Android Application to Detect and Alert Tachycardia and Bradycardia using Pulse Rate Sensor

by

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16009

Dissertation submitted in partial fulfilment of the requirements for the
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(Electrical and Electronic Engineering)

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CERTIFICATION OF APPROVAL

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Approved by,

_____

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TRONOH, PERAK

JAN 2016

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

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(MUGILLESWARI A/P MUTHUSAMY)

ABSTRACT

Heart rate monitoring is most vital in preventing disorders related to heart. Failure to detect heart disorder in early stage may lead to death. The lacking of devices to immediately detect the abnormalities in heart and alert the patients emergency contact lead to this problem. In this report the author propose a system to detect two heart disorders called Tachycardia and Bradycardia which are caused by abnormalities in heart rate. The proposed system will consist of a pulse sensor which will be connected to a smartphone via Bluetooth. The signal information which is processed by the microcontroller will be sent to the mobile phone. An app created will send an alert to the emergency contacts of the patients when Tachycardia or Bradycardia condition has been detected by the sensor. This will increase the possibilities of giving immediate treatment to the patient, and hope to reduce the death rate caused by heart disorders.

ACKNOWLEDGEMENT

First and foremost, I would like to express my gratitude to my supervisor Ms. Zazilah May for her guidance and determination to help me throughout the journey of completing my final year project. I was able to gain a better understanding and more knowledge regarding this project, thanks to her continuous support and experience sharing throughout the period.

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CHAPTER 1

INTRODUCTION

1.1. Background of study

The heart of an normaladult human being generally beats at around 60 to 100 beats per minute (BPM) [1]. The body fitness of every individual is one of the determinant of the heart rate. Tachycardia and Bradycardia is the conditions when the heart rate of an individual is higher and lower than the normal heart rate respectively. [2]. The efficiency of blood flow through the body decreases during the condition of Tachycardia and Bradycardia. This might lead to lack of sufficient oxygen to the organs as well as the heart and lead to severe diseases such as cardiac arrest and stroke. This abnormality can be identified by accurately measuring the pulse rate. ECG signals are commonly used to obtain the pulse rate. Besides that identifying the peaks of a Photoplethysmograph(PPG) signal may also lead to obtain the pulse rate.[1],[2]. PPG signal determines the blood flow and blood volume at every beat of heart. [3]. The heart rate of a person is detected when the blood volume of a person being synchronous to the heart beat. Reflectance and Transmitten are the two method to detect PPG signals. A light reflector and detector is places below the finger tip to obtain the PPG signal in reflectance photoplethysmorgraphy [4], [5]. Figure 1.1 shows example of an PPG signal.

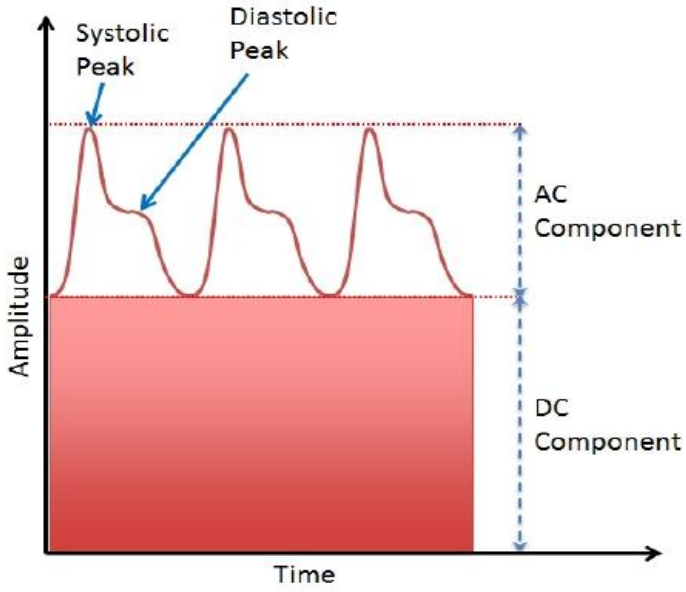

FIGURE 1.1 Example of PPG signal

Individuals aged above 60 are most likely to have this Arrhytmia. A quote was identified in a population bulletin stating that "Projections to 2030 indicate that more than 60 countries will have at least 2 million people age 65 or older" [1]. Considering the old age, individuals are advised to regularly monitor their heart rate to prevent from heart disorders.

1.2 Problem Statement

Cardiovascular disease is becoming the most serious health problem among people[1]. Failure of people to take immediate action has been the main reason for people to face difficulties in curing the disease. Lacking of portable devices to immediately detect the abnormalities in people's heart rate and alert the patients emergency contact on the patient's condition motivates author to do this project.

1.2.1 Problem identification

There is a need for a system that constantly monitors the heart rate of a person. Appropriate sensors need to be used to detect any irregularity of the heart rate . Besides that, a system is also needed to alert the patient's relatives using a smartphone regarding the patient's problem.

1.2.2 Significant of the project

The aim of the project is to come up with a system which could constantly monitor a person's heart rate using sensors and identify any irregularities of the heart rate or

possible heart attack. Besides that, the system also sends a alert to the emergency contacts of the patient.

1.3 Objectives

In completing the project, several objectives need to be accomplished. The design of the system includes:

a) To monitor the heart rate using appropriate sensors and detects any irregularity or heart attack.

b) To automatically send an alert in the form of a phone call or text message

c) To build, test and evaluate the performance of a working prototype of the above system.

1.4 Scope of study

- Analyzing the PPG signal
- Learn Java programming skills
- Use Android studio as a platform to develop and mobile application
- Use Bluebee Bluetooth module to send data wirelessly

1.5 Relevancy of the study

This project is relevant to the author's field of majoring since the transmitter and receiver system using sensors are also one of the focus are in Control system and instrumentation. Moreover the technology that will be used is one of the technology that the researchers outside are trying to develop. Besides that, smartphone will be chosen as a medium to detect heart attack since nowadays smartphone has been use by the majority of peoples with android as their operating system. Furthermore, it has been also made sure that this project is cost effective and is affordable by everyone.

1.6 Feasibility of the project

The project is feasible since it is within the scope and time frame. The research and

literature review has been planned to be completed by end of the first semester while preparing the equipment by week 10. The prototype building of this project will be started by end of the first semester. The first six weeks of final year design project II (FYP II) will be dedicated to complete the mobile app development, whereas the next six weeks has been planned to conduct the experiment to evaluate the efficiency of the designed prototype.

CHAPTER 2

LITERATURE REVIEW

For the study of this project, several research papers were reviewed and studied in order to understand the scope of the topic. The research done was divided into two part, which be the analysis of the heart rate signals as well as the development of the android application.

