AUSCULTATION EDUCATION KIT

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

DEPARTMENT OF ELECTRICAL ENGINEERING
POLITEKNIK SULTAN SALAHUDDIN ABDUL AZIZ SHAH
2017

DECLARATION

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

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ACKNOWLEDGEMENTS

First of all, I would like to take this opportunity to express my grateful to Allah S.W.T because gave me a good health to finish my final year project. Secondly, I would like to express my thankful to my supervisor Wee Soo Lee, Pushpa A/P Jegannathan, and Zunuwanas Bin Mohammad who give me chance to work with them and for their guidance during my final year project.

My appreciation also goes to my family members who has been tolerant and supporting me all these times in accomplishing my final year project. Thanks for their encouragement, loves and emotional support that they had gave to me.

Besides that, my sincere appreciation goes to course mate and my friends NorFazeelah Binti Mat Sidin and Mohammad ZulFikri Bin Zulkarnain who helped and advice throught this project. I wish you all the best in life and hope our friendship will last forever.

Lastly, I would like to thank all those who supported me in any aspect during the completion of the project.

ABSTRAK

Stetoskop ialah alat asas diagnostik yang memberikan maklumat mengenai sistem pernafasan jantung pesakit. Mendengar bunyi jantung merupakan satu kemahiran yang sukar untuk dikuasai ketika menjalani latihan perubatan. Walaubagaimanapun, stetoskop akustik dapat digunakan tetapi ia tidak mengelurkan bacaan denyutan. Disamping itu, ia memerlukan pengiraan secara manual dan pada masa yang sama menggunakan formula matematik bagi mendapatkan bacaan penuh setiap pesakit. Oleh itu, Auscultation Education Kit (AEK) ini dibina sebagai alat bantu belajar yang boleh memaparkan bacaan kadar degupan jantung dalam unit bpm dan memperdengarkan bunyi degupan jantung untuk membantu pembelajaran dalam latihan perubatan.

ABSTRACT

Stethoscope is a basic diagnostic tools that provides the information of a patient's cardio respiratory system. Cardiac auscultation is a difficult skill to master during their medical training. A standard Acoustic Stethoscopes (AS) can be used to this end, but these do not provide beat per minute (bpm) readouts and instead the heart beats must be manually counted and a calculation performed to give the required result. Therefore, Auscultation Education Kit (AEK) was developed as a practical tools for displaying heart rate in beat per minutes (bpm) and broadcasting the heart sound to assist learning in medical training.

Keywords: ***Acoustic Stethoscope (AS), Auscultation Education Kit (AEK), beat per minute (bmp), cardiac auscultation, and stethoscope.***

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND OF STUDY

Stethoscope has been used primarily to listen heart sound for diagnostic purpose [1] . As we know, most of the existing stethoscopes nowadays are manually used by doctor and medical assistant. This medical device can produce the auscultation result and give the result to the doctor to hear the heart beat sound from heart. The heart sounds are generated by the beating heart and the resultant flow of blood through it. This device not only can give the sound of normal patient but also can detect the irregularly sound of heart that is in others conditions such as pain, bleeding and so on.

The normal rate for the heart beat per minute is 60 bpm while the dangerous heart beat is 120 bpm. This device is only for monitoring and therapy, because it only gives the result base on the detection of sound effect.

There are rapid developments of analogue stethoscope to electronic stethoscope. It is because stethoscope is one of the basic diagnostic tools that provide the information of patient's cardio respiratory system [2].

Electronic stethoscope also can be used at home to check out heart beat rate whether they are in the good condition or not based on the healthiness of the lung and heart. It also can be used by untrained and non-technical people to detect irregular heartbeats sound that can tolerate with noise surrounding

Diaphragm of head stethoscope is the metal end that is placed on the chest to listen to the lungs and heart sound with the tubing to tapered inner bores. This structure is able to provide a better sound transmission while listening is known as a vacuum tube. The most type of stethoscope used these days is the acoustic stethoscope. However, the problem with this acoustic stethoscope is only allow for one listener and are uncomfortable for extended wear [3]. In learning process it is hard for medical students to analyze the heart sound because of ear sensitivity and environmental noise.

Therefore, this education kit is develop a stethoscope that contribute to the convenience of users and technological advancements. This kit used chestpiece which is function as input to transmit the heart and lung sounds from the subject, microphone is used to pick up the sound of the heart beat, LM386 Audio Amplifier circuit to greatly ampilify the heart sound, LCD display used to display the heartbeat counting and speaker for more than one person to listen. Therefore, the heart voice and respiration can be listened well through the speaker which the volume can be adjusted.

1.2 PROBLEM STATEMENT

Medical personnel frequently require to know a patient's heart rate. Particularly cardiac auscultation, is one of the most difficult clinical skills for students during their medical training. A standart acoustic stethoscopes can be used to this end, but these do not provide heart rate readouts and instead the heart beats must be personally counted and a calculation performed to give the required result. This procedure is not only time consuming but also liable to error because sound level was extremely low. Kind of words that usually been used in learning proces is " Do you hear your heartbeat?".

As stated an acoustic stethoscopes are commonly used but only allow for one listener and are uncomfortable for extended wear. An electronic stethoscope was developed which utilizes a speaker and microphone system, but it is too large for practical purposes.

Furthermore, this type of electronic stethoscope is not currently available in the market. In order to improve upon the existing device, a suitable power supply must be found. Ideally, changes should also be made to allow for a heart rate counting with LCD display capabilities, as well as a main receiver with a speaker for listening. With this device, instructor and students listen to the same source of sound that assist teaching and learning applications in all clinical and educational settings.

1.3 OBJECTIVE

The main objectives of this project are as follow:

- To develop an electronic stethoscope that can count the heart rate for educational purpose.
- To amplify the sound of heartbeat.
- To prove the capability of the electronic stethoscope counting the heart rate.

1.4 SCOPE OF PROJECT

Design a circuit will to be used for a heartbeats sound detection and counting in electronic stethoscope as education kit for instructors and students in physiology lessons. This design makes use of a electrode condenser microphone as the transducer to detect an input sound for heartbeats and converts heart sounds to electrical signal. The count of heartbeat is then displayed on liquid crystal display screen. Arduino software is used to build the code for calculating the heartbeat signal.

Next, design an audio amplifier circuit to act as receiver. The converted electrical signal then amplified and transmitted. The receiver receives the transmitted signal and then amplifies the signal. The amplified signal then is heard through speaker.

This scope of project is limited to the small group of medical students to facilitate them in hearing heart sound for analyzing heart and lung disease. In addition, limited as practical tools for listen to the heart sound using speaker and heartbeat counting in medical education.

1.5 SIGNIFICANT OF PROJECT

A stethoscope is a primary device used by medical students. It is used to listen a patient heart and lung sounds. Therefore, this study was conducted to design a prototype of Auscultation Education Kit for counting heart rate and hear rhythm sounds by using stethoscope.

This electronic stethoscope may act as practical tools for medical education . Thus, it will facilitate and ease the untrained and nontechnical person including medical students to detect the heart beats with accurate result. It also refers to pulses for producing a count corresponding to the heart rate of the heart sounds and displaying the said count as a detected heart rate.

Hence, the project may give impact especially to the student because they may use electronic stethoscope as an alternative and fun learning module in the class. They also will be able to diagnose their heartbeat rhythm regularly.

CHAPTER 2

LITERATURE REVIEW

2.1 STETHOSCOPE HISTORY

The Stethoscope is an acoustic medical device for listening to internal sounds in human body which is known, as auscultation in medical terms. Heart sound auscultation is one of the most basic ways to assess the state of the cardiac function[4].

Stethoscope history began in 1816 with French physician called Doctor Rene Laennec as shown in Figure 2.1, at Necker-Enfants Malades Hospital in Paris when he was examining an obese patient. He believed a method to diagnose chest conditions was needed, particularly for stout individuals where direct auscultation to the chest was either inadequate or embarrassing, especially for his female patients.

