PC BASED PULSE RATE MONITORING SYSTEM

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DECLARATION

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

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ABSTRACT

Health is one of the global challenges for humanity. Rapid economic and industrial development leads to increase intensity in daily life, which brings people negative sentiments, such as nervousness, anxiety, and disturbance. Nowadays, cardiovascular disease is the number one cause of death globally due to the negative sentiments along with changes of quickly lifestyle. Pulse rate is one of the important vital parameter to detect cardiovascular disease. This project presents an innovation of measuring device and monitoring system for pulse rate. Currently, the healthcare system is undergoing a cultural shift from a traditional approach to a modernized patient centered approach. In the traditional approach the healthcare professionals play the major role. The healthcare professionals have to move physically from one person to another for health check, where may not be possible to monitor their conditions continuously. Subsequently, any serious circumstances cannot be found easily except the doctor and nurse check the patient health at that moment. The second problem is patient movement are restricted to bed and wired to large machine. The primary objective is to develop health monitoring system for healthcare professionals to monitor their patients easily from the PC based station, to determine the pulse rate of patient and to analyze the reliability of the system. The reliability and validity of this project have been ensured via field test. The data analysis shows that this project can produce accurate readings that are similar to those produced by the existing medical device. By using this project the healthcare professionals can monitor their patients all the time. Hence, the healthcare professional can monitor their patients from a PC based station at any time.

Keywords – ***Cardiovascular disease, Pulse rate, Measuring Device, Monitoring System, Healthcare Professionals***

ABSTRAK

Kesihatan merupakan salah satu cabaran global bagi masyarakat. Pembangunan ekonomi dan perindustrian yang pesat membawa kepada peningkatan intensity dalam kehidupan seharian, yang membawa kepada sentimen negatif seperti perasaan takut, kebimbangan dan terasa tergugat. Pada hari ini, penyakit jantung adalah punca nombor satu yang menyebabkan kematian di seluruh dunia. Hal ini berpunca daripada sentimen negatif seiring dengan perubahan gaya hidup. Denyutan nadi merupakan salah satu parameter yang penting untuk mengenalpasti penyakit jantung. Projek ini merupakan satu inovasi alat untuk mengukur dan sistem pemantauan kadar denyutan nadi. Sistem pemantauan kesihatan pada masa kini sedang mengalami perubahan daripada pendekatan tradisional kepada pendekatan pesakit yang moden seiring dengan perubahan teknologi. Dalam pendekatan tradisional para profesional kesihatan memainkan peranan utama di mana mereka perlu bergerak secara fizikal dari satu pesakit ke satu pesakit yang lain untuk membuat pemeriksaan kesihatan. Oleh disebabkan itu, kadangkala mereka tidak dapat untuk membuat pemantauan keadaan pesakit mereka secara berterusan. Oleh hal yang demikian, sebarang keadaan yang serius tidak boleh dikesan dengan mudah kecuali para profesional memeriksa kesihatan pesakit pada masa itu. Masalah yang kedua adalah pergerakan pesakit adalah terhad kepada katil dan terpaksa terikat kepada wayar yang disambungkan ke alat perubatan. Objektif utama projek ini ialah untuk mereka sistem pemantauan kesihatan pesakit dengan memudahkan para profesional kesihatan memantau keadaan peasakit mereka dengan mudah dari komputer. Objektif yang kedua ialah untuk menentukan kadar denyutan nadi pesakit dan menganalisis kebolehpercayaan sistem. Kebolehan dan kesahihan projek ini telah dipastikan melalui ujian lapangan. Data yang telah dianalisis menunjukkan bahawa projek ini boleh menghasilkan bacaan yang tepat sama seperti alat perubatan yang sedia ada. Dengan menggunakan projek ini, para profesional kesihatan boleh memantau pesakit mereka sepanjang masa dengan menggunakan komputer.

Kata kunci– ***Penyakit jantung, Kadar denyutan nadi, Sistem pemantauan, Profesional Kesihatan***

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CHAPTER 1

INTRODUCTION

Cardiovascular disease is the number one killer in terms of diseases and health-related problem[1]. Cardiovascular disease is the number one cause of death globally more people die annually from cardiovascular diseases than from any other cause.

The World Health Report emphasized that the total global deaths from cardiovascular disease (CVD) contributed to 16.7 million (29.2%) deaths and 80% of these were in low and middle income countries[2]. It is probably not news anymore that cardiovascular disease which most notably, coronary heart disease and stroke are top killers in Malaysia. The total number of deaths in Malaysia resulted from coronary heart disease was at 22,701. This consists of to about 22.18% of the total deaths in the country[2].

One of the possible diagnostic tools that can early detection of cardiac events is pulse rate[3]. Taking a pulse not only measures the heart rate, but also can indicate heart rhythm and strength of the pulse, as well as whether the blood vessel feels hard or soft. The changes in heart rate or rhythm, a weak pulse or a hard blood vessel may be caused by heart disease or another problem. Hence, technological innovations in the field of disease prevention and maintenance of patient health have enabled the evolution of fields such as monitoring system.

In a hospital, it is necessary to have health monitoring system to constantly monitor the patient's vital parameters[4]. In the proposed study, a wireless sensor has attached on patient body to collect all the signals and sends them to the base station.

The device consists of sensors which are used to measure pulse rate of a patient and the data are sent to a receiving and utilizing wireless technology where the data displayed at PC base station of doctor and nurse. The data will be record in the system and every 10 minutes it will export to the Microsoft Excel.

1.1 Problem Statement

The traditional health care system is too old school to use anymore. It is because the doctor and nurse have to move physically from one person to another for health check, where may not be possible to monitor their conditions continuously[5]. Subsequently, any serious circumstances cannot be found easily except the doctor and nurse found the patient health at that moment. The second problem is the patient movement are restricted to bed and wired to large machine[6].

Pulse rate are important in order to find the changes in heart rate or rhythm, a weak pulse or a hard blood vessel may be caused by heart disease or another problem. By using this system, it provides a continuous health monitoring, where doctor and nurse can monitor pulse rate of their patients to help maintain an optimal health status. In addition, patient no longer need to be tethered to one spot by a tangle of wired.

1.2 Objective

The objective of this study is:-

- To develop health monitoring system for healthcare professionals to monitor their patients easily from their PC.
- To determine the pulse rate of patient.
- To analyze the reliability of the system.

1.3 Scope of Study

The scope of this project to build a PC based pulse rate monitoring system for the nurse and doctor to monitor their patient without physically go to the patient in ward one by one. The sample data of this project were taken from 30 students from the department of engineering electric of the Polytechnic Sultan Salahuddin Abdul Aziz Shah.

This study consists of hardware and software. For hardware, this project is uses ATMega 328P, ESPresso Lite V2.0 wireless communication and grove pulse sensor. Meanwhile for the software, this project is using arduino program, visual basic.

1.4 Significant of Study

The significant of this study is to develop the monitoring system to help the doctor and nurses monitor their patient. The doctor and nurse no longer need to go to the patient one by one to check their health status. The routine checking of the patient can be done easily and real time monitoring of the patient is possible. Besides that, these health monitoring systems provide continuous monitoring of patient pulse rate for every 10 minute.

Therefore, these health monitoring system provide a comfortable environment for the patient where patient no longer need to be tethered to one spot by a tangle of wired and large machine. In addition, this system, where all the medical data from patient directly send to the PC base station of doctor and nurse and the nurses no longer need to record all the data.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In this chapter, it will divide into four parts. The first part of this chapter is about an anatomy of heart, cardiovascular and the pulse rate. The second part explains the cardiovascular disease. There are many types of cardiovascular disease but for this study, it will more focus on ischemic heart disease, arrhythmias and heart failure. This chapter also explains about the major risk factor for cardiovascular disease and how to prevent it. The third part of this chapter is about wireless medical device technology and the benefit of using it. The last part of this chapter is explains the current devices that are use to taking pulse rate reading such as patient monitor, non-invasive blood pressure and pulse oximetry.

2.2 Anatomy of Heart

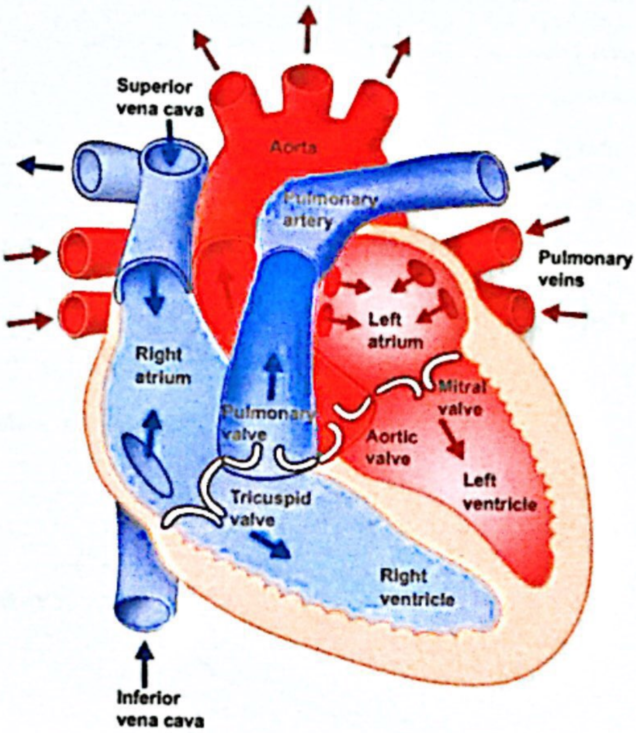

Figure 2.2: Anatomy of Heart

The heart weighs between 7 and 15 ounces (200 to 425 grams) and is a little larger than the size of your fist. By the end of a long life, a person's heart may have beat (expanded and contracted) more than 3.5 billion times. In fact, each day, the average heart beats 100,000 times, pumping about 2,000 gallons (7,571 liters) of blood[7].

The heart is a muscular organ about the size of a closed fist that functions as the body's circulatory pump. It takes in deoxygenated blood through the veins and delivers it to the lungs for oxygenation before pumping it into the various arteries; which provide oxygen and nutrients to body tissues by transporting the blood throughout the body. The heart is located in the thoracic cavity medial to the lungs and posterior to the sternum[7].

A double-layered membrane called the pericardium surrounds the heart is like a sac. The outer layer of the pericardium surrounds the roots of heart's major blood vessels and is attached by ligaments to spinal column, diaphragm, and other parts of the body. The inner layer of the pericardium is attached to the heart muscle. A coating of fluid separates the two layers of membrane, letting the heart move as it beats[8].

Heart has 4 chambers. The upper chambers are called the left and right atria, and the lower chambers are called the left and right ventricles. A wall of muscle called the septum separates the left and right atria and the left and right ventricles[8]. The left ventricle is the largest and strongest chamber in heart. The left ventricle's chamber walls are only about a half-inch thick, but they have enough force to push blood through the aortic valve and into the body.

2.3 Cardiovascular System

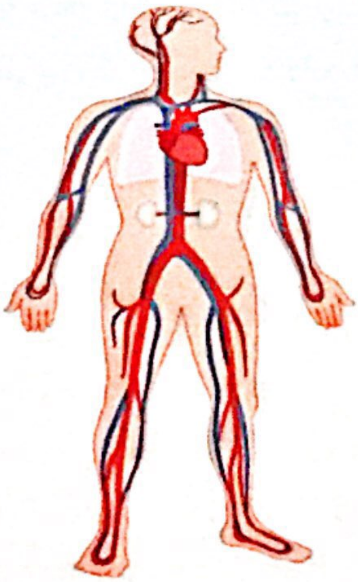

Figure 2.3: Cardiovascular System

The heart and circulatory system make up the cardiovascular system. The heart works as a pump that pushes blood to the organs, tissues, and cells into body. Blood delivers oxygen and nutrients to every cell and removes the carbon dioxide and waste products made by those cells[9]. Blood is carried from the heart to the rest of the body through a complex network of arteries, arterioles, and capillaries. Blood is returned to the heart through venules and veins.

Arteries carry oxygen-rich blood away from heart, and veins carry oxygen-poor blood back to the heart. In pulmonary circulation, though, the roles are switched. It is the pulmonary artery that brings oxygen-poor blood into the lungs and the pulmonary vein that brings oxygen-rich blood back to the heart[10]. The vessels that carry oxygen-rich blood are colored red, and the vessels that carry oxygen-poor blood are colored blue.

Twenty major arteries make a path through tissues, where they branch into smaller vessels called arterioles. Arterioles further branch into capillaries, the true deliverers of oxygen and nutrients to the cells. Most capillaries are thinner than a hair. In fact, many are so tiny only one blood cell can move through them at a time[10]. Once the capillaries deliver oxygen and nutrients and pick up carbon dioxide and other waste, they move the blood back through wider vessels called venules. Venules eventually join to form veins, which deliver the blood back to the heart to pick up oxygen.

2.4 Pulse Rate

The pulse rate is a measurement of the heart rate, or the number of times the heart beats per minute (bpm). As the heart pushes blood through the arteries, the arteries expand and contract with the flow of the blood. Taking a pulse not only measures the heart rate, but also can indicate heart rhythm and strength of the pulse, as well as whether the blood vessel feels hard or soft. The changes in heart rate or rhythm, a weak pulse or a hard blood vessel may be caused by heart disease or another problem.

A normal resting heart rate for adult's ranges from 60 to 100 beats a minute. Generally, a lower heart rate at rest implies more efficient heart function and better cardiovascular fitness[6]. There are four conditions of pulse rate which is normal resting heart, fast pulse, slow pulse and weak pulse. A fast pulse or heart rate may be caused by activity or exercise, anemia, some medicines; such as decongestants and those used to treat asthma, fever, heart disease or stress.

Meanwhile, for the slow resting heart rate may be caused by high level of fitness or an underactive thyroid gland. The last condition for pulse rate is weak pulse, which are may be caused by a blood clot in arm or leg, peripheral artery disease and heart failure.

Table 2.4: Pulse Rate Chart

Pulse Rate Chart : Infant to Adults	
Age	**Beats Per Minute (BPM)**
Infant to age 1	100 – 160
Children (1 – 10)	60 – 140
Children age 10+ & Adults	60 – 100
Athletes	40 - 60

Checking the pulse rate is important to see how well the heart is working. In the emergency situation, the pulse rate can help to find out if the heart is pumping enough blood. Besides that, it can help to find the cause of symptoms; such as an irregular or rapid heartbeat, dizziness, fainting, chest pain or shortness of breath. Pulse rate does not only for checking the general health but also can be use to check body fitness level. Measure the pulse rate at rest, during exercise or immediately after vigorous exercise can give the important information about overall fitness level.