Based on Android Base Heart monitoring and Reporting system by [7] on 2014, heart rate monitoring system can be developed by using the body sensor network(BSN). The system proposed uses, sensors which will detect the body temperature and the heart rate. The data collected from the sensor will be sent to the mobile app via Bluetooth and the alert will be sent the emergency contacts in the case of heart attack.

It has been said that, the author used wireless sensors so that it will be easier to connect the hardware to the mobile app. In the proposed project, the hardware consists of PCB on which the devices will be placed. ATMega32 microcontroller having 10-bit inbuilt ADC (Analogue to Digital Converter), MAX232 IC used for serial communication purpose, ULN Darlington as a voltage regulator are the devices proposed by the author in his research paper. The working mechanism of the project will be., the values detected from the sensor will sent to the android mobile phone via Bluetooth and the ECG signal of the user will be displayed on the phone.

Peter Leijdekkers et.al[8] has proposed the system used by the patient need to be simple and user friendly. The application designed will be consist of words in larger fonts and clearer images so that it will be easier to be used by the patient during emergency. it has been also proposed that, beside using ECG sensor, sensors which could detect blood pressure and blood glucose level could be also used. Although using a 12- lead ECG sensor would be accurate to detect heart attack, placing the electrodes would be difficult without the assistance therefore it has been suggested to use 2

electrodes, 2 lead. [8].

The are a system called heterogeneous wireless network system(HWNS) has been proposed.[9] The data recoded from the ECG sensor will be sent to the doctor through HWNS. It also includes the location of the patient through the GPS sensor connected. Broadband network or wireless LAN can be also used. This method will allow high data transfer. Patients old record can be also delivered using this. Table 1 illustrates the summary of the research done.

In [10], the system proposed shows us an ECG monitor system based on android smart phone. ECG signal is transmitted to an android phone and then be forwarded to a remote server. Using a PC, doctors can view the ECG after logging in the server. In this system, Android phone is sending ECG signal all the time when the system is running.

An android based Body Area Network (BAN) for the evaluation of medical parameters has been proposed [11]. The objective of the system is to build an Android OS based data collection platform, that can collect physiological data from multiple sensors, perform signal processing and analyses, store data in an internal memory and transmit data to a clinical server. This paper describes two BAN approaches. The first one is WBAN(Wireless body area network) architecture is based on the ZigBee. The second approach is the BAN architecture uses an Atmel board as sensor platform. Both BAN designs are connected via Bluetooth to an Android smartphone, which features apps for analysis and visualization of vital parameters.

A system which could monitor real time ECG and arrhythmia detection using android based mobile device[12]. An application was developed for android based mobile devices that allow real time ECG monitoring and automated arrhythmia detection by analyzing the ECG parameters. An wireless ECG sensor is used to detect the ECG signal and the data collected will be sent to the mobile phone via Bluetooth to be processed and evaluated

A system called CUEDATA has been also proposed [13]. This is a personal ECG monitoring system which consist of the data from biosensor like heart beat. Updates about a person’s health will be given on daily basis. The developed mobile Hear monitoring solution consist of of the Personal Health Information Management

System(PHIMS)in the PDA version and also the design of an integrated electrocardiogram (ECG) beat detector. This is also incorporating with the Facilitated Accurate Referral Management System (FARMS) through wireless network.

Mayur R. Bhoyar et.al [16] has compared several existing devices and proposed a system that will continuously monitor the ECG of a patient and send an immediate alert to the doctor. The author has surveyed that heart attack caused higher percentage of death in India, and the delay in the detection and failure to get early diagnosis was

the main reason for it. There for the authors have decided to use the mobile computing technologies which will lead to the early detection of cardiovascular disease.

The author also explained that, the current available system which has the ECG system implemented in mobile phones has no automatic detection method. Those system works in a way that, the patient need to press a button and the ECG reading will be taken. Those readings need to be taken to the cardiologist to further analyze and provide treatment.

The are a system called heterogeneous wireless network system(HWNS) has been proposed. [9] The data recoded from the ECG sensor will be sent to the doctor through HWNS. It also includes the location of the patient through the GPS sensor connected. Broadband network or wireless LAN can be also used. This method will allow high data transfer. Patients old record can be also delivered using this. Table 1.1 illustrates the summary of the research done.

TABLE 1.1 Summary of proposed projects

Year	**Title**	**Explanation**
2008	A self test to detect a Heart Attack using a mobile phone and wearable sensors	* Display several questions to the user * if symptoms detected immediately call emergency contact * No symptom proceed with ECG recording

2010	Real time monitoring and detection of Heart attack using wireless sensors network	* ECG sensors used to detect the ECG signals * Data will be sent to the doctor through heterogeneous wireless network system(HWNS) * *Detect user's location through GPS sensor.
2010	A Novel method to detect a real time heart monitoring system using android smart phone	* Estimating the heart beat rate using a mobile phone camera.
2011	Development of the Irregular Pulse Detection Method in Daily Life using Wearable Photoplethysmographic Sensor	* PPG sensor used to measure the arrhythmic pulse. * Analyze the correlation between the PPG and ECG data.
2012	ECG monitoring and Alarming system based on Android smart phone	* ECG data sent to an android phone to be processed * Delivers an alarm message to the doctor and emergency contact.
2012	Cue data : A real time heart monitoring system using android smartphone	* ECG monitoring using ECG sensor * Data will be stored in a PDA version of personal health information management system(PHIMS) through wireless network.
2012	Real time ECG monitoring and arrhythmia detection using android based mobile device	* ECG sensor used to collect the ECG signals * Data sent to mobile phone via Bluetooth

2012	A mobile ECG healthcare platform	* ECG sensor used to detect the ECG signal. * Signal will be transmitted to and android phone and forwarded to a remote server.
2014	Android Base Heart monitoring and reporting system.	* Using Body sensor network. * Sensors used to detect temperature and heart rate. * Data sent via Bluetooth.
2014	Android Based body area network for the evaluation of medical parameter.	* Android OS based data collection platform. Store data in an internal memory and transmit to the clinical server.

2.1 PPG Signal

Photoplethysmorgraphy(PPG) is the detection of blood flow in the skin using infrared light. PPG is an inexpensive and a convenient health diagnostic tool. There are a lot of researches has been carried out to emphasis the potential embedded in PPG Waveform signal [20].

The Combination of ancient Greek words ‘plethysmos’ which means increase and and the word graph forms the word plethysmograph. [21]. [22]. The blood flow variation in our body which happens with every heart beat is determined and registered using PPG. There are several type of PPG, where each of them measure the variation in blood flow in different manner. [23].