Figure 2.1: Dr. Rene Laennec c. 1816

To listen to his patient's heartbeats and breathing, he first used rolled up paper tied with string and realized that the sounds were amplified, an improvement over direct auscultation. The stethoscope designed by Dr. Rene consisted of a wooden tube and was monaural design as shown in Figure 2.2. With this device it was similar to the common ear trumpet, a historical form of hearing aid, indeed, his invention was almost indistinguishable in structure and function from the trumpet call microphone. [5]

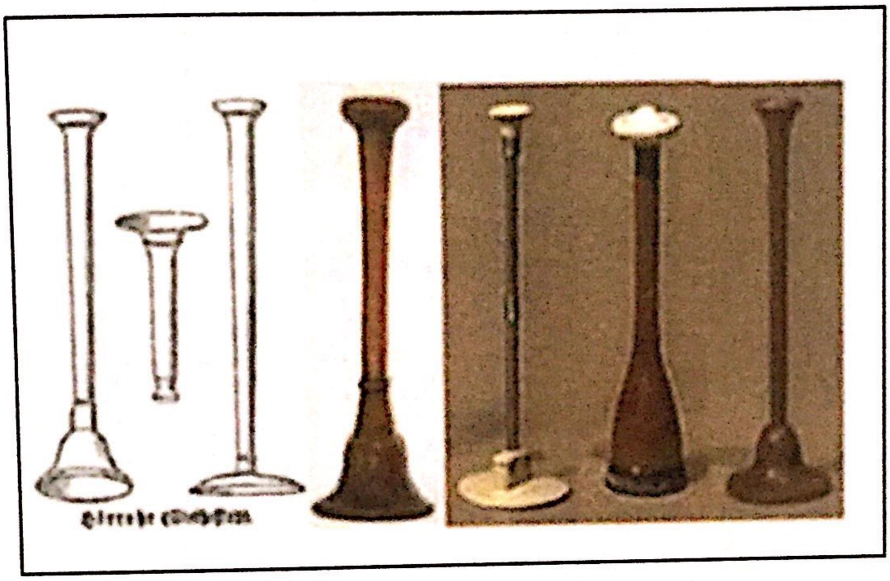


Figure 2.2: Ear Trumpet Microphone

He struggled to find a name for his invention, discarding such names as "sonometer," "medical cornet," and "pectrolique." He particularly disliked his uncle's selection of "thoraciscope." Finally he chose stethoscope which is literally meaning "I look into the chest" in Greek[6].

Stethoscope history further evolved to the binaural two ear stethoscope types in 1852 by Doctor George Cammann as shown in Figure 2.3 as a physician at the Northern Dispensary in New York City. He also creates a model of a soft metal and with an earpiece for each ear to listen at a same time as shown in Figure 2.4.

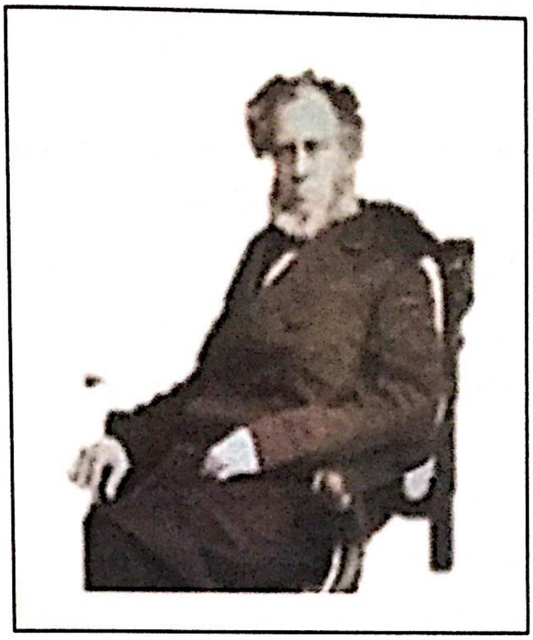


Figure 2.3: Dr. George Cammann c.1855

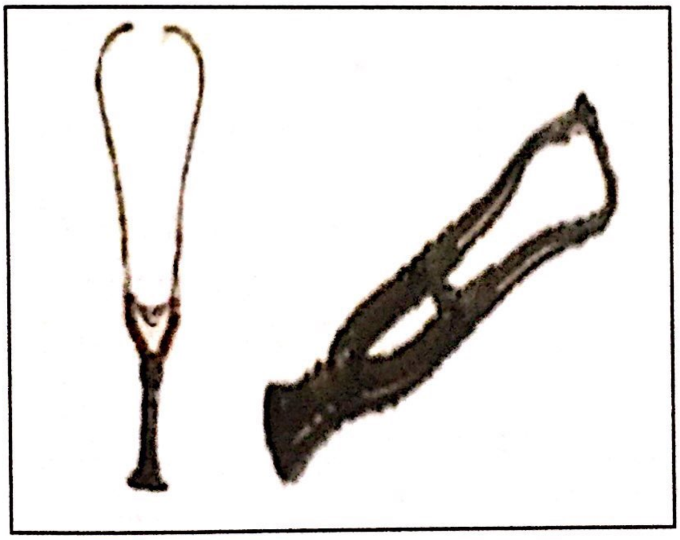


Figure 2.4: Cammann Binaural Stethoscope

George P. Cammann stethoscope would be used with only slight changes for the 100 years. The next evolution of modern stethoscopes was designed by Dr. David Littmann in the early 1960's. Dr. David Littman patented a new, lighter model with a single binaural tube that drastically improved the acoustic technology. The stethoscopes that are now commonly used are called "Littman stethoscopes"[7]. Today, the Littmann Stethoscopes manufactured by 3M are the industry standard. The devices tout modern design and high quality acoustics.

2.2 EVOLUTION OF STETHOSCOPE

Laennec began applying his device and compared auscultory findings with postmortem findings and wrote his treatise on auscultation, L'auscultation Mediate in 1819. Laennec's ideas spread slowly and were aided by the translation of the treatise into English by John Forbes in 1821. At the time of Laennec's death in 1826, acceptance of stethoscopes was widespread and gradual development in design began [8].

Table 2.1 shows the development of the main design of stethoscope from early development until 1900 onwards. The features enhance step by step when many inventions are created to make new stethoscope more reliable to be used nowadays.

Table 2.1: Development of Stethoscope

Years	Inventor	Development
1816	Laennec	Rolled paper cone, later a wooden tube.
1828	Priorry	Funnel shaped bell, a lightened stem, and thinner earpiece for a better seal
1843	Williams	The first binaural stethoscope, using lead pipes for earpieces.
1851	Marsh	Stethoscope chestpiece was fitted with a flexible membrane.
1855	Cammann	The Camman Stethoscope, a binaural model with a bell shaped chest piece is now considered the standard for superior "auscultation" to listen to sounds in the chest by American physicians. It would soon be followed by the Ford model.
1894	Bianchi	First stethoscope with a rigid diaphragm, known as a ''phonendoscope''
1925	Bowles and Sprague	The Bowles Stethoscope with its diaphragm chest piece in a flattering shape appears. These would be joined by the

		"combination stethoscopes" in 1902 - having both bell & diaphragm chest pieces for better diagnosis.
1945-46	Rappaport, Sprague and Groom	Experimented with various designs to determine ideal properties for the modern binaural stethoscope. For example, a combination chestpiece, short tubing with low internal volume and well-fitting earpieces.
1956 onwards	Various (eg: Leatham, Litman and others.)	Various modern stethoscopes have been developed with improvements to weight and appearance but using the same principles described by Rappaport, Sprague, and Groom

2.3 CATEGORIES OF STETHOSCOPE

The stethoscope is most often used to listen to heart sounds and breathing. Many inventions are created to make new stethoscope more reliable to be used nowadays. There are two basic types of stethoscopes for respiration system diagnostics of the human body which is acoustic stethoscope and electronic stethoscope [9]. Here are the different two types of those stethoscopes.

2.3.1 ACOUSTIC STETHOSCOPE

Acoustic stethoscopes are familiar to most people. Acoustic stethoscopes maintain their popularity and trust among doctors due to their longstanding use in the medical profession. Although it is taking digital stethoscopes time to catch up, they are rapidly gaining in popularity. However, acoustic stethoscopes are the most commonly used. They operate by the transmission of sound through a chest piece via air-filled hollow tubes to the doctor or listener's ears.

The chest piece of the acoustic stethoscope usually consists of two sides, a diaphragm (which is like a plastic disc) and bell (which is like a hollow cup). The chest piece is placed on the patient's chest for listening to the sounds of the heart/lungs.

"The bell transmits low frequency sounds, while the diaphragm transmits higher frequency sounds" .

The disadvantages of the acoustic stethoscope are that its frequency response shows maxima and minima at specific frequencies due to tubular resonance effects, its sound level is low, it attenuates sound transmission proportional to frequency, and its transmission properties differ from model to model.

