APPLICATION SYSTEM MONITORING DEVICE FOR ARRHYTHMIA BASED ON INTERNET OF THINGS

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THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF BACHELOR OF ELECTRONIC ENGINEERING TECHNOLOGY (MEDICAL ELECTRONICS) WITH HONOURS

DEPARTMENT OF ELECTRICAL ENGENERRING
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DECLARATION

I hereby declare that the work in thesis is my own except for quotation and summaries which have been duly acknowledged.

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ABSTRACT

Medical devices have been improved with rapid growth of technologies. Electrocardiogram (ECG) is one the best way to obtained the heart condition information. An ECG can provide and analysed data such as heart beats, heart rhythm and type of heart disease. The percentage of death of heart patient do increase. Lack of awareness among the public on heart rhythm disease which is one of the main causes of sudden death or weaken a heart condition. In addition, the patients need to spend few hours in order to check the heart condition frequently. This paperwork describes on the Internet of Things (IoT) based product which is android mobile application receiving the data from heart rate sensor (AD8232) sent to the microcontroller and transmit in form of electrical signal (ECG signal) in real time and heart rate via Bluetooth module and Wi-Fi from a user and display on the smartphone screen. The device with ability of monitoring heart patients and alert the caregiver via smart phones by using Android Application. The android application is providing the data to the user and caregiver so that the caregiver able to monitor the patient from long and short distance. The output will be sent via Bluetooth and WIFI medium. The display of the output on an android mobile application which is friendly user and simple method of usage was applied in handling this device. This device will help the society to take good care of their heart in good condition. In addition, device may use as educational purpose to learn on how the heart is functioning with several types of arrhythmia Indirectly, it creates awareness to all stage of ages.

Keywords: Electrocardiogram (ECG), Heart rate sensor, Android Application

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ABSTRAK

Alat perubatan telah dipertingkatkan dengan pertumbuhan pesat teknologi. *Elektrokardiogram (EKG)* adalah satu cara terbaik untuk mendapatkan maklumat keadaan jantung. EKG boleh menyediakan dan menganalisis data seperti denyutan jantung, irama jantung dan jenis penyakit jantung. Peratusan kematian pesakit jantung meningkat. Tambahan pula, kurang kesedaran di kalangan orang ramai mengenai penyakit irama jantung yang merupakan salah satu punca kematian mendadak atau melemahkan keadaan jantung. Di samping itu, pesakit perlu menghabiskan beberapa jam untuk memeriksa keadaan jantung dengan kerap. Kertas kerja ini menerangkan produk berasaskan *Internet of Things (IoT)* yang merupakan aplikasi mudah alih android yang menerima data dari sensor denyutan jantung *(AD8232)* yang dihantar ke mikrokontroler dan menghantar dalam bentuk isyarat elektrik (isyarat EKG) dalam masa nyata dan kadar jantung melalui modul *Bluetooth* dan *Wi- Fi* dari pengguna dan paparan pada skrin telefon pintar. Alat dengan keupayaan memantau pesakit jantung dan memberi amaran kepada penjaga melalui telefon pintar dengan menggunakan aplikasi android. Aplikasi android menyediakan data kepada pengguna dan pengasuh supaya penjaga dapat memantau pesakit dari jarak jauh dan pendek. Hasil pengeluaran akan dihantar melalui media *Bluetooth* dan *WIFI*. Paparan hasil pengeluaran pada aplikasi mudah alih android yang merupakan pengguna yang mesra dan kaedah pemakaian yang mudah telah digunakan untuk mengendalikan alat ini. Alat ini akan membantu masyarakat untuk menjaga jantung mereka dalam keadaan baik. Di samping itu, alat boleh digunakan sebagai tujuan pendidikan untuk mengetahui bagaimana jantung berfungsi dengan beberapa jenis *Arrhythmia*. Secara tidak langsung, ia mewujudkan kesedaran kepada semua peringkat umur.

Kata Kunci: Elektrokardiogram (EKG), Sensor kadar jantung, Aplikasi Android

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Arrhythmia is a medical condition that covers a wide range of cardiac pathology. Arrhythmia define heart rhythm irregularity of a human [1]. It causes the heart rhythm too fast (tachycardia), too slow (brachycardia) or irregular. In addition, arrhythmia cause the heart does not pump enough blood to the body, which lead to the brain, heart and other vital organs damages. ECG devices are the vital medical equipment used by medical experts to detect arrhythmia. Heart health is categorised as one of important parameters to be monitored for normal human and especially heart disease patients. Continuous monitoring while doing daily life activity and condition of heart for bedridden patients can be observe to determine the condition of the heart. In addition, the ECG data recording can be very useful for analysis by professionals and support the mobility of monitoring system. Nowadays, the smart phone has a highspeed processor to support digital signal processing in real time. Smart phone devices also have been widely used for biomedical signal recording and analysis of the medical data. Tonnes of researchers had done research on heart monitoring system using smartphone with different kind of methods. However, it remains necessary justification of medical experts to diagnose [2]. In this project, the main focus on detection of several types of arrhythmia, alarm system during emergency, location tracking using GPS and the data of patient health condition received and recorded in Android application. To secure the data from losing during the transmission via Wi-Fi to Android application, SD card had insert in this device to record the ECG data. Contribution of this research is developing a mobile ECG device towards Internet of Things (IoT) application and low-cost ECG as alternative medical devices and affordable to user.

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1.2 PROBLEM STATEMENT

Heart rhythm disease had become one of the causes which may lead to heart disease or sudden death. Nowadays, the percentage of death of heart patient do increase. Lack of awareness among the public on heart rhythm disease which is one of the main causes of sudden death or weaken a heart condition. In addition, the patients need to spend few hours in order to check the heart condition frequently.

1.3 PROJECT OBJECTIVE

1. To develop a heart rhythm monitoring device for heart disease patients.
2. To study the relationship between heart rate and ECG wave.
3. To identify the benefit gain of the heart disease patients by using Arrhythmia monitoring device.

1.4 BLOCK DIAGRAM

Figure 1.1 shown the block diagram of the device function with the connection of hardware and software. There are 3 parts are divided which is input, process and output. The block diagram mainly described on the components for the input, process and output in order to produce and received data within the device and smartphone. The 2 types of medium used to receive data and display on android application.

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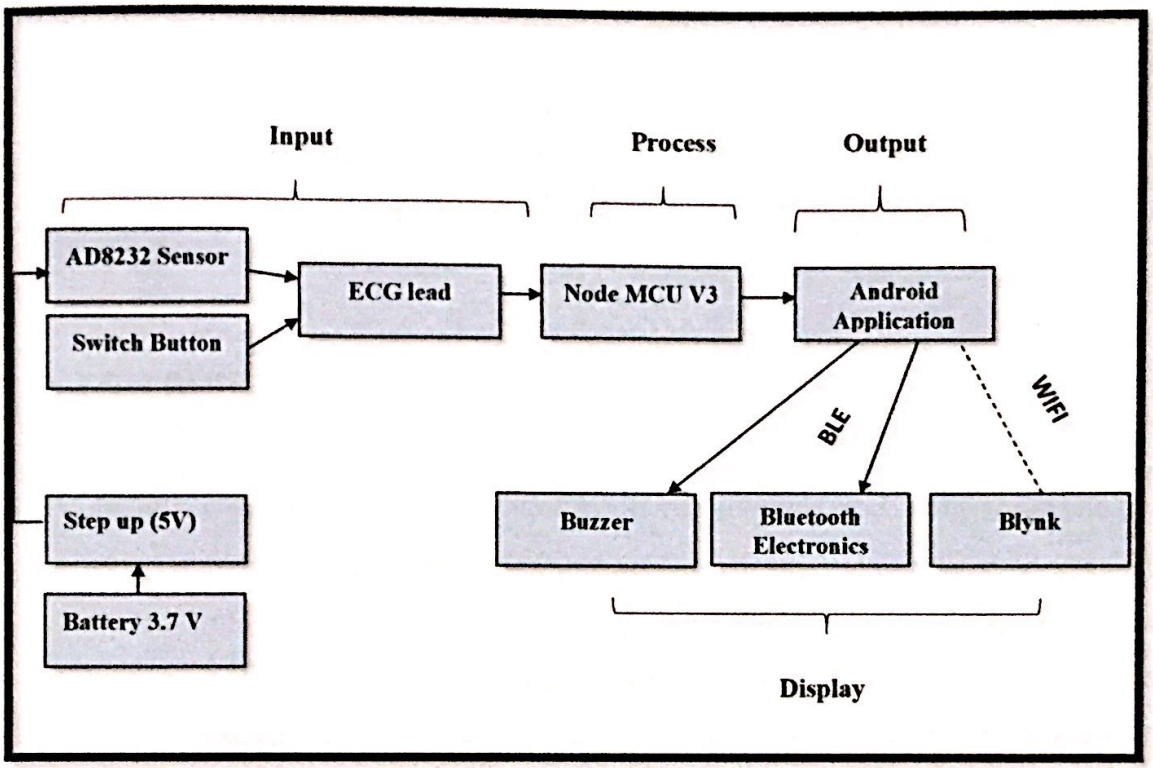

Figure 1.1: Block diagram of the device.

1.5 SCOPE

The scope of this project is mainly for heart disease patient. It comprises of continuous monitoring of heart rhythm and heart rate. Heart rate sensor had been the main input which transferring the electrical signal captured from the heart. The data captured will be processed and send to the android application via Bluetooth and WIFI medium. Its help the caregiver to take care of the user by receiving alert message via Email and produce of alarm during emergency. This device able to detect 5 types of Arrhythmia which is Sinus rhythm, bradycardia, tachycardia, ventricular tachycardia and atrial flutter. It is an early stage of Arrhythmia that should be focused.

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CHAPTER 2

LITERATURE REVIEW

2. 1 INTRODUCTION

In this chapter the main discussion on the journals and facts researched to identify the problem statement and objective. Several journals are referred and facts are studied to get the idea on developing this project. The importance of heart monitoring devices to community especially heart patients saved from heart disease. The innovation of this device is increasing drastically in market due to demand for this device. Numerous of researches and proposal of idea had been bring forward to innovate heart monitoring devices.

2. 2 DISEASE

The heart is a pump that is driven by a series of electrical impulses produced by a bunch of special cells in the right atrium, called the sinus node. The sinus node is sometimes called the heart's 'natural pacemaker'. The sinus node produces pulses of electrical activity that spread through the heart's cells, causing the heart muscle to contract. When the electrical signals travel through heart, it's like electricity going down a circuit of wires. The electrical impulses from the sinus node travel down through the atria to special cells in the AV node. These impulses make the atria contract. This squeezes blood into the ventricles (the two lower chambers of the heart). The impulses then travel from the AV node through the ventricles via an electrical pathway. These electrical impulses cause the ventricles to contract and squeeze the blood out of heart to body and lungs.

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The heart's normal rhythm is called sinus rhythm. Its rate is between 60 and 100 beats per minute (bpm) while are resting. If the sinus rhythm is slower than 60 bpm, it is called sinus bradycardia. If the sinus rhythm is faster than 100 bpm, it is called sinus tachycardia. ('Brady' means slow and 'tachy' means fast.) The normal heart rate varies from minute to minute, depending on the demands on the heart. Sinus arrhythmia is a normal variation of sinus rhythm, where the heart rate increases very slightly as take a breath in. Sinus rhythm, sinus bradycardia, sinus tachycardia and sinus arrhythmia are all normal heart rhythms where the electrical impulses travel in a normal way through the heart [9].

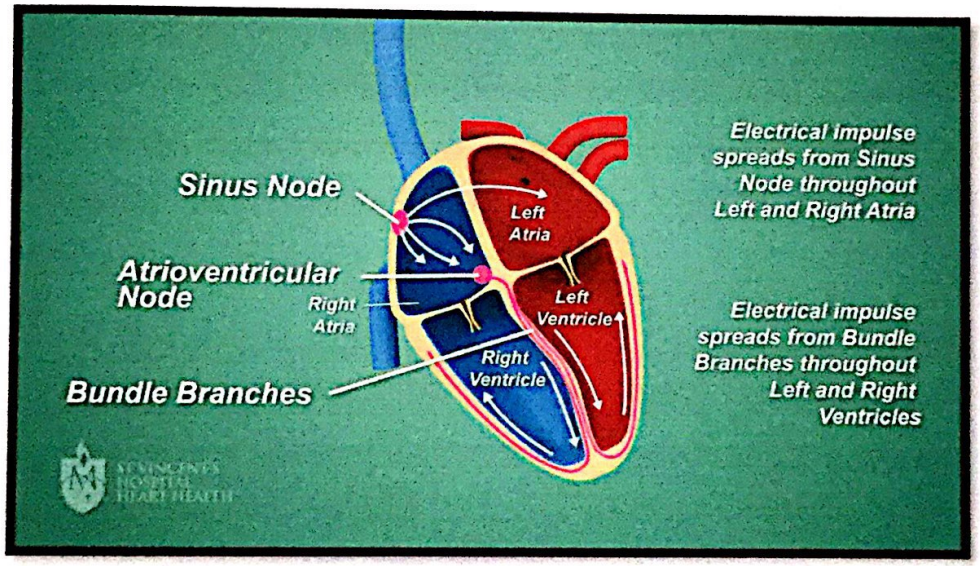

Figure 2.1: Flow of electrical signal in heart.

According to European heart disease and heart failure Congress millions of people across the world are affected by cardiac disorders. Some are categorised as minor others critical. As per World Health Organization (W.H.O.) research, more than 17.5 million people have CVDs, an estimated 31% of all deaths worldwide and 80% of all CVD deaths are due to heart attacks and strokes. According to the market study, the expectation on Cardiovascular disease in 2019 may grow from $13.7 billion to 18.2 billion. Due to this seriousness, a major part of research is going on the top universities

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on Cardiology conferences 2019 across the globe. It has been clearly seen, the number of companies are associated with various diagnostic instruments and other therapeutics [3].

According to Yayasan Jantung Malaysia, arrhythmias are defines as an abnormal heart rhythms which caused by issues with the electrical framework that manages the enduring pulse in atria, ventricles, junctions or because of the blocks formed. The heart rate may too fast or too slow and also can produce irregular heart rhythm. A few arrhythmias are extremely unsafe and cause sudden cardiovascular death, while others might be troublesome yet not dangerous [12]. World heart rhythm conference had centralized this issue as one of the causes lead heart disease. Arrhythmia disease can be prevented by monitoring in the early stage with the symptoms. Creating awareness to the public about the heart rhythm disease can save a person from death due to irregularities of heart rhythm.

As per stated on Star newspaper, "When you have a sudden cardiac arrest, it's mainly two issues. It's either a plumbing issue, that is, the narrowing of a blood vessel, which is blocked, or an irregular heart rhythm, where the heart rate goes either too fast or too slow," says consultant cardiologist and electrophysiologist Dr Azlan Hussin. "Whatever the cause, the end point is that a person dies suddenly [5]." It clearly shown irregular of heart rhythm may lead to heart disease which the public need to emphasize on.

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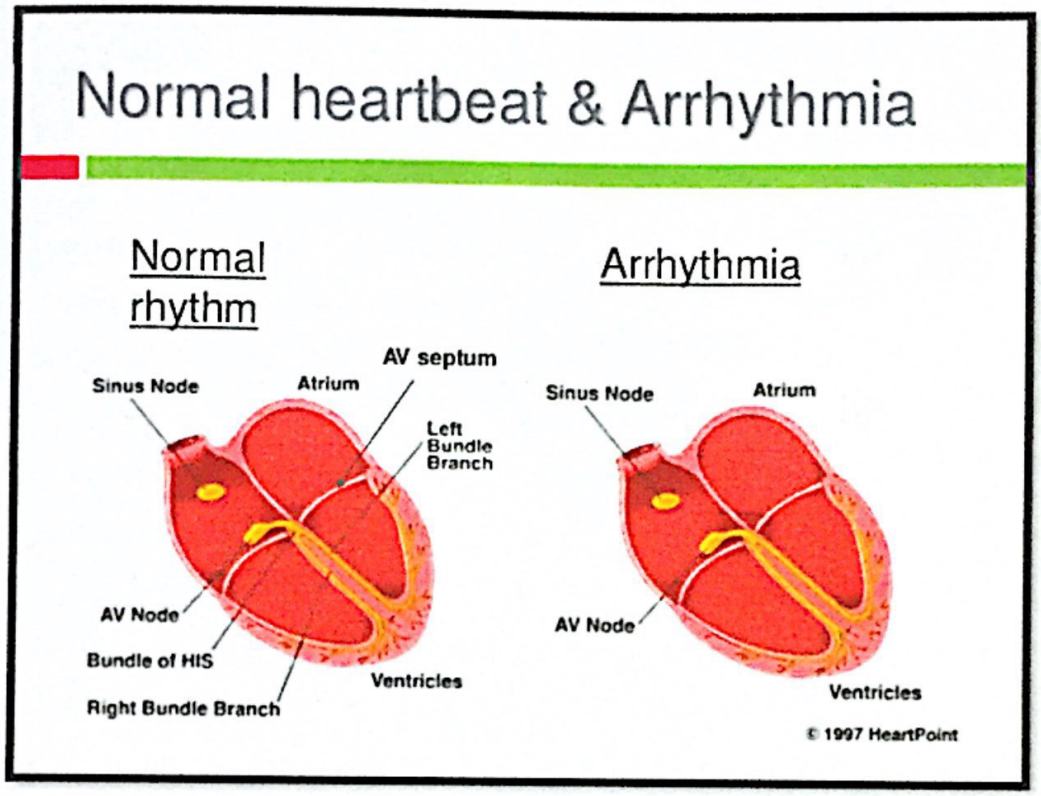

Figure 2.2: Normal and abnormal flow of electrical signal.

2. 3 HARDWARE

Hardware is important part in project development. Several components had been chosen via the research which is compatible to the project functioning.

2.3.1 Heart rate sensor

A person's heartbeat is the sound of the valves in his/her heart contracting or expanding as they force blood from one region to another. The number of times the heart beats per minute (BPM), is the heart beat rate and the beat of the heart that can be felt in any artery that lies close to the skin is the pulse [18].

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- **Manual Way**: Heart beat can be checked manually by checking one's pulses at two locations- wrist (the **radial pulse**) and the neck (**carotid pulse**). The procedure is to place the two fingers (index and middle finger) on the wrist (or neck below the windpipe) and count the number of pulses for 30 seconds and then multiplying that number by 2 to get the heart beat rate. However, pressure should be applied minimum and also fingers should be moved up and down till the pulse is felt [18].
- **Using a sensor**: Heart Beat can be measured based on optical power variation as light is scattered or absorbed during its path through the blood as the heart beat changes.

ECG records the electrical activity generated by heart muscle depolarizations, which propagate in pulsating electrical waves towards the skin. Although the electricity amount is in fact very small, it can be picked up reliably with ECG electrodes attached to the skin (data unit: microvolt, uV). The full ECG setup comprises at least four electrodes which are placed on the chest or at the four extremities according to standard nomenclature (RA = right arm; LA = left arm; RL = right leg; LL = left leg). Of course, variations of this setup exist in order to allow more flexible and less intrusive recordings, for example, by attaching the electrodes to the forearms and legs. ECG electrodes are typically wet sensors, requiring the use of a conductive gel to increase conductivity between skin and electrodes [15].

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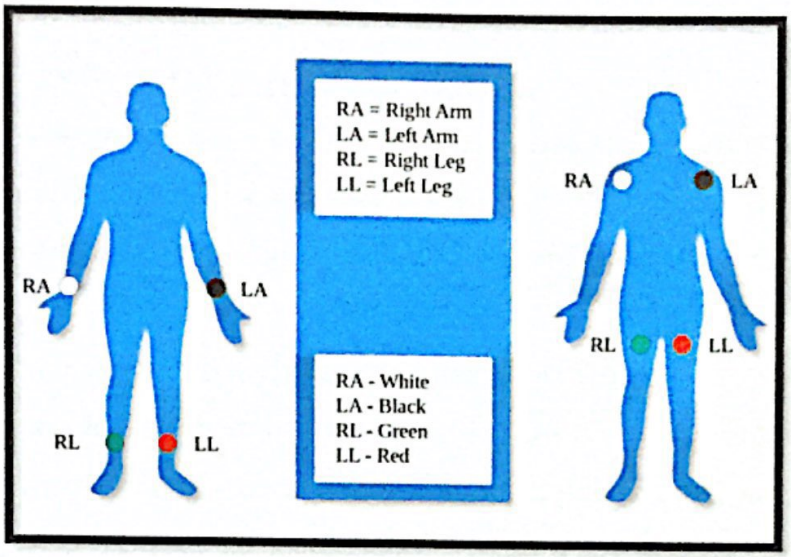

Figure 2.3: Attachment of ECG lead on body.

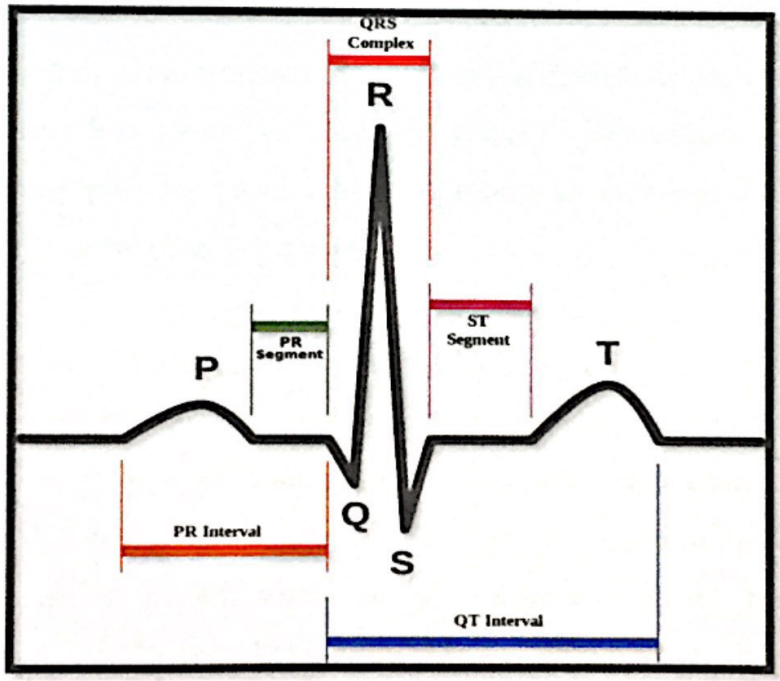

Figure 2.4: PQRST waveform.

Heart Rate (HR). HR reflects the frequency of a complete heartbeat from its generation to the beginning of the next beat within a specific time window. It is typically expressed as beats per minute (bpm). HR can be extracted using ECG and PPG sensors [15].

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2.3.2 Microcontroller

A microcontroller is a compact integrated circuit designed to govern a specific operation in an embedded system. A typical microcontroller includes a processor, memory and input/output (I/O) peripherals on a single chip.

Sometimes referred to as an embedded controller or microcontroller unit (MCU), microcontrollers are found in vehicles, robots, office machines, medical devices, mobile radio transceivers, vending machines and home appliances among other devices. A microcontroller's processor will vary by application. Options range from the simple 4 bit, 8-bit or 16-bit processors to more complex 32-bit or 64-bit processors. In terms of memory, microcontrollers can use random access memory (RAM), EPROM or EEPROM. Generally, microcontrollers are designed to be readily usable without additional computing components because they are designed with sufficient onboard memory as well as offering pins for general I/O operations, so they can directly interface with sensors and other components.

Common MCUs include the Intel MCS-51, often referred to as an 8051 microcontroller, which was first developed in 1985; the AVR microcontroller developed by Atmel in 1996; the programmable interface controller (PIC) from Microchip Technology; and various licensed ARM microcontrollers. A number of companies manufacture and sell microcontrollers, including NXP Semiconductor, Renesas Electronics, Silicon Labs and Texas Instruments.

Microcontrollers are used in multiple industries and applications, including in the home and enterprise, building automation, manufacturing, robotics, automotive, lighting, smart energy, industrial automation, communications and internet of things (IoT) deployments [20] .

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2.3.3 Bluetooth module

Bluetooth wireless technology features low-bandwidth, short-range connection between two devices enabled to receive the data. The structure behind this technology is complicated, and the extent of operation is implementation specific. Using Bluetooth is not difficult and allows many useful features that enhance today's technology [21].

2.3.4 Android mobile

A quiet revolution has been going on in the medical profession and the field of personal health in the last two years, spearheaded by smartphones and tablets, that will change forever the way we obtain and process medical information. It is reported that over 80% of US physicians carry smartphones, and north of 30% carry tablets for their medical needs, overwhelmingly Apple's iPad, although slates like the BlackBerry PlayBook, or Android tablets like the HTC EVO View 4G with its capacitive stylus pen are also being adopted. Healthcare services by phone, however, don't have to be high tech. Although many people in low- and middle-income countries (LMICs) own a mobile phone, far fewer of them own a smartphone compared to people living in high income countries, and simple text messages are increasingly being used as a tool in a number of healthcare-related settings [2].

2. 4 SOFTWARE

2.4.1 Programming

The software part of this project consists of writing the coding on how the project going to be functioning. Suitable algorithm will be creates using

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programming software. Multiple of software available in order to create the algorithm and to test run.

2.4.2 Android Application

Android application developer had developed open source application to be easily used by the android user. Some of the application may help in providing the health data information to the patients and users. It has been the very useful and helpful for the inventors in order to synchronizing the application with the product developed. Moreover, the user and inventor may create their own application in the android platform. As usual, it's all about the apps, and there is no shortage of them both in the App Store and Android Market. From diet helpers, through online medical records management with HMO, to 3D visualization of the body that is replacing the atlases of human anatomy or interactive step-by-step treatment guides - the possibilities here are endless.

They have become so prolific and comprehensive, that the federal Food and Drug Administration felt the need to craft a review and approval process for medical apps, which is about to be enforced for the most vital ones out there. On the chopping block first will be those that transform the smartphone or tablet into a medical device, such as glucose meters or blood pressure monitors, and which control existing FDA-approved gear like insulin pumps.

General fitness and diet apps, or medical reference compilations won't need the FDA approval, and there are many of those, for almost each and every field of modern medicine. While in the beginning they were simply digital copies of medical encyclopaedias and popular journals, now they have entered the Medicine 2.0 era with interactivity and search functions galore [2].