Photoelectric plethysmography is one of type used in PPG which is know as photoplethysmography(PPG). Compared to other types of plethysmography, PPG is one of the inexpensive, simple and convenient type. A light source and a detector is used to detect the cardio vascular pulse wave through our body. The blood movement through the blood vessels from our heart to the fingertip is reflected by the PPG signal

in a wave like motion. [24]. In this optical measurement technique, an infrared light is sent to the tissues and the reflected light corresponds to the variation of blood flow. [22]. Further development of PPG could place this methodology among other tools used in the management of vascular disease. Figure 2.1 shows the common structure of PPG diagnostics

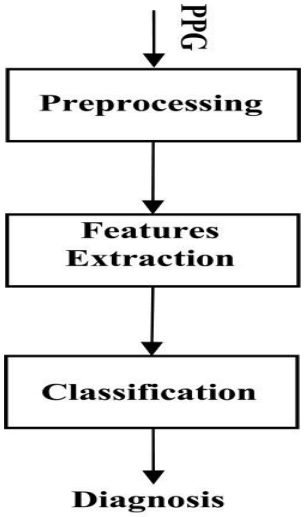

FIGURE 2.1 Common structure of PPG diagnostic

2.2 Limitation of the existing system

* The existing system does not have automatic detection and alert method. [8]

* The data collected need to be sent to the doctors in order to analyze the data and diagnose the problem. [8]

* The existing system needs action from the patient to call the relatives, which sometime won't be able by the patients. [10]

2.3 Bluetooth Protocol

In order to exchange files within a short range(2.4GHz) using wireless technology that uses radio frequency, Bluetooth will be a good technology. It consumes low power

and its cost is also inexpensive. [18]. Figure 2.2 shows the 3 groups of the Bluetooth protocol stack.

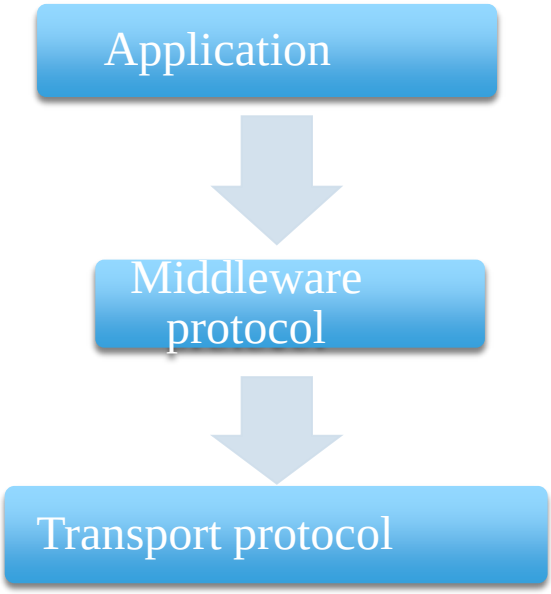

FIGURE 2.2 Bluetooth Protocol stack

Bluetooth devices will find a paring device and locate the device in the transport protocol. The synchronous and asynchronous of a Bluetooth device will be the part of the transport protocol. The figure 2.3 shows the design of the transport protocol. Table 2.1 shown the function of every element in the transport protocol.

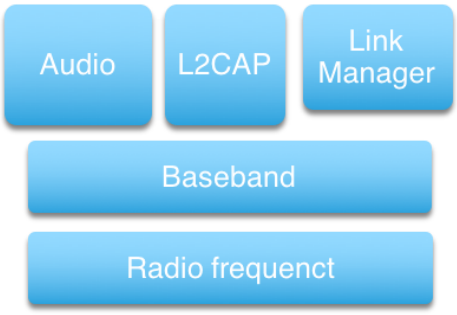

FIGURE 2.3 Overview of transport protocol.

TABLE 2.1 Protocol and its function in transport function

Protocol	Function
Audio	Responsible for physical Host Controller Interface (HCI) transport.
Logical Link Control and Adaptation Protocol (L2CAP)	Responsible for interfacing of high and low layer of transport protocol.
Link Manager	Responsible for setting up the air-interface link between Bluetooth devices.
Baseband	As a Bluetooth link controller that responsible for looking the Bluetooth devices to pair.
Radio Frequency	Bluetooth transceiver with design of 2.4GHz operating ISM band.

Audio in the protocol function will be taking care of the Host Controller Interface (HCI) transport. The air interface lint within the Bluetooth devices will be set up by the Link Manager. Besides that the lower layer and higher layer of the transport protocol will be interfaced by the Logical Link Control and Adaptation Protocol (L2CAP). In order to look for a pair for the Bluetooth devices the baseband plays a role as a Bluetooth link controller. The operating ISM band of the Radio Frequency Bluetooth transceiver will be 2.4GHz.

Bluetooth air- interfaces link will be used to work on the previous and different application in the Middleware protocol. From the host the user would control the input and output data using the Protocol Function Human Interface Device (HID) . The setting up of a Bluetooth device will be done by Telephony control protocol (TCP) RFComm Serial port emulation protocol which allows more than one protocols and

applications share same air- interface. The applications that uses Bluetooth link like such as printers, headset, dial-up networking and fax will fall under this application group. The figure 2.4 shows the design of the middleware.