2.5 Cardiovascular Disease

The diseases and conditions affecting the heart are collectively known as cardiovascular disease. The heart consists of a muscle that pumps blood, arteries that supply blood to the heart muscle, and valves that ensure that the blood within the heart is pumped in the correct direction. Problems can arise in any of these areas.

Cardiovascular disease is a class of diseases that affects the heart and blood vessel many of which are related to a process called atherosclerosis[11]. Atherosclerosis is a condition that develops when a substance called plaque builds up in the walls of the arteries[11]. This buildup narrows the arteries, making it harder for blood to flow through. If a blood clot forms, it can stop the blood flow.

There are different types of cardiovascular disease such as ischemic heart disease or also known as coronary artery disease, cardiac arrhythmias, heart failure, hypertensive heart disease, coronary heart disease and congenital heart disease. This study is more focusing on ischemic heart disease and cardiac arrhythmias.

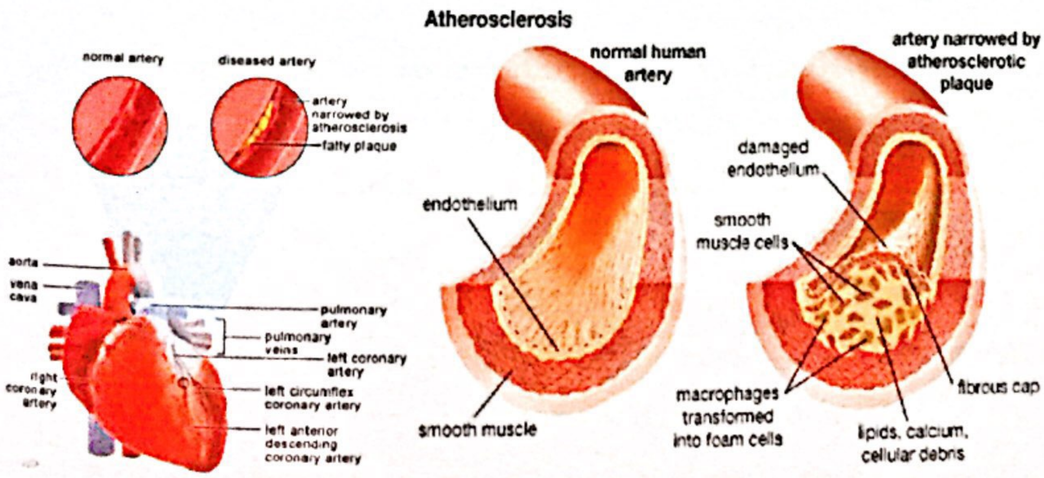

Figure 2.5: Aetherosclerosis

2.5.1 Ischemic Heart Disease

Ischemic heart disease otherwise known as coronary artery disease is a condition that affects the supply of blood to the heart. The blood vessels are narrowed or blocked due to the deposition of cholesterol plaques on their walls. This reduces the supply of oxygen and nutrients to the heart musculature, which is essential for proper functioning of the heart.

This may eventually result in a portion of the heart being suddenly deprived of its blood supply leading to the death of that area of heart tissue, resulting in a heart attack[12]. As the heart is pump that supplies oxygenated blood to the various vital organs, any defect in the heart immediately affects the supply of oxygen to the vital organs like the brain, kidneys[13].

This leads to the death of tissue within these organs and their eventual failure or death. Ischemic heart disease is the most common cause of death in several countries around the world[12].

2.5.2 Arrhythmias

Heart is one among the most important organ in the human body. Heart cannot function without its rhythmic heart beat. Arrhythmias are abnormal beats. The term "arrhythmia" refers to any change from the normal sequence of electrical impulses, causing abnormal heart rhythms. Arrhythmias may be completely harmless or life-threatening. Cardiac arrhythmia is defined as any cardiac rhythm other than regular sinus rhythm. The cause of arrhythmias is by a disorder of impulse generation, impulse conduction or a combination of the two. It may be life-threatening due to a reduction in cardiac output, reduction in myocardial blood flow or precipitation of a more serious arrhythmia[14].

Arrhythmia is broadly divided into tachycardia and bradycardia. Tachycardia is more symptomatic when the arrhythmia is fast and continuous which a resting heart rate above 100 bpm[15]. There are many different types of tachycardia which are atrial fibrillation, atrial flutter, superventricular tachycardia, ventricular tachycardia and ventricular fibrillation.

Meanwhile, bradycardia is defined as a slow heart rate or irregular heart rhythm. A healthy heart beats 60 to 100 times per minute, which is necessary to supply oxygen-rich blood to the body but for bradycardia, the heart rate is less than 60 beats per minute[14].

2.5.3 Heart Failure

Congestive heart failure is common clinical disorder that results in pulmonary vascular congestion and reduced cardiac output. Heart failure does not mean the heart has stopped working. Rather, it means that the heart's pumping power is weaker than normal. With heart failure, blood moves through the heart and body at a slower rate, and pressure in the heart increases. As a result, the heart cannot pump enough oxygen and nutrients to meet the body's needs[16].

The chambers of the heart may respond by stretching to hold more blood to pump through the body or by becoming stiff and thickened[16]. This helps to keep the blood moving, but the heart muscle walls may eventually weaken and become unable to pump as efficiently. As a result, the kidneys may respond by causing the body to retain fluid (water) and salt. If fluid builds up in the arms, legs, ankles, feet, lungs, or other organs, the body becomes congested, and congestive heart failure is the term used to describe the condition.

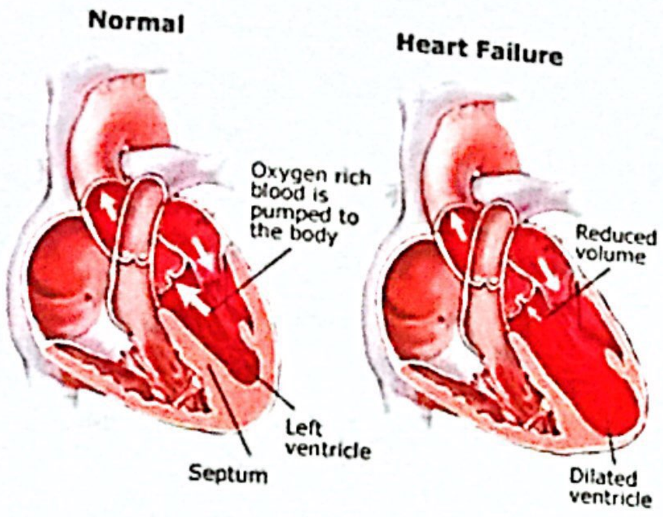

Figure 2.5.3: Normal Heart VS Heart Failure

2.6 Major Risk Factors for Cardiovascular Disease

In the context of cardiovascular disease, a risk factor can be defined as a characteristic that is associated with increased or decreased likelihood of subsequent development of cardiovascular disease[11]. There are several major risk factors that be found for cardiovascular diseases.

The first risk factor is hypertension or also known as high blood pressure. Hypertension is defined as an average systolic blood pressure greater than or equal to140 mmHg or an average diastolic blood pressure of greater than or equal to 90 mmHg[11]. High blood pressure is harmful to the arteries and increases the risk of heart attack, heart failure and stroke.

Next risk factor is uses of tobacco. Smoking leads to the accumulation of plaque in the arteries; this build-up blocks blood flow and can cause coronary heart disease and heart attacks[17]. Cigarette smoking, even a few a days, increases the risk of cardiovascular disease.

Other risk factor for cardiovascular disease is physical inactivity. Physical inactivity is an important contributor to coronary heart disease. The American Heart Association recommends at least 150 minutes of moderate exercise per week (or 75 minutes per week of vigorous exercise) to promote cardiovascular fitness, since regular physical activity reduces the risk of dying from CVD.[17] The benefits of regular physical activity for cardiovascular is reduced blood pressure, weight control, reduced waist circumstances. All this benefits from regular physical activity can help to reduce the risk of developing cardiovascular disease.

The last risk factor is being overweight or obesity. Obesity can have significant effects on the body, especially the cardiovascular system; coronary heart disease, hypertension, and stroke are some of the major effects of obesity[17]. This is in part because people who are overweight are more likely to have high blood pressure, diabetes and high blood fat

2.7 Prevention of Cardiovascular Disease

Cardiovascular disease may be a leading cause of death; there are many factors such as family history, sex or age. If there is cause, surely there is a way to prevent cardiovascular disease by adopting a healthy lifestyle. There are seven cardiovascular disease prevention tips:

1. Do not smoke or use tobacco

Smoking or using tobacco of any kind is one of the most significant risk factors for developing heart disease. Chemicals in tobacco can damage your heart and blood vessels, leading to narrowing of the arteries due to plaque buildup; atherosclerosis. Atherosclerosis can ultimately lead to a heart attack[18].

Carbon monoxide in cigarette smoke replaces some of the oxygen in your blood. This increases your blood pressure and heart rate by forcing your heart to work harder to supply enough oxygen. When it comes to cardiovascular disease prevention, no amount of smoking is safe. Smokeless tobacco, low-tar and low-nicotine cigarettes, and secondhand smoke also can be risky. Even so-called social smoking; smoking only while at a bar or restaurant with friends; can be dangerous and increase the risk of heart disease.

2. Exercise for about 30 minutes on most days of the week

Getting some regular, daily exercises can reduce the risk of cardiovascular disease and when it combines physical activity with other lifestyles measures such as maintaining a healthy weight, the payoff is even greater. Physical activity can help the body to control the weight and reduce the chances of developing other conditions that may put a strain on the heart such as high blood pressure, high cholesterol and diabetes.

3. Eating a heart-healthy diet

Eating a healthy diet can reduce the risk of cardiovascular disease. Two examples of heart-healthy food plans include the Dietary Approaches to Stop Hypertension (DASH) eating plan and the Mediterranean diet[19].

A diet rich in fruits, vegetables and whole grains can help protect the heart. Aim to eat beans, low-fat or fat-free dairy products, lean meats, and fish as part of a healthy diet. Besides that, avoid too much salt and sugars in our diet. Limiting certain fats also is important. The types of fat are saturated, polyunsaturated, monounsaturated and trans fat; try to limit or avoid saturated fat and trans fat. Aim to keep saturated fat to 5 or 6 percent of daily calories and try to keep trans fat out of diet altogether.

4. Maintain a healthy weight

Being overweight can increases the risk of cardiovascular disease. Excess weight can lead to conditions that increase the chances of heart disease that including high blood pressure, high cholesterol and diabetes. Metabolic syndrome is a combination of fat around the abdomen, high blood pressure, high blood sugar and high triglycerides also can increases the risk of heart disease[19].

One way to see if the weight is healthy is to calculate the body mass index (BMI), which considers the height and weight in determining whether a healthy or unhealthy percentage of body fat. BMI numbers 25 and higher are generally associated with higher cholesterol, higher blood pressure, and an increased risk of heart disease and stroke.

5. Get enough quality sleep

Most adults need seven to nine hours of sleep each night. If you wake up without your alarm clock and you feel refreshed, you are getting enough sleep. But, if you are constantly reaching for the snooze button and it is a struggle to get out of bed, you need more sleep each night[20]. A person who does not get enough sleep has a higher risk of obesity, high blood pressure, heart attack, diabetes and depression.

6. Manage stress

Some people cope with stress in unhealthy ways such as overeating, drinking or smoking. Find an alternative ways to manage stress such as physical activity, relaxation exercises or meditation. It can help improve body health and reduce the risk of getting cardiovascular disease.

7. Regular health screenings

Regular blood pressure screenings usually start in childhood. Have a blood pressure test performed at least once every two years to screen for high blood pressure as a risk factor for heart disease and stroke, starting at age 18. If aged 40 or older, ask the doctor for a blood pressure reading every year. Optimal blood pressure is less than 120/80 millimeters of mercury (mm Hg)[20].

Furthermore, adults should generally have their cholesterol measured at least once every five years starting at age 18. Earlier testing may be recommended if have other risk factors, such as a family history of early-onset cardiovascular disease. The regular health screenings are important in order to prevent cardiovascular disease.

2.8 Wireless Technology

Wireless networks are computer networks that are not connected by cables of any kind. The use of a wireless network enables enterprises to avoid the costly process of introducing cables into buildings or as a connection between different equipment locations[21]. The basic of wireless systems is radio waves, an implementation that takes place at the physical level of network structure.

Wireless networks use radio waves to connect devices such as laptops to the Internet, the business network and applications. When laptops are connected to Wi-Fi hot spots in public places, the connection is established to that business's wireless network.

There are four main types of wireless networks:

i. Wireless Local Area Network (LAN): Links two or more devices using a wireless distribution method, providing a connection through access points to the wider Internet.

ii. Wireless Metropolitan Area Networks (MAN): Connects several wireless LANs.

iii. Wireless Wide Area Network (WAN): Covers large areas such as neighboring towns and cities.

iv. Wireless Personal Area Network (PAN): Interconnects devices in a short span, generally within a person's reach.

2.9 Wireless Medical Device Technology

There are two categories of wireless medical devices which is short range and long range. Short range technologies transmit data from the patient to a local receiver/monitor. The local receiver may stand alone or connect to a central monitoring station. Meanwhile, long range technologies generally transmit patient data directly to a remote monitoring location.

The first category of wireless medical device is short range. In short range category, there six several types. The available technologies for short range patient monitoring are inductive implants, medical device radiocommunication service, Wi-Fi – Bluetooth – Zigbee, ultra wideband, medical micropower networks and medical body area network.

Meanwhile, for the second category of wireless medical device is long range medical telemetry. In this category, there are only two types of available technologies for long range medical telemetry which are wireless medical telemetry and worldwide interoperability for internet access.

This project is more focuses on Wi-Fi – Bluetooth and Zigbee. The unlicensed technologies are commonly used with cell phones, handheld devices and personal computers, but can also be used for implanted or body-worn medical devices. These devices operate in the 902-928, 2400-2483.5 and 5725-5850 MHz bands at distances up to a few hundred feet[21].

2.9.1 Benefits of having a WLAN throughout the healthcare institution

The healthcare industry was an early adopter of WLANs because they enabled more timely and accurate bedside medical statistics recording, voice-over-IP-over-Wi-Fi, asset location, and guest Internet access – which benefitted clinicians, IT and biomedical groups, as well as patients and their families[22]. The benefits of having a WLAN throughout the healthcare institution are including:

1. Expansion of telemetry coverage

The telemetry system can operate across the entire facility, and not be limited to specific care areas.