Figure 2.5: Acoustic Stethoscope

2.3.2 ELECTRONIC STETHOSCOPE

Electronic stethoscopes function in a similar way as acoustic stethoscopes, but the sound is converted to electrical signals which can then be amplified and processed for optimal listening. Because the sounds are transmitted electronically, an electronic stethoscope can be a wireless device, can be a recording device, and can provide noise reduction, signal enhancement, and both visual and audio output.

Electronic stethoscopes are designed to overcome the disadvantages of the acoustic stethoscopes. They are designed to have a uniform frequency response and to amplify the sound level. In general, an electronic stethoscope is comprised of a chest piece, sound transducer, adjustable gain amplifier, frequency filters, mini-speaker or head phones, and a dry cell or battery.

The chest piece consists of a sound transducer (microphone) that converts the sound to an electrical signal and this converted electrical signal is transmitted to the conditioning circuit, which may consist of an amplifier and a frequency filter. This conditioned signal then is transmitted through an electrical cable to a headset.

Figure 2.6: Electronic Stethoscope

2.4 PRINCIPLE OPERATION OF STETHOSCOPE

The stethoscope is composed of three major parts. The first part is the chest piece, tubes and headset as shown in Figure 2.7. It consists of a shallow, bell-shaped piece and a clear, stiff diaphragm, which is connected to the metal earpieces by a flexible tube. The bell is used to pick up lower frequency sounds, and the diaphragm is used for higher frequency sounds. When the chest piece is placed on the skin, vibrations within in the body are amplified by either the bell or diaphragm. These acoustic pressure waves then travel up through the tubing to the earpieces and into the listener's ears [2].

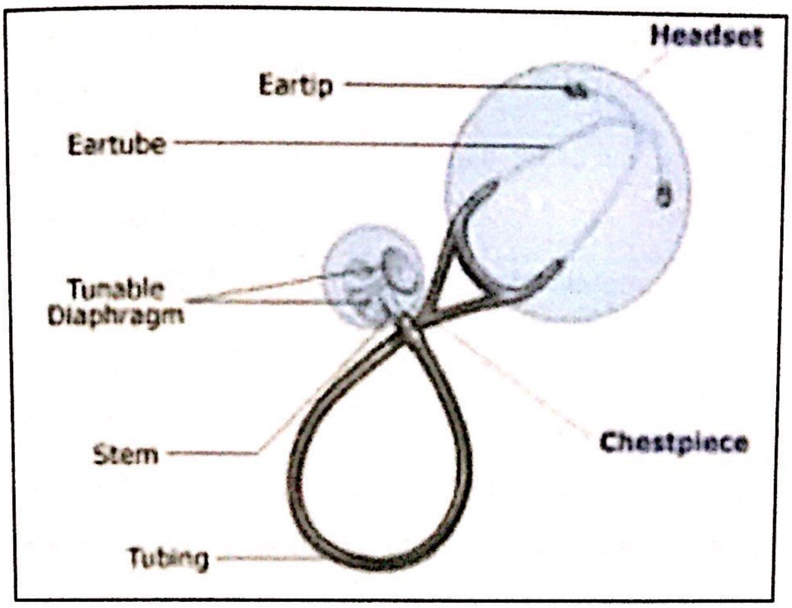


Figure 2.7: Parts of Stethoscope

Table 2.2 shows the the parts of a stethoscope that focuses on design of acoustic stethoscope. Every parts has its own function to make it more reliable and easy to be used by doctors, physicians and others end user.

Table 2.2: Parts of Stethoscope

Parts	Definition
Chestpiece	"Stethos" means "chest," so this is the logical place to start. The chestpiece is the part of the instrument that medical people hold against the body of the patient.
Diaphragm	It may be single-sided or double-sided. - A two-sided chestpiece will typically have a diaphragm on one side and a deep cup-shaped side called the bell. - Both single-sided and double-sided pieces will usually have a flexible ring called a chill ring encircling them, which helps to make an airtight seal and buffer the patient against the coldness of the part.

Stem	The stem is what connects the chestpiece to the tubing. Tubing:
Acoustic tubes	The acoustic tubes are the hollow rubber-like tubes that connect the chestpiece to the ear tubes.
Headset	This is typically the metal portion of the stethoscope.
Ear tubes	The ear tubes are hollow metal tubes that connect to the acoustic tubes on one end and the earpieces on the other.
Earpieces	Earpieces are the small tips on the ends of the ear tubes that fit into your ears. Some stethoscopes may have a choice of hard plastic or soft silicone earpieces.

2.5 COMPARISON BETWEEN STETHOSCOPE

Every stethoscope shares some basic features like a chest piece, earpieces and tubing. It is needed to detail each given of these for the wide range of quality and price.

The chest piece is made of the diaphragm (for high frequencies) and the bell (for low frequencies). Dual-head chestpieces have the diaphragm on one side and the bell on the other. Single-head chestpieces have both the diaphragm and bell on one side and depend on pressure to detect different frequencies.

In most stethoscopes the tubing is essentially the same. What is really important is the length: not because shorter tubing allows to hear better , but because longer tubing enables to avoid bending over patients, to keep sick patients at arms length, and to drape the stethoscope around neck without slipping off. The standard lengths are 22 inches to 28 inches.

Table 2.3 shows the comparison of stethoscope that focuses on acoustic stethoscope. Every stethoscope has its own quality depends on it price.

Table 2.3: Comparison of Stethoscope

Brand	Description
3M Littman	• These stethoscopes feature a diaphragm that can be tuned to low or high frequencies without being turned over. • Lightweight II S.E. has a unique chest piece shaped to fit easily under blood-pressure cuffs and patient clothing. It comes in six colors and 28-inch length. Price $45. • Classic II S.E. has acoustics that are superior over the Lightweight. It is available in 15 colors and 28-inch length. Price $70. • The Cardiology III chestpiece has two tunable diaphragms: one large for adult patients and one small for thin adult and pediatric patients. It is available in nine colors and 22-inch length. Price $140.
Welch-Allyn	• It only focusing on practitioners on the front line of care. • The Professional has a dual-head chest piece and custom-fitting headset. Available in six colors and 28-inch length. Price $85. • The Tycos Harvey Elite has a double-head chest piece that enable to hear different frequencies without variable pressure. Features dual-bore tubing for optimal sound. Available in four colors and 25-inch and 28-inch length. Price $232.

Sprague Rappaport	• Were the first instruments to combine the diaphragm and bell into one chestpiece. Sprague Rappaport prides itself on offering choices that are easy to use. • The Adscope 641 features five chest piece fittings (two diaphragms and three bells for infant, pediatric and adult). It may be the huge selection of colors or it may be the price, but this model outsells all other stethoscopes worldwide. Comes in 24 colors and 22-inch length. Price $18. • The Omron is designed to detect the entire range of heart and lung tones. Also features five chest piece fittings. Available in three colors and 22-inch length. Price $28.

2.6 HEART

The heart is a powerful muscle, about the size of a clenched fist, located at the left of the centre of the chest with the special type of muscle called the myocardium. Function of heart that has a rhythmic, automatically repeated beating and it is maintained by electrical impulse originating in the sinoatrial central node. It also known as a natural pacemaker that is to supply the blood and oxygen at all parts of the body. The heart is located in the chest cavity just posterior to the breastbone, between the lungs and superior to the diaphragm. Blood is pumped away from the heart through arteries and returns to the heart through veins. The major artery of the body is the aorta and the major veins of the body are the vena cavae (Sepehri et al. 2010). Figure 2.8 shows the heart of human [10].