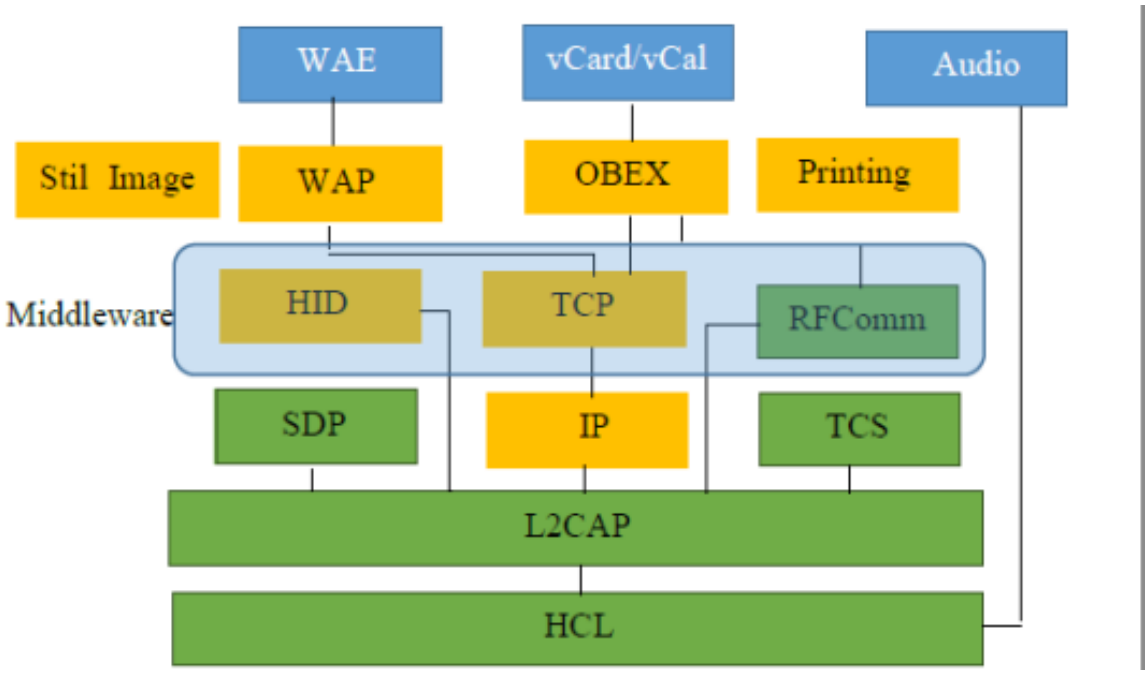

FIGURE 2.4 Design of Middleware [18]

CHAPTER 3
METHODOLOGY

According to Businessdictionary.com, research methodology is defined as the process used to collect information and data for the purpose of making business decision. The methodology includes publication research, interviews, surveys and other research techniques. The scope of review covers the theoretical analysis of the PPG signals as well as the procedures to develop an android application.

Following this, an appropriate PPG sensor was chosen and a compatible microcontroller will be used to process the signal. Android studio will be used to be the platform for application development

3.1 Project work

The figure 3.1 shows the workflow of the project for the completion of the project.

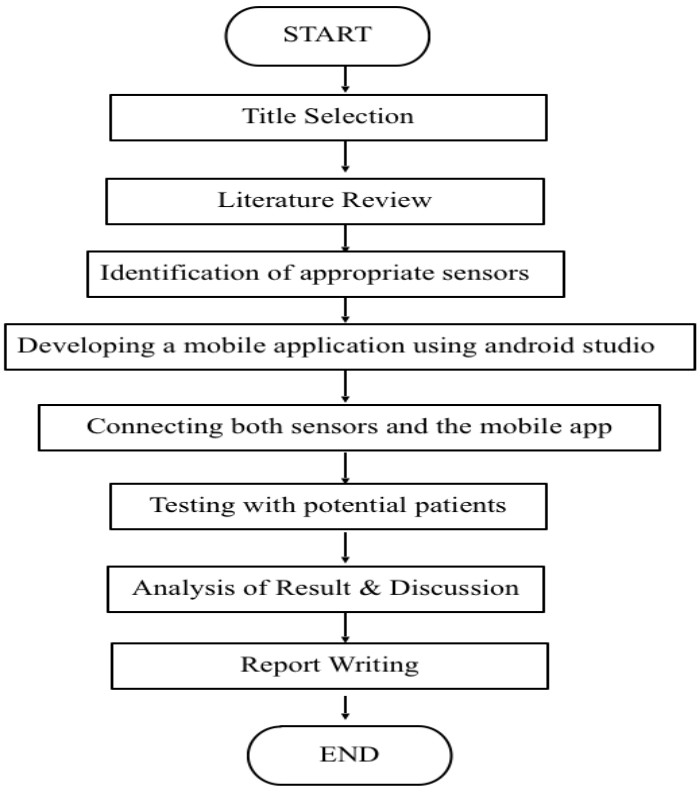

FIGURE 3.1 Work Flow of the project

3.2 Gantt Chart

3.2.1 Gant chart of FYP l

Activities/Weeks	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Selection of Project Topic														
Study on sensors suitable for heart rate detection and methods of sending data to mobile phone														
Study on android application development														
Submission of Extended Proposal														
Finalize the appropriate sensors								*						
Proposal Defense														
First draft design of the pulse rate processing circuit and transmission method														
Finalize the microcontroller Circuit and Transmission method												*		

Submission of Interim Draft Report													*	
Submission of Interim Report														*

Legends

* **Keymilestone**

Process

3.2.2 Gantt chart for FYP ll

Activities/Weeks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Purchase needed components.														
Started on the HR monitor application development														
Assemble the components and program the microcontroller														
Debug errors on the developed system														
Trial Run								*						
Data Gathering and Analysis														
Project Viva														

Documentation **a) Progress report** **b) Final Report Draft** **c) Dissertation** **d)Hardbound** **Submission**												*		

Legends

Keymilestone

Process

3.3 Tools required

Hardware

* Pulse rate sensor

* Bluebee Bluetooth Module

* Arduino smartphone

* Smartphone with Android operating system

Software

* Android studio

* Arduino

3.4 Overall Project system flow

Figure 3.2 shows the overall system flow of the project.

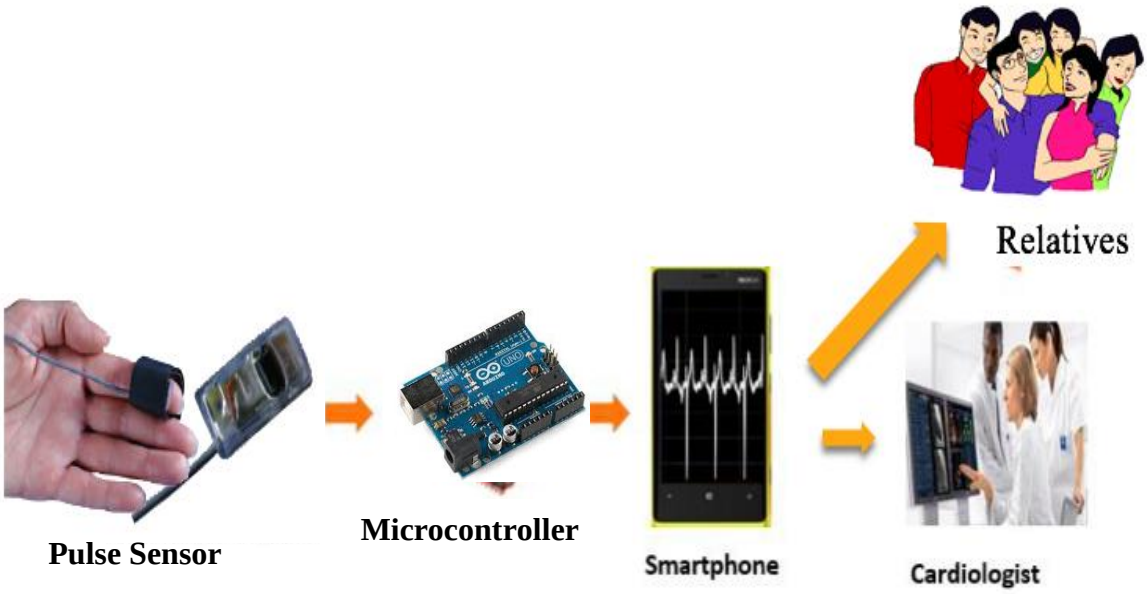

FIGURE 3.2 System Flow of the project

3.5 System Design

The concept of the real-time assessment for elderly people who are staying at home during Tachycardia and Bradycardia conditions are not able to communicate with their relatives, they also unable to inform their conditions to their relatives. Figure 3.3 below, shows the concept of communication for the real-time monitoring system.