2. Reliability

Patient monitoring can leverage proven networking technology that is consistent in design and deployment[22]. This networking infrastructure can provide true bi-directional communication for increased overall system reliability.

3. Increase space utilization and patient safety

Having all monitors networked through the WLAN gives the hospital the flexibility to monitor patients anywhere in the hospital. For example, if the Emergency Department is at capacity, they can add extra monitored beds in another unit, thereby keeping the patient in the delivery network, versus having to divert the patient to another facility because of the lack of monitored beds.

4. Reduced risk of undetected events

For example, if a prior cardiac patient comes in for an orthopedic procedure, the orthopedic nurse could easily have a cardiac trained nurse observe that patient using WLAN monitoring while the patient is being treated for that orthopedic procedure[22].

2.10 Current Device

2.10.1 Patient Monitor

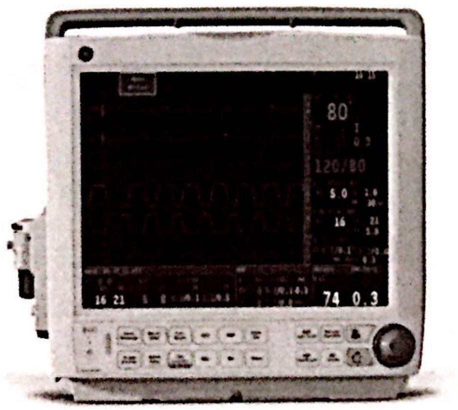

Figure 2.10.1: Patient Monitor

Patient monitor is a device that continuous measurement of patient parameters such as heart rate and rhythm, respiratory rate, blood pressure, blood-oxygen saturation, and many other parameters have become a common feature of the care of critically ill patients[23].

There are several types of patient that required using patient monitor which are patient with a suspected life threatening condition such as patient who has findings indicating an acute myocardial infarction(heart attack), patient with unstable physiologic regulatory system such as patient whose respiratory system is suppressed by a drug overdose or anesthesia, patient at high risk of developing a life-threatening condition such as patient immediately post open heart surgery or premature infant whose heart and lungs are not fully developed and the last one is patient in a critical physiological state such as patient with multiple trauma[23].

2.10.2 Non-Invasive Blood Pressure

Figure 2.10.2: Non-Invasive Blood Pressures

Blood pressure (BP) is a core vital sign used as a basis for diagnosis, management and treatment of patients in the emergency care setting[24]. This blood pressure refers to the pressure exerted on the wall of blood vessels as the heart pumps, and represents one of the principal vital signs.

Blood pressure measurement helps in diagnosing cardiovascular disease. Every single heartbeat results in the flow of blood in the arteries of the body[25]. This flow of blood varies with time, and is caused by a periodic rise in blood pressure from a static value to a maximum value[26]. This device not only measure and display the blood pressure in the artery, but it also measure and display the patient pulse rate. This may be important when assessing patient of cardiac status because a patient heart rate and pulse rate may vary if there is any cardiac compromise.

Blood pressure can be measured using a variety of techniques. There can be classified into two categories which are invasive and non-invasive blood pressure. The invasive approach inserts a catheter into an artery of a test subject. The catheter may contain a pressure transducer at its tip or it may be fluid filled and couple the blood pressure thru the fluid to an external transducer[25]. The change of blood pressure in the artery is said to be measured invasively. This technique is also referred to as a direct measurement, because the parameter being measured is directly coupled to the transducer.

The non-invasive technique can be realized several ways. It usually involves the use of an inflatable cuff wrapped around the limb of a test subject. The cuff is inflated and deflated at a controlled rate and physical parameters are observed. The auscultatory and oscillometric techniques are well known non-invasive methods. These methods are indirect because they do not couple directly to the artery[26].

This device not only measure and display the blood pressure in the artery, but it also measure and display the patient pulse rate. This may be important when assessing patient of cardiac status because a patient heart rate and pulse rate may vary if there is any cardiac compromise.

2.10.3 Pulse Oximetry

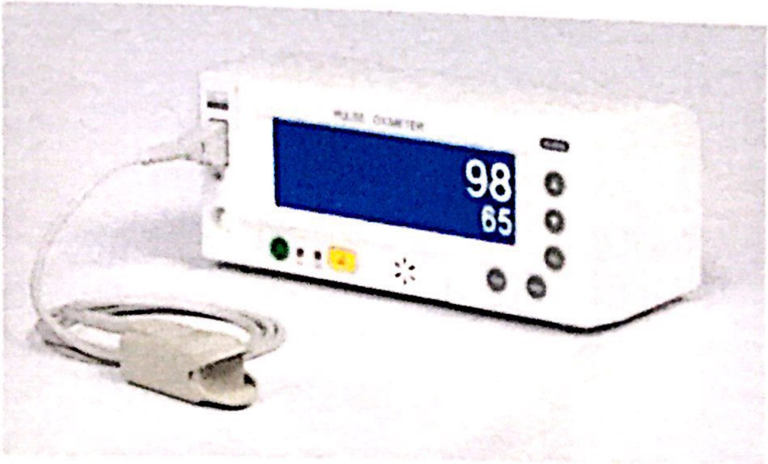

Figure 2.10.3: Pulse Oximetry

Pulse oximetry is a test used to measure the oxygen level (oxygen saturation) of the blood. Pulse oximetry is a noninvasive method that enables fast measurement of the oxygen saturation of hemoglobin in arterial blood[27].

This device uses two frequencies of light which are red and infrared to determine the percentage of hemoglobin in the blood that is saturated with oxygen[28]. The percentage is called blood oxygen saturation (Spo2). SpO2 stands for peripheral capillary oxygen saturation, an estimate of the amount of oxygen in the blood. It is the percentage of oxygenated hemoglobin compared to the total amount of hemoglobin in the blood.

A pulse oximeter also measures and displays the pulse rate at the same time it measures the Spo2 level. In addition it can measure the blood pressure, temperature and respiratory system. The use of pulse oximetry for patient assessment and monitoring is well found in critical care, anesthesiology, and emergency departments[27].

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter will cover about the process and the method that was being used to complete this project. Methodology plays an important role in executing PC Based Pulse Rate Monitoring System. In this study, there will two categories will be involve such as are hardware and software.

3.2 Design

This PC Based Pulse Rate Monitoring System consist two parts which are hardware and software. The hardware will include the pulse sensor which is used to collect the pulse rate data from patient, the amplifier circuit is to greatly detect the pulse rate, the ATMega 328P is the microcontroller of this project to generate the data collected and the ESPresso Lite V2.0 is a device kit that make this project working in wireless system. Meanwhile for the software in this project, visual basic the important part of the system to design the interface and the MicrosoftExcel is to store the entire database collected from patient.

3.2.1 2D Design

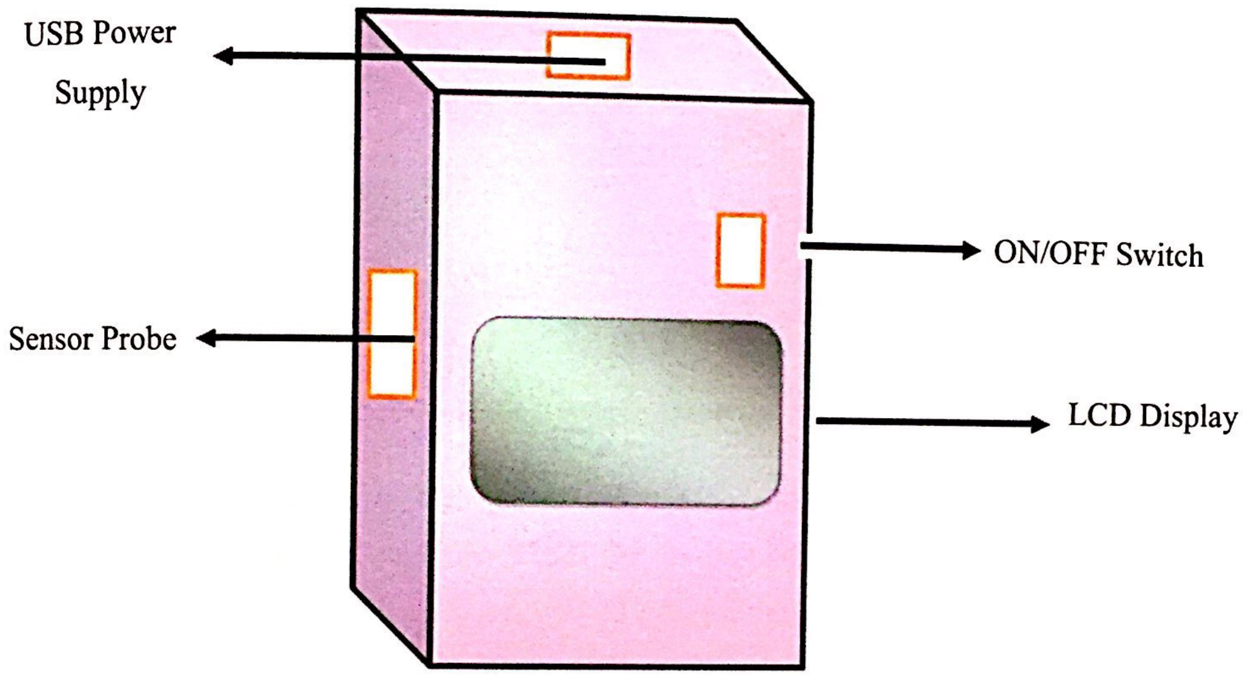

Figure 3.2.1: 2 Dimensional PC Based Pulse Monitoring System

The figure 3.2.1 is a design for the PC Based Pulse Rate Monitoring System. As shown in the figure, the project design consists of USB Power Supply, ON/OFF Switch, Sensor Probe and the LCD Display to display the pulse rate reading.

3.3 Hardware

3.3.1 ATmega 328P

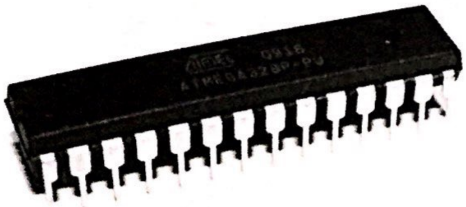

Figure 3.3.1: ATmega 328P

The ATmega 328P is high-performance Microchip picoPower 8-bit AVR RISC-based microcontroller combines 32KB ISP flash memory with read-while-write capabilities, 1024B EEPROM, 2KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable USART, a byte-oriented 2-wire serial interface, SPI serial port, a 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages), programmable watchdog timer with internal oscillator, and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

3.3.2 Grove Pulse Sensor

Figure 3.3.2: Grove Pulse Sensors

The Grove Pulse Sensor is a module based on optical technology. It is based on PAH8001EI-2G, a high performance and low-power CMOS-process optical sensor with Green LED and DSP integrated serving as a Heart Rate Detection (HRD) sensor. This sensor measures the variation human blood movement in the vessel. The advantages of this sensor are low power consumption and flexible power saving mode make it suitable for wearable device. The pulse rate sensor chip need high processing speed for the algorithm of heart rate data, this module integrate a STM32, reserved SWD interface allow users to reprogram the STM32.

3.3.3 ESPresso Lite V2.0

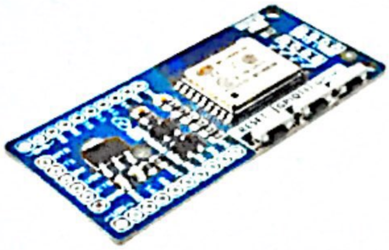

Figure 3.3.3: ESPresso Lite V2.0

The topic of Internet-of-Things (IoT) is one of the most talked about among the tech or start-up circle as the most promising trend that potentially could lead to big financial rewards. Fundamentally, any IoT framework would consist of three layers which are hardware, communication and software.

ESPresso Lite V2.0 is an affordable Wi-Fi development board, which technically is an integrated microcontroller with Wi-Fi communication protocol[29]. It uses the ESP8266 chipset as the main micro-controller and supports the Arduino environment. The board consists many features such as Espressif's certified ESP-WROOM-02 Wi-Fi module (which houses the popular 32-bit 80 Mhz ESP8266 SoC with 64kb RAM & 4Mb flash), two user-programmable buttons (connected to pin 0 & 13) and a reset button, supports the Arduino IDE with own board manager and libraries, auto program loading from Arduino IDE and many more.

3.3.4 Adafruit Power Boost

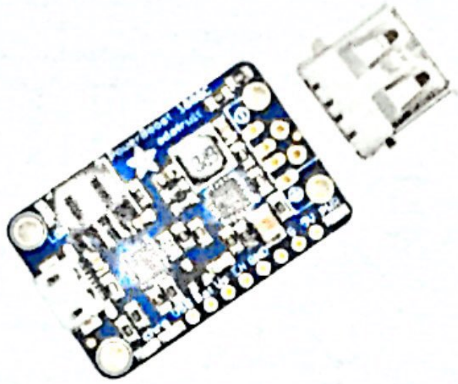

Figure 3.3.4: Adafruit PowerBoost 1000C

The PowerBoost 1000C has at the heart a TPS61090 boost converter from TI. This boost converter chip has some really nice extras such as low battery detection, 2A internal switch, synchronous conversion, excellent efficiency, and 700 KHz high-frequency operation. Other features for this boost converter are synchronous operation which means can disconnect the output completely by connecting the ENable pin to ground; this will completely turn off the output, 2A internal switch (~2.5A peak limiting), can get 1000mA+ from a 3.7V LiPoly/LiIon battery and low battery indicator LED lights up red when the voltage dips below 3.2V, optimized for LiPo/LiIon battery usage.