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CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter, mainly discuss on method used to proceed this project. Several methods had been successfully applied to get the information and data. Tonnes of reading material has read to create the flowcharts and identified components to be used for this project development which is suitable to monitored the disease. Recently, the number of researches done on Arrythmia disease device has increase. Different kind of methodology is proposed by the researchers which helps the future researchers. Some had successfully developed the device with latest technology and Internet of Things. The concept of Internet of Things recently used in all medical equipment to make it easy in data transferring and save time.

3.2 OBSERVATION

One of the methods applied during the progression of this project is observation. Observation on several project that had been done by seniors of degree studies and diploma students during their final year presentation. Some ideas are collected during the observation of the project to improvised on this project idea. The importance of device based on heart are always given priority compare to other. Heart is one of major part of the body. This method had conducted for 1 month around polytechnics and hospitals. The information gained from polytechnic the importance of developing devices for heart patients. Lecturers are encouraged in idea of developing with heart monitoring and alerting system devices. Next, observation around the hospitals feed with the information on number of patients attending hospitals in one month especially

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heart disease. The finding helps improvising the effectiveness of device functioning. Lastly, by observing it had help to identify the problems need to solve and the importance in innovating heart disease monitoring devices.

3.3 QUESTIONNAIRE

Questionnaire has been one of the best methods in identifying the importance of developing of a product with customers or user requirements. It also helps the inventor to specify the features, parameters, size of products and methods of usage. Once the product was done the post questionnaire was done in order to know the efficiency, usability and comfortability of the product to the user. Several questionnaires were done with scaling method of answering to easily decide the efficacy of the product to the society.

3.3.1 Pre-Questionnaire

Pre-questionnaire was done before the development of the project started. It is the initial process whereby to identify the methodology of the product. It is important to research on the parameter, method of usage, availability of the same product in market and how the customers prefer to improve the available product in market. By applied this method the inventor able to recognise on how to develop the product as customer preference. The results are shown below on figure 3.1 with the attachment of sample of questionnaire on appendices.

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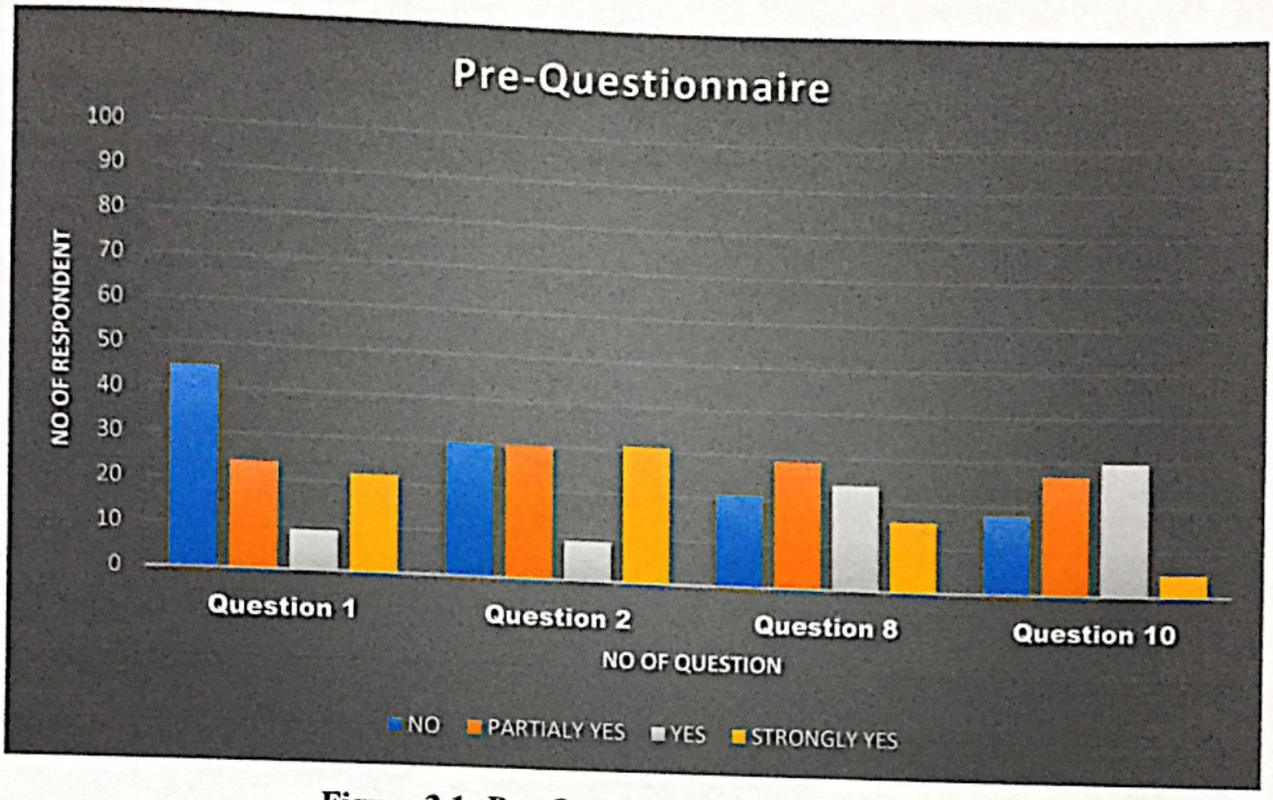

Figure 3.1: Pre-Questionnaire results.

The results from the pre-questionnaire shown above. The graph mainly on scaling question to getting know on how much the knowledge of the society on heart rhythm disorder. These questionnaire sets distribute among electrical department in order to knew the importance of the heart monitoring devices. From this survey had been proven most of the public are not aware on heart rhythm disorder which is the early sign of heart malfunctioning. There could be any symptom to lead to heart disease. In order for that, the public needs to monitor their heart condition frequently. Even the consumers are preferring wireless device which they able to bring anywhere in this world and connected to the smartphones. Smartphones are the one of the things that everyone brings everywhere. It could be one of the parts of the monitoring devices. Easy method of applying the display on the smartphones.

Nowadays, they could be tonnes of medical devices that could help the society to monitor their health condition every day. Some cheapest medical

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device could not give much information about the health condition especially the heart. If the consumers need further information, they need to go to hospitals for medical check-up which may consume more the 2 to 3 hours. An expensive device may provide good information but the users need to spend quite big amount of cash purchase it. It may cause as discouragement to the consumers to monitor their health condition due to expensive device prices.

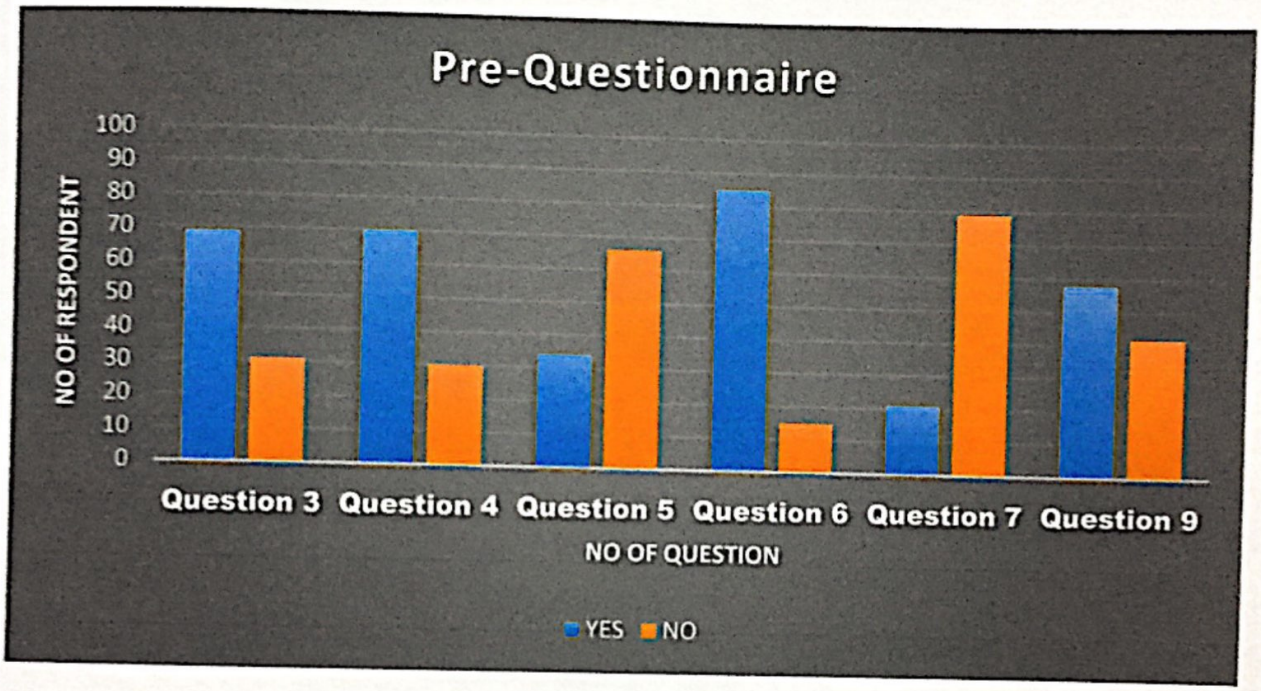

Figure 3.2: Pre-Questionnaire results

The figure 3.2 represents results on Yes or No questions. These questions had been mainly exploring on the percentage of the society are having patient of heart rhythm disorder in their families or they itself having irregular of heart rhythm due to some causes. Moreover, the society are aware on heart rhythm disorder may attack regardless age and gender. It is important to get know the early stage of the irregular heart beat and heart rhythm during performing the daily task. the public are also not well encouraged on using heart monitoring devices on their daily life. Even they preferring in device which may help monitoring their heart condition with affordable price, handy and simple method of usage. The most important not hazardous to health after long term of usage.

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3.3.2 Post Questionnaire

The post questionnaire mainly created to identify the comfortability of the user once testing the device on them. This questionnaire was done after the product was complete and testing on user. the main focus is to know on the application of user of this product in their daily life and reliable results outcome. The results from this survey is shown below. The attachment of sample of questionnaire on appendices.

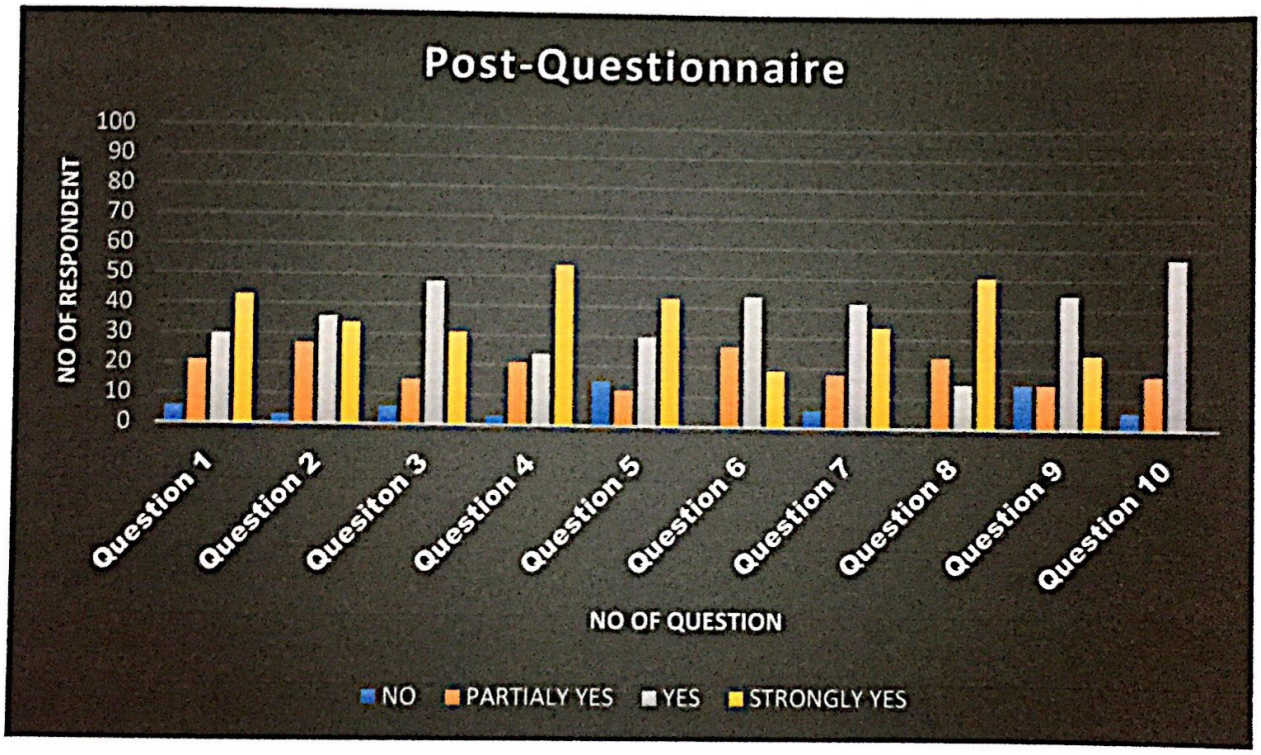

Figure 3.3: Post-Questionnaire results.

Post-questionnaire successfully done in order to knew the comfortability, efficiency and affordability of consumer using and buying this device to monitor their heart condition. Once the product had done with calibration and technical test. The device was tested on a normal subject in order to identify the output is trustable and accurate. Later on, the devices had been given to several people with one set of questionnaires. This survey mainly done to distinguish on user are safe and secure by using this device and helpful in term of providing reliable data. The consumer had agreed on the device had gave accurate data of their heart condition. The same

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patients are also tested with patient monitor at the medical laboratory. It has been proven the data are accurate. In term of application of the devices on consumers body and method of handling the device are way too easy. They are also had agreed on this device may help on the consumers saves their time from queuing for long hours at hospitals for medical check-up. They can immediately take fast action once they knew the heart condition are irregular. It may save some life before getting to worst. It is also secured device with handy housing with extra features on the housing itself in order to keep it everything save. Safety features are giving more importance in this device.

3.3.3 Clinical Test

Clinical test survey one the important task to be done by the inventors in order to find the quality and benefits of this product to the society. This device was done clinical test at the private clinic. The doctor evaluated the product by testing it on user. Once the product was done with technical testing. The device is brought to doctor at clinic to check and identify the results obtain from this device are reliable. Doctor from Perdana Medical Centre had review in this product and several comments had received from the doctor. The feedback form from the clinic is attached on appendices.

3.3.4 Engineering Department Testing

This product also had reviewed from engineering department which is Radibems Sungai Buloh Hospital. The staff from the department had test the device functionality and usability. They also had provided comments and suggestion to improvise. The feedback form was attached on appendices.

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3.4 INTERNET

Surfing internet able to help in providing information from different aspects. The information finding process is based on the block diagram. Internet one of the main sources providing information. Journals, articles, facts and examples of diagrams may help in guide in project development. Internet also help the researchers or the inventors in studying deep on the topic that had been chose. There are two type sources of information, which is certified and uncertified. The information's should extract from certified and reliable source.

3.5 GANTT CHART

Gantt chart helps the inventors in reaching their specific targeted tasks as per scheduled. The time allocated for each of the task was well planned before start up the project development. There were 2 Gantt charts were creating to ease in performing the task. The Gantt chart was attached on appendices.

3.6 DISEASE

Heart rhythm problems (heart arrhythmias) occur when the electrical impulses that coordinate heartbeats don't work properly, causing heart to beat too fast, too slow or irregularly. Heart arrhythmias (uh-RITH-me-uhs) may feel like a fluttering or racing heart and may be harmless. However, some heart arrhythmias may cause bothersome — sometimes even life-threatening — signs and symptoms. Heart arrhythmia treatment can often control or eliminate fast, slow or irregular heartbeats. In addition, because troublesome heart arrhythmias are often made worse — or are even caused — by a weak or damaged heart, may be able to reduce arrhythmia risk by adopting a heart healthy lifestyle.

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3.6.1 Types of Arrhythmia

- **Bradyarrhythmia**

Bradyarrhythmia is a slow arrhythmia in a heart that beats too slowly—a condition called bradycardia. For adults, this means slower than 60 beats per minute. Some people, especially people who are young or physically fit, may normally have slow heart rates. For them, bradycardia is not dangerous and does not cause symptoms [9].

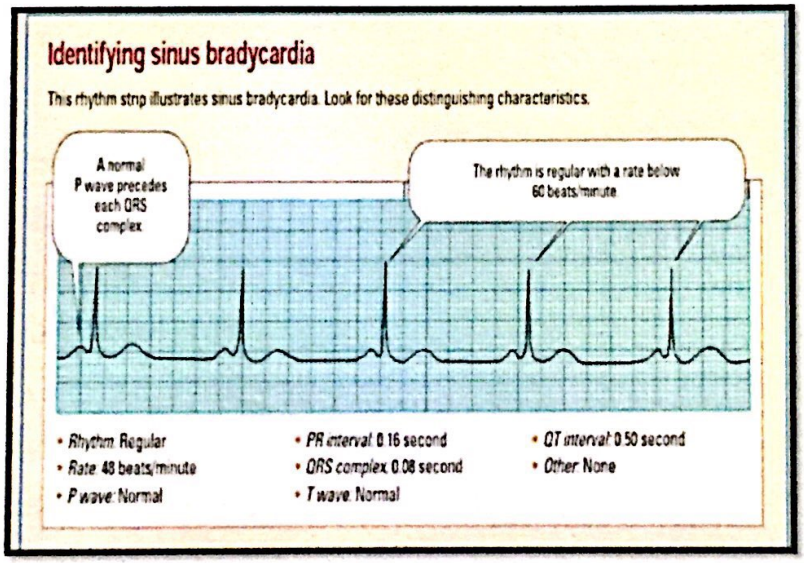

Figure 3.4: Waveform of Bradycardia.

- **A premature heartbeat**

It happens when the signal to beat comes early. It can feel like heart skipped a beat. The premature, or extra, heartbeat creates a short pause, which is followed by a stronger beat when heart returns to its regular rhythm. These extra heartbeats are the most common type of arrhythmia. They are called ectopic heartbeats and can trigger other arrhythmias [9].

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- **Supraventricular arrhythmia**

Arrhythmias that start in the heart's upper chambers, called the atrium, or at the gateway to the lower chambers are called supraventricular arrhythmias. Supraventricular arrhythmias are known by their fast heart rates, or tachycardia. Tachycardia occurs when the heart, at rest, goes above 100 beats per minute. The fast pace is sometimes paired with an uneven heart rhythm. Sometimes the upper and lower chambers beat at different rates [9].

Types of supraventricular arrhythmias include:

❖ **Atrial fibrillation.**

This is one of the most common types of arrhythmia. The heart can race at more than 400 beats per minute.

❖ **Atrial flutter.**

Atrial flutter can cause the upper chambers to beat 250 to 350 times per minute. The signal that tells the upper chambers to beat may be disrupted when it encounters damaged tissue, such as a scar. The signal may find an alternate path, creating a loop that causes the upper chamber to beat repeatedly. As with atrial fibrillation, some but not all of these signals travel to the lower chambers. As a result, the upper chambers and lower chambers beat at different rates [9].

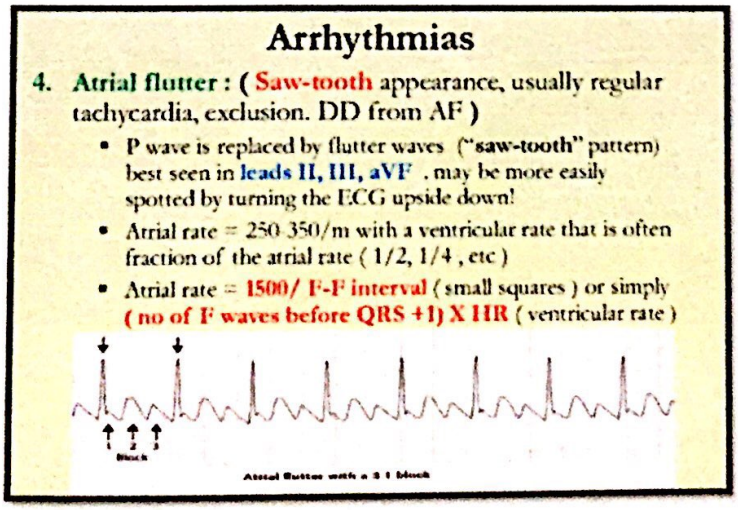

Figure 3.5: Waveform of Atrial flutter.

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❖ **Paroxysmal supraventricular tachycardia (PSVT).**

In PSVT, electrical signals that begin in the upper chambers and travel to the lower chambers cause extra heartbeats. This arrhythmia begins and ends suddenly. It can happen during vigorous physical activity. It is usually not dangerous and tends to occur in young people [9].

- **Ventricular arrhythmia**

These arrhythmias start in the heart's lower chambers. They can be very dangerous and usually require medical care right away [9].

❖ **Ventricular tachycardia** is a fast, regular beating of the ventricles that may last for only a few seconds or for much longer. A few beats of ventricular tachycardia often do not cause problems. However, episodes that last for more than a few seconds can be dangerous. Ventricular tachycardia can turn into other more serious arrhythmias, such as ventricular fibrillation, or v-fib [9].

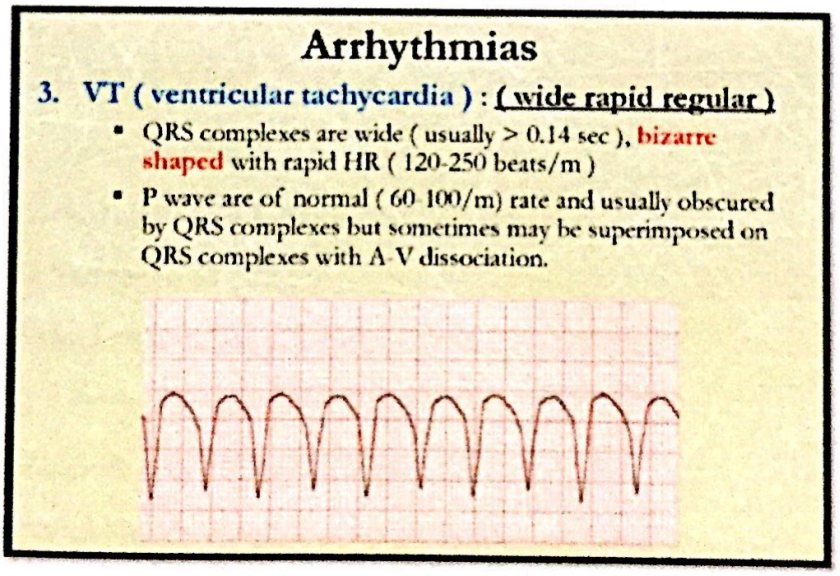

Figure 3.6: Waveform of Ventricular Tachycardia

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❖ **Ventricular fibrillation** occurs if disorganized electrical signals make the ventricles quiver instead of pumping normally. Without the ventricles pumping blood to the body, sudden cardiac arrest and death can occur within a few minutes. Torsade's de pointes is a type of arrhythmia that causes a unique pattern on an EKG and often leads to v-fib [9].

3.6.2 Symptom

- A fluttering in chest
- A racing heartbeat (tachycardia)
- A slow heartbeat (bradycardia)
- Chest pain Shortness of breath
- Light-headedness or dizziness
- Sweating
- Fainting (syncope) or near fainting

3.6.3 Cause

- A heart attacks
- Scarring of heart tissue from a prior heart attack
- Changes to heart's structure, such as from cardiomyopathy
- Blocked arteries in heart (coronary artery disease)
- High blood pressure Overactive thyroid gland (hyperthyroidism)
- Underactive thyroid gland (hypothyroidism)
- Smoking Drinking too much alcohol or caffeine
- Drug abuse
- Stress
- Diabetes

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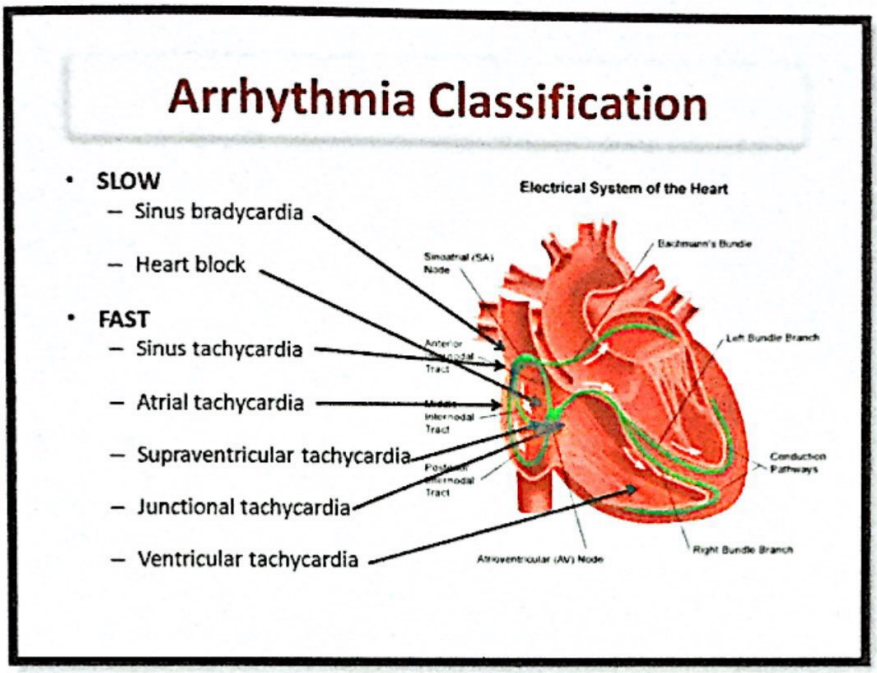

Figure 3.7.: Arrhythmia Classification.

3.6.4 Complication

- **Stroke.**

When heart quivers, it's unable to pump blood effectively, which can cause blood to pool. This can cause blood clots to form. If a clot breaks loose, it can travel from heart to r brain. There it might block blood flow, causing a stroke. Certain medications, such as blood thinners, can greatly lower risk of stroke or damage to other organs caused by blood clots. The doctor will determine if a blood-thinning medication is appropriate for you, depending on type of arrhythmia and risk of blood clots [11].

- **Heart failure.**

Heart failure can result if heart is pumping ineffectively for a prolonged period due to a bradycardia or tachycardia, such as atrial fibrillation. Sometimes controlling the rate of an arrhythmia that's causing heart failure can improve heart's function [11].