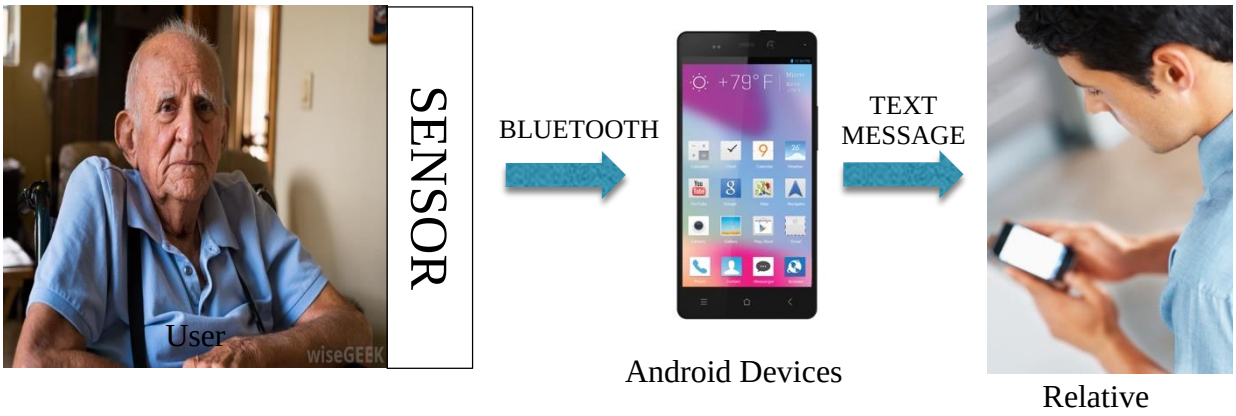

FIGURE 3.3 Concept of Communication

Based on the concept of communication design as illustrated in the figure 8, the user

will be wearing the pulse sensor that detects the heart rate of the user. The data will be then transmitted to an android smartphone. The data transmitted is via Bluetooth since the sensor the user wears and the mobile phone that they carry are near, hence Bluetooth is the best option. The application is programmed using android studio and java eclipse to receive the data from the heart rate monitoring device for every 1 seconds. As the data transits to the device at real-time, the data about the heart rate of the user are shown in the smartphone accordingly. Besides that, it has been programmed to do intelligent sampling where by it will trigger the user about Tachycardia and Bradycardia condition and also send an alert to the relatives of the user.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 System design

The concept of the real-time assessment of this project not only detects the abnormalities of a person, besides that, it also sends alerts to the users emergency contact of the patient to alert them on the patients condition. Based on the proposed concept of communication the user will be always attached with the Pulse sensor. When the signal is detected, the signal is processed through a microcontroller. With this, microcontroller will be used to convert the analogue values to digital values. The digitalized data sending to the android smartphone will be then controlled by the microcontroller via a Bluetooth module. Figure 4.1 shows the flow of the system proposed.

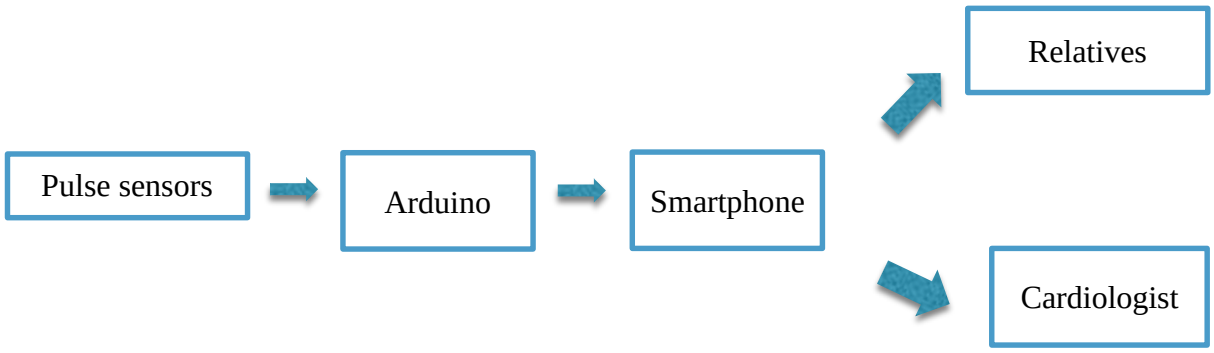

FIGURE 4.1 Flow of the system

The data is transmitted via Bluetooth since the sensor on the user and his mobile phone will be near, hence Bluetooth is the best option. The app to device technique is use in this Bluetooth scenario. The developed app will have a continuous wireless communication with the device via Bluetooth. The developed app will continuously

search for the device when it wanted to access it. The Bluebee Bluetooth module as been used in this project to search and attempt to connect with the device. A socket will be created with Bluebee by the app once the Bluebee attempts a connection with the application. The application now can receive and send data via Bluetooth transmission once the socket is created.

The pulse data then will be sent to the mobile phone once the device has been connected to the the microcontroller.. The connection manager in the phone will be responsible to send the command to the microcontroller. The initialization to receive message and send command event will be handled by the connection manager. When the 'send' command is sent, the size of the command will be informed to the Arduino by the connection manger. Once Arduino has received the size, the serial communication will be used to send the command to the Arduino. As a response to the 'send' command, the Arduino will keep sending continuous pulse data to the mobile phone. This data then will be managed by the connection manager based on the size of the message as well as the real message. Figure 4.2 show the flow of data transmission

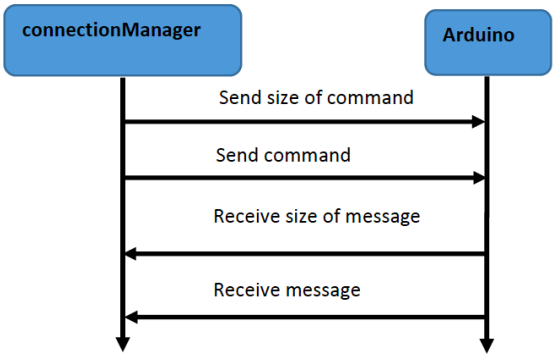

FIGURE 4.2 Flow of data transmission

In the phone, a mobile app has been developed to receive the incoming pulse data and analyze it with the threshold set. With the analyze the mobile app could identify whether the user is experiencing Tachycardia or Bradycardia. If yes, then the app will automatically send and alert to the user's relatives with this, the delay in getting doctors advice and treatment on heart rate abnormalities can be avoided.