3.3.5 Schematic Diagram

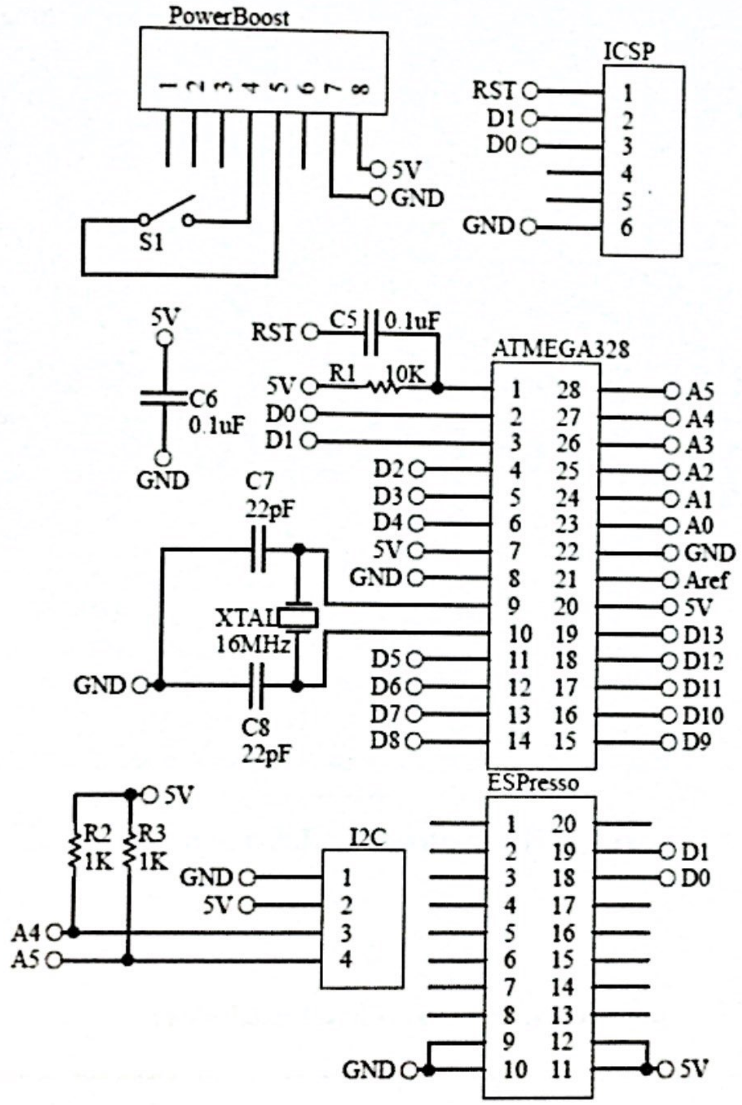

Figure 3.3.5 Schematic Circuit

Figure 3.3.5 shows schematic circuit that used to design the PC Based Wireless Pulse Monitoring System. There are two circuits which is power supply circuit (PowerBoost) and the microcontroller circuit.

3.3.6 Hardware Diagram

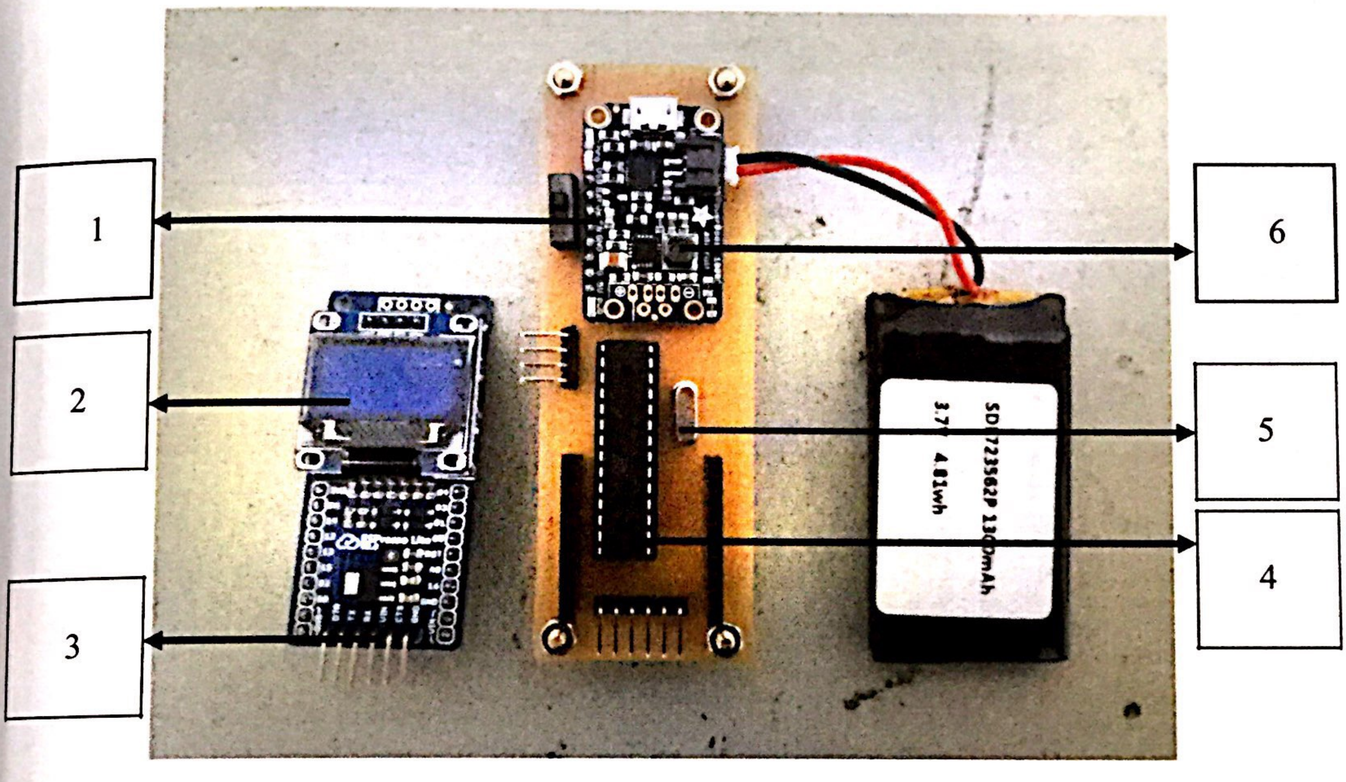

Figure 3.3.6: Hardware Diagram

Table 3.3.6: Hardware Diagram Function

No.	Parts	Function
1	Switch	To power on/off the device.
2	12C OLED Display	To display the pulse rate reading.
3	ESPresso Lite V2.0	An integrated microcontroller with Wi-Fi communication protocol.
4	ATmega 328P	To store all the programming code.

5	Crystal Oscillator	To generate an electrical signal of precise frequency by utilizing the vibrating crystal's mechanical resonance made of piezoelectric material.
6	Adafruit Power Boost	A DC-to-DC power converter that steps up voltage (while stepping down current) from its input (supply) to its output (load).

3.4 Software

3.4.1 Visual Basic

For this study, visual basic is one the software that used to create an interface for the system. Visual Basic was designed for programmers who needed to develop visual elements in their programs. In Visual Basic, users can drag and reposition visual elements like windows, buttons, and forms and then create events and triggers for those elements.

3.4.2 Microsoft Excel

An electronic spreadsheet is a computer software program that is used for storing, organizing and manipulating data. Electronic spreadsheet programs were originally based on paper spreadsheets used for accounting. As such, the basic layout of computerized spreadsheets is the same as the paper ones. Related data is stored in tables - which are a collection of small rectangular boxes or cells organized into rows and columns.

Current versions of Excel and other spreadsheet programs can store multiple spreadsheet pages in a single computer file. The saved computer file is often referred to as a workbook and each page in the workbook is a separate worksheet[30].

3.4.3 Arduino IDE

Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board also refer as microcontroller and a piece of software, or IDE (Integrated Development Environment) that runs on the computer, used to write and upload computer code to the physical board[31].

The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software.

3.5 Flowchart

3.5.1 Flowchart for Whole Project

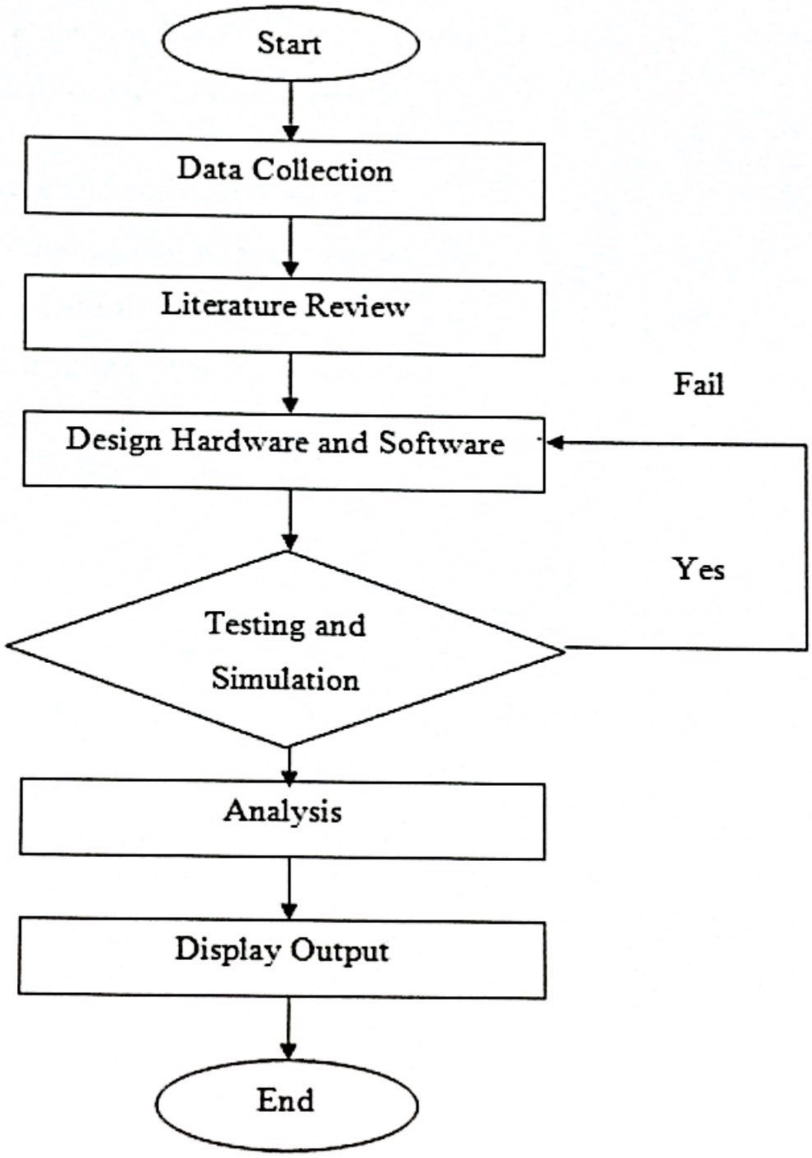

Figure 3.5.1: Flowchart for Whole Project

The data collection was the first step of this study. To collect the data, I did some session and distributed the questionnaire to healthcare professionals such doctors and nurses. After done with the data collection, focused on literature review for this study. Next step is, after done with the literature review and problem statement; design the suitable shape of the device according to the problem statements. Determine the suitable materials, hardware or software that will be use. Planned the software that suitable used for pulse rate monitoring.

When the hardware and software was done, the pulse rate monitoring device to ensure the device is functioning and working in good and safe aspect. If testing failed, return to the step before, redo the process, testing again the devices. Last step of the whole project process is testing and collect data. Test the device on 30 subjects for the clinical testing and usability testing. Discuss and conclude the result that analyzed.

3.5.2 Flowchart for PC Based Pulse Rate Monitoring System

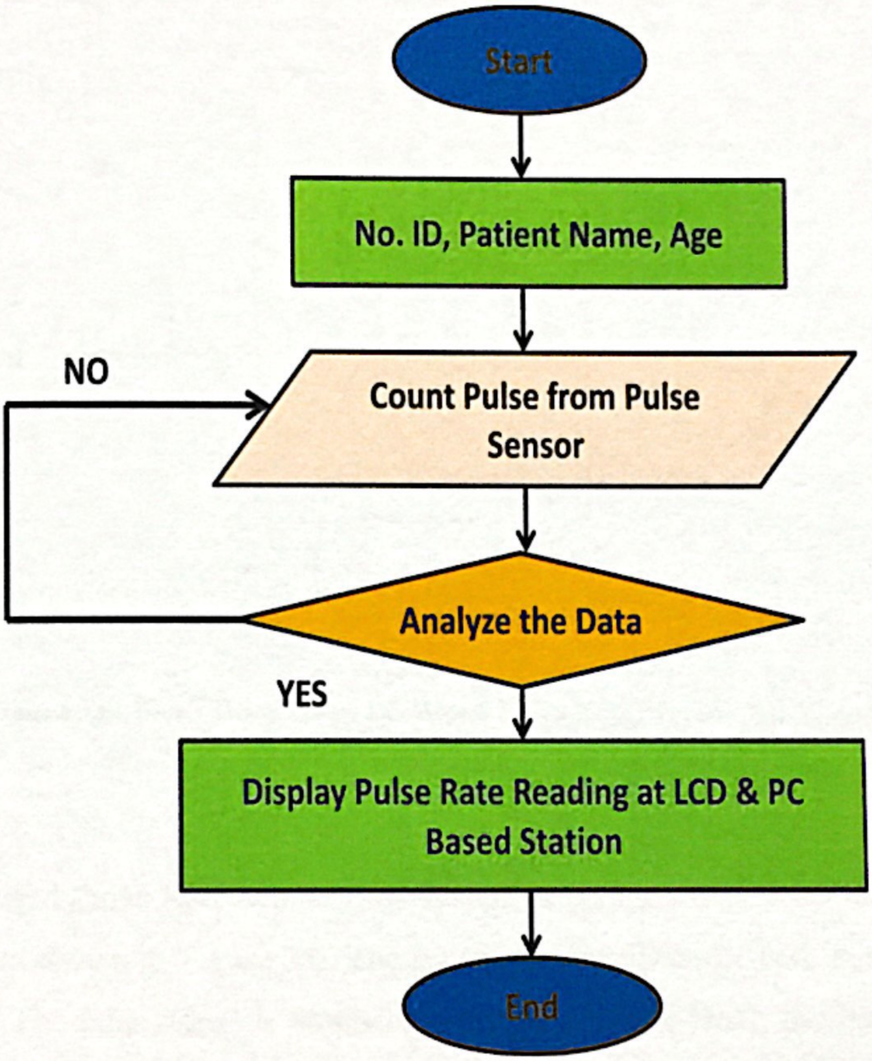

Figure 3.5.2 Flowchart for PC Based Pulse Rate Monitoring System

Flow Chart above showed that the whole process of PC Based Pulse Rate Monitoring System. The first step of this process is the doctor or nurse need to key in the patient name, age, sex, bed number and disease in the database system. Next, when the pulse rate device is switch on, it will collect the reading of patient's pulse rate. After done collecting the reading of pulse rate, it will display at LCD and PC.