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3.7 HARDWARE

3.7.1 Heart rate sensor (AD8232)

The AD8232 is a neat little chip used to measure the electrical activity of the heart. This electrical activity can be charted as an ECG or Electrocardiogram. Electrocardiography is used to help diagnose various heart conditions. Analog Devices' AD8232 is an integrated signal-conditioning block for ECG and other biopotential measurement applications. It is designed to extract, amplify, and filter small biopotential signals in the presence of noisy conditions, such as those created by motion or remote electrode placement. This design allows for an ultra-low power analogue-to-digital converter (ADC), or an embedded microcontroller to acquire the output signal easily. The AD8232 can implement a two-pole high-pass filter for eliminating motion artefacts and the electrode half-cell potential. This filter is tightly coupled with the instrumentation architecture of the amplifier to allow both large gain and high-pass filtering in a single stage, thereby saving space and cost. An uncommitted operational amplifier enables the AD8232 to create a three-pole low-pass filter to remove additional noise. The user can select the frequency cut off of all filters to suit different types of applications [6].

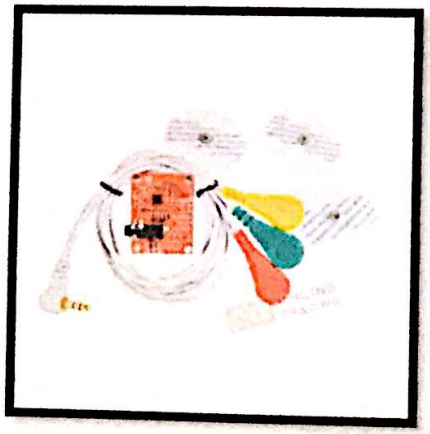

Figure 3.8: Heart rate sensor (AD8232).

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3.7.2 ECG lead

Simple three electrode monitoring uses two electrodes at a time for active monitoring and third one as ground electrode. But the electrodes can be used in different configurations to get lead I, II or III, one at a time. The signal acquisition is bipolar, between the chosen two electrodes for the given lead. Three electrode system was quite common with telemetry monitors [7].

3.7.3 Node MCU

The Node MCU (Node Micro Controller Unit) is an open source software and hardware development environment that is built around a very inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espresso Systems, contains all crucial elements of the modern computer: CPU, RAM, networking (Wi-Fi), and even a modern operating system and SDK [13].

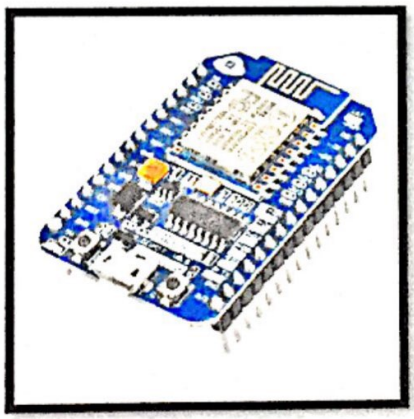

Figure 3.9: Node MCU

3.7.4 Bluetooth Module

The Bluetooth HC-05 module are integrated with this device to transmit the data in short distance to send the ECG wave with less interruption of other signals. Bluetooth are proven as good transmitting data medium. There are numerous

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numbers of devices that's has been used Bluetooth as transmitting medium of health data [21].

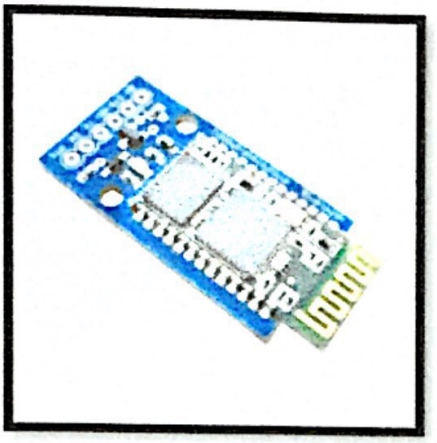

Figure 3.10: Bluetooth Module (HC05).

3.8 SOFTWARE

Mobile devices like smartphones and tablet computers continuously grow in processing power and become an integral part of daily life, even in developing countries. Recently, such mobile devices are also used for biomedical signal processing and ECG analysis [2]. The drastic changes in technology, the inventors are encouraged to develop the devices with collaboration of smartphone application either Android or IOS application. It creates friendly user and the user doesn't need to carry extra devices in order to view the health data.

3.8.1 Arduino IDE

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece of software, or IDE (Integrated Development Environment) that runs on computer, used to write and upload computer code to the physical board.

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The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board -- can simply use a USB cable. Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro-controller into a more accessible package [22].

3.8.2 Bluetooth Electronic

Control electronic project with an Android device. This app communicates using Bluetooth to an HC-06 or HC-05 Bluetooth module in project. This app comes with a library containing 11 Bluetooth examples for Arduino. It can also be used with Raspberry Pi or any other rapid prototyping system in which have included a suitable Bluetooth module to project.

- Ideal for learning electronics in a fun way.
- Ideal for rapid prototyping a new idea.
- Ideal for exhibiting project.

Some electronics skills required. Requires an Android device with Bluetooth capability enabled. Version 1.1 only works with Bluetooth Classic. Version 1.2 supports Bluetooth Low Energy and USB connectivity in addition to Bluetooth Classic. Large selection of controls available including buttons, switches, sliders, pads, lights, gauges, terminals, accelerometers and graphs. Drag and drop them onto the panel grid. Then edit their properties. 20 customisable panels available [16].

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3.8.3 *Blynk*

Blynk was designed for the Internet of Things. It can control hardware remotely, it can display sensor data, it can store data, visualize it and do many other cool things. There are three major components in the platform [15]:

- *Blynk* App - allows to create amazing interfaces for your projects using various widgets we provide.
- *Blynk* Server - responsible for all the communications between the smartphone and hardware. Can use our *Blynk* Cloud or run your private *Blynk* server locally. It's open-source, could easily handle thousands of devices and can even be launched on a Raspberry Pi.
- *Blynk* Libraries - for all the popular hardware platforms - enable communication with the server and process all the incoming and outcoming commands.

3.8.4 Proteus

Proteus combines ease of use with powerful features to help design, test and layout professional PCBs like never before. With nearly 800 microcontroller variants ready for simulation straight from the schematic, one of the most intuitive professional PCB layout packages on the market and a world class shape-based auto router included as standard, Proteus Design Suite 8 delivers the complete software package for today and tomorrow's engineers [23].

3.8.5 Solid Work

Intuitive 3d design and product development solution from Solid Work. It lets to create, conceptualize, validate, communicate, manage and transform the innovation idea into great product design [24].

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3.9 FLOWCHART

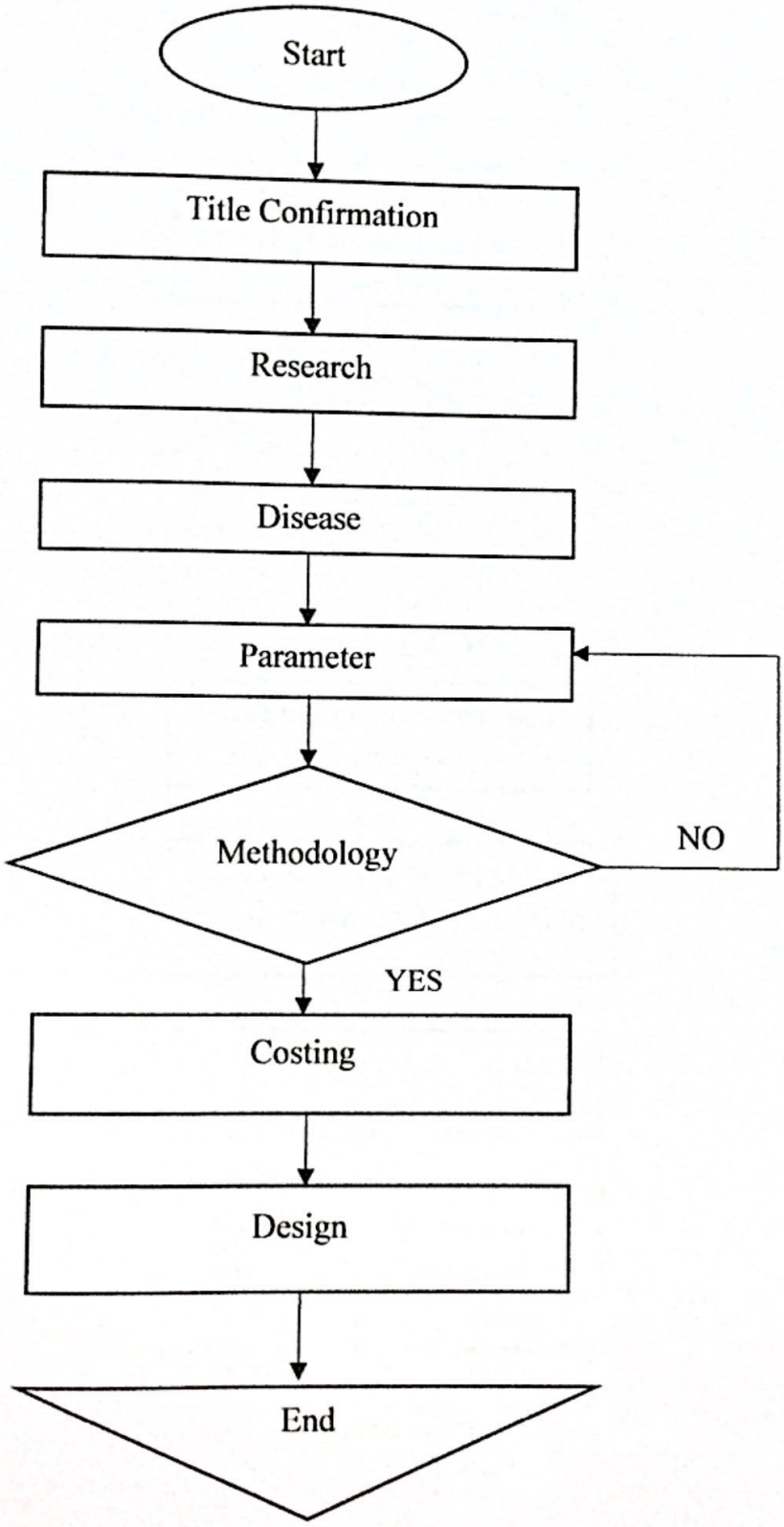

Figure 3.11: Flowchart of project process.

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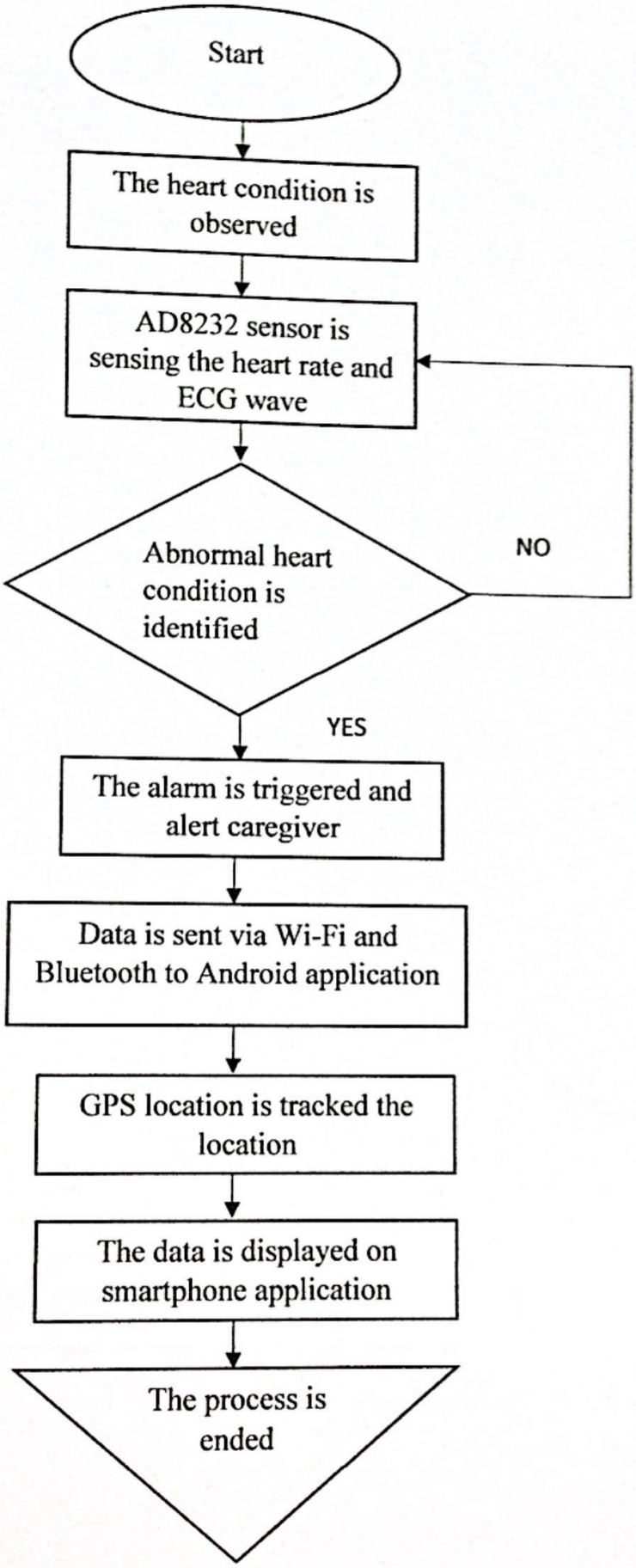

Figure 3.12: Flowchart of device process.

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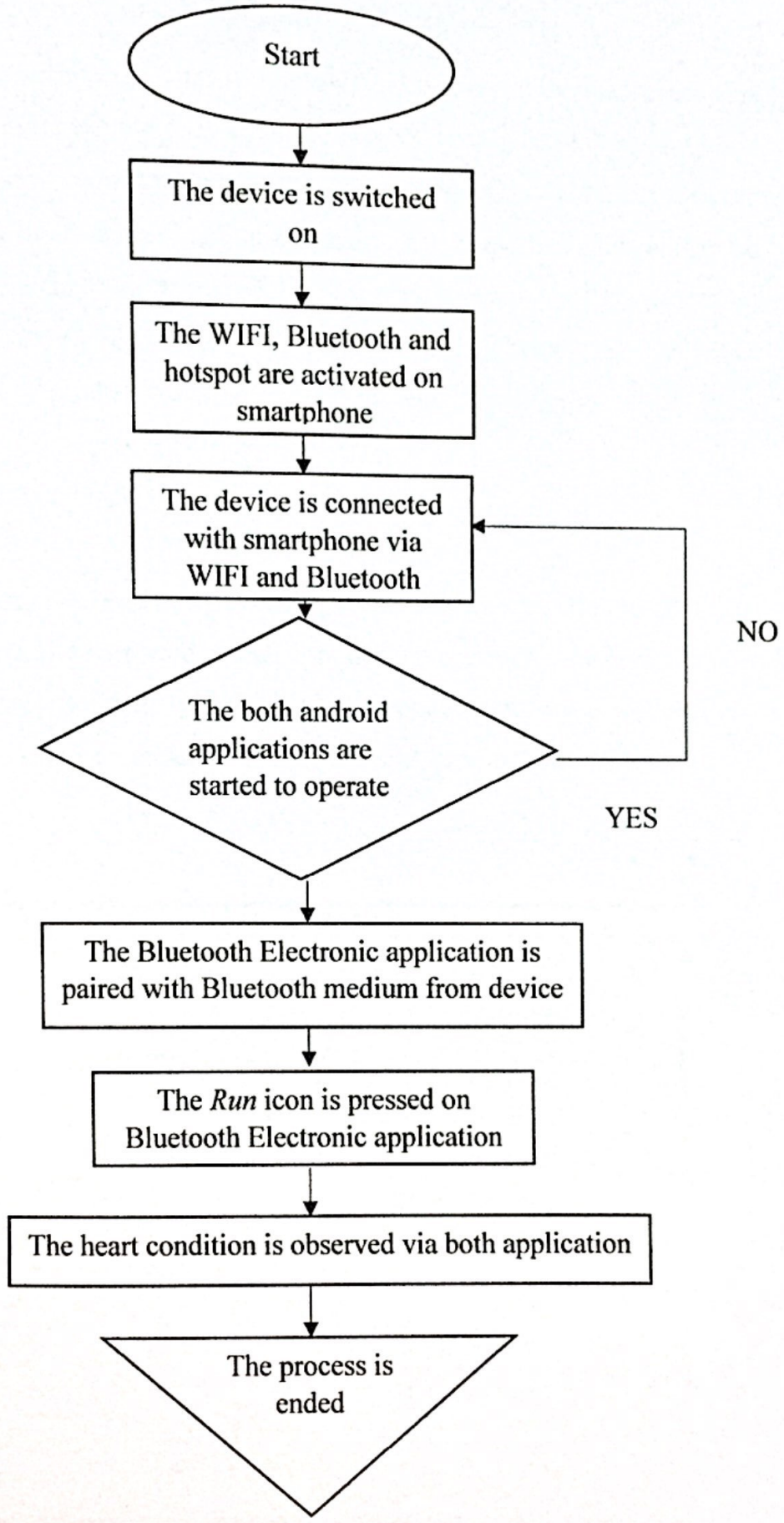

Figure 3.13: Standard of Procedure flowchart

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Figure 3.11 above described on basic flowchart of project development. This flowchart was followed during the starting of the project development. The important on deciding the methodology part to fixed on the product functioning. Next the figure 3.12described on how the product function internally. It is important flowchart to be explained during technical part. Figure 3.13 described on standard of procedure flowchart. This flowchart mainly to explained on how use the device. It also can help the user to understand on product handling.

3.10 SCHEMATIC DIAGRAM

Schematic diagram has been designed using Proteus 8 software. Before start with etching of circuit board and hardware connection, designing circuit with component is compulsory. It is because to identify the suitable component, amount of voltage, and proper wiring before done practically. The successful running circuit may use to develop project.

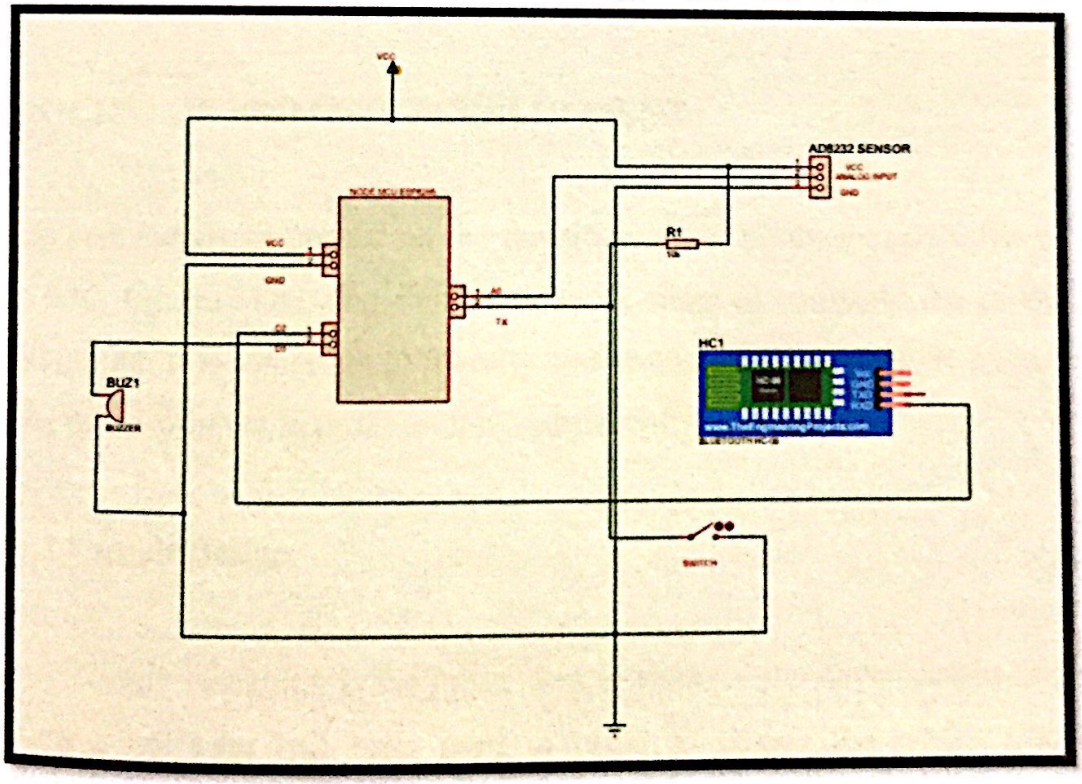

Figure 3.14: Schematic diagram of device

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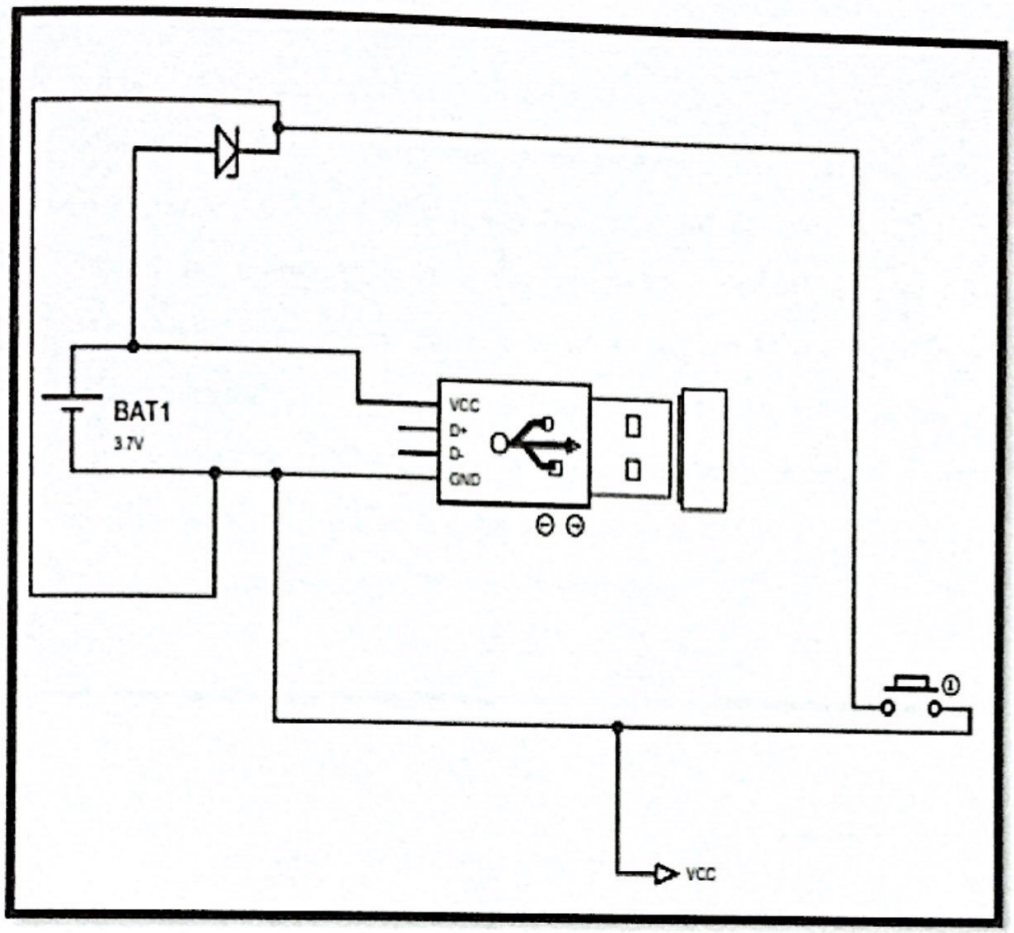

Figure 3.15: Input (VCC) schematic diagram.

3.11 PROCESS OF PROJECT DEVELOPMENT

This part mainly discussed on the development of hardware and software of the product with figures. The step that undergo in order to complete the product with expected output. It is important to identify and arrange the step of performing the task according to the product in order to done successfully.

3.11.1 Circuit Design

Circuit designing is the initial step to starts of the development of product. Proteus 8 software had been used in order to design the circuit diagram as preference. Several installation of new components parts need to be done before designing. Once the components parts are connected according to its pole. The

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circuit connection should undergo simulation process to declare this circuit connection is success. Any error in this connection during simulation may cause the project unable to done in practical. Moreover, the unsuitable components may change to suitable for more efficiency output from the product. The size of the device should be comfortable for the user. In order of that component with multifunction will be used to reduce the size which is compatible with device function. The circuit design was done with aid of help from Proteus circuit designing videos. Trial and error method were applied in order to knew the suitable circuit design for this product. The figure 3.16 shown the process of connecting and simulation of the component in Proteus 8 software.

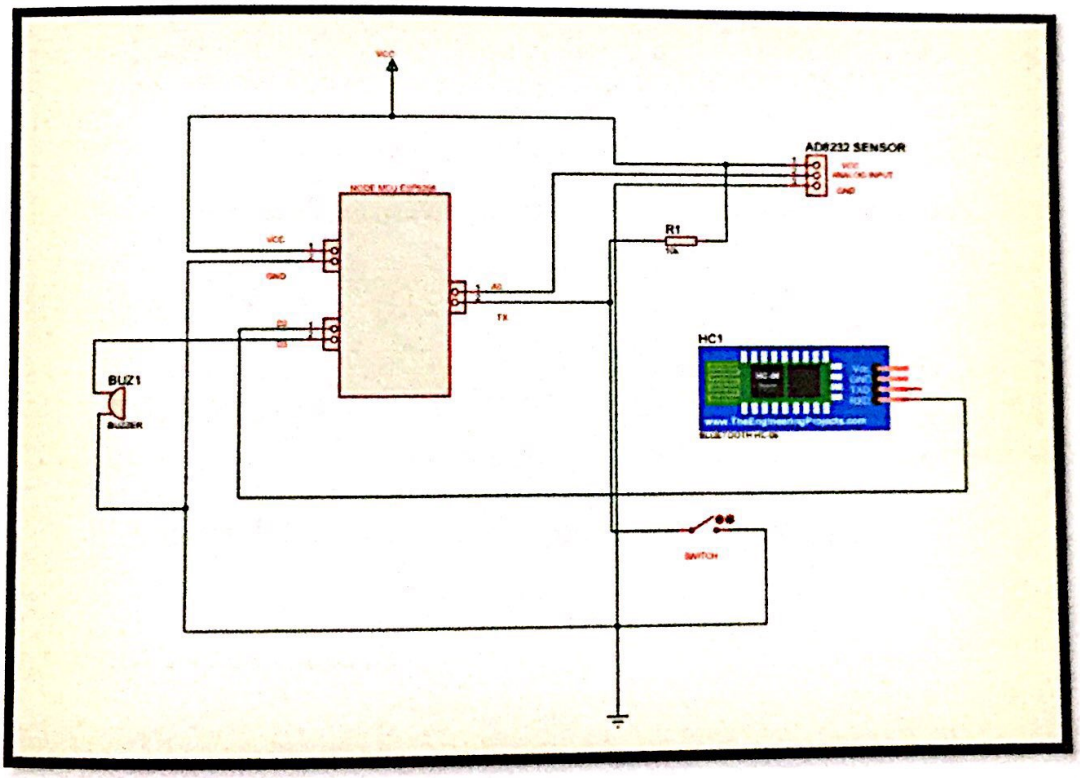

Figure 3.16: Circuit designing using Proteus 8

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3.11.2 Hardware Connection

Secondly, the hardware connection process done. Once the simulation complete. The survey of components for hardware are proceed. The connection was done based on the circuit designing on Proteus 8 software. Heart rate sensor with ECG lead, Node MCU, Bluetooth module, buzzer, switch button, ON/OFF switch, jumper wire, external board, battery and charging board was bought to connected to develop one product. The figures 3.11.2 shown the hardware connection task.