4.2 System Specification

This section focusses on the system specifications that is used as part of the project to achieve the objective. Every important aspect of the system device is discussed in this section.

TABLE 4.1 Parameters to be monitored

No	Parameters	Specifications			
		Minimum	Typical	Maximum	Unit
1	Heart Rate	0-49 (Bradycardia)	60-100 (Nominal)	101-200 (Tachycardia)	Beats Per Minute (BPM)
2	Bluetooth Transmitter	2.4	-	2.835	Gigaherts(GHz)
3	Battery Voltage	3.5	4.2	5	Voltage(V)

From the Table 4.1, the heart rate monitoring device is able to detect the heart rate ranging from 0 BPM to 200 BPM. The nominal heart rate of a human being aged above 15 when they are at rest is from 60 BPM to 100BPM. The condition when their heart beat drops below 59 BPM is called as Bradycardia, whereas the situation when their heart beat shoot up above 100 BPM is called as Tachycardia.

The heart rate data from the heart beat sensor is transmitted via Bluetooth to the android phone at the range of 2.4 GHz to 2.835 GHz. The battery life span of the physiological monitoring sensors are 24 hours. The time taken for it to be fully charged is 3 hours.

4.2.1 Pulse sensor and Arduino

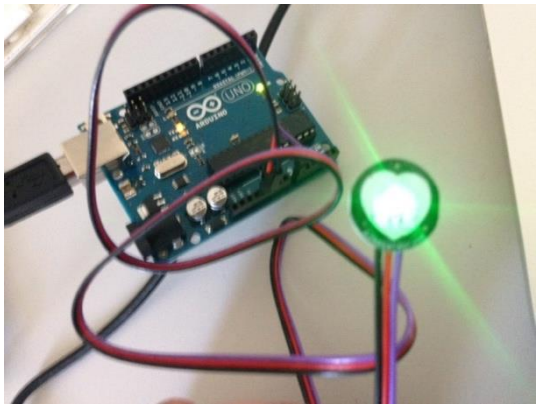

FIGURE 4.3 Pulse sensor with microcontroller

The pulse sensor is compatible with Arduino. This will allow the microcontroller to record the PPG signal which will be used to detect the heart beat per minute of an individual. For a reliable pulse reading this sensor this sensor combines an optical sensor with noise cancellation and amplification circuit. The above circuit is very much compatible to be used with mobile application since it works in 4mA current draw at 5V.

4.2.2 Bluebee Bluetooth module

FIGURE 4.4 Bluetooth Module

BlueBee used in this project as the Bluetooth module to transmit data wirelessly. A simple coding will be done to transmit the data to computer as a testing for the bluebee transmission. Once this Bluebee verification has been completed, it will be implemented in the Arduino and Pulse sensor circuit. The pin assignment on the Arduino will be declared earlier for connection purpose.

4.2.3 Android smart Phone

A smartphone with an android processor is also a part of the system. An application compatible with android platform is created. The data sent from the pulse sensor will be received by the mobile application and an alert will be sent to the emergency contact of the user if Tachycardia or Bradycardia conditions are being detected.

4. 3 Android Application

An android application Android studio as been developed as the part of this project. The application works as a platform to transmit and receive data from the microcontroller. The data received from the microcontroller will be displayed in the app as show in the figure 4.5. The will then analyze and send alert to the user's relatives if there are any abnormalities in the heart rate.

FIGURE 4.5 Screenshot of android application

Based on the figure 12, HR-Monitoris the app name. At the top center of the application there are text stated as "! welcome to HR-Monitor!", to welcome the user to the application. At the top right of the screen the is a button with Bluetooth symbol which will assist the user to connect to the sensor. When the button is clicked, a list of available devices will appear on the screen as shown figure 4.6.

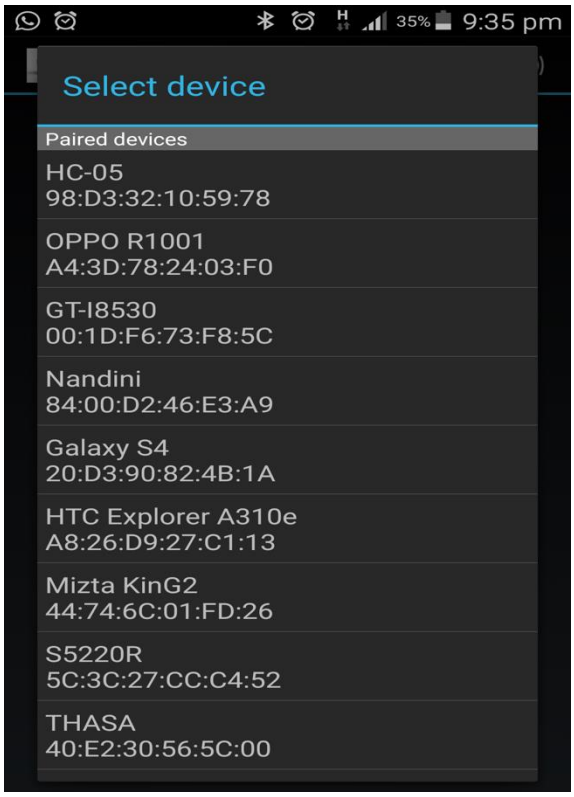

FIGURE 4.6 List of available devices

The user need to choose the HC-O5 which will be the device's name. With this the application and the sensor circuit is now connected. The pulse rate data transmission from the microcontroller to the application begin when the user wears the pulse sensor as shown in the figure 4.7.

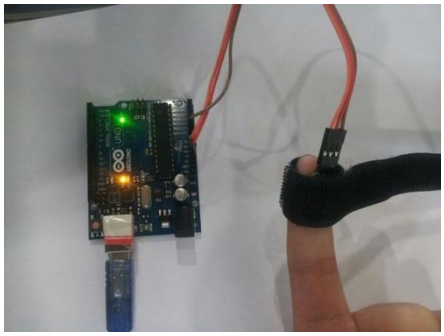

FIGURE 4.7 User wearing pulse sensor

4.4 Bluetooth Connection

The Android Platform supports the Bluetooth network will allow the device to receive and transmit data wirelessly. [11] It also allows multiple connections to take place. The Figure 4.8 shows flow diagram of Bluetooth connection from the microcontroller circuit to the mobile application.