3.6 Block Diagram

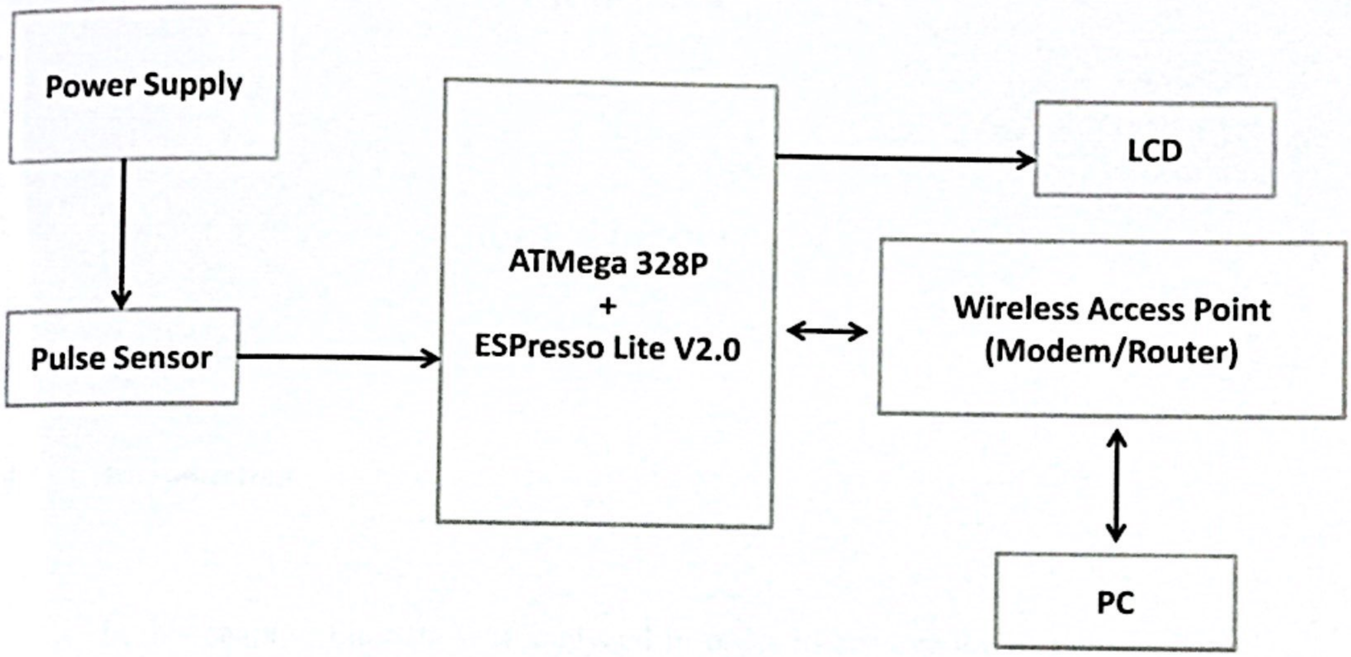

Figure 3.6: Block Diagram of PC Based Pulse Rate Monitoring System

PC Based Pulse Rate Monitoring System is composed of several blocks of the components as shown in Figure 3.6. The pulse sensor will work as to detect pulse rate from patient. Then the signal is amplified by an amplifier. Next, the data from pulse sensor will send to the microcontroller to convert from analog to digital. The ESPresso Lite will act as wireless network so that the data that have been processed in arduino will be transmits to the PC in wirelessly. Then, the data will be displayed at PC based station.

CHAPTER 4

RESULT & DISCUSSION

4.1 Introduction

In this chapter, the data was analyzed in order to achieve the objectives. This chapter will discuss the results from the data that have been collected and questionnaires. The data analysis for this project was based on project testing. The result was shown in table and the bar graph was plotted. The data project testing was collected at Polytechnic Sultan Salahuddin Abdul Aziz Shah on 30 random subjects who were divided into 15 females and 15 males. The questionnaires are distributed to the 20 person who is doctor and nurse to find out how the monitoring system that the hospital used. Besides that, the survey was conducted to know whether the doctors and nurses would agree if there is monitoring system that would let them monitor from the PC based station.

4.2 Result Evaluation Questionnaire

In this project, a survey has been done by distributing the questionnaire to the 20 people who is medical staff; doctor and nurse. There is 12 question are need to be answered in this survey. Question 1 until 3 are general question which is only asked about the occupation either doctor or nurse, age and gender. The rest question is more to about the project.

4.2.1 Percentage of Question 4,6,7,8 and 12

Table 4.2.1: Total Answer; YES/NO for Question 4,6,7,8 and 12

Question No.	ANSWER	TOTAL
4	YES	16
	NO	4
6	YES	17
	NO	3
7	YES	18
	NO	2
8	YES	20
	NO	0
12	YES	18
	NO	2

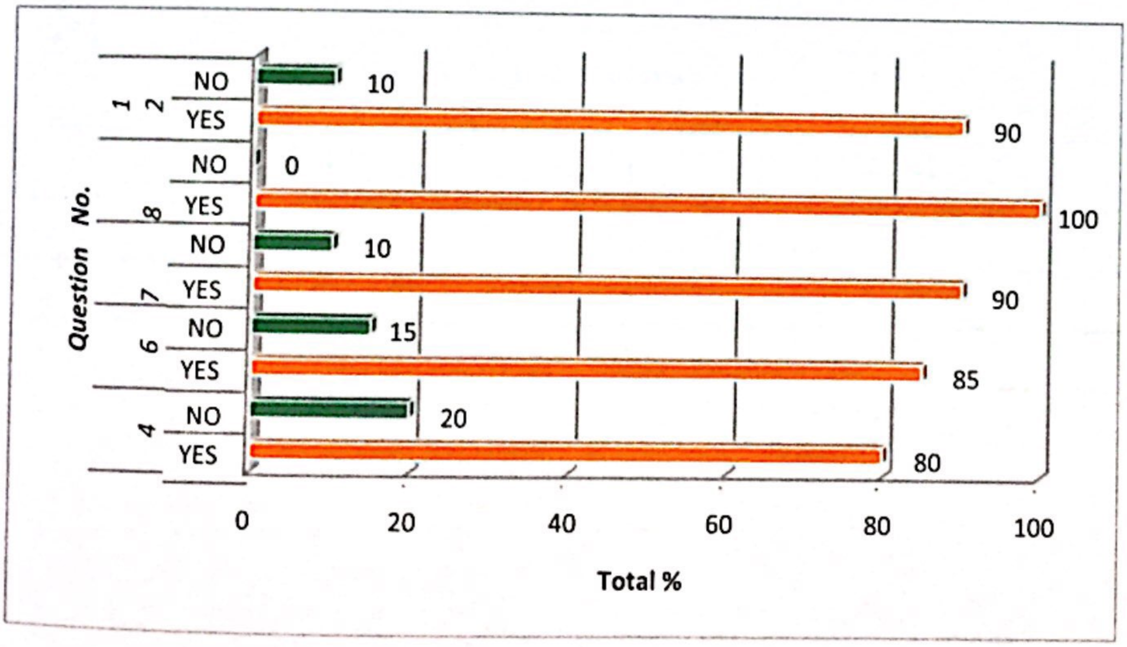

Figure 4.2.1: Total Answer; YES/NO for Question 4,6,7,8 and 12

Based on bar graph above, total answers for YES in question 4 is 80% and for NO is 20% which mean almost respondent know how to use a computer. The question for number 4 is "Do you know how to use a computer to record the patient data?" Next question for number 6 is "Do you think this system will reduce your workload?" As can be seen from the bar graph above is 85% of respondent answer is YES and only 15% answer is NO. That is mean the respondent agree that this project can reduce their workload.

For question number 8, all respondent choose YES for "Do you have a problem in finding the patient's health record?" This make the percentage of this question is 100%. The last question for YES/NO section is question number 12 which is "In your opinion, does this project will provide effectiveness in patient data monitoring system?" From the bar graph above, 90% of the answer is YES; agree with the question and only 10% answer NO.

4.2.2 Percentage of Question 5

Table 4.2.2: Question 5

ANSWER	TOTAL
3rd in day	0
5th in day	2
Always	18

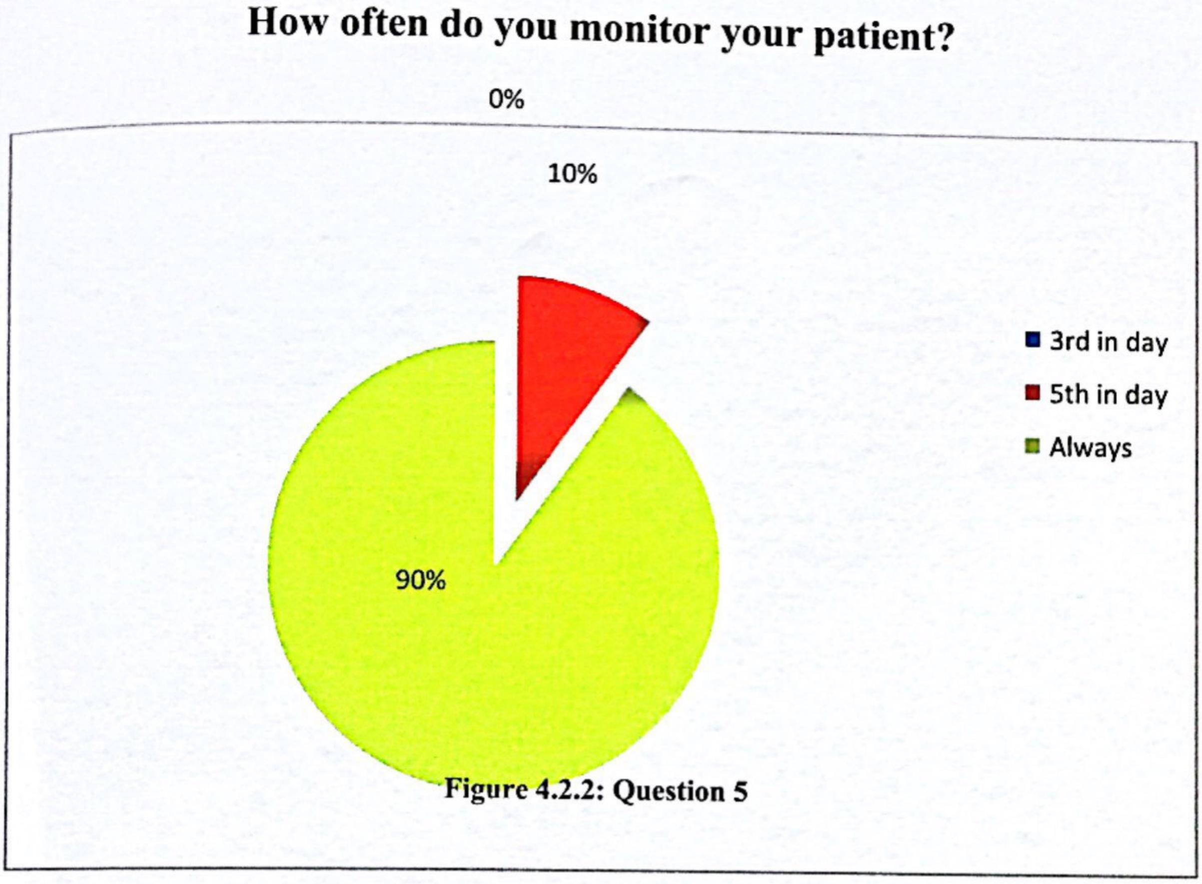

Figure 4.2.2: Question 5

Table 4.2.2 and figure 4.2.2 shows that the data of question 5. Based on Table 4.2.2, only 2 respondent choose the 5th in day for that question and the rest; 18 respondent choose always for the answer. This make the percentage of pie chart in Figure 4.2.2 is 90% choose Always to answer question 5.

4.2.3 Percentage of Question 9

Table 4.2.3: Question 9

ANSWER	TOTAL
Manual	20
Computerized	0

What kind of method used in the current system?

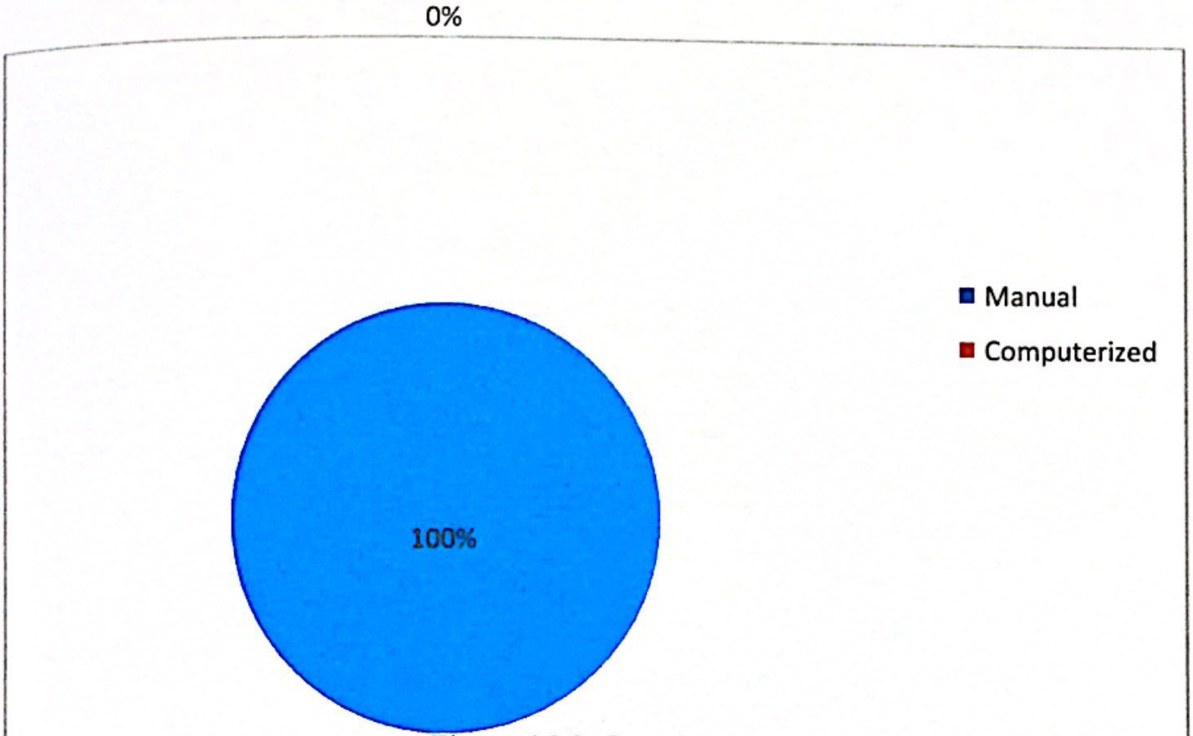

Figure 4.2.3: Question 9

Table 4.2.3 and Figure 4.2.3 shows the data of question 9. Based on Table 4.2.3, all respondent choose the answer of this question is Manual, none of them choose computerized. This make the percentage of pie chart in Figure 4.2.3 is 100% answer Manual to question 9.