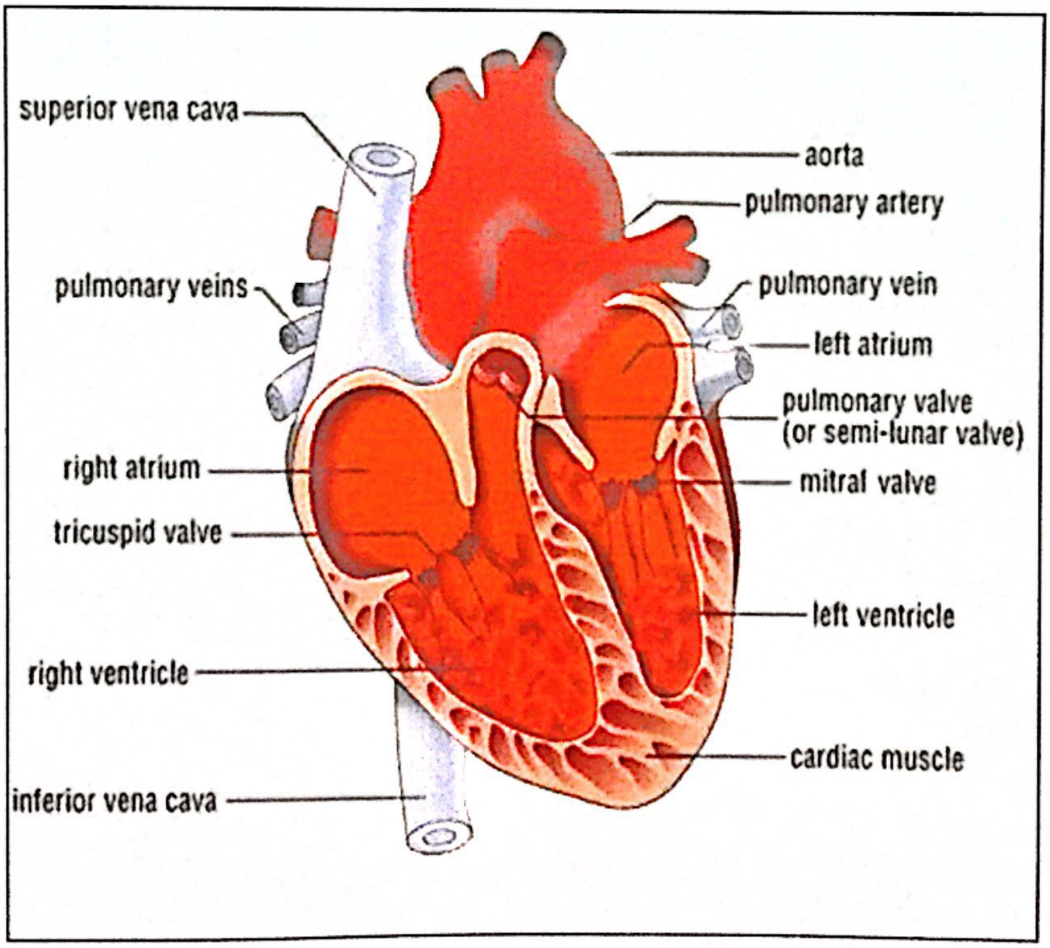
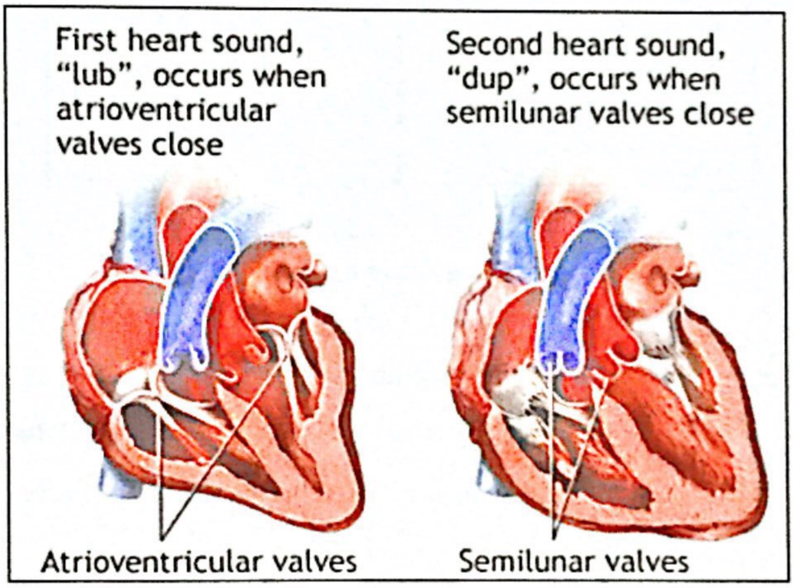


Figure 2.8: Human Heart's

2.7 HEART SOUND

Acoustic heart sounds are produced when the heart muscles open valves to let blood flow from chamber to chamber. A normal heart will produce two heart sounds, S1 and S2 as shown in Figure 2.8 and Figure 2.9. S1 symbolizes the start of systole. The sound is created when the mitral and tricuspid valves close after blood has returned from the body and lungs. S1 is primarily composed of energy in the 30Hz - 45 Hz range. S2 symbolizes the end of systole and the beginning of diastole. The sound is created when the aortic and pulmonic valves close as blood exits the heart to the body and lungs which lie with maximum energy in the 50 Hz - 70 Hz range with higher pitch.



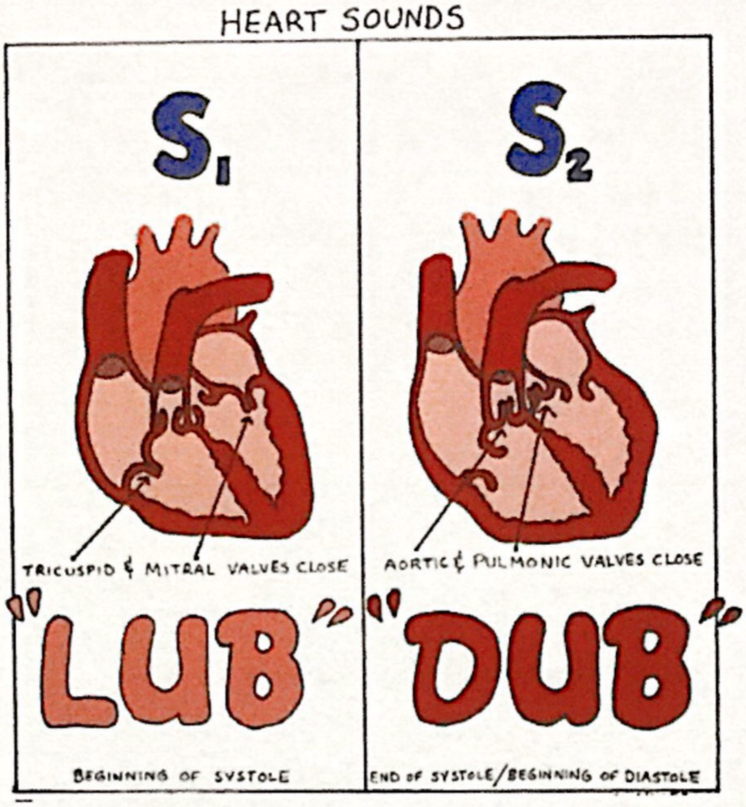


Figure 2.9: Heart Sound

Typically, heart sounds and murmurs are of relatively low intensity and are band limited to about 100–1000 Hz. Meanwhile, Speech signal is perceptible to the human hearing. Therefore, auscultation with an acoustic stethoscope is quite difficult[4].

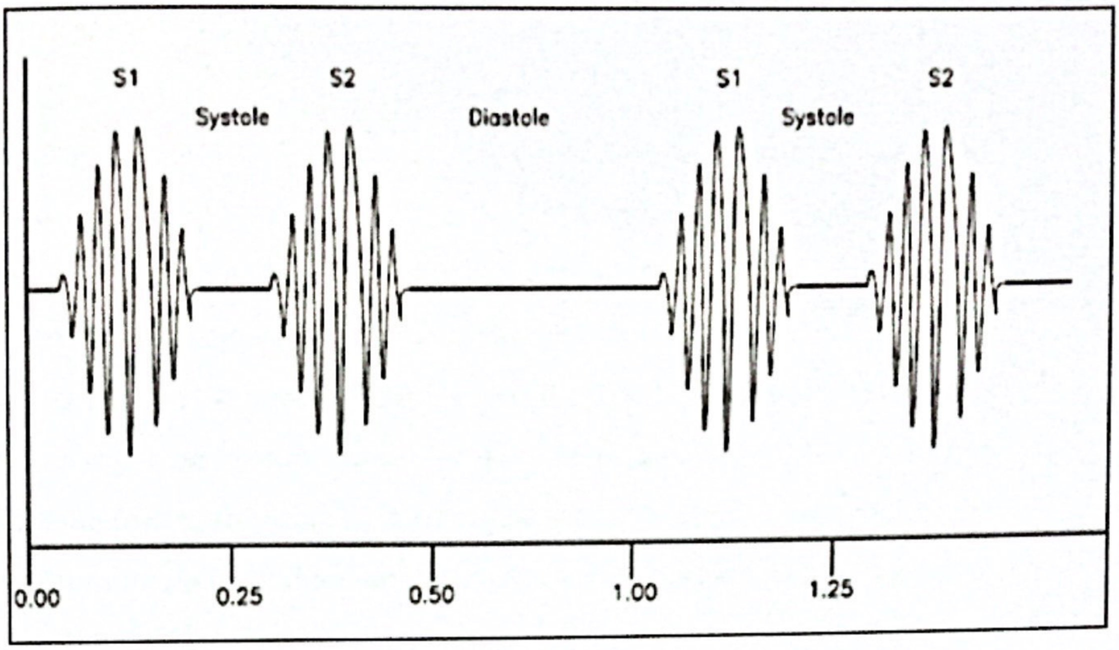


Figure 2.10 : Waveform of Heart Sounds

Table 2.4 shows the different sound of heart and their meaning. This type of sound heard can be guide to medical people to diagnose condition of patient.