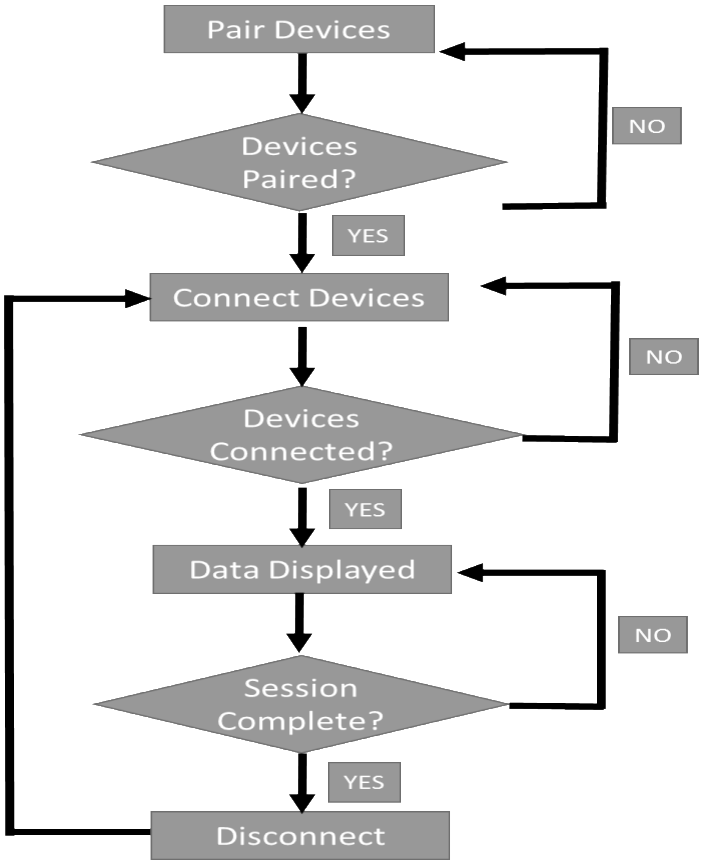

FIGURE 4.8 Flow of Bluetooth connection in the application

Figure 4.9 shows the coding on the Android Studio for the Bluetooth connection. The Heart Rate monitoring device has its own MacID. The HR monitor app is created to be connected to that specific MacID. Hence the heart rate data from the device can be received accordingly. The MacID for the Heart rate monitoring device is "E0:D7:BA:A7.FE:9A.

```
Button btnConnect = (Button) findViewById(R.id.ButtonConnect);
if (btnConnect != null)
{
    btnConnect.setOnClickListener((v) → {
            String BhMacID = "E0:D7:BA:A7:FE:9A";
            //String BhMacID = "00:07:80:9D:8A:E8";
            //String BhMacID = "00:07:80:88:F6:BF";
            adapter = BluetoothAdapter.getDefaultAdapter();

            Set<BluetoothDevice> pairedDevices = adapter.getBondedDevices();

            if (pairedDevices.size() > 0)
            {
                for (BluetoothDevice device : pairedDevices)
                {
                    if (device.getName().startsWith("BH"))
                    {
                        BluetoothDevice btDevice = device;
                        BhMacID = btDevice.getAddress();
                        break;

                    }
                }
```

FIGURE 4.9 Android studio coding for Bluetooth connection

Once the heart rate monitoring device is paired with the smartphone, The status of Bluetooth connection will be displayed in the application whether connected or not. Figure 4.10 shows the coding for the status message to be displayed on the application. When the device is connected to the application the “Connected” status will appear. Once the device has been chosen from the available list the “ Connecting…” status will appear. Whereas, when the connection failed the “Not Connected” status will be appeared. When this device is paired with the smart phone, any other Bluetooth devices other than heart rate monitoring device will not be able to connect to the mobile phone. This device works as one way terminal. This will make sure that the will be no any interruption from the third party when the device is connected When the device is connected the application, it indicates the application is ready to receive data from the device. The packet data from the heart rate monitoring device will be received by the smartphone. The user may end the data transmission by disconnecting the the device from the application.

```
@Override
public void handleMessage(Message msg) {
    DeviceControlActivity activity = mActivity.get();
    if (activity != null) {
        switch (msg.what) {
            case MESSAGE_STATE_CHANGE:

                Utils.log("MESSAGE_STATE_CHANGE: " + msg.arg1);
                final ActionBar bar = activity.getSupportActionBar();
                switch (msg.arg1) {
                    case DeviceConnector.STATE_CONNECTED:
                        bar.setSubtitle(MSG_CONNECTED);
                        break;
                    case DeviceConnector.STATE_CONNECTING:
                        bar.setSubtitle(MSG_CONNECTING);
                        break;
                    case DeviceConnector.STATE_NONE:
                        bar.setSubtitle(MSG_NOT_CONNECTED);
                        break;
                }
                break;
```

FIGURE 4.10 Coding to display the connection status

4.5 Receiving Data

In this section, the route of the data transmission from the heart rate monitoring device to the smartphone application which is H-Das is being discussed. The data transmitted by the heat rate monitoring device is through packet data. To recognize the value of the heart rate, the header of the packet data is important so that the data is received properly. An hexadecimal value has been assigned to the heart rate data that need to be monitored. The data transmitted is in real time and it is transmitted every one second. After getting the string data from the device, it is stringed to the text box which will be displayed at the screen of the app. It order to display the data in appropriate position the GUI of the app is programmed. Figure 4.11 shows the programming code of the mobile application GUI which will ensure the data received is directed to the box assigned correctly. The id indicated the identification for the particular text in this case is for the heart rate. The text calls upon the data of heart rate in which the number of heart beats per minutes will be displayed.

```
<TextView
    android:layout_width="wrap_content"
    android:layout_height="wrap_content"
    android:text="Heart Rate"
    android:id="@+id/HRTextBox"
    android:layout_gravity="left|top"
    android:textSize="40dp"
    android:layout_centerVertical="true"
    android:layout_centerHorizontal="true" />
```

FIGURE 4.11 GUI

4.6 Intelligent Monitoring.

This android Based heart rate monitoring device doesn't only receive and display the on the application. It also sends alert to the emergency contact of the user when the condition for tachycardia and bradycardia has been detected. The figure 4.12 shows the flow diagram of the alert system.