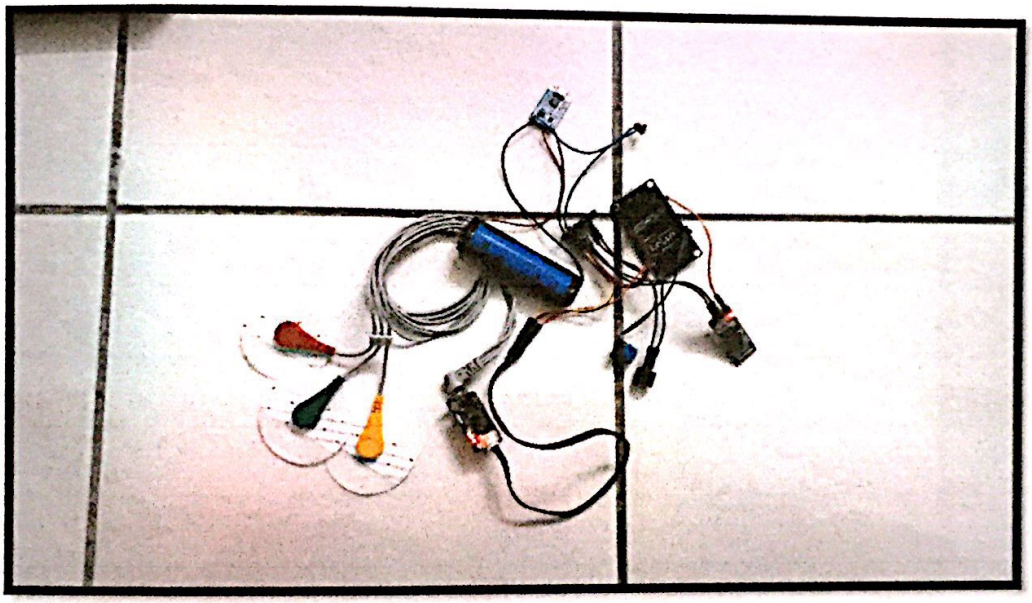

Figure 3.17: Hardware connection with components.

3.11.3 Coding Development

Coding development one of the important steps to be done with much more care. Development of coding has been done with Arduino Ide 1.8.8 software with aid of help from Arduino homepage. Several coding has been edited to get as per the methodology fixed for this device functioning. The input and output should be declared clearly. Before the coding development the flowchart an important element that should constructed early and some data collection should be made to insert in the coding language. Some calculation method also has been inserted in this coding.

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This device mainly on display the heart rhythm via Bluetooth medium and the alerting the caregiver via WIFI medium. In addition, the heart will be calculated from the heart rhythm. So, it is important to identify the formula to calculate heart rate based on heart rhythm. It should synchronize. The figure 3.18 shown on the process of coding writing, verifying and uploaded in the microcontroller.

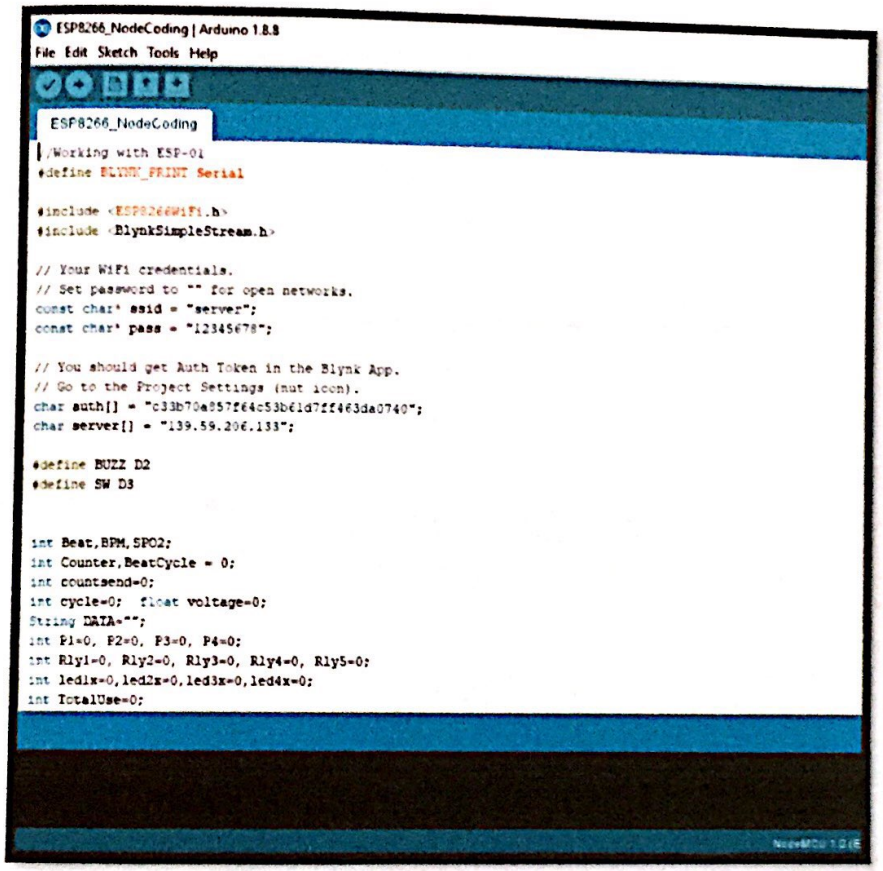

Figure 3.18: Coding process using Arduino IDE.

3.11.4 Running and Testing

Once the hardware and software connected and uploaded successfully. The running and testing of the product should be done. At first, the circuit voltages need to be check with multimeter in order to confirmed with no short circuits which may cause explosion of the components. Next, switched on the device and run it for several minutes. Then continue with testing the output of the product. Several times

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of testing are done to discover the accuracy and sensitivity of the device. Any error on the output can be adjusted on coding to get accurate results.

3.12 DESIGN

In this part, mainly explained on the design of housing. The design was sketched using *Solidworks* software. The measurement of the each of the component insertion port need to identify and insert on it. Figures below was labelled with each part.

3.12.1 Front Casing

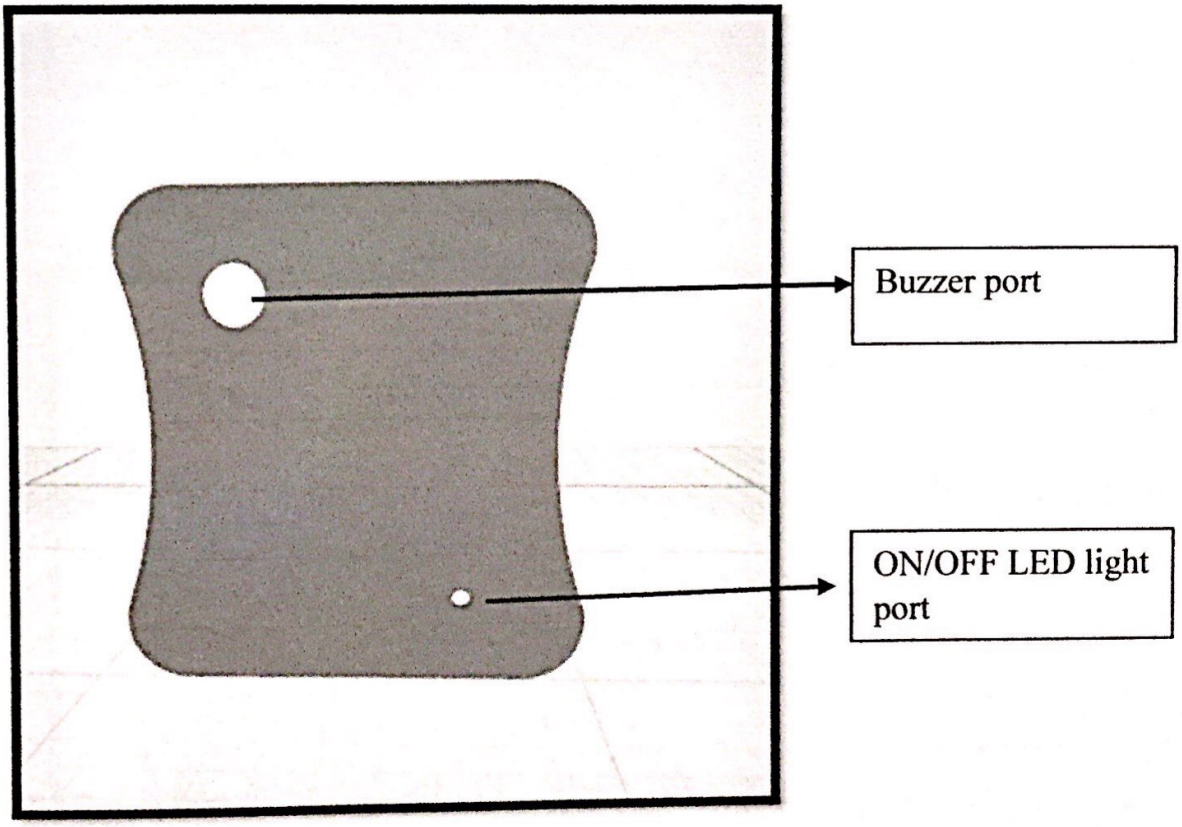

Figure 3.19: Front view

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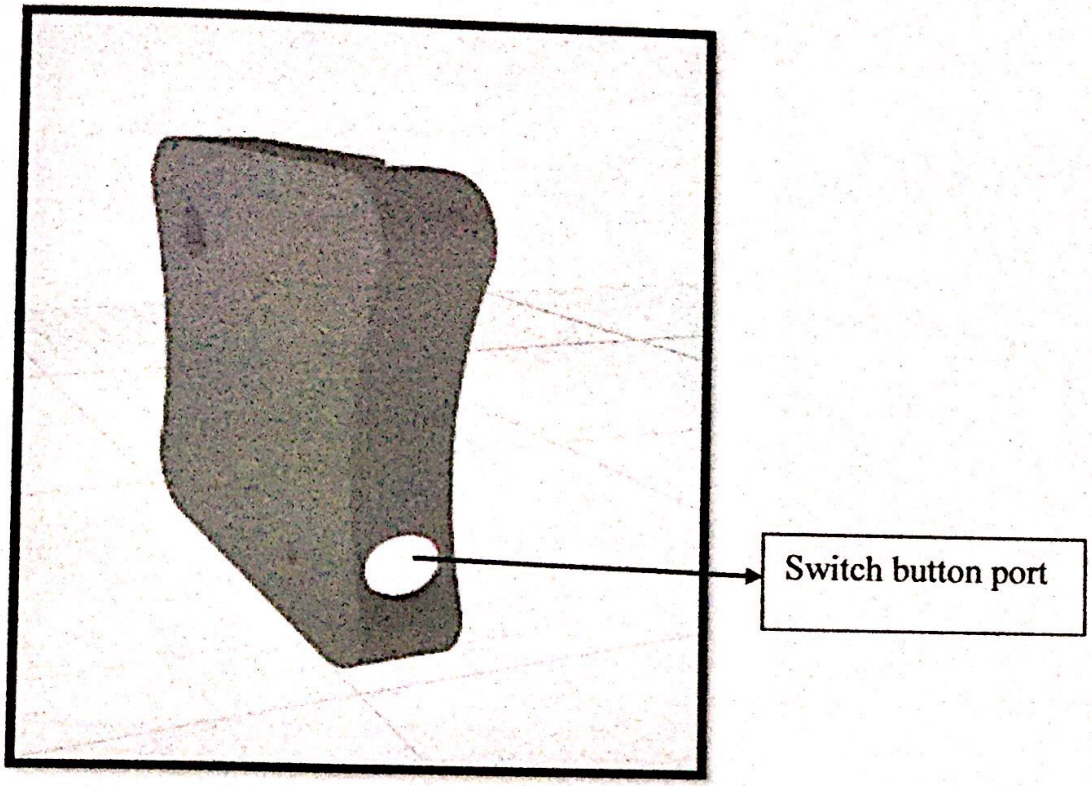

Figure 3.20: Side view

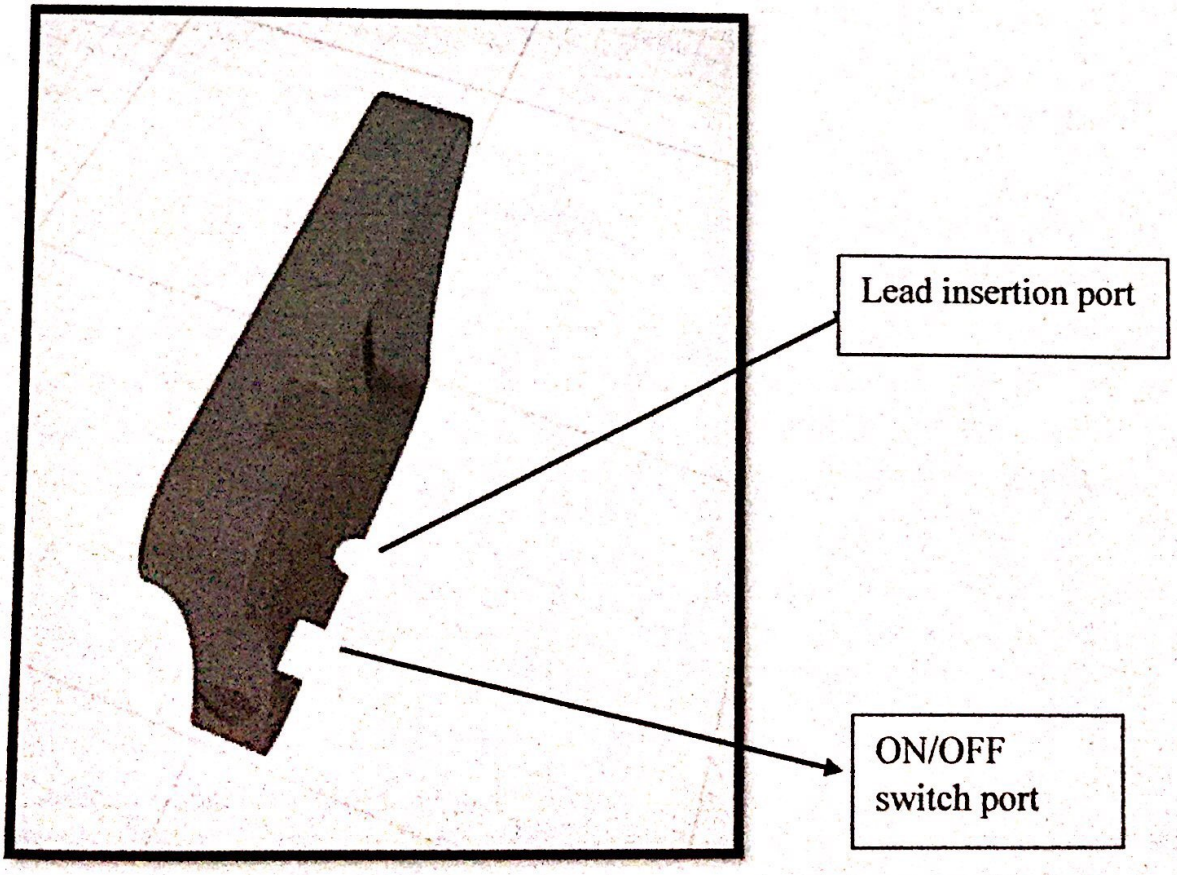

Figure 3.21: Side view

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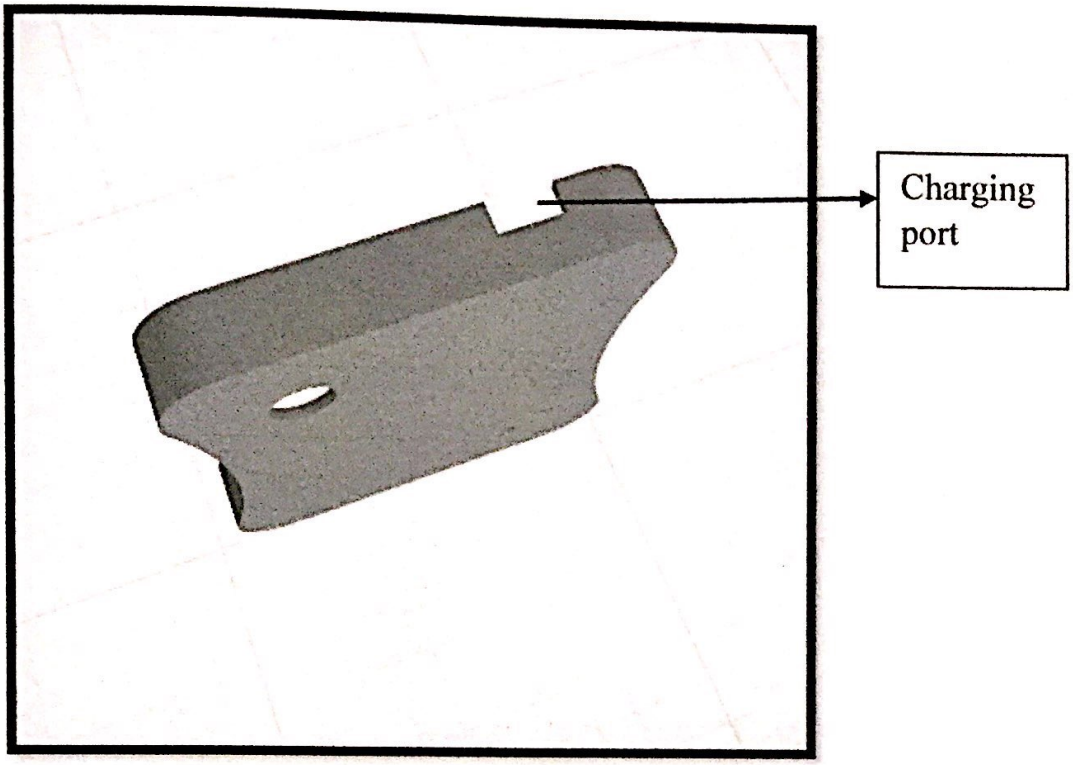

Figure 3.22: Side view.

3.12.2 Back Casing

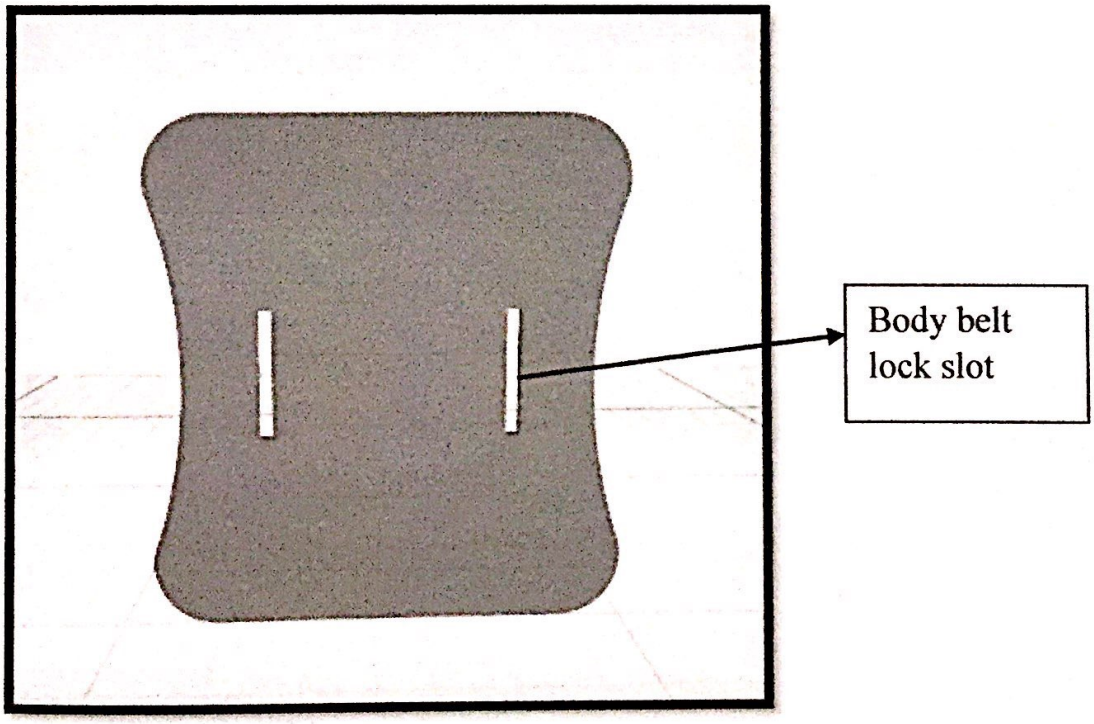

Figure 3.23: Back view

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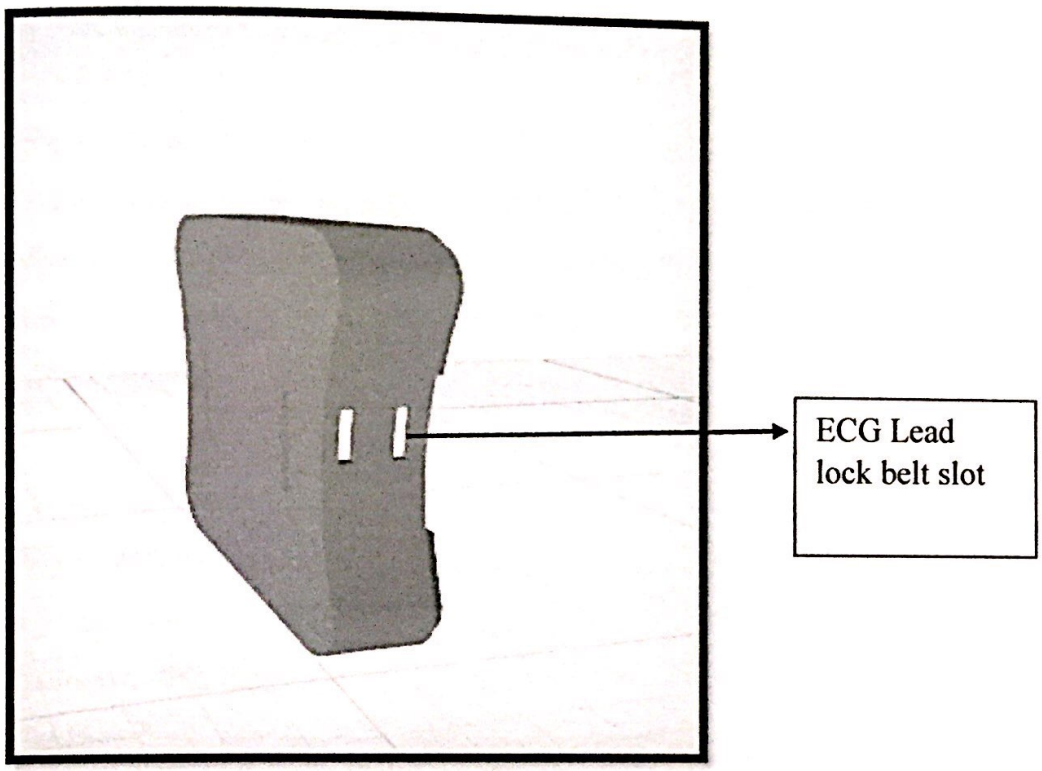

Figure 3.24: Back view

The function of labelled parts above are tabulated on table 3.1.

TABLE 3.1: 3D housing parts functions

Features	Function
Buzzer port	To insert the buzzer in this device
ON/OFF LED light port	To alert user on state of the device in ON or OFF mode
Switch button port	To pressed during urgent to switch ON the buzzer
ECG Lead insertion port	To insert 3 lead of ECG lead
ON/OFF switch port	To ON and OFF the device
Charging port	To insert the USB cable to charge the device
Body belt lock slot	To hold the device within the body and reduce movement
ECG Lead lock slot	To lock the ECG lead and avoid in loss of lead.

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3.13 MATERIAL OF CASING

1) PLA (Polylactic Acid)

PLA (Polylactic Acid) is one of the two most usually utilized work area 3D printing fibres (with the other being ABS fibre). It is the "default" prescribed material for some work area 3D printers, and in light of current circumstances - PLA is valuable in an expansive scope of printing applications, has the uprightness of being both unscented and low-twist, and does not require a warmed bed. PLA fibre is additionally one of the eco-friendlier. It is produced using every year inexhaustible assets (corn-starch) and requires less vitality to process contrasted with conventional (oil based) plastics [28].

2) ABS (Acrylonitrile Butadiene Styrene)

ABS (Acrylonitrile Butadiene Styrene) is another usually utilized 3D printer material. Best utilized for making tough parts that need to withstand higher temperatures. In contrast with PLA fibre, ABS plastic is not so much "weak" but rather more "malleable." It can likewise be present handled with CH3)2CO on give a reflexive completion [28].

3) PRO (Series PLA Polylactic Acid)

PRO Series PLA is a plan of PLA fibre proposed for delivering proficient, excellent, 3D printed parts. It includes an outwardly unmistakable completion and a progressively lively, obscure shading than MH Build PLA fibre [28].