Table 2.4: Heart Sound

Sound	**Meaning**
"lub-dub"	These sounds are also called systolic and diastolic. Systolic is the "lub" sound and diastolic is the "dub" sound. The "lub," or systolic, sound happens when the mitral and tricuspid valves of the heart close. The "dub," or diastolic, sound happens when the aortic and pulmonic valves close.
whooshing sound "lub...shhh...dub"	Patient might have a heart murmur. A heart murmur is blood rushing quickly through the valves. Many people have what are called "innocent" heart murmurs. But some heart murmurs do point to issues with heart valves.
Third heart sound that is like a low frequency vibration	Patient might have a ventricular defect. This third heart sound is referred to as S3 or a ventricular gallop.

2.8 RESPIRATORY SOUND

There are two main descriptors of single tone sound vibrations, frequency and amplitude, which we perceive as the pitch and loudness respectively. In a complex sound, such as the breath sounds, it is the presence of simultaneous higher frequencies, in particular harmonics, which give the sounds their distinctive character. When we listen to a complex sound, we usually hear the lowest note (in musical terms the fundamental note). The predominance of the lower note is increased as the amplitude of the sound rises, resulting in masking of higher frequency components by lower frequency ''turning up the volume accentuates the base'' as anyone with teenage children will have noted[11].

Breath sounds are generated by turbulent air flow in the trachea and proximal bronchi. Airflow in the small airways and alveoli is of lower velocity and laminar in type and is therefore silent. What is heard at the chest wall depends on the conductive and filtering effect of lung tissue and the characteristics of the chest wall. The lung parenchyma and chest wall act as a low pass filter (reducing higher frequencies) and sounds transmitted from the proximal airways are greatly attenuated and consist mainly of low frequencies. Most normal ''vesicular'' breath sounds are found between 37.5–1000 Hz, with the main energy below 100 Hz where they are mixed with muscle and heart sounds.

The intensity of sound is progressively reduced between 100–200 Hz with only little energy between 400– 1000 Hz. Higher frequency sounds do not spread as diffusely or retain as much amplitude across the chest wall as do lower frequencies. The high frequency but low amplitude sounds are thus important for localising the breath sounds to underlying pathology. When lung tissue is consolidated there is an increase in higher frequency energy because filtering of higher frequencies is reduced. There is also a reduction of low frequency sounds which leads to less masking of the higher frequency sounds. The resultant sound is of higher pitch and resembles its source in the bronchi and trachea[12].

Frequencies range from 240–1000 Hz.11 Added sounds contain strong peaks of energy and can be continuous and musical, for example, wheezes, or discontinuous, explosive and non-musical, for example, crackles. The main energy of wheezes is .400 Hz, rhonchi ,200 Hz, and crackles 750–1200 Hz.

2.9 EDUCATION SIMULATION TOOL

Theres a many way to help enhance studets understanding. In most medical schools, the simulation is use to introduce the new medical student to the basic principals of the physical examination and history taking. Additionally, it provides an early opportunity to integrate basic science information being learned in the classroom, with clinical situations [13]. It also allowed more flexibility and spontaneous interactions rather than following a strict script of learning module.

2.9.1 VENTRILOSOPE

The ventriloscope is one of the education simulation tools that have been used widely As the stethoscope is of the most fundamental tools for doctors and can be one of the most powerful in initial detection of cardiac or pulmonary illnesses. This tools is developed to give medical educators a better way to teach students to use it and understand what they hear at a basic level.

The device called Lecat's Ventriloscope. It looks like a stethoscope but has a receiver box between the headpiece and the chestpiece. That receiver is connected wirelessly to a remote control used by an actor who's portraying a patient during a mock examination.

The sounds that the student hears through this stethoscope during the exam are controlled by the actor or the instructor. They're sounds that have been digitally recorded from real patients (with their approval, of course), to simulate what a doctor would hear when examining a patient with a heart murmur or atrial fibrillation or tachycardia, or a number of other conditions.

Intended to be used alongside a mock patient history and physical exam, the Ventriloscope is designed to help students recognize abnormalities that might give them clues to what's really going on with a patient.