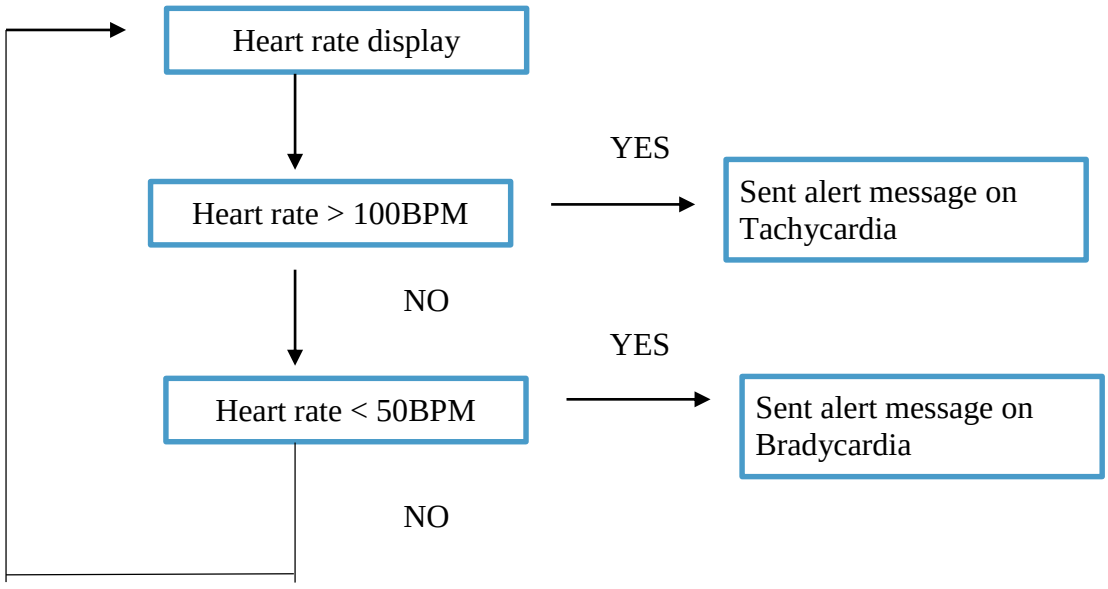

FIGURE 4.12 Flow diagram of the alert system

Figure 4.12 shows that, when the heart rate per minute exits 100BPM, it is considered as Tachycardia, whereas when the hear rate drops below 50 BPM it is considered as

bradycardia. When either of this condition detected, and alert SMS will be sent to the emergency contact of the user.

4.7 Data Validation

This section discuss about the data validation process carried out in order to make sure the hear rate data given by the hear rate monitor is valid. In order to validate the data, the device has been tested with 10 users from different age group. The result was compared with an IOS application which also uses PPG signal[26] to measure the heart rate. Figure 4.13 and 4.14 shows the comparison of heart beat displayed in both application. Table 4.1 shows the comparison of heart beat of 10 user according to their age.

FIGURE 4.13 BPM obtained from HR

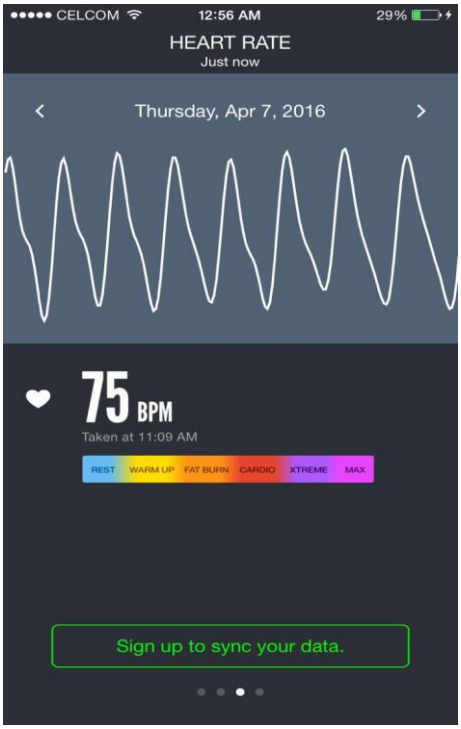

FIGURE 4.14 BPM obtained from IOS

TABLE 4.2 Comparison of BPM

No	Age	Gender	Heart Rate	
			HR Monitor	IOS application
1	18	F	59	61
2	25	M	64	65
3	20	M	68	68
4	32	M	73	75
5	30	F	65	67
6	45	F	68	66
7	60	M	72	72
8	62	F	69	68
9	65	M	60	59
10	56	M	66	66

Table 4.1 shows the comparison of heart beats for 10 different users using HR monitor and IOS application. From the result, both data are similar. With this the data from HR monitor is proven to be a valid data.

4.8 Power Consumption

For the power supply of the heart rate monitor device a 5000mAh 3.7 V lithium polymer battery will be used. This is because the pulse sensor, Bluetooth module and the microcontroller needs at least 3.3V to be powered up. It also consumes 0.23A of current as shown in figure 4.15. So using the equation below it has been calculated that, for 21 hours of usage we need 5000mAh. Therefore, this battery has been chosen.

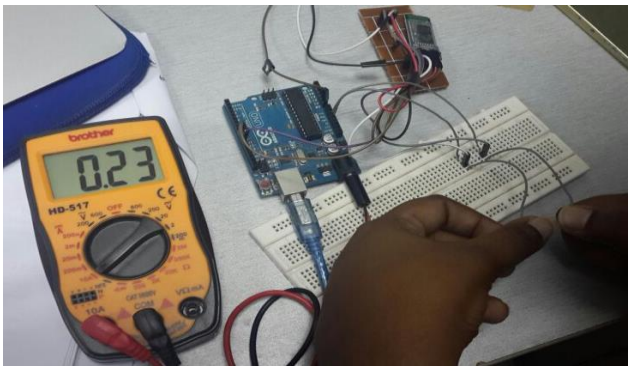

FIGURE 4.15 Current consumption

$$Battery\ Life = \frac{\text{Battery Capacity in Milli amps per hour}}{\text{Load Current in Milli Amps per hour}}$$

$$\text{Battery Capacity} = \text{Battery Life x Load current}$$

$$\text{Battery Capacity} = 21\text{H x } 230\text{mA}$$

$$= 4830\text{mAh}$$

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

In a nutshell, an android application was successfully created as part of the android platform for the smartphone to cater the data received from the Heart Rate monitoring devices. The heart rate data transmitted from the monitoring device have been successfully received by the android platform. The android application is able to interpret and display the value of heart rate. When the data received is incompatible with the threshold set, an alert about the user's condition will be sent to the user's emergency condition.

5.2 Future Recommendation

In future the heart rate data transmission can be done via Wi-Fi instead of Bluetooth. This will ensure that the arrhythmia conditions can be also detected if the user is far away from their mobile phone. Besides that, the mobile applications can be also developed in a way where the users can key in their basic personal detail like their age, blood pressure, breathing rate or any other health situation, which will be significant to determine the most appropriate threshold to detect tachycardia and bradycardia. Further more a data storage system can be also implemented so the user can provide those data to their doctors to analyse during their regular medical check ups.

CHAPTER 6

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