4) PRO Series ABS (Acrylonitrile Butadiene Styrene)

PRO Series ABS fibre is a plan of ABS plastic planned to enable 3D prints remain to out with an excellent, gleaming, dark completion. It is made in the USA and best utilized while creating top notch, exactness 3D prints. Similarly, as with ordinary ABS fibre, printed parts will withstand higher temperatures than PLA plastic [28].

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5) ColorFabb nGen

ColorFabb nGen is the ideal fibre for fledglings or the individuals who would prefer not to continually refine print settings. nGen streams very well through the print spout and does not obstruct frequently. This fibre is extraordinary for making tough parts while evading print disappointments and the need to change print settings. nGen has the amazing capacity to print parts with numerous scaffolds effectively where different materials have fizzled. Furthermore, nGen has an exceptionally dark and fresh-looking appearance when printed [28].

6) PRO Series Nylon Polyamide

PRO Series Nylon fibre is a definition of Nylon plastic planned to enable the 3D prints remain to out with a delightful completion in an assortment of dynamic hues. Adaptable when slight, yet with high between layer grip, nylon loans itself well to things like living pivots and other utilitarian parts. Nylon fibre is amazingly touchy to dampness, so taking drying measures amid capacity and promptly preceding printing (utilizing desiccant, vacuum, or raised temperature) is very suggested for best outcomes [28].

7) PRO Series PETG Polyethylene Terephthalate

PRO Series PETG fibre, is a modern quality fibre with a few extraordinary highlights. Allegorically, it consolidates the usability of PLA fibre with the quality and sturdiness of ABS fibre. To begin with, its quality is a lot higher than PLA and it is FDA endorsed for sustenance compartments and instruments utilized for nourishment utilization. In contrast to ABS fibre, it scarcely twists, and creates no smells or exhaust when printed. PET fibre isn't biodegradable, yet it is 100% reclaimable [28].

3.14 PROCESS OF 3D PRINTING

3D printing refers to any manufacturing process which additively builds or forms 3D parts in layers from CAD data. The technology is significant because it offers direct

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manufacturing, meaning a design goes directly from designer to physical product through a computer and a printer.

3D printing starts with a digital file derived from computer aided design (CAD) software. Once a design is completed, it must then be exported as a standard tessellation language (STL) file, meaning the file is translated into triangulated surfaces and vertices. The STL file then has to be sliced into hundreds – sometimes thousands – of 2-D layers. A 3D printer then reads the 2-D layers as building blocks which it layers one atop the other, thus forming a three-dimensional object. All design files, regardless of the 3D printing technology, are sliced into layers before printing. Layer thickness – the size of each individual layer of the sliced design – is determined partly by technology, partly by material, and partly by desired resolution and project timeline; thicker layers equates to faster builds, thinner layers equate to finer resolution, less visible layer lines and therefore less intensive post-processing work. After a part is sliced, it is oriented for build [25].

3.14.1 Application of 3D

- Education

Educators and students have long been using 3D printers in the classroom. 3D printing enables students to materialize their ideas in a fast and affordable way [25].

Primary & High Schools

3D printer manufacturers have taken up a more direct role in education. Companies often undertake programs to promote technologies. These programs serve as a cheaper way for schools to make 3D printers available for use in classes.

Programs such as Create Education Project enable schools to integrate additive manufacturing technologies into their curriculum for essentially no cost. The project lends a 3D printer to schools in exchange for either a blog post about the teacher's

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experience of using it or a sample of their lesson plan for class. This allows the company to show what 3D printers can do in an educational environment.

Similarly, certain companies provide lesson plans to schools, teaching kids how to use them. This is important as many schools may not have anyone on staff with abundant experience in this field.

Similarly, many educational companies such as Kidesign partner up with printer manufacturers to create projects like Kid Deville with very specific aims in mind. This project is a collaborative design project where students designs elements of a scale model of a city. Over the course of these kinds of projects, teachers guide them through research, development and printing. Such programs give a much more specific goal and a level of focus that regular classes don't have [25].

Universities

While additive manufacturing-specific degrees are a fairly new advent, universities have long been using 3D printers in other disciplines. There are many educational courses one can take to engage with 3D printing. Universities offer courses on things that are adjacent to 3D printing like CAD and 3D design, which can be applied to 3D printing at a certain stage.

In terms of prototyping, many university programs are turning to printers. There are specialisations in additive manufacturing one can attain through architecture or industrial design degrees. Printed prototypes are also very common in the arts, animation and fashion studies as well.

Research labs in a diverse range of vocations are employing 3D printing for functional use. While most studies are still employing the printers for models, medical and aerospace engineers are putting them to use in creating new technologies. Medical labs

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are producing all sorts of bio-printers and designs for prosthetics. Engineers are, similarly, incorporating printing into designs automobiles and airplanes [25].

Workshops & Online Courses

The educational environment is not only limited to institutional and schools. There is a great deal of other ways one can learn about additive manufacturing. One of the increasingly popular ones is to do it online. To supplement online studies, many companies offer discount deals for 3D printers and related tech. One such deal comes packaged with Coursera's online classes [25].

- Rapid Prototyping

Manufacturers have long used 3D printers in their design process to create prototypes. Using 3D printers for these purposes is called rapid prototyping. it's fast and relatively cheap.

- Rapid Manufacturing

Besides rapid prototyping, 3D printing is also used for rapid manufacturing. Rapid manufacturing is a new method of manufacturing where companies are using 3D printers for short run / small batch custom manufacturing. In this way of manufacturing the printed objects are not prototypes but tools, moulds or end-use products.

- Automotive

Car manufacturers, restorers and repairers have been utilizing 3D printing for a long time. Automotive industry experts only expect the use of additive manufacturing technologies to grow in the coming years. Companies are using it to produce not just parts, but tools, jigs and fixtures. It has also enabled on-demand manufacturing, leading to lower stock levels for spare parts.

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- Architecture

Architects were one of the early adopters of 3D printing technology. When architects need to present their work as a physical scale model, 3D printing will always be a quick and efficient way to do it. 3D printers help cut down manpower and time when it comes to visualizing designs for clients.

- Consumer Products

Even though prototyping is still the number one use of printers, there are many instances of companies producing end user products with 3D printers.

- Medical

The outlook for medical use of 3D printing is evolving at an extremely rapid pace as specialists are beginning to utilize 3D printing in more advanced ways. Patients around the world are experiencing improved quality of care through 3D printed implants and prosthetics never before seen. Even 3D pens are helping out in orthopaedic surgery.

Bio-printing

As of the early two-thousands 3D printing technology has been studied by biotech firms and academia for possible use in tissue engineering applications where organs and body parts are built using inkjet techniques. Layers of living cells are deposited onto a gel medium and slowly built up to form three dimensional structures. We refer to this field of research with the term: bio-printing [25].

- Dental

The dental industry is embracing 3D printed goods in a rapid pace. AM has allowed dentists to make bite splints, night guards, retainers, dentures and crowns. In fact, there's a whole market for dental printers like the EnvisionTEC Vida. These printers allow dental professionals to craft appliances in the exact shape that clients need them in for a fraction of the usual cost.

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- Food

Additive manufacturing invaded the food industry a long time ago. 3D Printing is allowing for odd kinds of food to come about. Shape-changing or transparent pastas could be available at a store near any time soon. Even NASA are getting in on the act with pizza printed in space.

3.15 COST

Table 3.2 on costing for this development of project. The summation of hardware purchasing.

TABLE 3.2: Costing list for product development

Component	Price (RM)
Heart rate sensor (AD8232)	90
Node MCU V3	28
Bluetooth Module (HC-05)	25
Battery 3.7 V + Step Up converter	12
Buzzer	1.30
Switch Button	0.50
ON/OFF switch	1.50
Jumper Wire	2.50
3D casing	80
Total:	240.80

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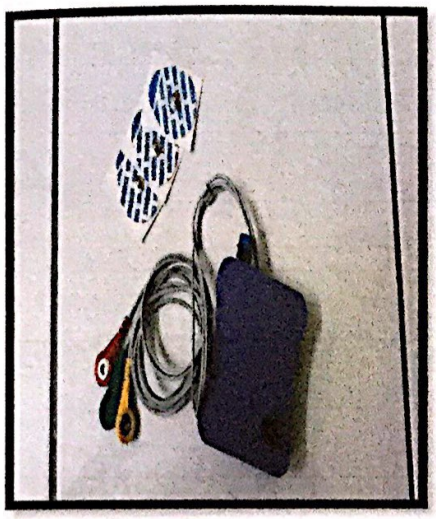
3.16 COMPARISON OF PRODUCT

TABLE 3.3: Comparison of product with existing product.

MY PRODUCT (A&A)	eMotion ECG Mobile Monitor
	

eMotion ECG Mobile Monitor one the device existing in market which has similar function compare to this product (A&A). This device has been chosen to compare the differences between these 2 devices. A&A product has its methodology of device functioning. Moreover, the design of the housing specially made for this device. The Li-Po battery also has it protection on over charging and discharging characteristics. Additional of safety features such as buzzer, emergency switch button, ECG lead lock and body lock belt. All these features function was stated on 3.12 Design part. These features are made this product to have it special function to market in industry.

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CHAPTER 4

DATA ANALYSIS

4.1 INTRODUCTION

In this part, the results received from the device has discussed. Different form of output was displayed on smartphone screen. Heart rate, heart rhythm and status of the heart were mainly focused in the results. 2 different android application was used which is *Blynk* and Bluetooth Electronic.

4.2 RESULTS

The figures below show two types of results received from device. Figure 4.1 show the results from Bluetooth Electronics android application. The data was transferred via Bluetooth medium to the Bluetooth Electronics android application and display on smart phones. The information received were heart rhythm, heart rate and status of the heart. This application act as mini patient monitor to the user. Next, figure 4.2 shows the results from *Blynk* android application. The data received via WIFI medium to the Blynk android application. The Blynk application is connected to the Email and GPS location. Blynk application mainly act as alert application to the user and caregiver. It able to provide information such as heart rate, history of heart rate, synchronize working with Email and GPS module in smartphone to provide alert message to the caregiver during emergency hours of the users.

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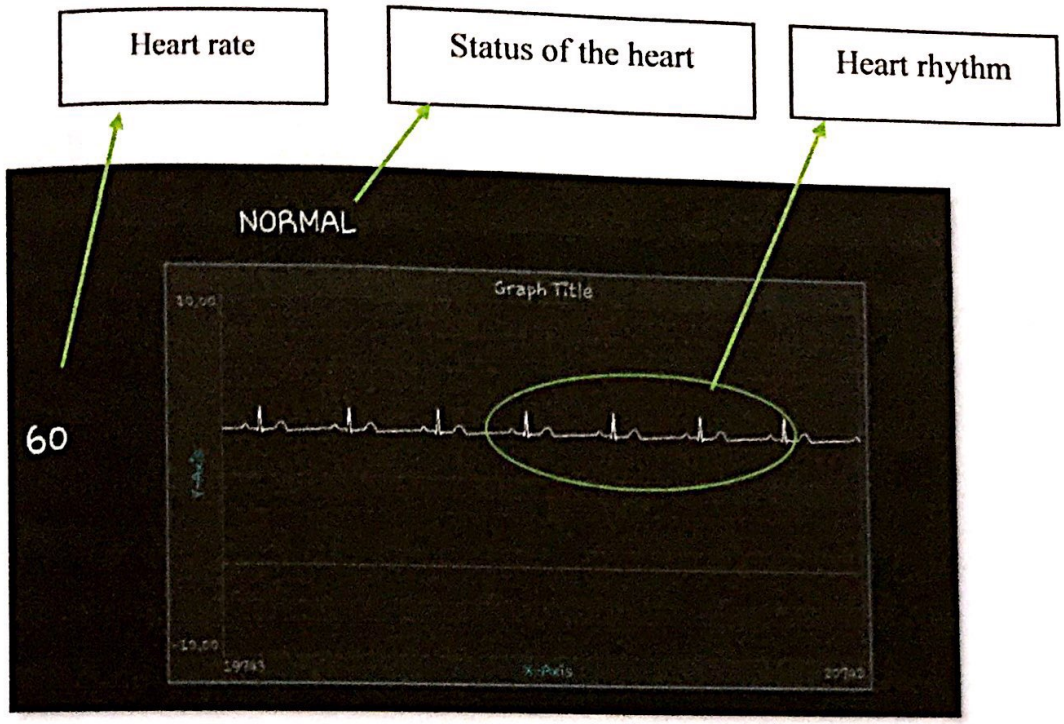

Figure 4.1: Results from Bluetooth Electronic android application.

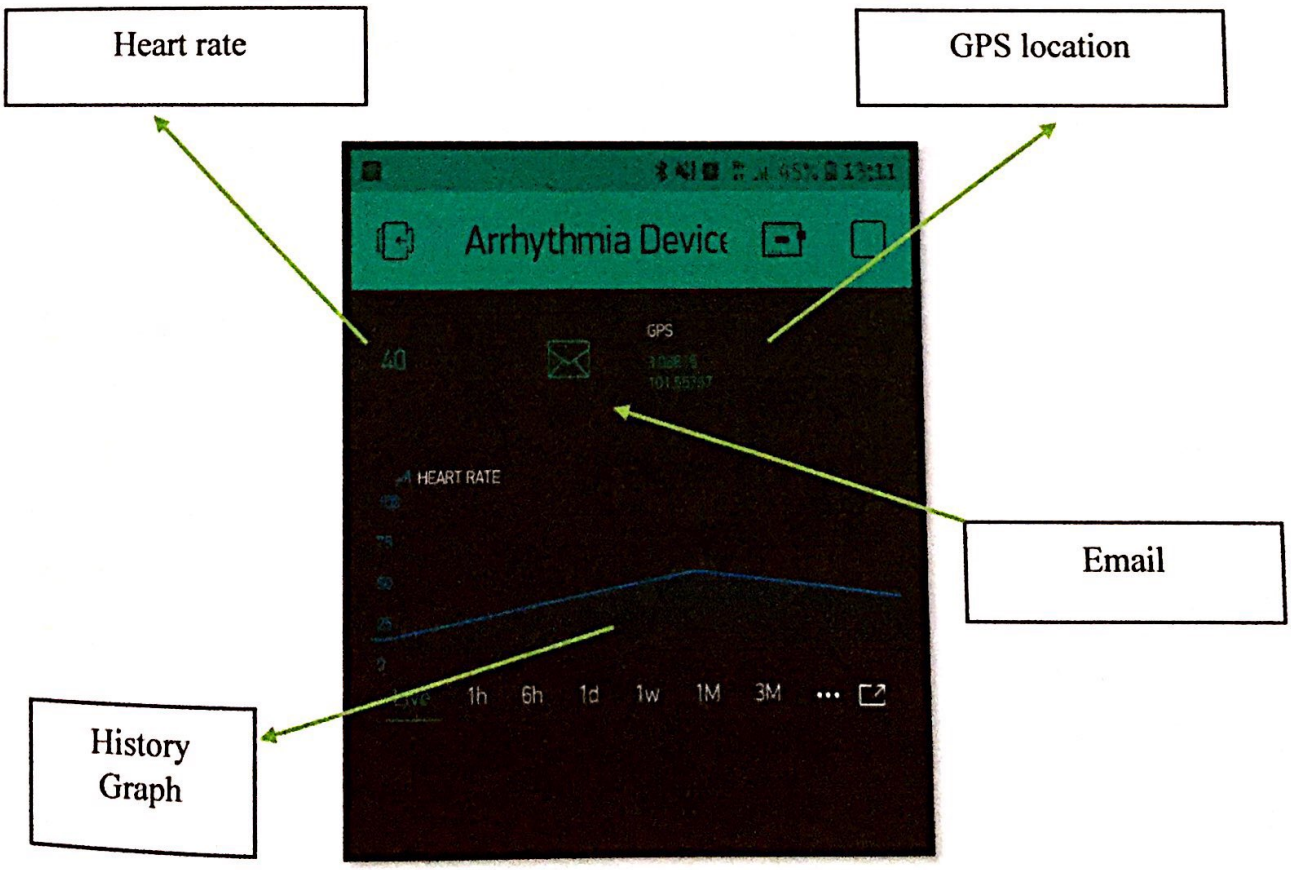

Figure 4.2: Results from Blynk andriod application.

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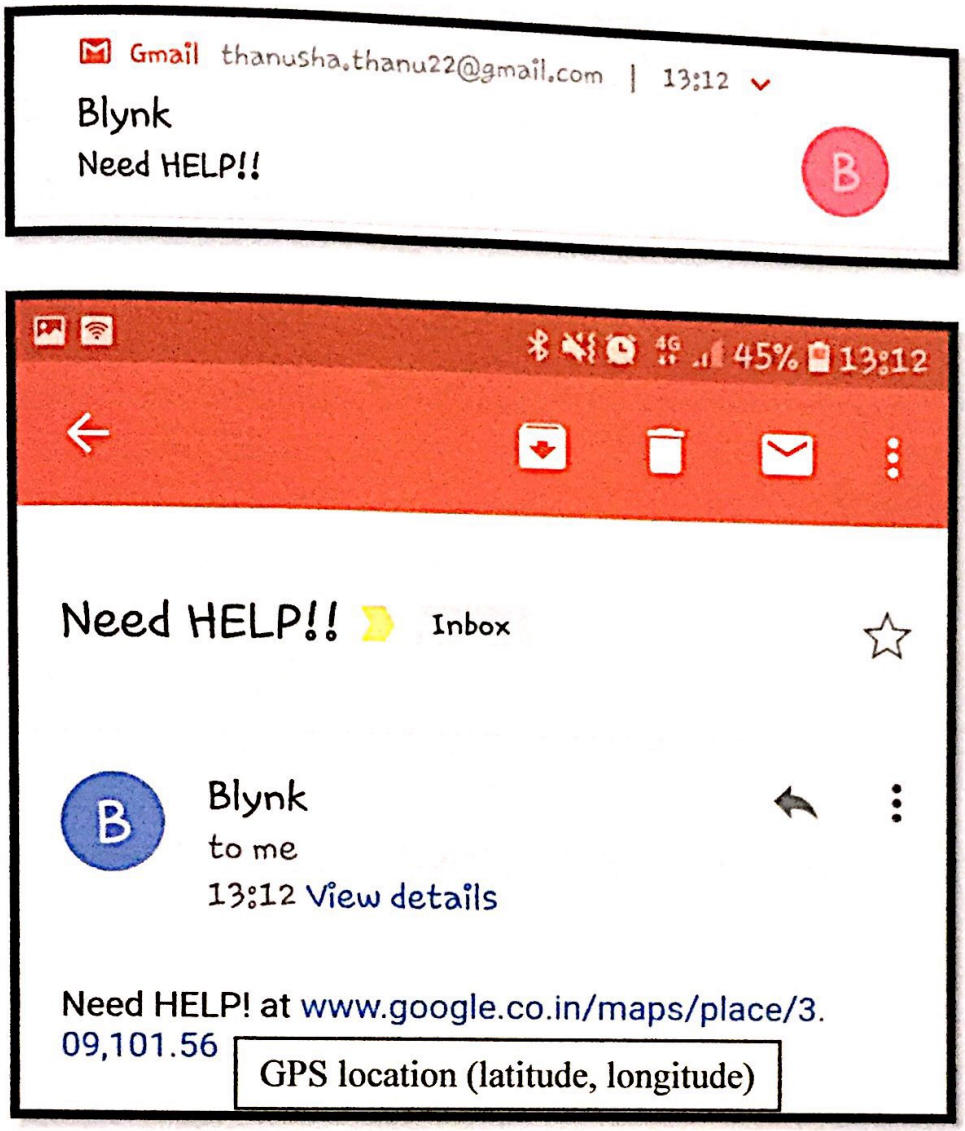

Figure 4.3: Alert message from Email

4.3 4 TYPES OF ARRHYTHMIA

This device able to produce 4 types of Arrhythmia or heart rhythm disorder. The device is programmed to detect bradycardia, tachycardia, normal rhythm and ventricular tachycardia. The figures below shown the results received from the device and displayed on smartphone.

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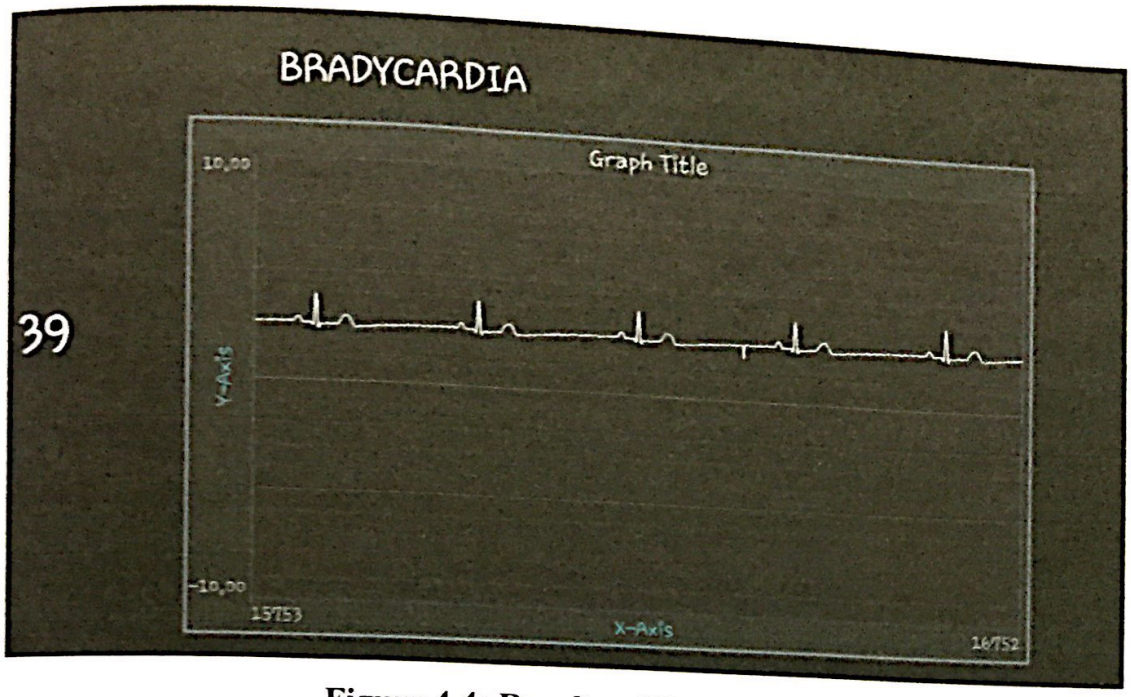

Figure 4.4: Results of Bradycardia

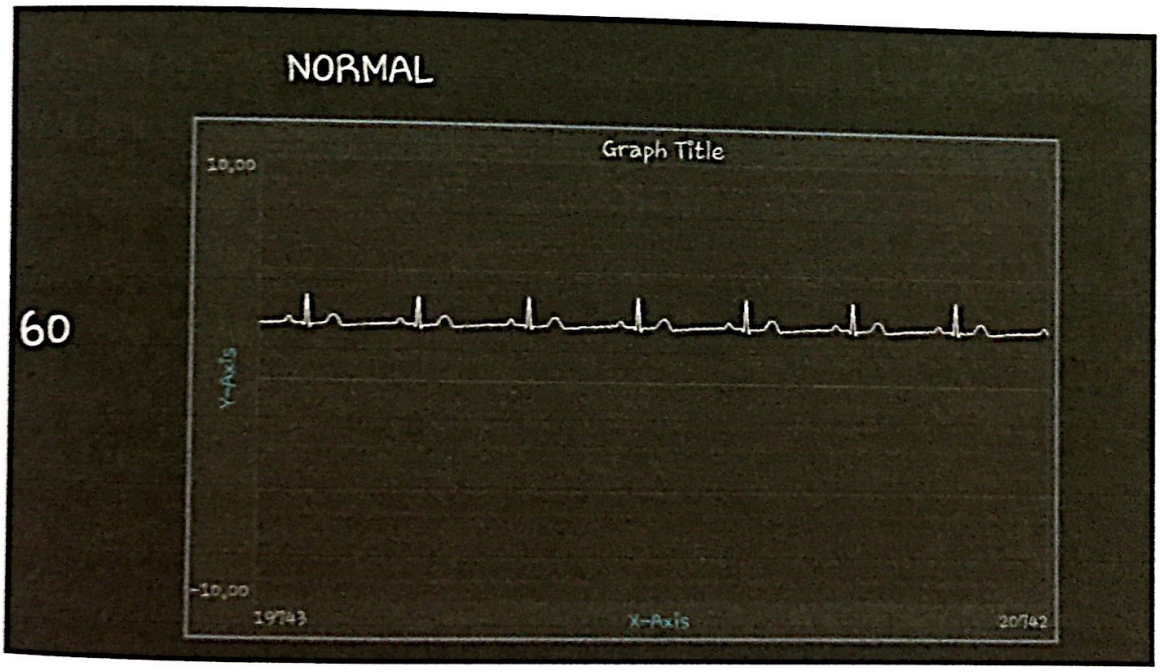

Figure 4.5: Results of Normal

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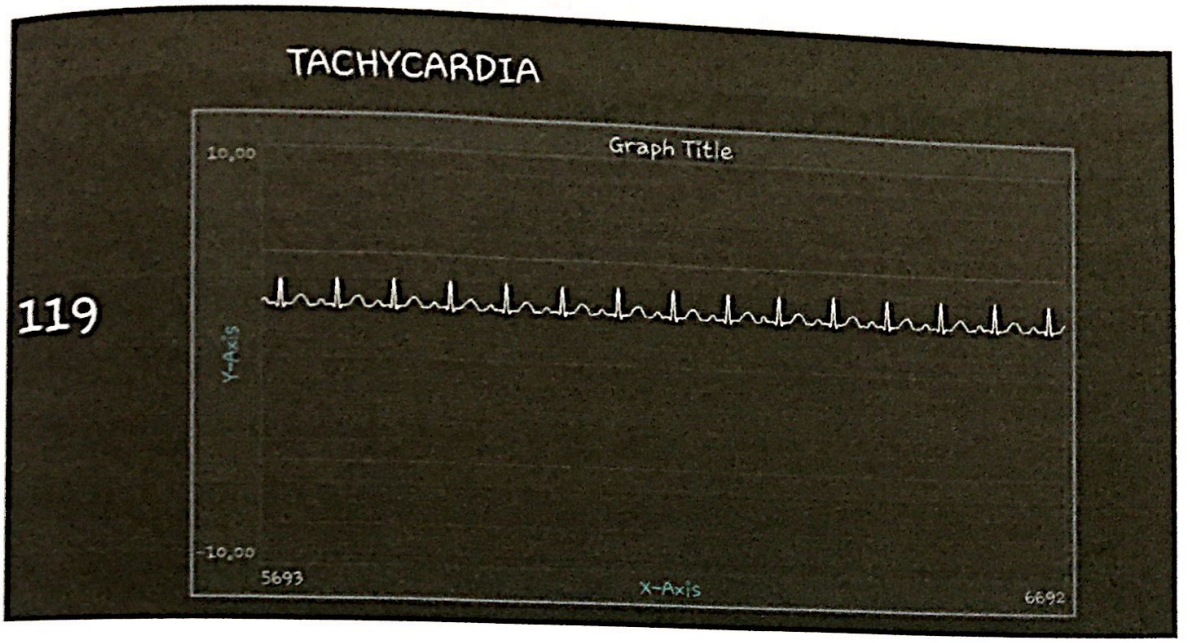

Figure 4.6: Results of Tachycardia

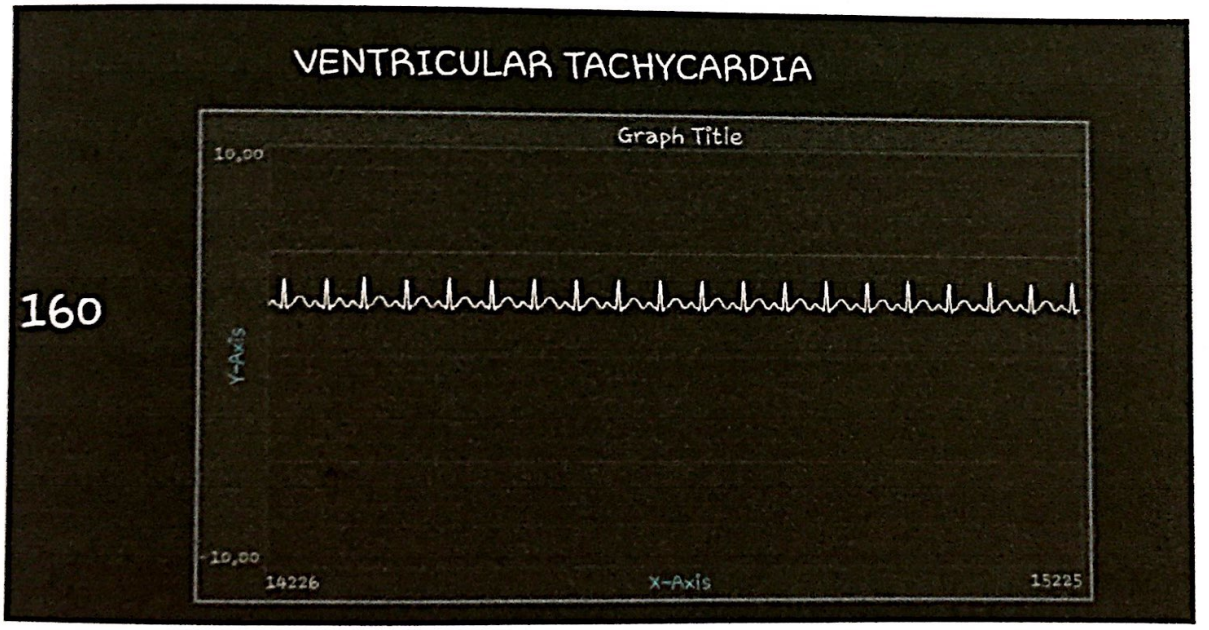

Figure 4.7: Results of Ventricular Tachycardia

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4.4 ANALYSIS OF RESULTS

4.4.1 Testing of ECG Simulator With Patient Monitor

The first step of analysis of data is the ECG simulator is tested with real equipment which is patient monitor. The reason is to identify the condition of the ECG simulator and patient monitor is in good condition. It is important to test the real equipment condition before proceed to the device testing with real equipment. The figure 4.8 shows the tesitng process of ECG simulator with patient monitor.