4.2.4 Percentage of Question 10

Table 4.2.4: Question 10

ANSWER	TOTAL
SLOW	12
MEDIUM	8
FAST	0

How long do you retrieve patient data in existing method?

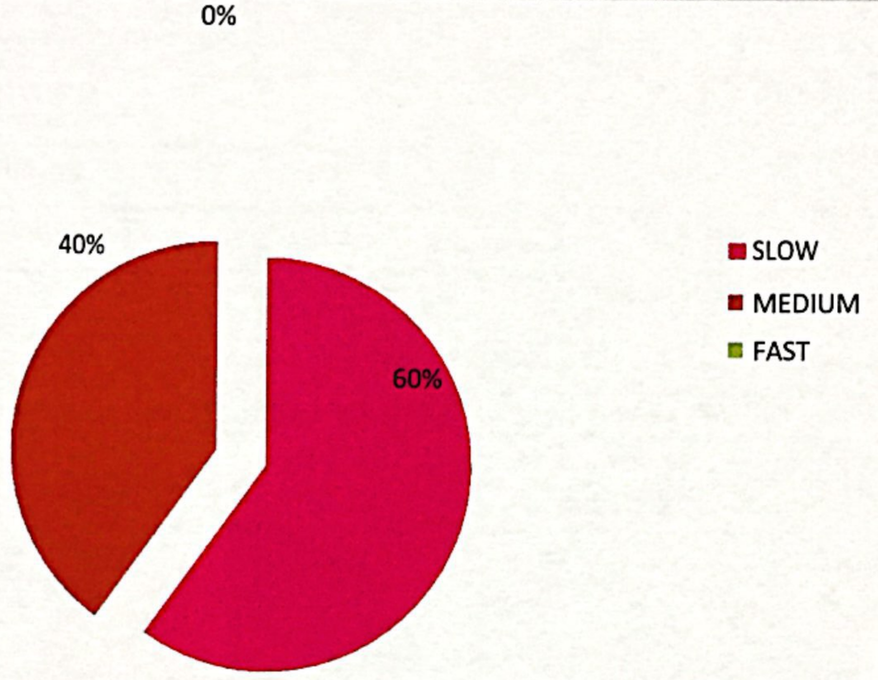

Figure 4.2.4: Question 10

Table 4.2.4 and Figure 4.2.4 shows the data of question 10. Based on the Table 4.2.4, half of the respondent; 12 choose Medium answer and 8 respondent choose Slow answer for the time there to retrieve patient data in existing method. This make the percentage of pie chart in Figure 4.2.4 is 60% for Medium, 40% for Slow and 0% for Fast.

4.2.5 Percentage of Question 11

Table 4.2.5: Question 11

ANSWER	TOTAL
Existing	4
Innovation	16

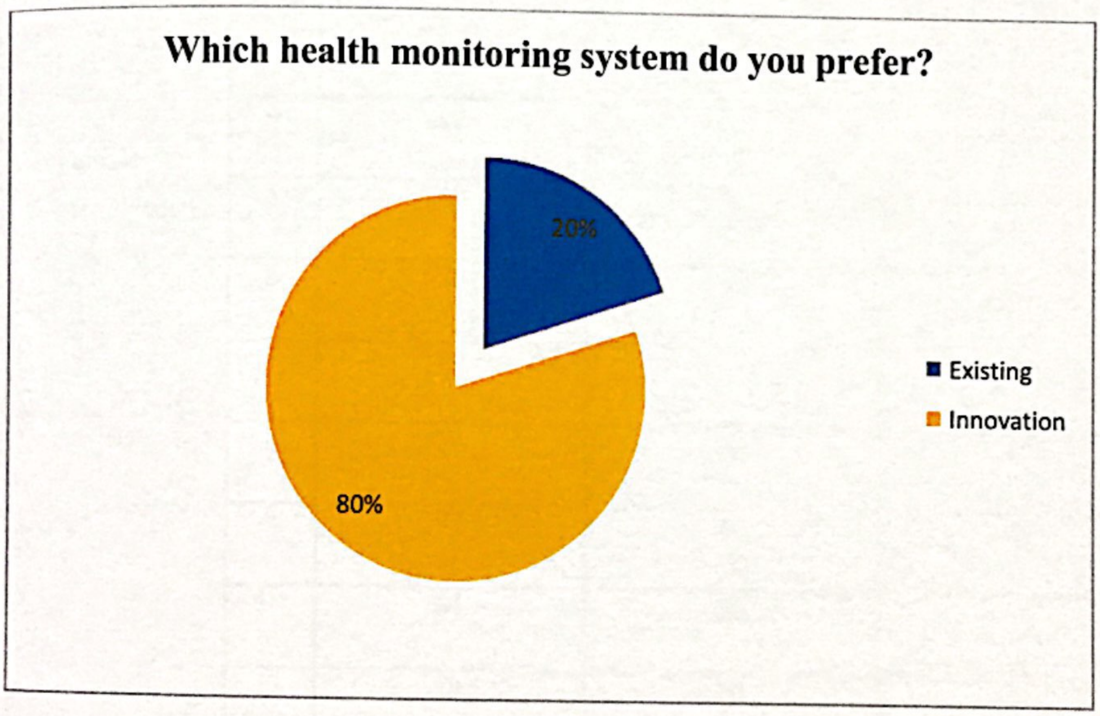

Figure 4.2.5: Question 11

Table 4.2.5 and Figure 4.2.5 shows the data of question 11. Based on Table 4.2.5, 16 of respondent choose the answer for Innovation and only 4 of them choose Existing. From the answer given, most of them agree to prefer the innovation monitoring system. This make the percentage of pie chart in Figure 4.2.5 is 80% prefer innovation monitoring system.

4.3 Data Collection of Pulse Rate

Table 4.3: Pulse Rate (Finger, Wrist, Insert Elbow)

Gender	No.	Finger (bpm)	Insert Elbow (bpm)	Wrist (bpm)
Female	1	79	79	80
	2	63	69	60
	3	88	81	81
	4	69	66	69
	5	66	65	70
	6	70	70	70
	7	84	77	71
	8	74	68	75
	9	77	84	88
	10	64	75	70
	11	79	80	81
	12	75	78	78
	13	84	77	84
	14	79	78	76
	15	72	78	75
	1	78	79	71
	2	80	78	80

Male	3	86	78	79
	4	84	77	78
	5	74	78	75
	6	71	74	74
	7	80	76	79
	8	69	76	76
	9	80	74	73
	10	70	80	77
	11	79	80	83
	12	81	84	81
	13	69	72	72
	14	78	73	72
	15	72	72	73

The Table 4.3 shows that, the readings of pulse rate; beat per minute (bpm) between female and male subjects. The pulse rates readings were taken when subject are in the condition at resting heart. The purpose of making comparison between female and male readings is to see whether there is a big difference reading of pulse rate for each of the body part which is at the finger, wrist and insert elbow.

4.3.1 Female VS Male (Insert Elbow)

Table 4.3.1: Female VS Male (Insert Elbow)

Part of Body	Female	Male
Insert Elbow	79	79
	69	78
	81	78
	66	77
	65	78
	70	74
	77	76
	68	76
	84	74
	75	80
	80	80
	78	84
	77	72
	78	73
	78	76

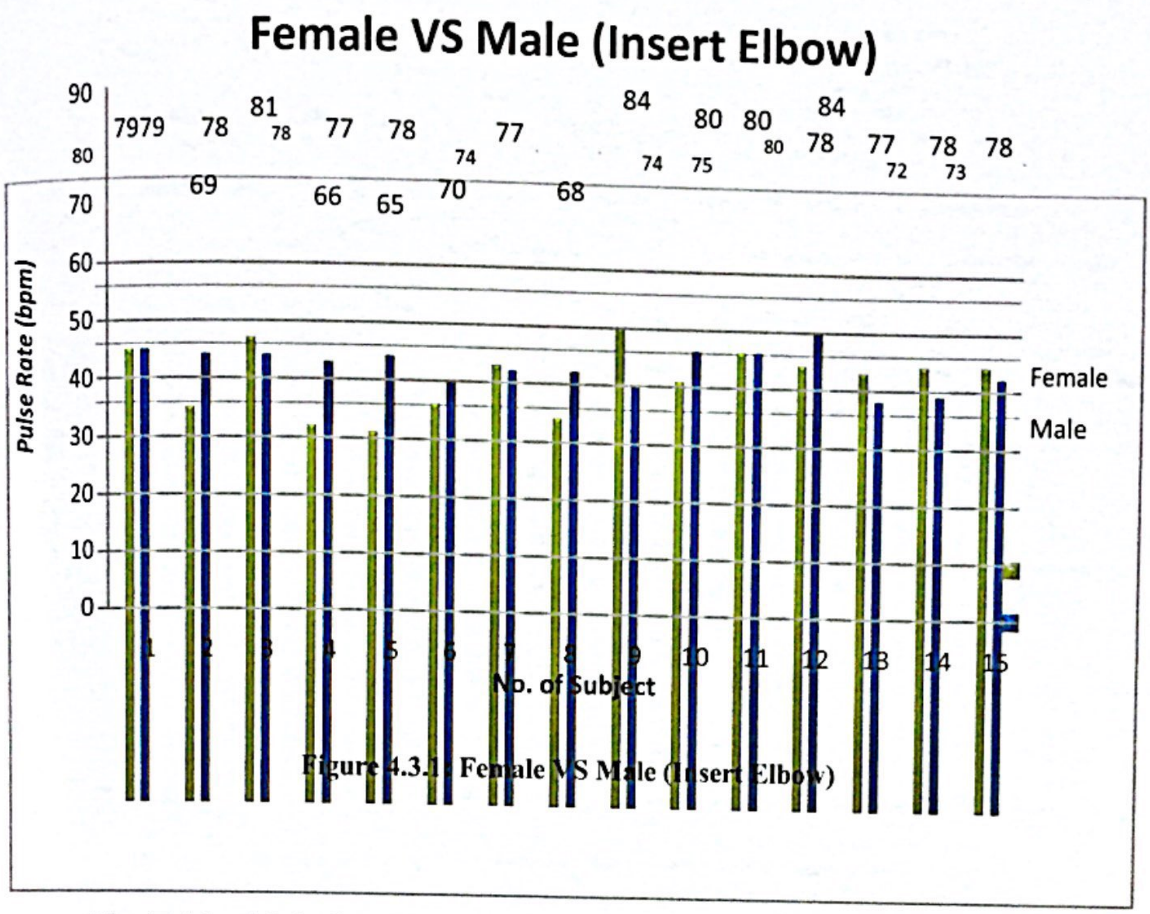

Figure 4.3.1: Female VS Male (Insert Elbow)

The Table 4.3.1 shows that the comparisons of pulse rate readings at insert elbow between female and male. From the table above, the male pulse readings are higher than female pulse readings. As can be seen in the bar graph above, there are only four subjects that get the same reading which is from subject 1 female and male; 79 bpm and subject 11 female and male; 80 bpm. Meanwhile, for other subjects there is only slightly differences pulse readings between female and male.

4.3.2 Comparison Pulse Reading; Female VS Male (Insert Elbow)

Table 4.3.2: Comparison Reading PR with Existing Device (Insert Elbow)

No. of Subject	My Device (A)	Current Device (B)	Compare (B-A)	Percentage of Error	Accuracy Percentage
Female	79	80	1	1.43	98.6
	69	70	1	1.22	98.8
	81	82	1	1.45	98.6
	66	69	3	4.41	95.6
	65	68	3	4.11	95.9
	70	73	3	3.90	96.1
	77	77	0	0.00	100.0
	68	70	2	2.35	97.6
	84	85	1	1.33	98.7
	75	75	0	0.00	100.0
	80	80	0	0.00	100.0
	78	78	0	0.00	100.0
	77	78	1	1.28	98.7
	78	78	0	0.00	100.0
	78	80	2	2.44	97.6
Male	79	82	3	3.80	96.2
	78	79	1	1.25	98.8
	78	80	2	2.53	97.5
	77	79	2	2.56	97.4
	78	78	0	0.00	100.0
	74	76	2	2.53	97.5
	76	79	3	3.85	96.2
	76	78	2	2.67	97.3

	74	75	1	1.25	98.8
	80	80	0	0.00	100.0
	80	80	0	0.00	100.0
	84	85	1	1.35	98.6
	72	74	2	2.67	97.3
	73	75	2	2.56	97.4
	76	78	2	2.56	97.4

