system so that when an alert message is received, the ambulance can quickly get to the house of the individual in distress without wasting any time thus saving precious amount of life.

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