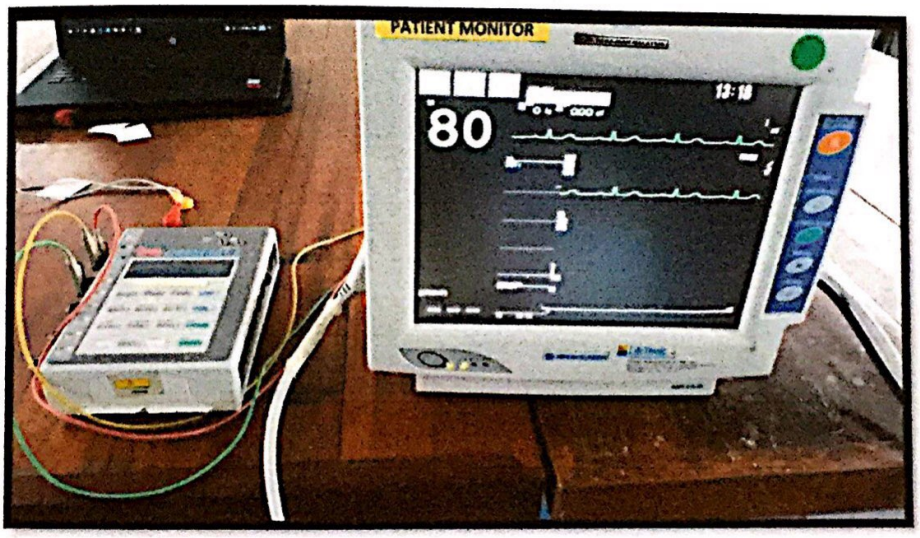

Figure 4.8: ECG simulator tested with patient monitor

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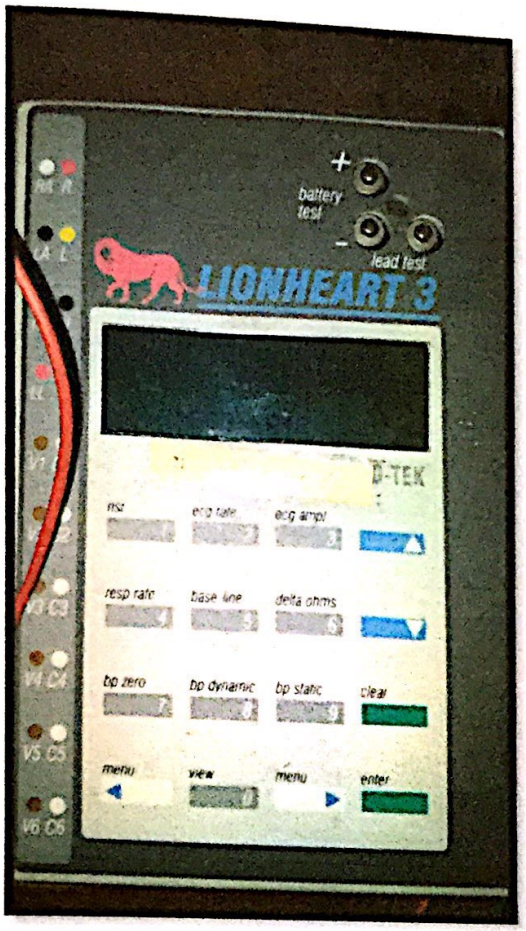

Figure 4.9: ECG simulator display

4.4.2 Testing of device with ECG simulator

The next step to calibrate the device with ECG simulator. The process is done to calibrate the device using ECG simulator in order to produce correct output from the device. All the medical devices are important to undergo calibration process. The calibrated device was taken for the further process. Data received from the device after calibration were tabulate below. The heart rate starts from 30bpm till 240bpm was tested with aid of electrical signal according to the heart rate.

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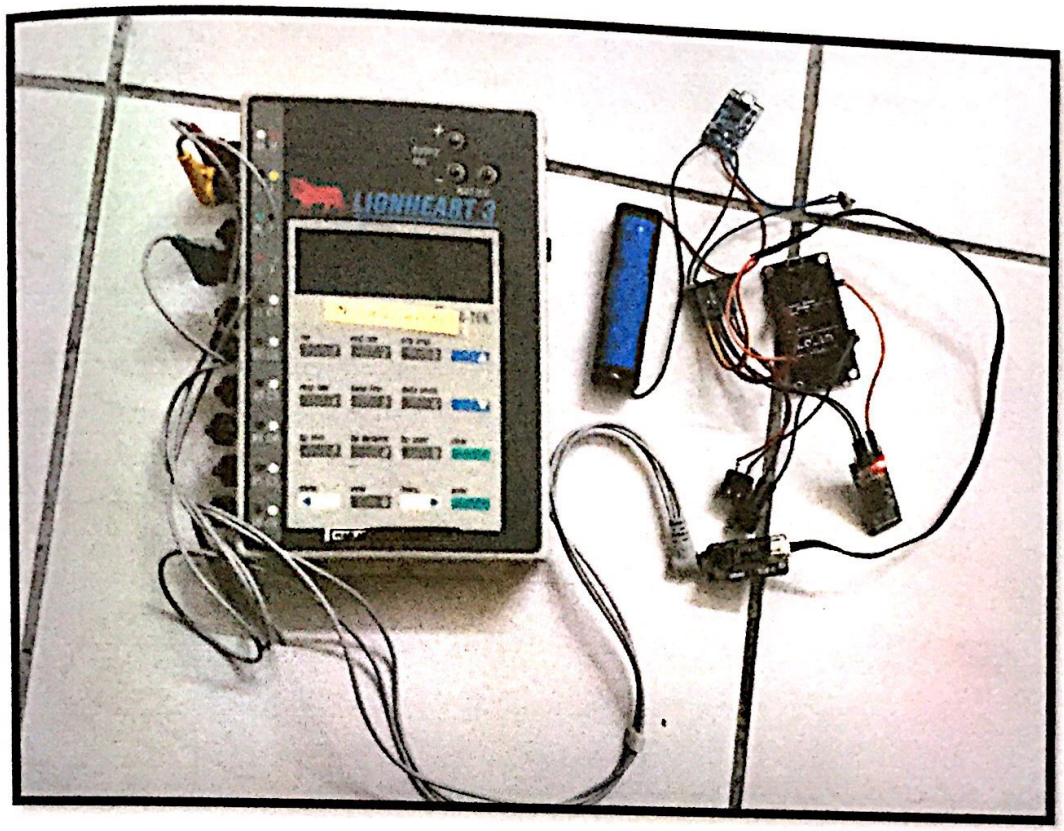
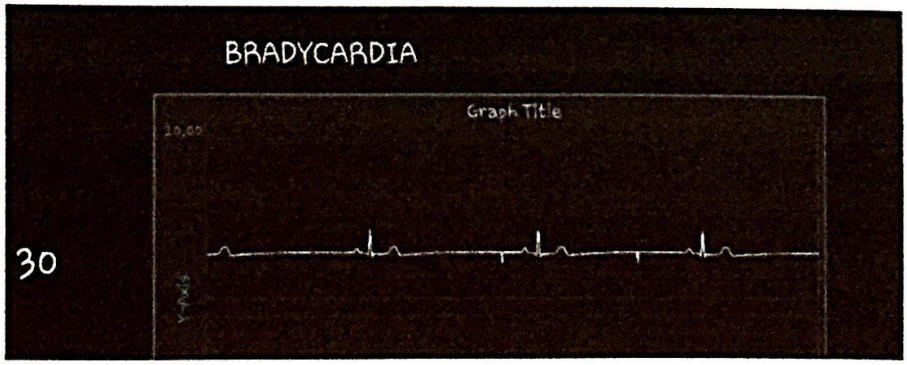


Figure 4.10: Calibration process with ECG simulator

TABLE 4.1: Results received from ECG simulator and displayed on android application

Heart rate (bpm) -ECG simulator	Results (ECG wave +heart rate, bpm)
30	

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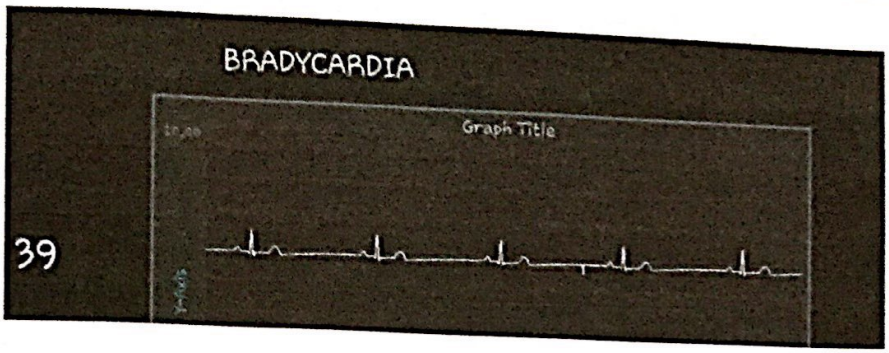
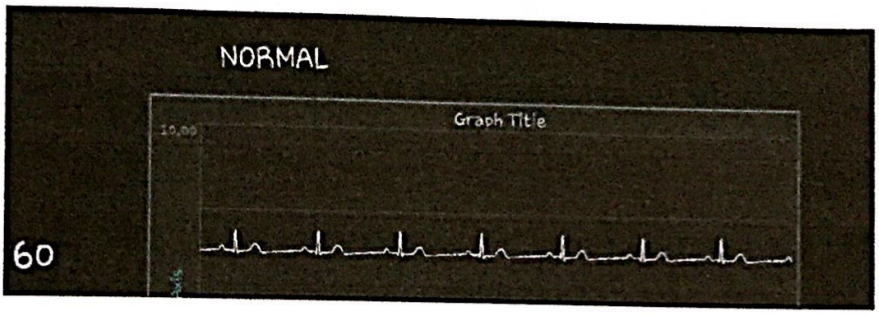
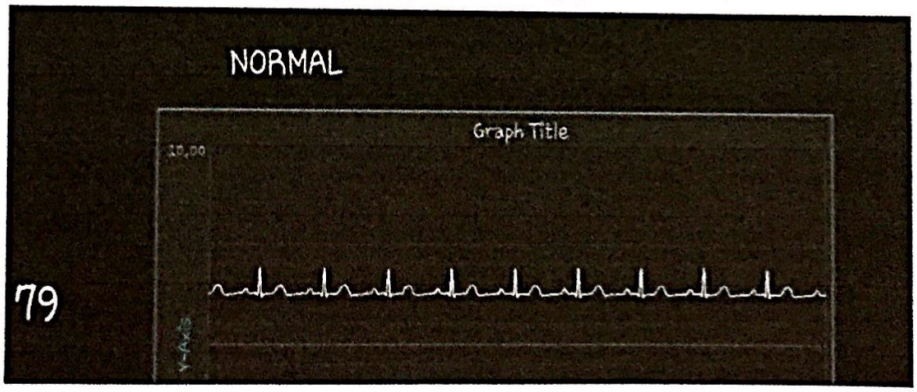
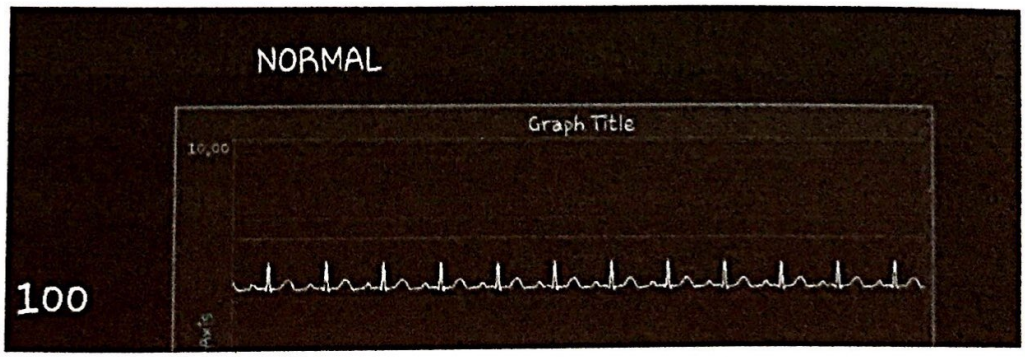
40	
60	
80	
100	

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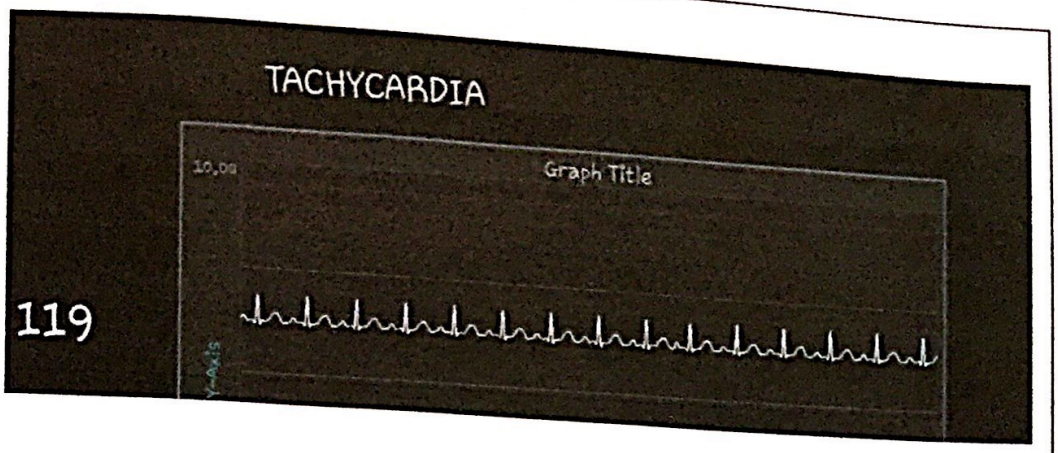
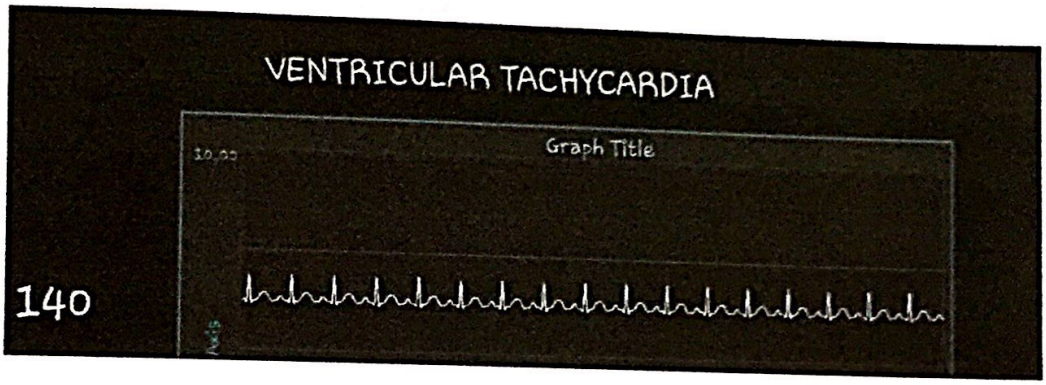
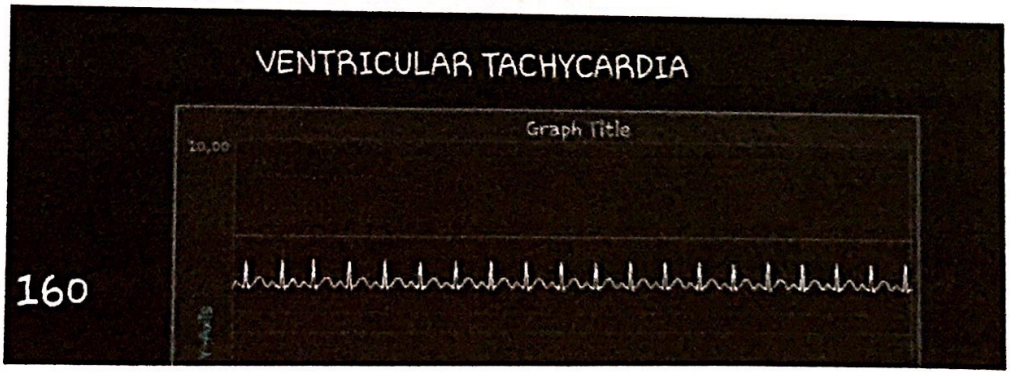
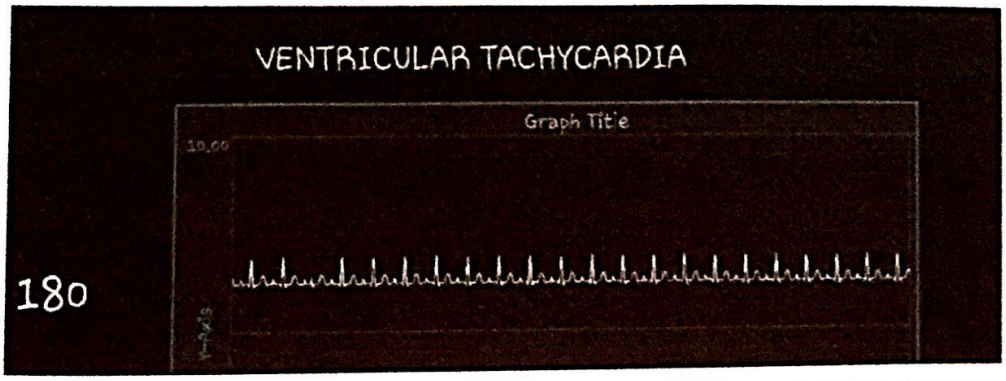
120	
140	
160	
180	

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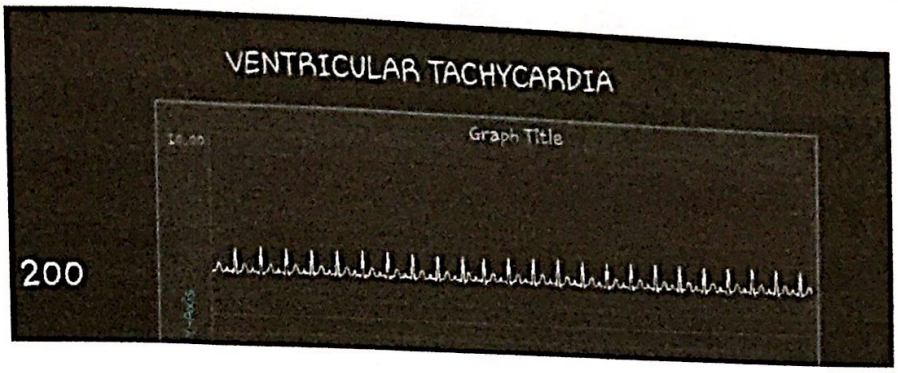
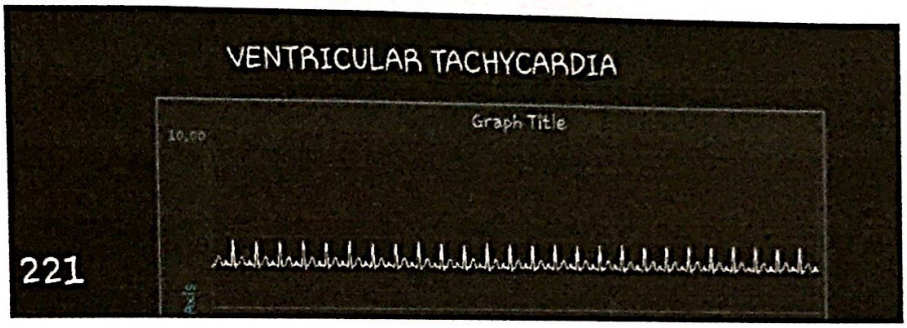
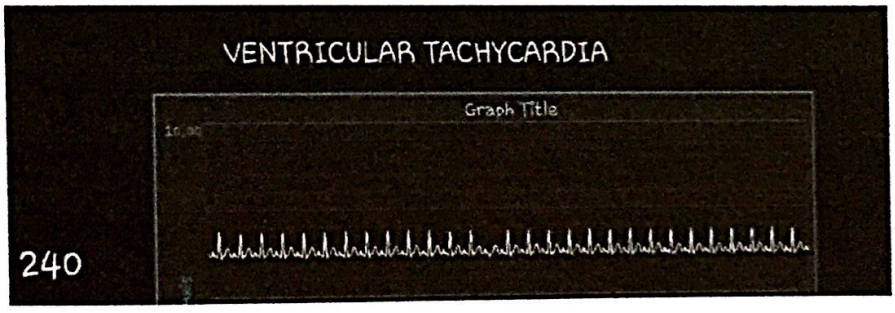
200	
220	
240	

4.4.3 Testing of Device with Subject

Once the device is calibrated. The device was tested with a subject. At first the subject was tested using patient monitor and the same subject was tested with device. It is mainly to done to determine the results or data received from patient monitor and device produce same output.

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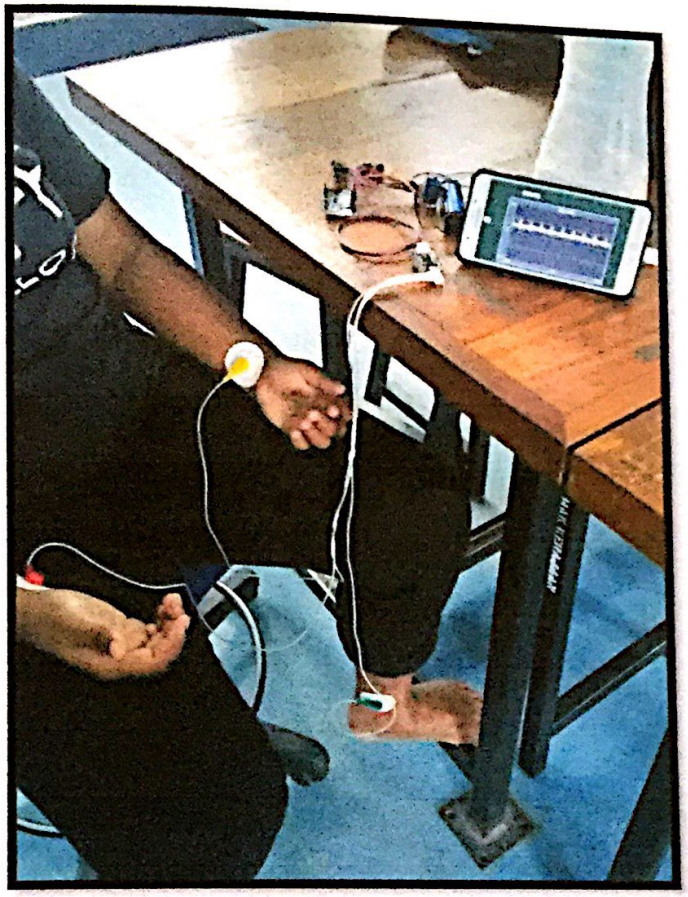

Figure 4.11: Testing subject with device and patient monitor

4.4.4 Comparison of Results with Patient Monitor

Comparing the results received from patient monitor and device are done. The output received from the device and patient monitor are producing quite similar of heart rhythm and heart rate. It is proven the data received from the device are trustable. In addition, the heart rhythm also was produced with same waves with device and patient monitor. There is error in heart rate value for 1bpm within patient monitor and device. Figure 4.12 and 4.13 shown the output from the patient monitor obtain by testing with normal condition subject. Followed by the output received from device which were obtained by testing the same subject. This process is mainly done to distinguish the results from patient monitor and device.