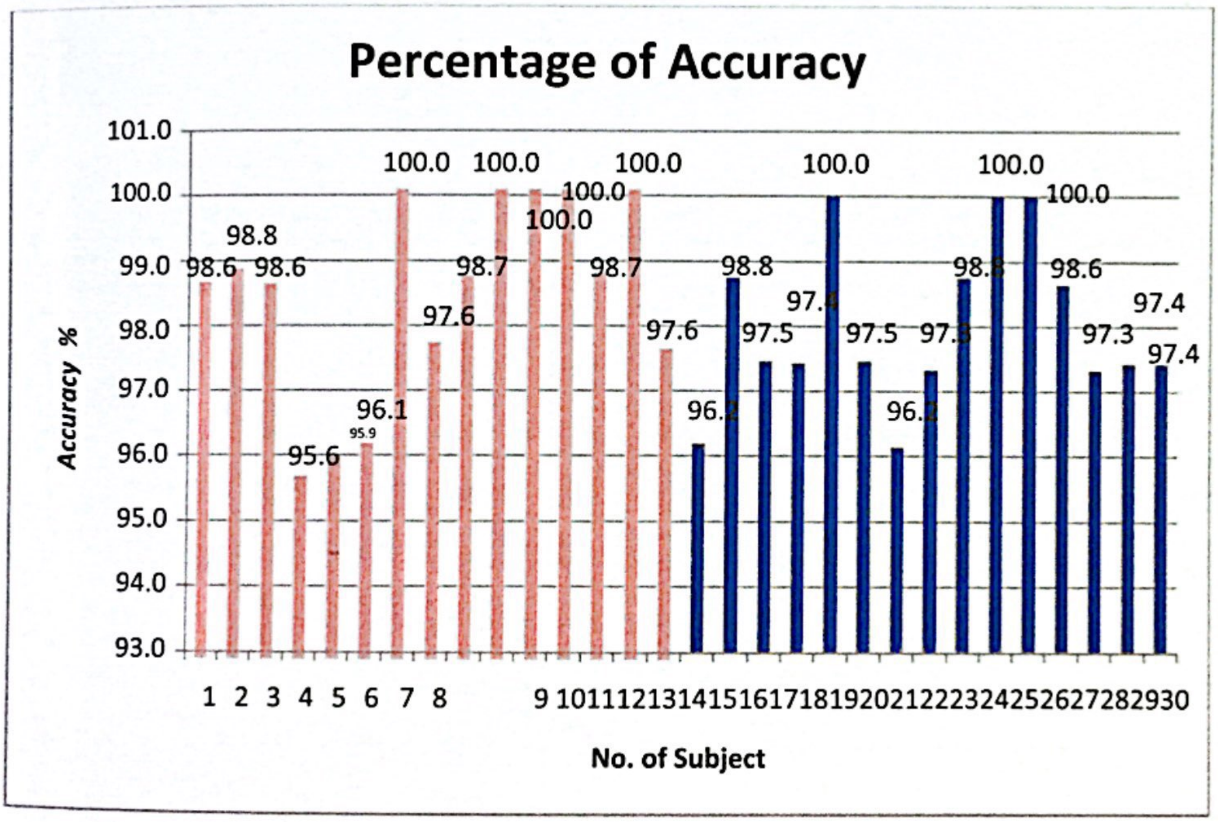

Figure 4.3.2: Percentage of Accuracy Female VS Male (Insert Elbow)

The Table 4.3.2 shows that, the difference pulse readings between the device and the existing device and compares the readings. The purpose of the comparison is to see the percentage of accuracy with the existing devices. From the bar graph, the biggest difference accuracy is 95.6% followed by 95.9% and 96.1%. For an accurate reading, there are eight accurate reading at wrist which get 100% have been achieved during the data collection process[32]. The conclusion can be made from the comparison reading between the device and existing device is the device is able to get the accurate pulse reading.

4.3.3 Female VS Male (Wrist)

Table 4.3.3: Female VS Male (Wrist)

Part of Body	Female	Male
Wrist	80	71
	60	80
	81	79
	69	78
	70	75
	70	74
	71	79
	75	76
	88	73
	70	77
	81	83
	78	81
	84	72
	76	72
	75	73

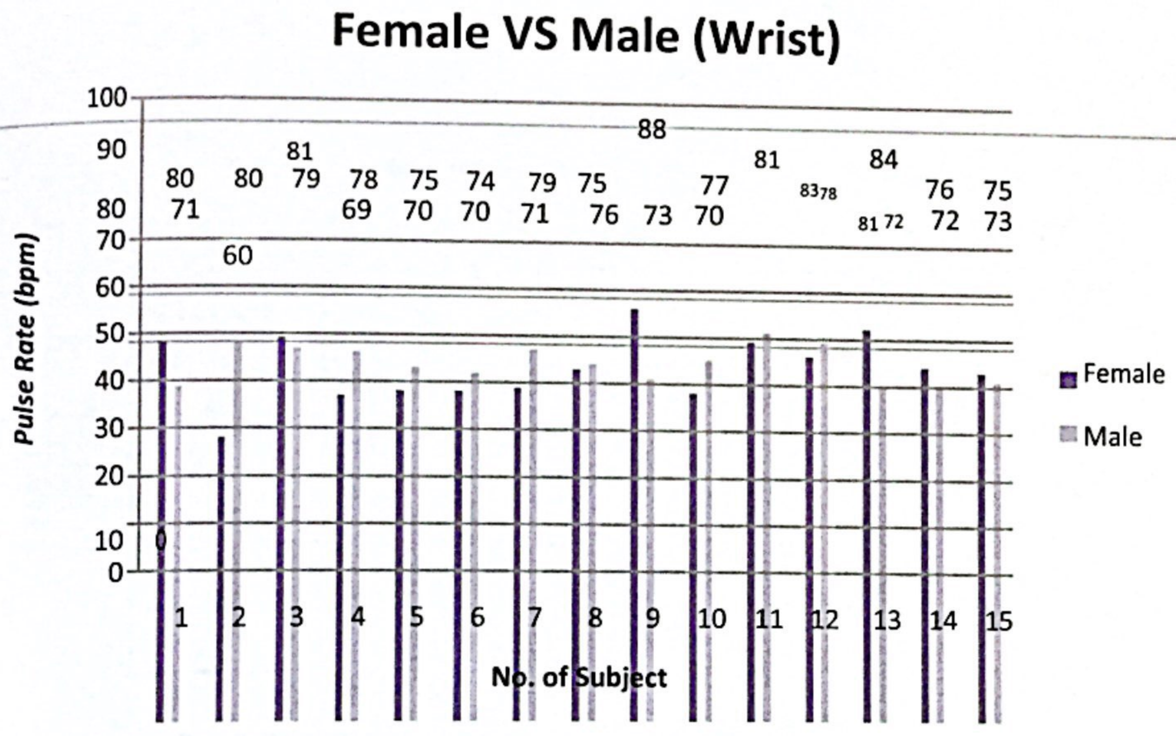

Figure 4.3.3: Female VS Male (Wrist)

The Table 4.3.3 shows that, the comparison of pulse rate readings at wrist between female and male. From the table above, the average male pulse readings are higher than female pulse readings. As can be seen in the bar graph above, the highest pulse reading for female subject is 88 bpm; subject 9 and the lowest reading is 60 bpm; subject 2. Meanwhile, for the highest pulse reading for male subject is 83 bpm; subject 11 and the lowest reading is 70 bpm; subject 1.

4.3.4 Comparison Pulse Reading; Female VS Male (Wrist)

Table 4.3.4: Comparison Reading PR with Existing Device (Wrist)

No. of Subject	My Device (A)	Current Device (B)	Compare (B-A)	Percentage of Error	Accuracy Percentage
Female	80	80	0	0.00	100.0
	60	61	1	1.64	98.4
	81	81	0	0.00	100.0
	69	70	1	1.43	98.6
	70	71	1	1.41	98.6
	70	70	0	0.00	100.0
	71	72	1	1.39	98.6
	75	75	0	0.00	100.0
	88	88	0	0.00	100.0
	70	71	1	1.41	98.6
	81	81	0	0.00	100.0
	78	78	0	0.00	100.0
	84	84	0	0.00	100.0
	76	77	1	1.30	98.7
	75	75	0	0.00	100.0
Male	71	72	1	1.39	98.6
	80	80	0	0.00	100.0
	79	80	1	1.25	98.8
	78	79	1	1.27	98.7
	75	75	0	0.00	100.0
	74	75	1	1.33	98.7
	79	79	0	0.00	100.0
	76	77	1	1.30	98.7

	73	74	1	1.35	98.6
	77	77	0	0.00	100.0
	83	83	0	0.00	100.0
	81	81	0	0.00	100.0
	72	73	1	1.37	98.6
	72	73	1	1.37	98.6
	73	73	0	0.00	100.0

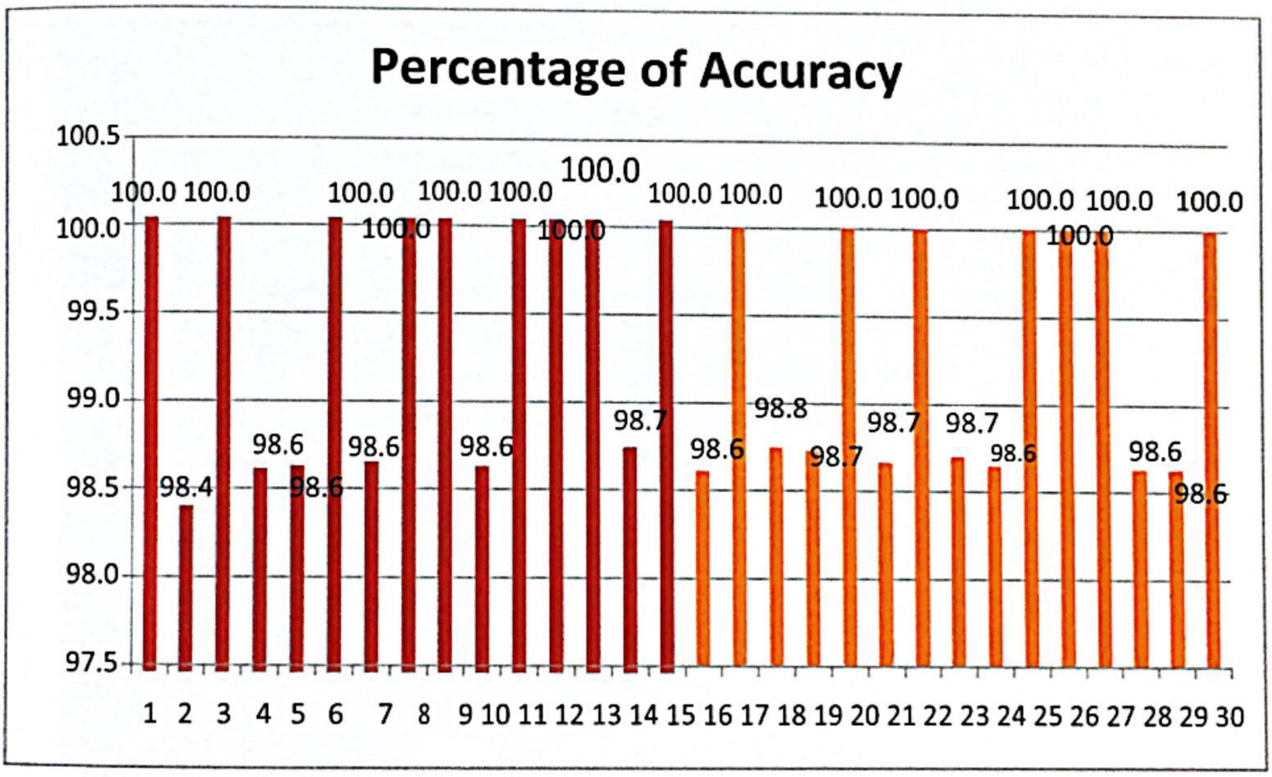

Figure 4.3.4: Percentage of Accuracy Female VS Male (Wrist)

The Table 4.3.4 shows that, the difference pulse readings between the device and the existing device and compares the readings. The purpose of the comparison is to see how much percent accuracy with the existing device. From the bar graph above, half of the readings recorded by using the device have same readings value with the existing device which can see from the bar graph above that 100% accuracy reading. The least percentage accuracy from this part of body is only 98.4%. The conclusion that can be made from the readings, this can proves that the device is able to get an accurate reading same with the existing device.

4.3.5 Female VS Male (Finger)

Table 4.3.5: Female VS Male (Finger)

Part of Body	Female	Male
Finger	79	78
	63	80
	88	86
	69	84
	66	74
	70	71
	84	80
	74	69
	77	80
	64	70
	79	79
	75	81
	84	69
	79	78
	72	72

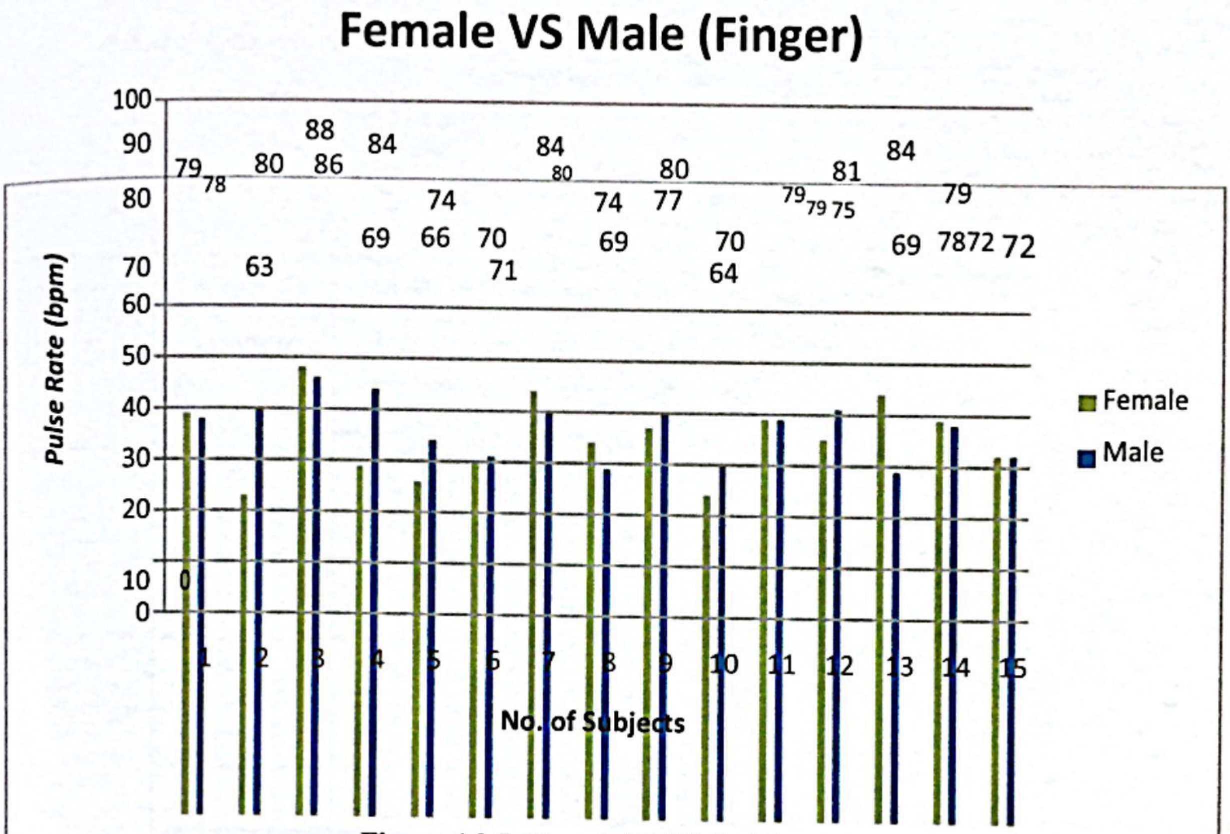

Figure 4.3.5: Female VS Male (Finger)

The Table 4.3.5 shows that, the comparison of pulse rate readings at finger between female and male. From the table above, the highest reading is 88 bpm from a female subject and the lowest reading from a male subject is 69 bpm. As can be seen from the bar graph above, subject 11 and subject 15 from female and male have the same readings of pulse rate which is 79 bpm and 72 bpm. Meanwhile, for other subjects there is only slightly differences pulse readings between female and male.