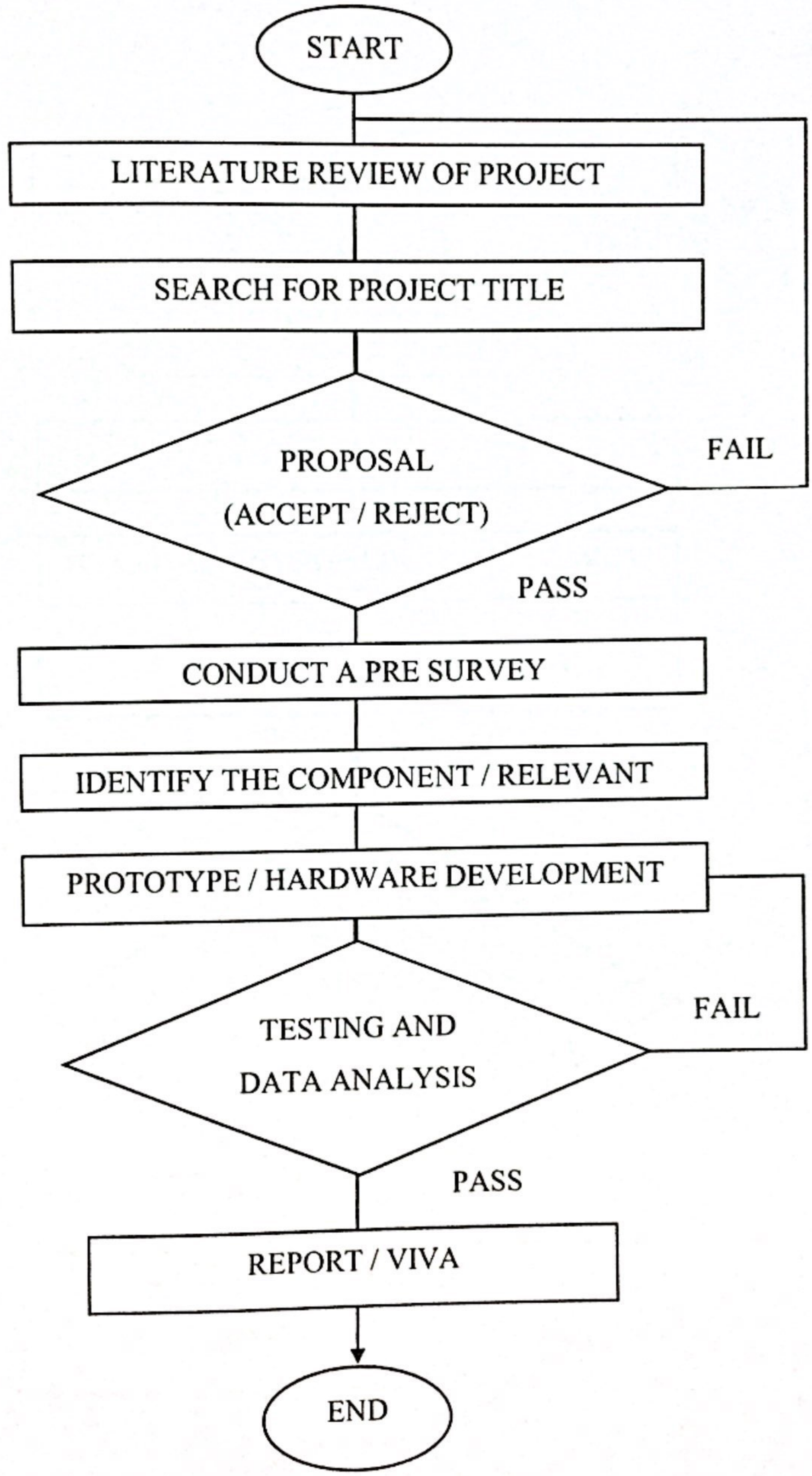
CHAPTER 3

METHODOLOGY

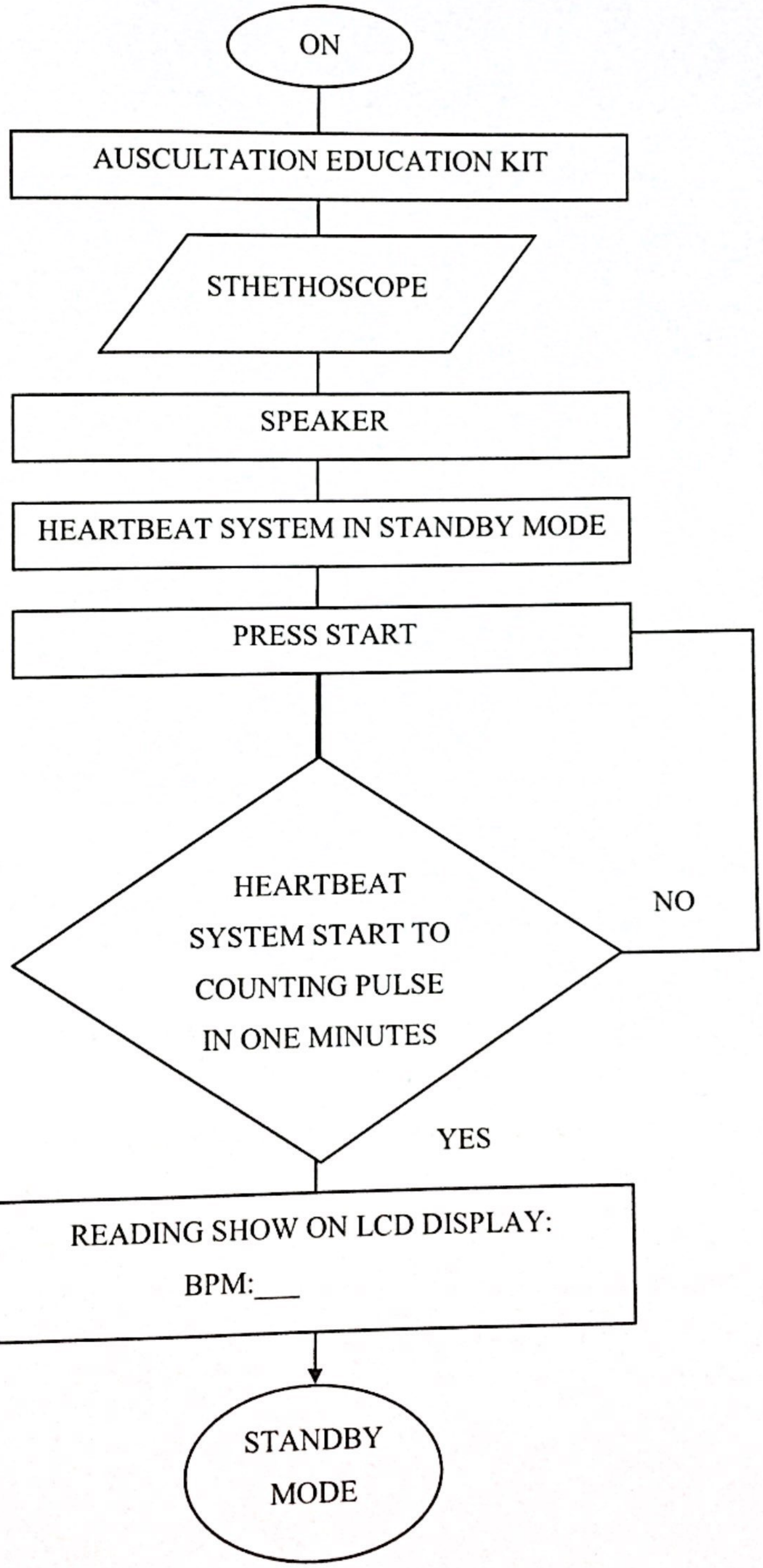
3.1 INTRODUCTION

This chapter will explain about the methodology that is used to make this project complete. Methodology plays an important role in implementing Auscultation Education Kit. The method use is to achieve the objective of the project that will accomplish a good result. In order to produce this project, there are involving two major part, which is hardware and software.

3.2 FLOWCHART OF PROJECT



3.3 FLOWCHART OF AUSCULTATION EDUCATION KIT SYSTEM



3.4 HARDWARE

This project used hardware component to detect, listen and calculate heart sound as shown in Figure 3.1. The main component used in this project are chestpieces stethoscope, microphone, LM 386 amplifier, speaker, arduino uno, and LCD display.

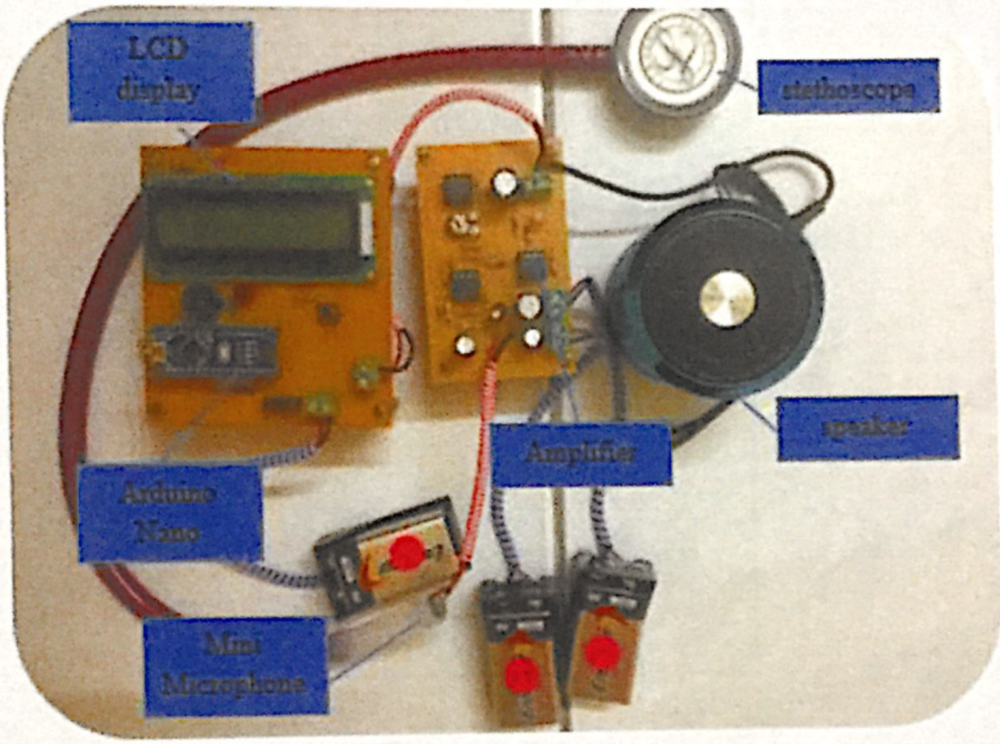


Figure 3.1: The major component of Auscultation Education Kit

3.4.1 CHESTPIECES STETHOSCOPE

As shown in Figure 3.2, the Littman model was being used because the trusted accurancy of the equipment in medical field. Then the Littmant stethoscope was being cut to get the tubing and chestpiece of stethoscope for design the prototype of Auscultation Education Kit. A chestpiece was made from machined stainless steel material with two sided, the diaphragm is tunable about 1.7 inchi long, the tubing length is 28 inchi as standart use by medical staff .