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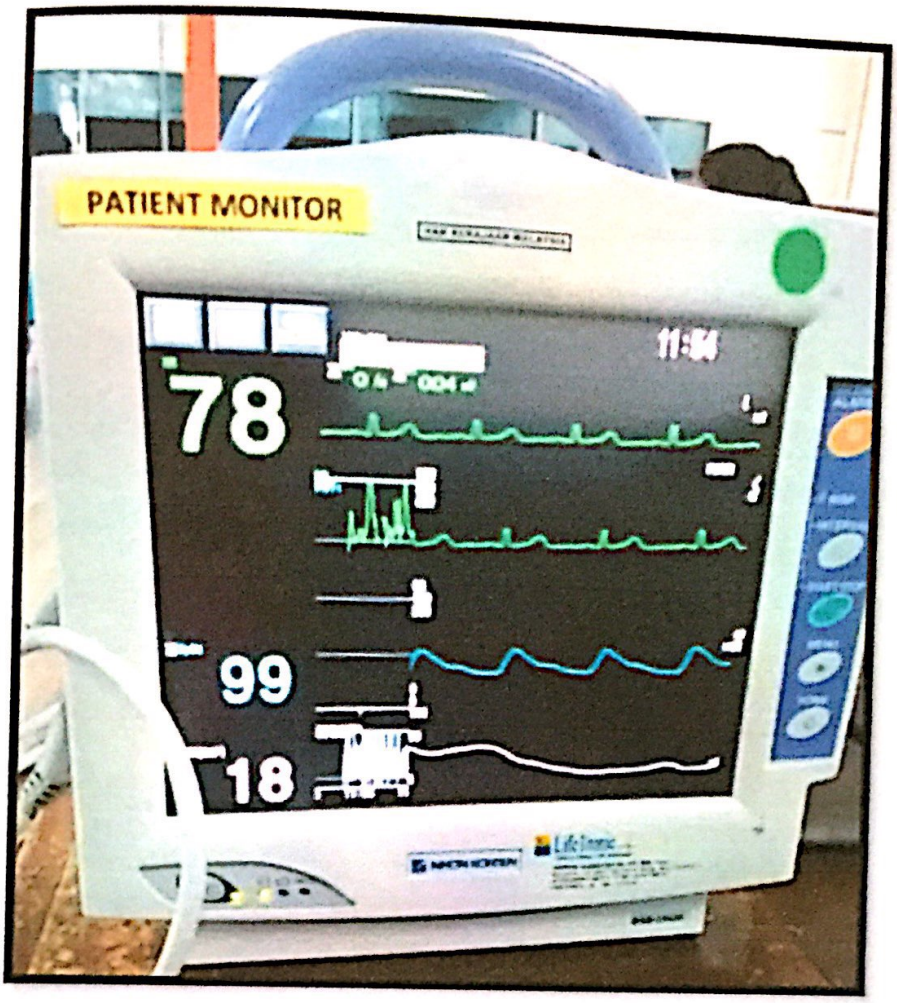

Figure 4.12: Output from patient monitor

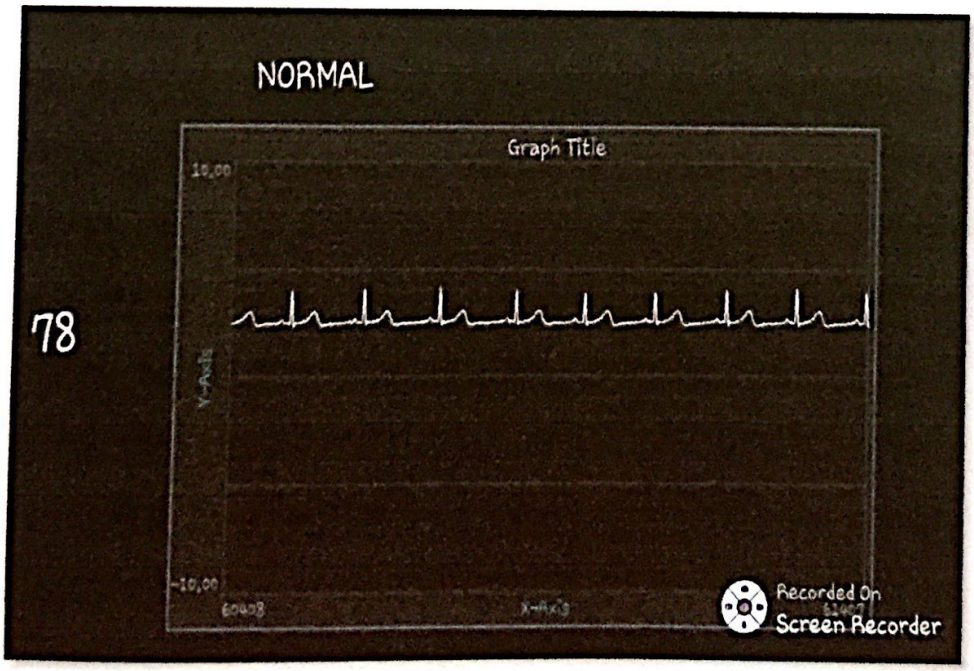

Figure 4.13: Output from device.

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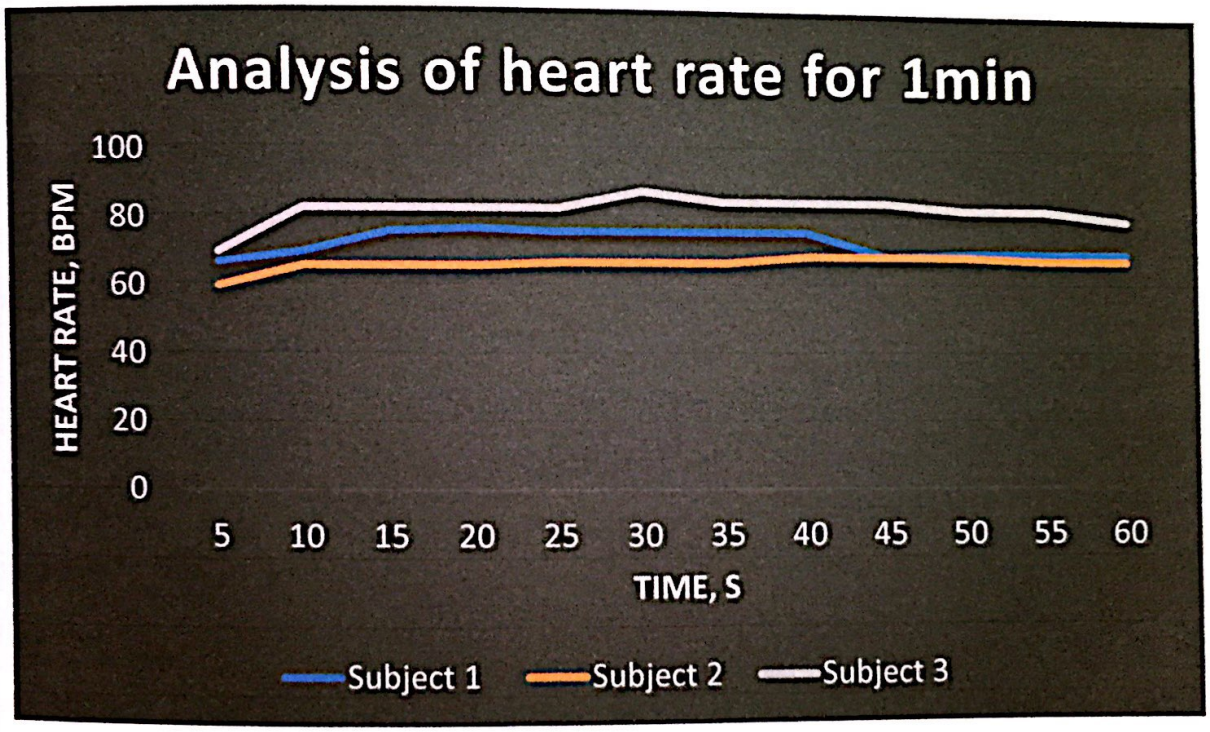
4.4.5 Analysis the stability of heart rate for 1 minute

Figure 4.14 is the graph of data analysis was to test the stability of device in providing the data to the user without too much of difference in heart rate value within 1 minute. 3 subjects are tested for 1 minute and the data are saved in Blynk application. The history of the heart rate of these 3 subjects for 1 minutes are transferred into excel and produce graph. The graph explained on the changing of heart rate within 1 minute of 3 different subject testing using the device. The difference of changing of heart rate are increasing and decreasing with small numbers. It is proven the device able to produce heart rate data with good stability.



Figurer 4.14: Analysis of heart for 1 minute with 3 different subjects

4.5 3D DESIGN FOR HOUSING

It is important to provide friendly user device with safety features of housing to the users. This housing is specially designed for this device. Figure 4.15 was the housing of the device with full package of ECG lead. Moreover, figure 4.16, 4.17

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and 4.18 are the front and back view of the housing without components placement. The housing is designed with curvy edges in order to hold the device easily without slipping. Non-edge of 4 sides of corner to protect the user from get hurt with sharp edge. Small in size which the user able to put in pocket during outings.

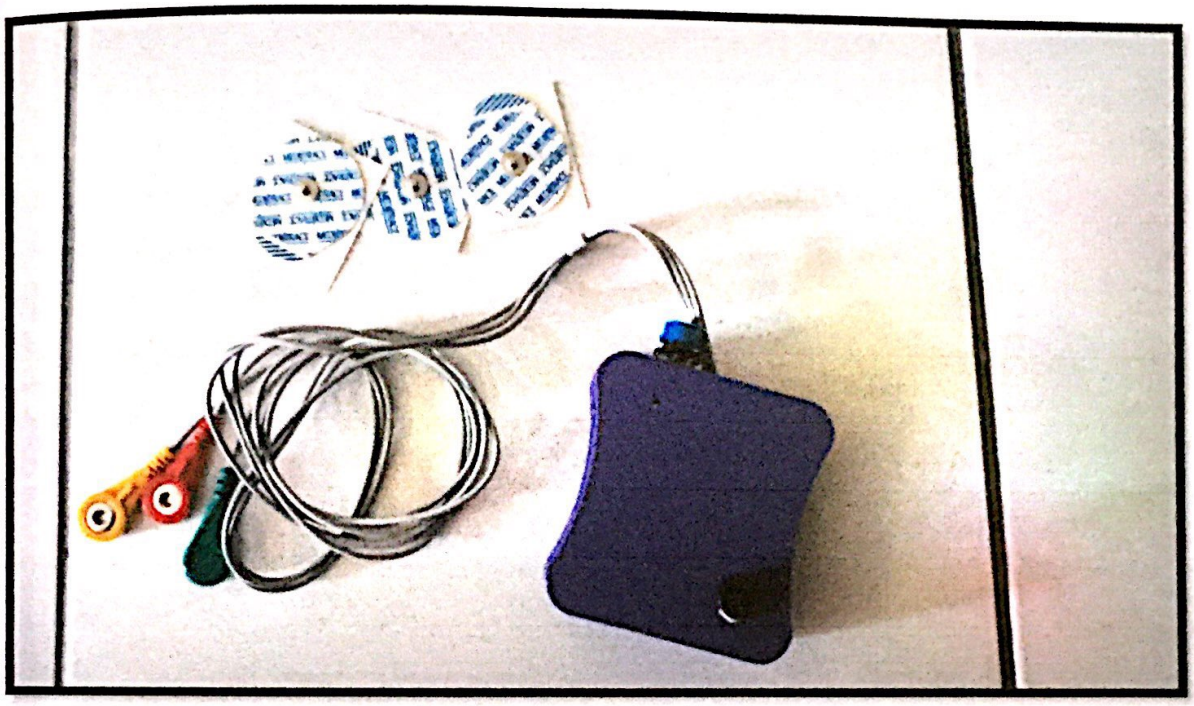

Figure 4.15: Device with 3D housing

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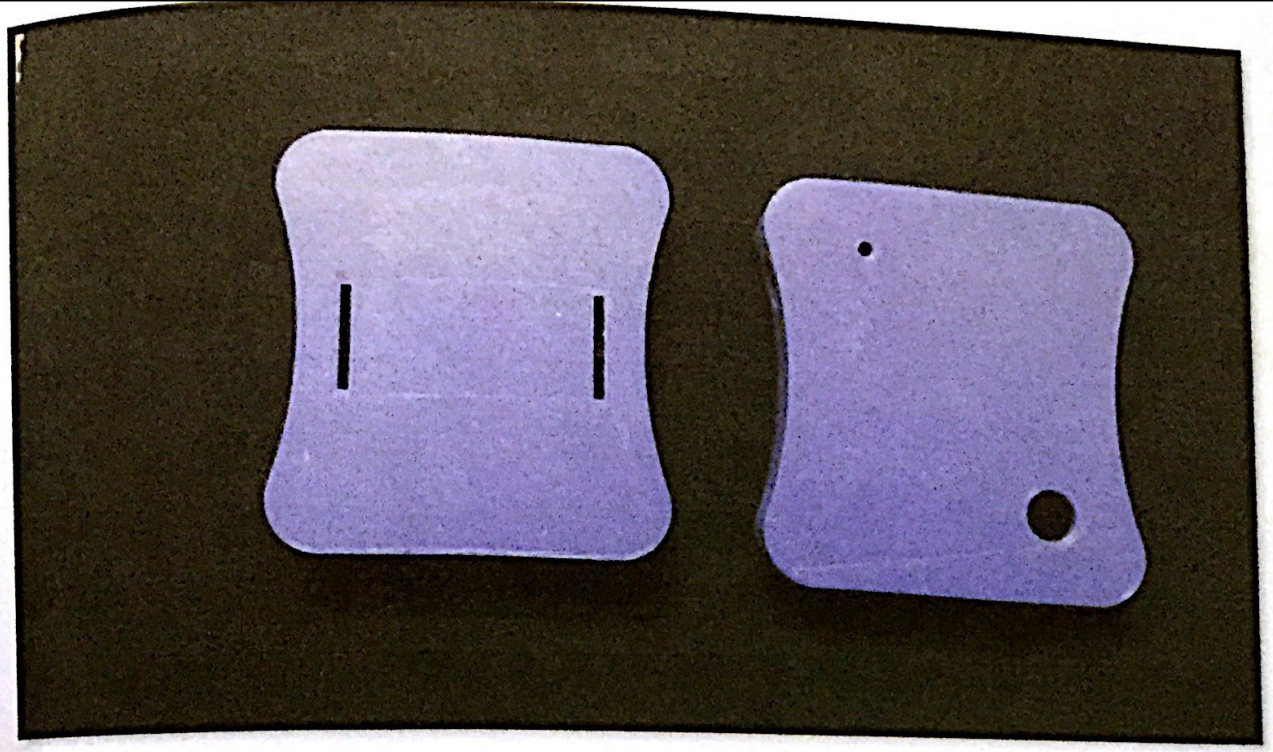

Figure 4.16: Front view of front and back part of housing

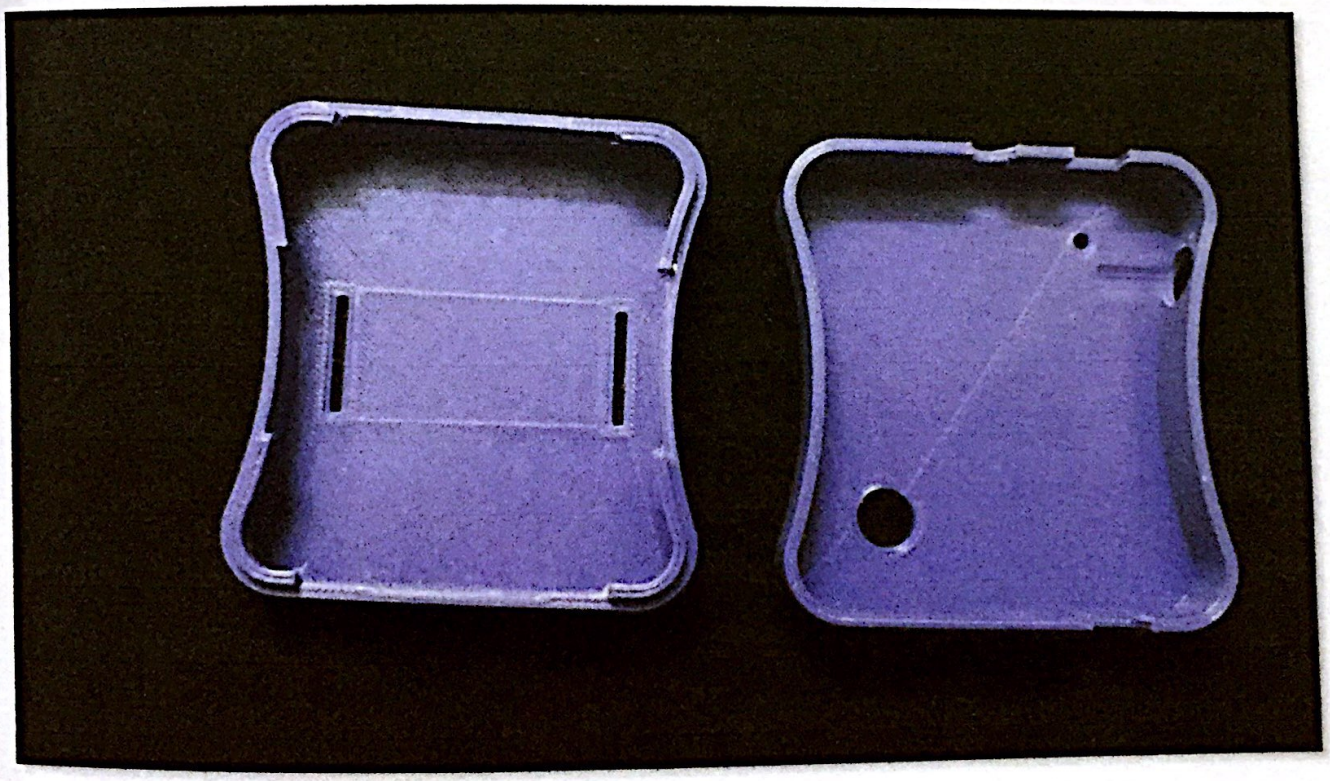

Figure 4.17: Back view of front and back part of housing

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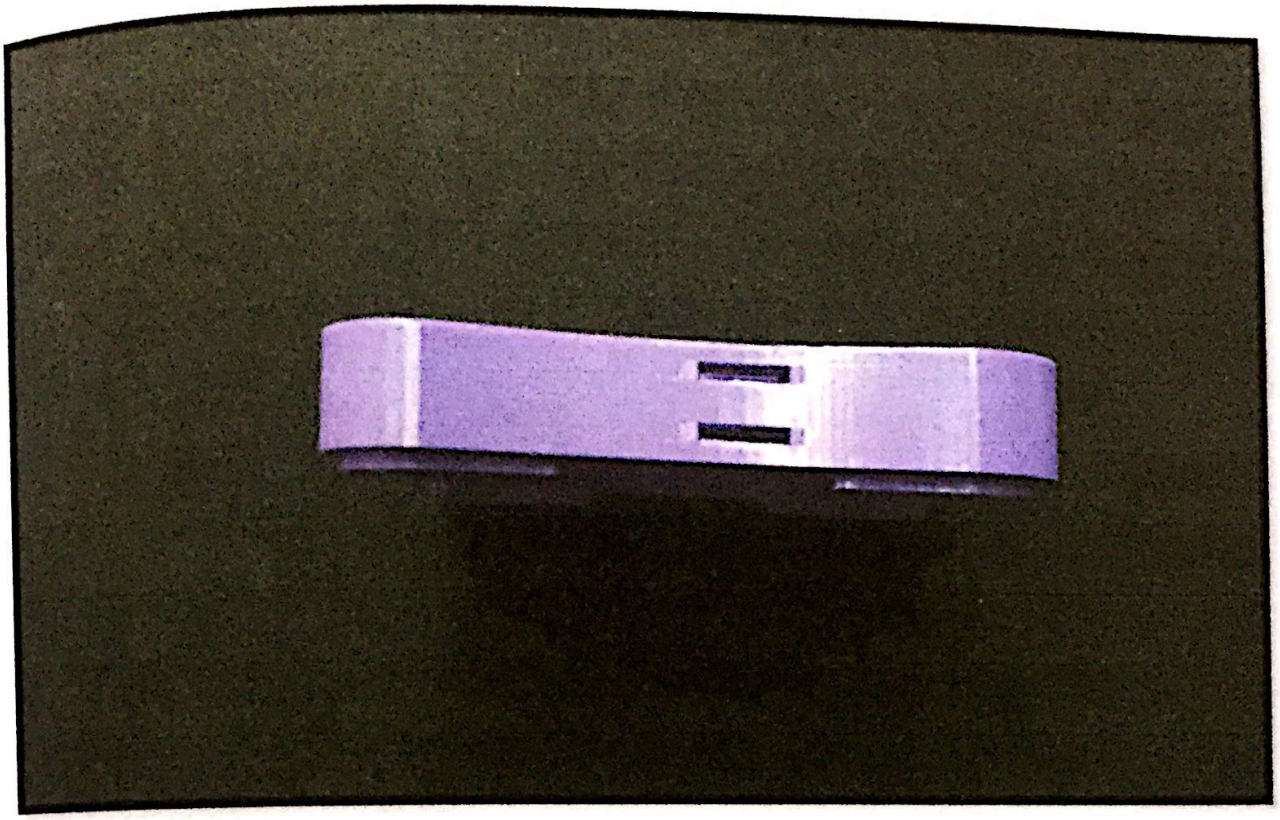

Figure 4.18: Side view of back part of housing

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CHAPTER 5

CONCLUSION

The heart has been proven an important internal part of body. This device will help the society to taking a good care of their body system especially heart in good condition. Moreover, the application with latest technology with easy method of using has been applied in this device. The device may use as educational purpose to learn on how the heart is functioning with several types of arrhythmia that may happened to human heart. Indirectly, it creates awareness to all stage of ages to take care of the heart at early stage. Simple methodology has been setup to help the needy. The innovation of this device may useful to the user in multiple way. It can be helping the users to monitor their heart and health condition with trouble-free. They do not need to long queue in hospitals in order to check the heart condition. This device is capable in providing reliable and trustable data to users as the data are compared with the results get from the patient monitor. It can reduce the number of heart disease death by using this device at anywhere in this world as precautioning device.

Limitation and Recommendation

- Instead of using 2 application make it in one customize application specifically for this device
- Upgrade in programming
- Customize of miniature board

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APPENDIX A

PRE QUESTIONAIRE

KEMENTERIAN PENDIDIKAN MALAYSIA

POLITEKNIK MALAYSIA

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

TITLE: Application system monitoring device for Arrhythmia

(Final Year Project)

Project 1 (BEU5173)

COURSE: Bachelor of Electronic Engineering Technology (Medical Electronic) with Honor

PROJECT OUTLINE:

Medical devices have been improved with rapid growth of technologies. Electrocardiogram (ECG) is one the best way to obtained the heart condition information. An ECG can provide and analyzed data such as heart beats, heart rhythm and type of heart disease. This device mainly on the Android Mobile phones receiving the data from heart rate sensor (AD8232) in form of ECG signal and heart rate via Bluetooth module and synchronize with Wi-Fi from a user in real time and display on the smartphone screen. Heart condition requires special attention to keep his her health in safe. In addition, monitoring the heart condition of the heart patient is crucial. The device with ability of monitoring heart patients and alert the guidance via smart phones by using Android Application. The android application is providing the data to the user so that the guidance can monitored the patient from long and short distance. The device has been tested with patient to get the results. Followed by the same patient was examine using patient monitor to get the heart rhythm and heart rate data to compare with this device results. It has been proven the data produced by the patient monitor and device is almost same with difference in few numbers of percentage.

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NAME:

AGE:

GENDER:

POSITION DEPARTMENT

QUESTIONNAIRES

- **Choose the range between 1 – 5 for all question.**
  1-No 2-Partially Yes 3-Yes 4-Strongly Yes.
- **Tick (/) on correct circle for Yes or No questions.**

NOTES: This question refers to all

1. Do you know what an Arrhythmia (Heart Rhythm Disorder) is?

1	2	3	4

2. Do you know the symptoms of an Arrhythmia (Heart Rhythm Disorder?

1	2	3	4

3. Can Arrhythmia be prevented?
   - o YES
   - o NO

4. Based on your family history, do anyone facing an Arrhythmia (Heart Rhythm Disorder)?
   - o YES
   - o NO

5. Are you suffering from Arrhythmia (Heart Rhythm Disorder)?
   - o YES
   - o NO

6. Arrhythmia can be in anyone regardless of age and gender?
   - o YES
   - o NO

7. Did you ever used applied any heart rhythm sensing device?
   - o YES
   - o NO

8. Do those customers patients prefer wireless heart rhythm sensing device?

1	2	3	4

9. Will you buy our product with perfect combination of affordability, health and safety with accurate sensing?
   - o YES
   - o NO

10. Is the available heart rhythm sensing product expensive?

1	2	3	4

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APPENDIX B

POST QUESTIONAIRE

KEMENTERIAN PENDIDIKAN MALAYSIA

POLITEKNIK MALAYSIA

POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH

TITLE: Application system monitoring device for Arrhythmia

(Final Year Project)

PROJECT 2 (BEU6225)

COURSE: Bachelor of Engineering Technology (Medical Electronics) With Honors

PROJECT OUTLINE:

Medical devices have been improved with rapid growth of technologies. Electrocardiogram (ECG) is one the best way to obtained the heart condition information. An ECG can provide and analyzed data such as heart beats, heart rhythm and type of heart disease. This device mainly on the Android Mobile phones receiving the data from heart rate sensor (AD8232) in form of ECG signal and heart rate via Bluetooth module and synchronize with Wi-Fi from a user in real time and display on the smartphone screen. Heart condition requires special attention to keep his/her health in safe. In addition, monitoring the heart condition of the heart patient is crucial. The device with ability of monitoring heart patients and alert the guidance via smart phones by using Android Application. The android application is providing the data to the user so that the guidance can monitored the patient from long and short distance. The device has been tested with patient to get the results. Followed by the same patient was examine using patient monitor to get the heart rhythm and heart rate data to compare with this device results. It has been proven the data produced by the patient monitor and device is almost same with difference in few numbers of percentage.