4.3.6 Comparison Pulse Reading; Female VS Male (Finger)

Table 4.3.6: Comparison Reading PR with Existing Device (Finger)

No. of Subject	My Device (A)	Current Device (B)	Compare (B-A)	Percentage of Error	Accuracy Percentage
Female	79	79	0	0.00	100.0
	63	66	3	4.55	95.5
	88	86	2	2.33	97.7
	69	72	3	4.17	95.8
	66	69	3	4.35	95.7
	70	70	0	0.00	100.0
	84	84	0	0.00	100.0
	74	74	0	0.00	100.0
	77	78	1	1.28	98.7
	64	67	3	4.48	95.5
	79	77	2	2.60	97.4
	75	75	0	0.00	100.0
	84	80	4	5.00	95.0
	79	79	0	0.00	100.0
	72	73	1	1.37	98.6
Male	78	79	1	1.27	98.7
	80	80	0	0.00	100.0
	86	87	1	1.15	98.9
	84	83	1	1.20	98.8
	74	77	3	3.90	96.1
	71	74	3	4.05	95.9
	80	82	2	2.44	97.6
	69	70	1	1.43	98.6

	80	81	1	1.23	98.8
	70	72	2	2.78	97.2
	79	81	2	2.47	97.5
	81	83	2	2.41	97.6
	69	72	3	4.17	95.8
	78	79	1	1.27	98.7
	72	73	1	1.37	98.6

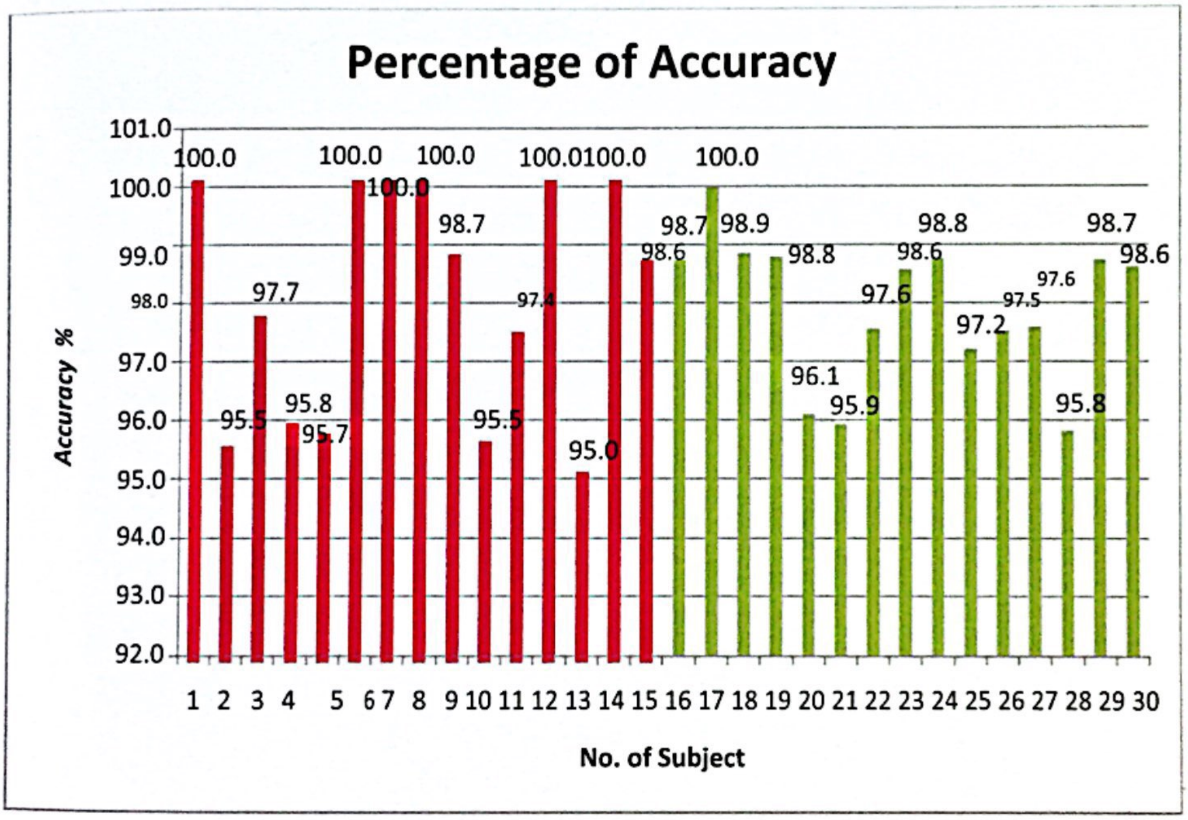

Figure 4.3.6: Percentage of Accuracy Female VS Male (Finger)

The Table 4.3.6 shows that, the differences pulse readings between the device and the existing device at finger and compares the readings. The purpose of the comparison is to see how much the difference accuracy percent with the existing device. From the bar graph above, there is only seven pulse reading that accurate with the existing device and the remaining readings less accurate with existing device. The highest accuracy percent is 95.0% which mean the difference reading are too much from the existing device. From the comparison reading above, the conclusion that can be made is the device is less accurate when taking the reading at finger. This is probably because of the sensor itself has been designed not to take readings at finger.

CHAPTER 5

CONCLUSION & RECOMMENDATION

5.1 Conclusion

Biomedical engineering (BME) is the application of engineering principles and techniques to the medical field. It combines the design and problem solving skills of engineering with medical and biological sciences to improve patient's health care and the quality of life of individuals[33]. Cardiovascular disease is one of the major causes of deaths in world; one of the possible diagnostic tools that can early detection of cardiac events is pulse rate.

This project focuses on the pulse rate monitoring system which is able to monitor the pulse rate reading of patient. The system determines the pulse rate beat per minute and the physiological data are stored and published online. Hence, by using the system the healthcare professionals can monitor and diagnose their patients from a PC Based location at any time. The system is simple. It is just the microcontroller of the sensors connected to IP address of the PC Based and then placed the sensor on patients. At the system interface, after done key-in all the patient's record, then click "START MONITOR", the healthcare professionals can easily monitor their patients from there without goes to the patient's bed. In contrast to other conventional medical equipment, the system has ability to save data for future reference. From the data analysis that has been done, the PC Based Pulse Monitoring System can produce the medical data that are similar to those produced by the existing medical device.

As a conclusion, the PC Based Pulse Monitoring System is developed and it have achieved the objective, which the primary objective is to develop health monitoring system for healthcare professionals to monitor their patients easily from their PC. Next objective is to determine the pulse rate of patient and for the last objective is to analyze the reliability of the system.

5.2 Recommendation

In completing the PC Based Pulse Monitoring System, there are several future works that are recommended. First is to add another vital parameter that is usually used in the hospital such as blood pressure, breathing rate (SPO2) and body temperature. Next recommended is the sensor replacement by using more suitable sensor that can produce accurate readings. This is because the sensor that is used in this device only can give accurate readings when the subject is in static condition. When there is a movement, then the readings become slightly difference from the medical device reading. Other recommendation is to improving the design by installing indicator warning system if the pulse rate is too high or low.

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APPENDIX A

Questionnaire

Sultan Salahuddin Abdul Aziz Shah

A Survey for Final Year Project

PC BASED PULSE RATE MONITORING SYSTEM

PC Based Pulse Rate Monitoring System is a device which measures the pulse rate of patient. After the vital parameters are measured it will transmit the data wirelessly to a PC base station. The objectives of this project is to help the doctor and nurse in monitoring patients regularly and they no longer need to go to the patient to check their pulse rate.

1. Occupation : Doctor [ ] Nurse [ ]
2. Age : 21-30 [ ] 31-40 [ ]
   41-50 [ ] 51-60 [ ]
3. Gender : Male [ ] Female [ ]
4. Do you know how to use a computer to record the patient data?
   Yes [ ] No [ ]
5. How often do you monitor your patient?
   3rd in day [ ]
   5th in day [ ]
   Always [ ]
6. Do you think this system will reduce your workload?
   Yes [ ] No [ ]
7. Do you think this system can help to simplify the task of Intensive Care Unit?
   Yes [ ] No [ ]

8. Do you have a problem in finding the patient's health record?

Yes ☐ No ☐

9. What kind of method used in the current system?

Manual ☐ Computerized ☐

10. How long do you retrieve patient data in existing method?

Slow ☐ Medium ☐ Fast ☐

11. Which health monitoring system do you prefer?

Existing ☐ Innovation ☐

12. In your opinion does this project will provide effectiveness in patient data monitoring system?

Yes ☐ No ☐

Prepared by:

....

(Munira Mohd Amir)
Student

Verified by:

....

(Mdm Pushpa Jagannathan)
Supervisor

APPENDIX B

Source Code

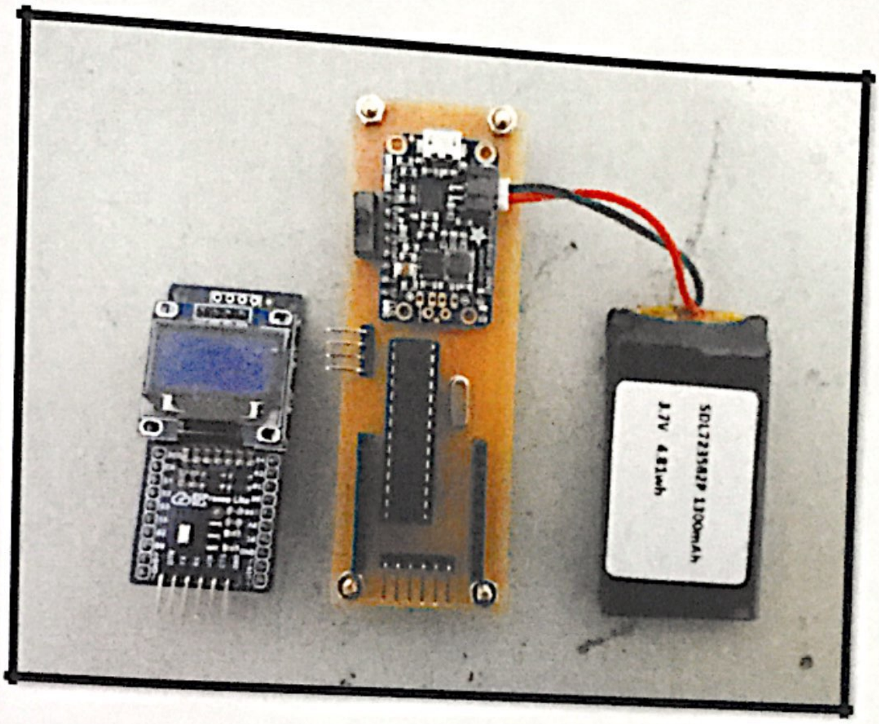
PR Monitoring Wifi

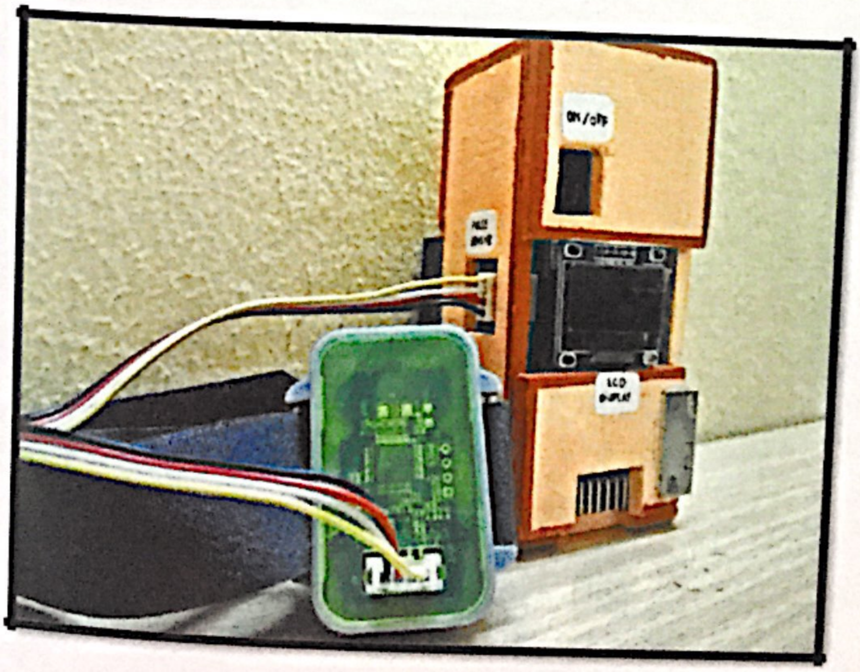
```
#include <ESPert.h>

ESPert espert;

String url,message;

int mode,start,end,bpm;

void setup()

{

 espert.init();

 espert.dht.init();

 espert.oled.init();

 espert.oled.println();

mode=espert.wifi.init();

if(mode==ESPERT_WIFI_MODE_CONNECT)

{

 espert.println(">>> WiFi mode: connected.");

 espert.oled.println("WiFi: connected.");

 espert.oled.print("IP..: ");
```

```
start=message.indexOf("bpm");
end=message.indexOf(" ");
if((start>=0)&(end>=0))
{
message=message.substring(start+3);
message=message.substring(0,end-start-3);
bpm=message.toInt();
if(mode==ESPERT_WIFI_MODE_CONNECT)
{
espert.oled.clear();
espert.oled.println(espert.info.getId());
espert.oled.println();
espert.oled.println("IP = " + espert.wifi.getLocalIP());
espert.oled.println();
espert.oled.println("BPM = " + (String)(bpm));
if(bpm>20)
{message=espert.info.getId();
```

```
message=message.substring(7);

/*

zone=0; store data every 1-2s

zone=1; store data every 10s

zone=2; store data every 20s

zone=3; store data every 30s

zone=4; store data every 60s

zone=5; store data every 10m

zone=6; store data every 20m
```

Picture of the device





Picture of testing device