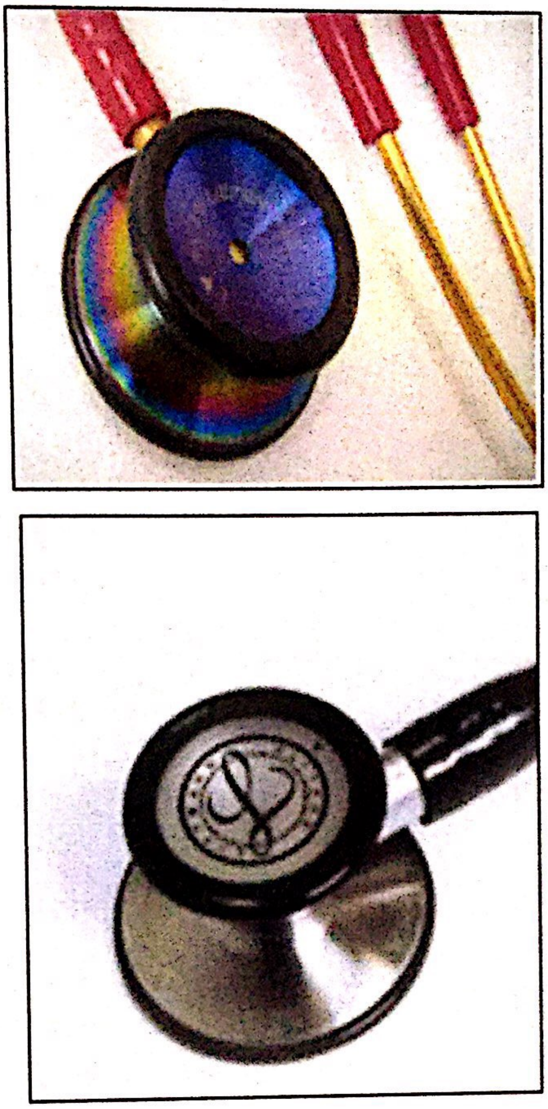


Figure 3.2: Chestpiece of Littman II S.E. Stethosocope

3.4.2 MICROPHONE

A microphone is a sound transducer that converts sound to an electrical signal. It is used as a chest piece connected to tubing of stethoscope to sense heart and lung sounds in the design of an Auscultation Education Kit. The microphone used in the project is WM-61A omnidirectional back electrode condenser microphone because of its cost and its supply voltage.

The images of the front side (with black top) and back side (for soldering) of the microphone are shown in Figure 3.3. It is of circular shape, 6 mm in diameter and 3.4 mm in thickness, and has solder pads to connect to other parts. It has an operating voltage range of 2 – 10 V and consumes a maximum of 0.5 mA. Its frequency range is 20 – 16,000 Hz. The supply voltage is in the range of the supply voltages of the other components. This frequency range makes it compatible for this design, as the heart and lung sounds are in the range of 30 – 1,000 Hz.

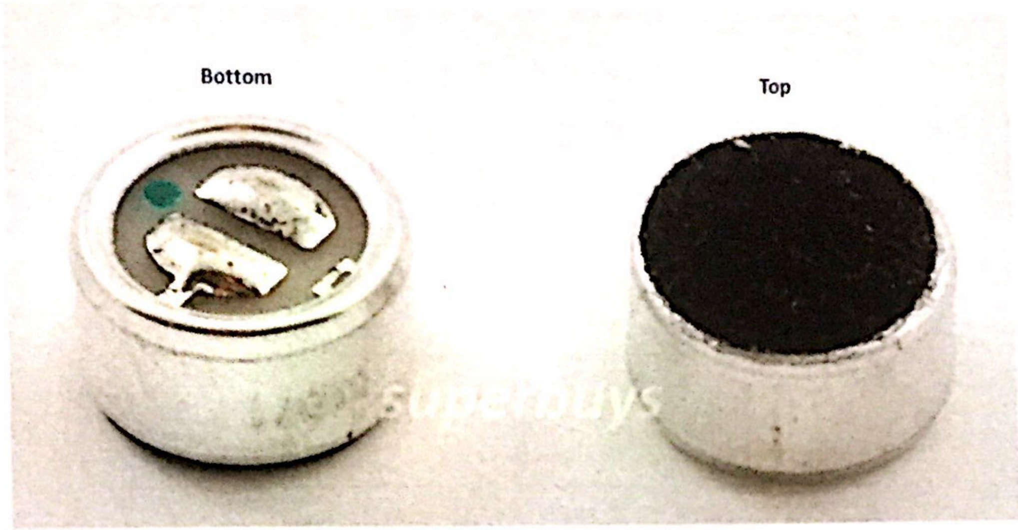


Figure 3.3: Panasonic WM-61A Omnidirectional Electrode Condenser Microphone

3.4.3 AUDIO AMPLIFIER

The LM386N is audio amplifier used in this project. It is low voltage audio amplifier. The factors that were considered in the choice of the low voltage audio amplifier are cost, operating voltages, and operating frequencies. Figure 3.4 shows the pin layout of the LM386N[14]. This project used 400 gain amplifier. Therefore two circuit of amplifier with gain 200 as shown in Figure 3.5 were used to design an Auscultation Education Kit.

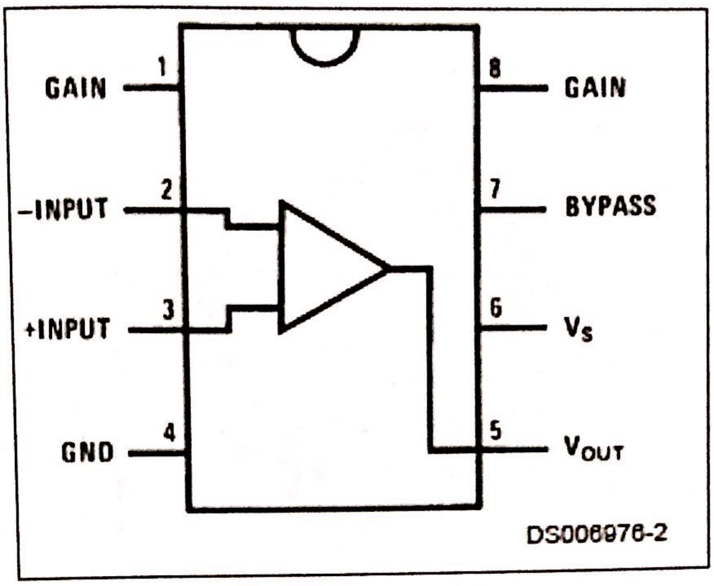


Figure 3.4: LM386N Pin Layout

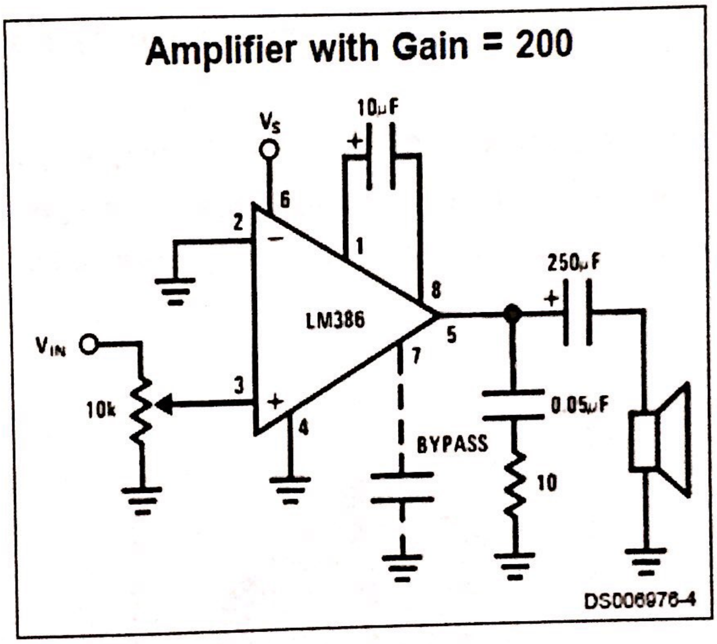


Figure 3.5: LM386N Circuit

3.4.4 JFET AMPLIFIER

This project use low noise JFET dual operational amplifier as shown in Figure 3.6. It is because the transistor is latch up free operation. The low harmonic distortion is suitable for audio pre-amplifier applications. The factors that were considered include low power consumption, wide common-mode and differential voltage, and high input impedance.

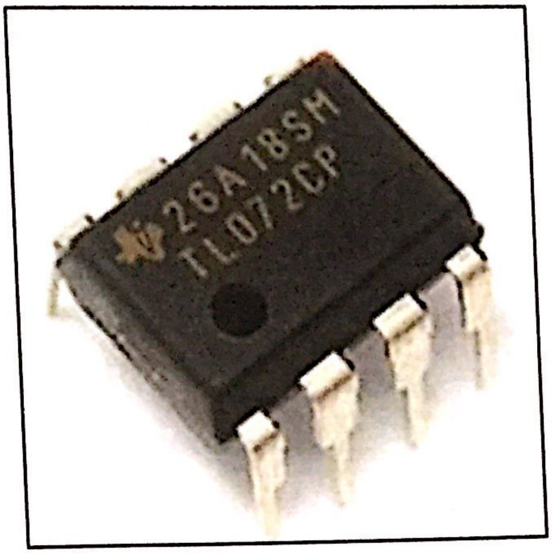


Figure 3.6: Low noise JFET dual operational amplifier

3.4.5 GENERAL PURPOSE AMPLIFIER

Referring to Figure 3.7 is a UA741CN general purpose operational amplifier. Its internal frequency of this amplifier can ensure the stability without external component used in the project. Figure 3.8 shows the pin layout of the UA741CN.