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SECTION A (PERSONAL INFORMATION)

NAME:

AGE:

GENDER:

POSITION DEPARTMENT:

SECTION B

QUESTIONNAIRES

Please tick in the table provided.

1-Strongly Disagree 2- Disagree 3-Partially Agree 4- Agree 5- Strongly Agree

No	Questions	1	2	3	4	5
1	This device creates comfortable zone for patients					
2	Patient secured while wearing this device					
3	This device would be helpful for doctors in easily diagnosing arrhythmia disease					
4	This device would be helpful for patients in monitoring heart rhythm					
5	The results of from the device is understandable					
6	Arrhythmia Detector device will save or prolong someone's life					
7	Arrhythmia detector would help the caregiver to take care of the user easily					
8	This device saves user time					
9	Simple method of usage was applied					
10	User friendly with latest technology					

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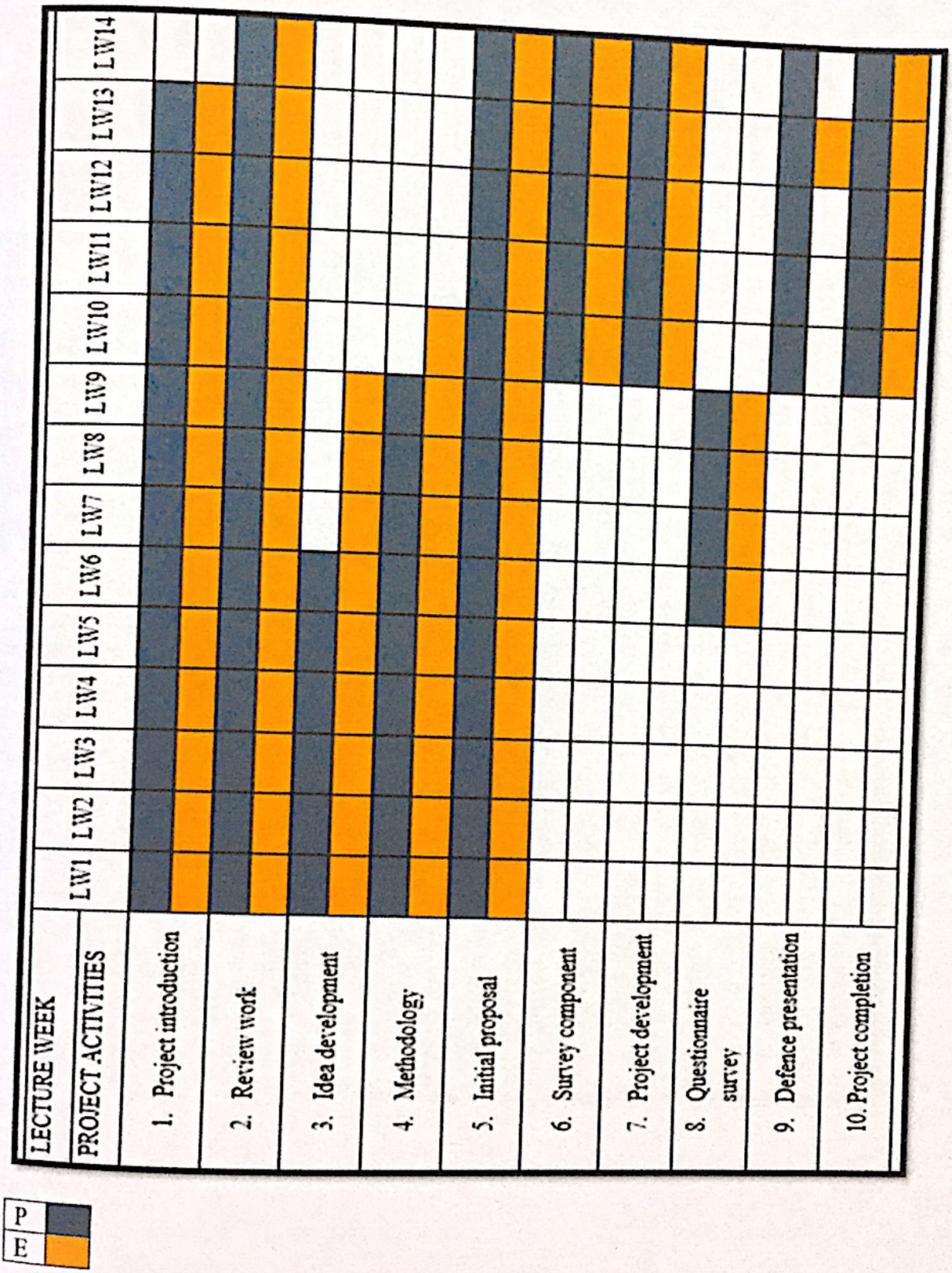
APPENDIX C

GANNT CHART SEMESTER 5



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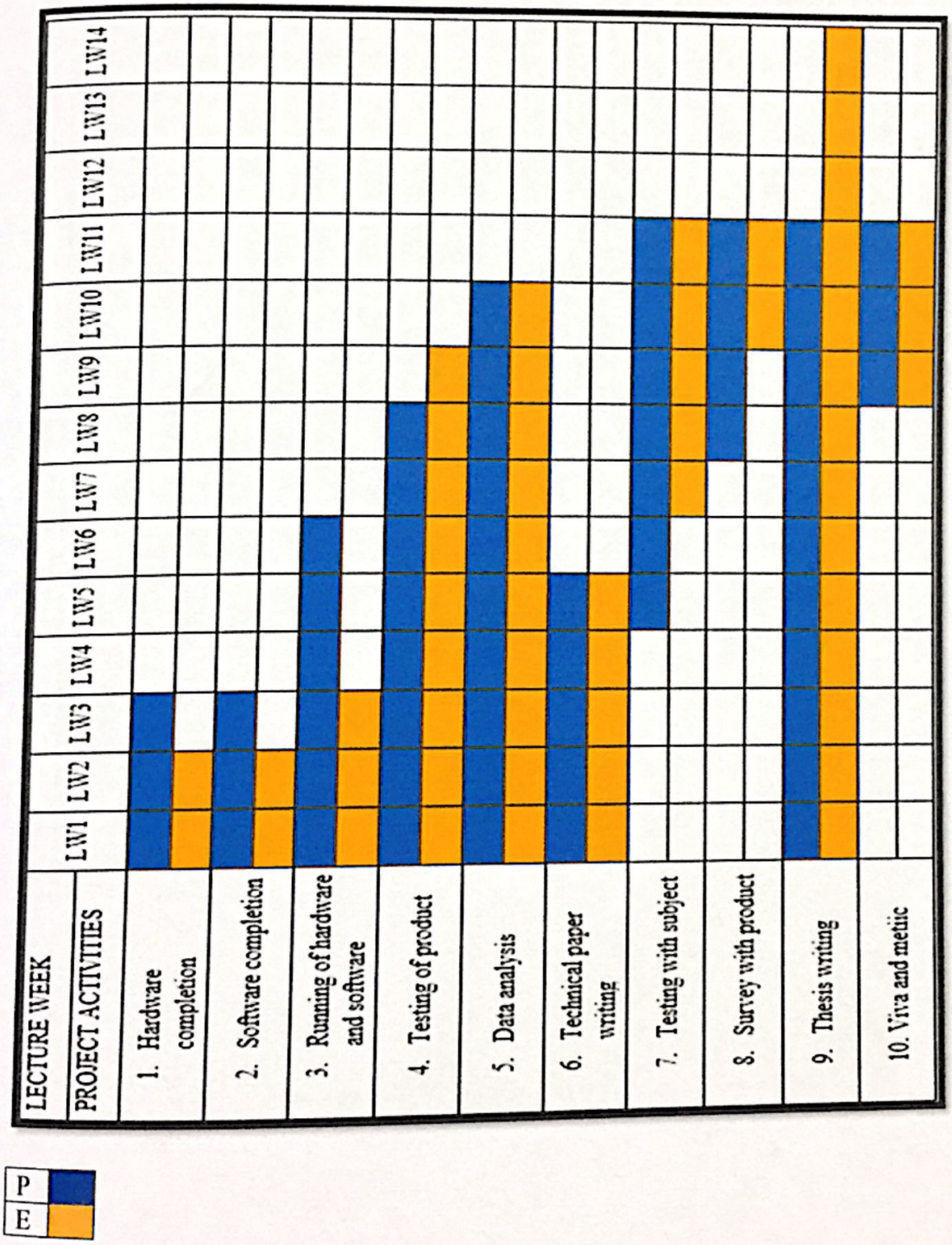
APPENDIX D

GANNT CHART SEMESTER 6



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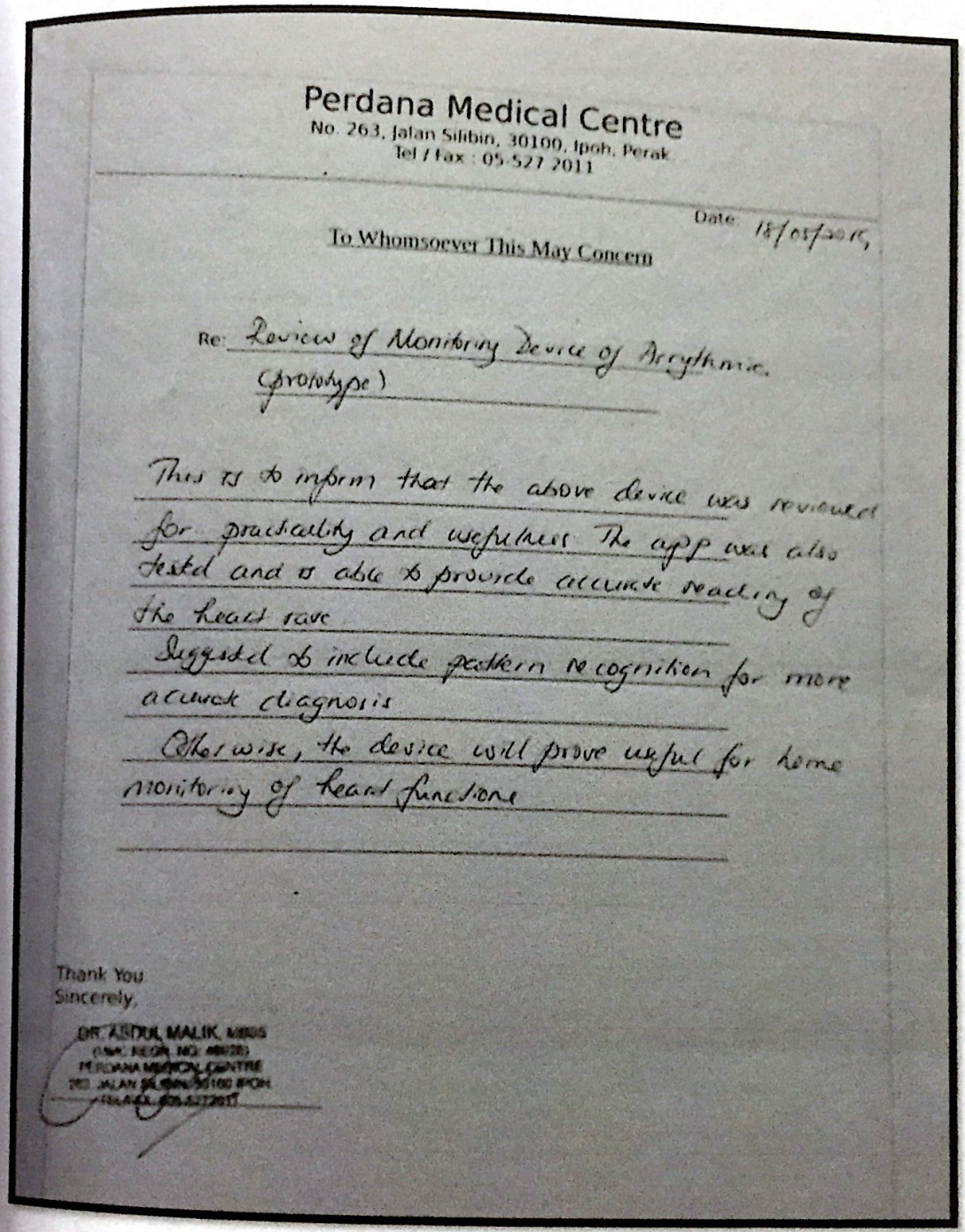
APPENDIX E

FEEDBACK FORM CLINICAL DEPARTMENT



Perdana Medical Centre
No. 263, Jalan Silibin, 30100, Ipoh, Perak
Tel / Fax : 05-527 2011

Date: 18/03/2015

To Whomsoever This May Concern

Re: Review of Monitoring Device of Arrythmia (Prototype)

This is to inform that the above device was reviewed for practicality and usefulness. The app was also tested and is able to provide accurate reading of the heart rate.

Suggested to include peakkin recognition for more accurate diagnosis.

Otherwise, the device will prove useful for home monitoring of heart functions.

Thank You
Sincerely,

DR. ABDUL MALIK, MBBS
(MM, MCOM, NO: 46828)
PERDANA MEDICAL CENTRE
263, JALAN SILIBIN, 30100 IPOH
TEL & FAX: 05-5272011

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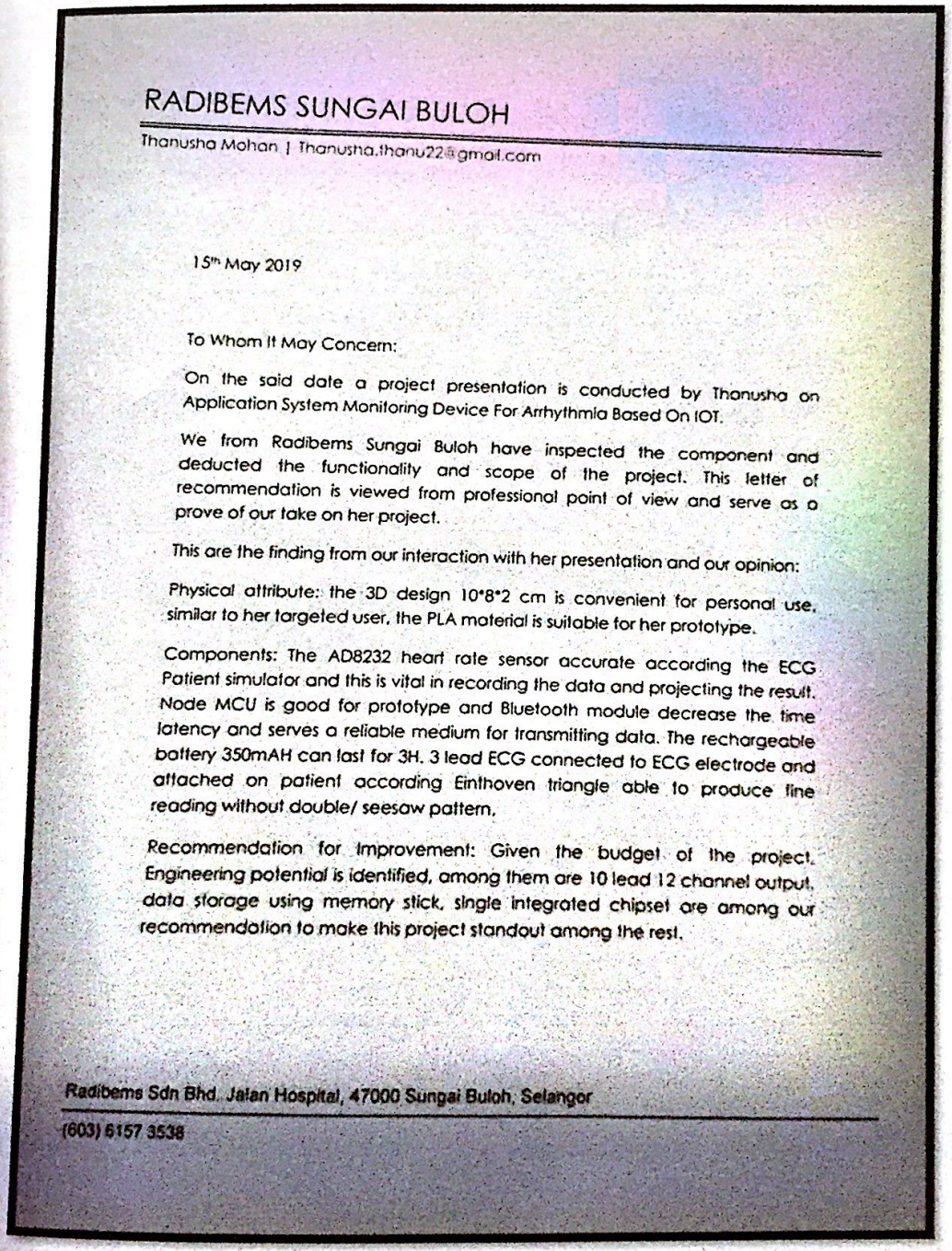
APPENDIX F

FEEDBACK FORM OF ENGINEERING DEPARTMENT



RADIBEMS SUNGAI BULOH

Thanusha Mohan | Thanusha.thanu22@gmail.com

15th May 2019

To Whom It May Concern:

On the said date a project presentation is conducted by Thanusha on Application System Monitoring Device For Arrhythmia Based On IOT.

We from Radibems Sungai Buloh have inspected the component and deducted the functionality and scope of the project. This letter of recommendation is viewed from professional point of view and serve as a prove of our take on her project.

This are the finding from our interaction with her presentation and our opinion:

Physical attribute: the 3D design 10*8*2 cm is convenient for personal use, similar to her targeted user, the PLA material is suitable for her prototype.

Components: The AD8232 heart rate sensor accurate according the ECG Patient simulator and this is vital in recording the data and projecting the result. Node MCU is good for prototype and Bluetooth module decrease the time latency and serves a reliable medium for transmitting data. The rechargeable battery 350mAH can last for 3H. 3 lead ECG connected to ECG electrode and attached on patient according Einthoven triangle able to produce fine reading without double/ seesaw pattern.

Recommendation for Improvement: Given the budget of the project, Engineering potential is identified, among them are 10 lead 12 channel output, data storage using memory stick, single integrated chipset are among our recommendation to make this project standout among the rest.

Radibems Sdn Bhd, Jalan Hospital, 47000 Sungai Buloh, Selangor

(603) 6157 3538

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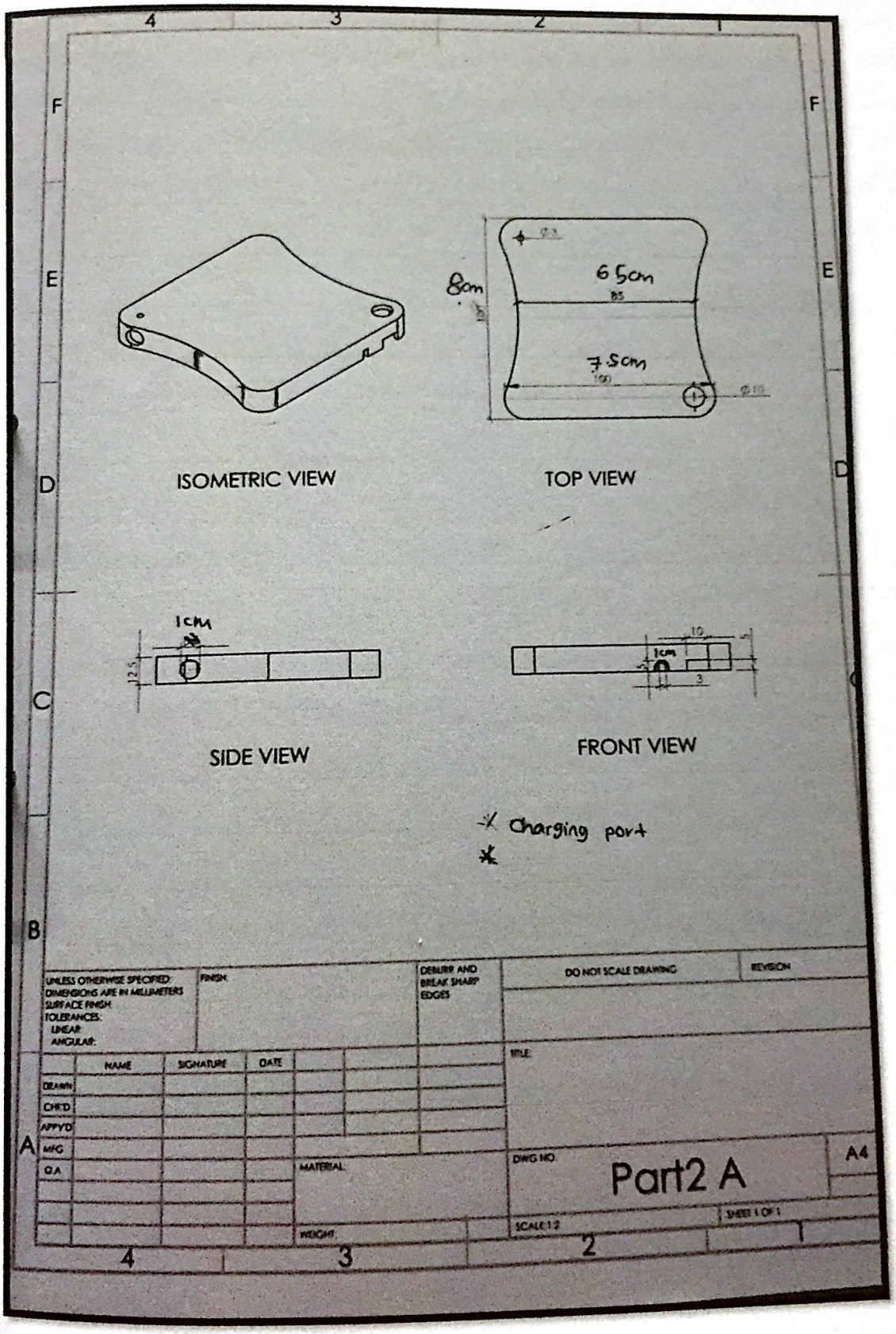
APPENDIX G

DESIGN



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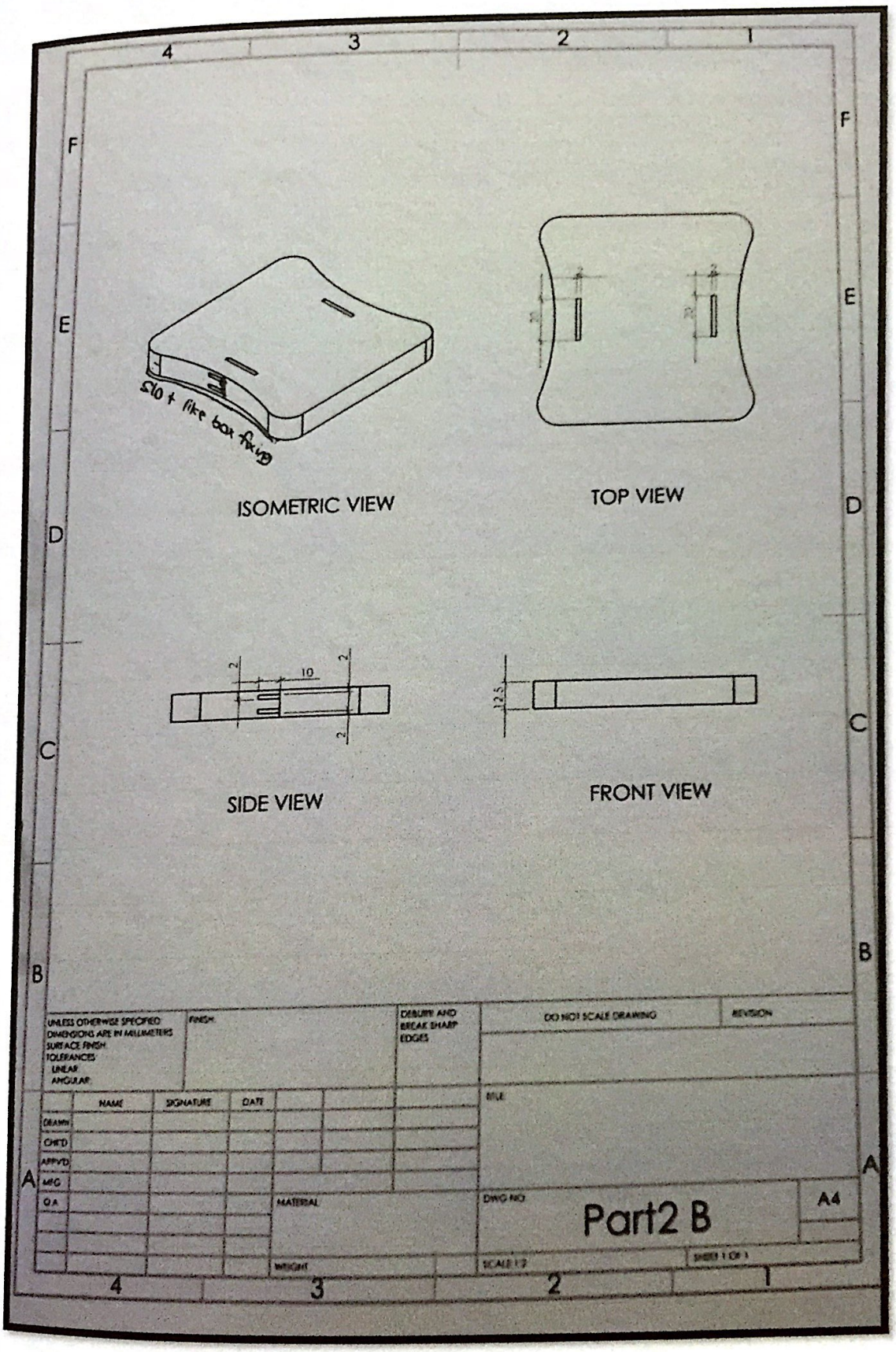

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