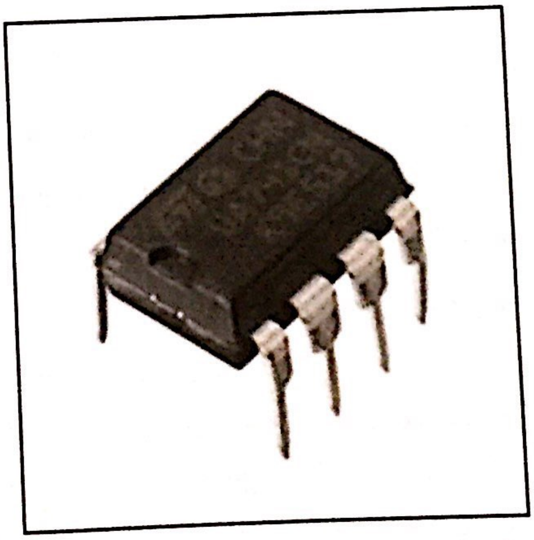


Figure 3.7: UA741CN general purpose operational amplifier

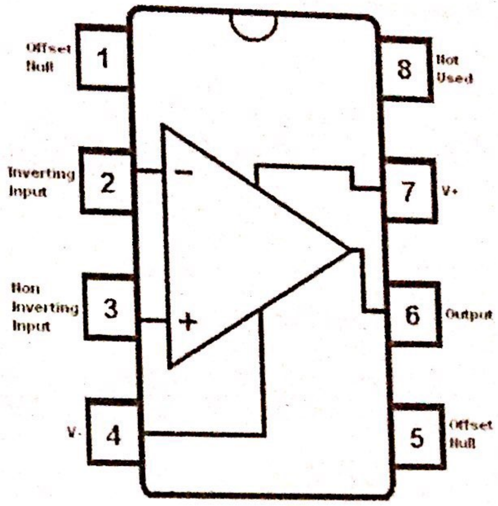


Figure 3.8: UA741CN Pin Layout

3.4.6 SPEAKER

Speaker as a transducer will produce the input signal that have been processed. The heart voice and respiration can be listened well through the speaker which the volume can be adjusted. In this project, the portable speaker has been used because of the low cost.

3.4.7 ARDUINO NANO

Arduino is an open-source electronics prototyping platform based on flexible, simple microcontroller board. The development hardware is easy to use with software writing in the board. For this project by taking an inputs signal from the sensors, it also can control a LED and LCD display. Referring to Figure 3.9, this project used Arduino Nano as a microcontroller to receive data and then display it through LCD display. Arduino Nano is a small, complete, and breadboard friendly board based on the ATmega328 with operate supply power at 5 volts.

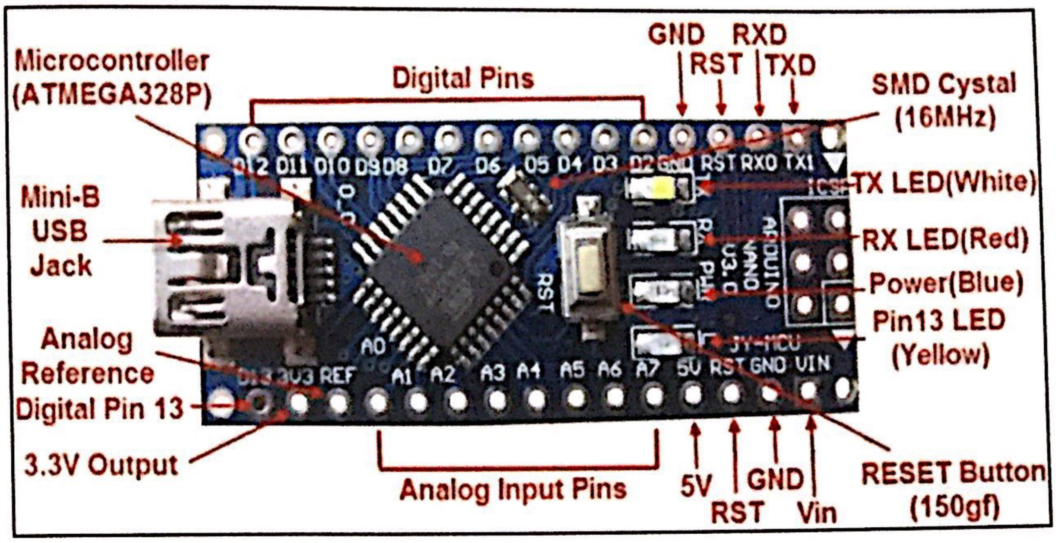


Figure 3.9: Arduino Nano

3.4.8 LCD DISPLAY

Liquid crystal displays (LCD) as shown in Figure 3.10, come in different shapes, colors and sizes. The Arduino used the Liquid Crystal library to communicate with the LCD display [15]. In this project, the character LCD is connected to the micro-controller to display the heart rate readings because of the amount character will display. The heart beat will be start to count when the push button being pressed.

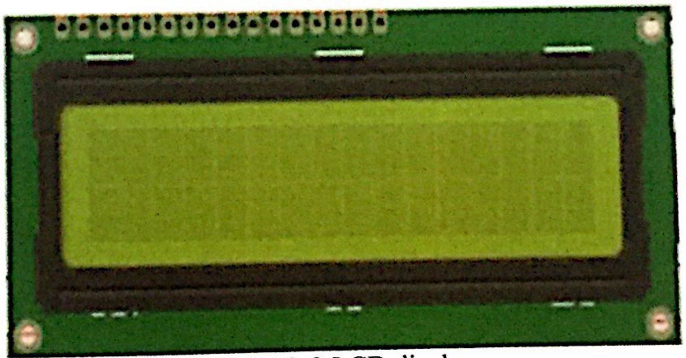


Figure 3.10: 16x2 LCD display

3.5 SOFTWARE

Software that is needed to control this electronic stethoscope system can be monitored and analyzed the heartbeats by the student or educator. The system that is used for this project is capturing the input signal in voltage that is from condenser microphone sensor and then being read by the software programming system to convert from analog signal into digital signal for final result in the development of electronic stethoscope.

3.5.1 ARDUINO SOFTWARE

Referring to figure 3.11, the Arduino integrated development environment (IDE) is a crossplatform application written in Java. It is capable of compiling and uploading programs to the board. A language reference in Arduino programs can be divided in three main parts that is structure, values for variables with constants, and functions. It runs machine code compiled from either C, C++, Java4 or any other language that has a compiler for the Arduino instruction set [15].

Figure 3.11: Icon Arduino software

3.5.2 MICROSOFT EXCEL

Microsoft Excel is an electronic spreadsheet application for storing, organizing and manipulating data. In this project, it is used for analyzing data, managing record data, identifying trends, building charts and forms of Auscultation Education Kit.

3.6 BLOCK DIAGRAM

Auscultation Education Kit is composed of several blocks of the network as show in Figure 3.12. Firstly, the chestpiece which serves to detect heart sounds. Electrode condenser microphone works converts sound into electrical vibration. Then the signal is amplified by an amplifier. Finally, speaker as transducer produces sound signals that have been processed. At the same time, the arduino start to counting the heart beat and display it.

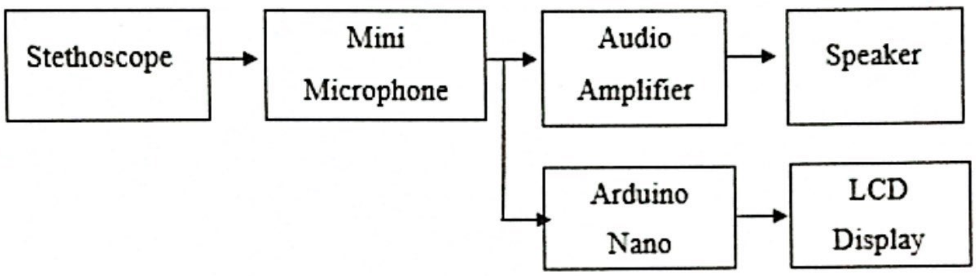


Figure 3.12: Block Diagram of Hardware

3.7 SCHEMATIC CIRCUIT

Figure 3.13 shows schematic circuit that used to design the Auscultation Education Kit. There is three circuit which is power supply circuit, amplifier circuit and LCD circuit.

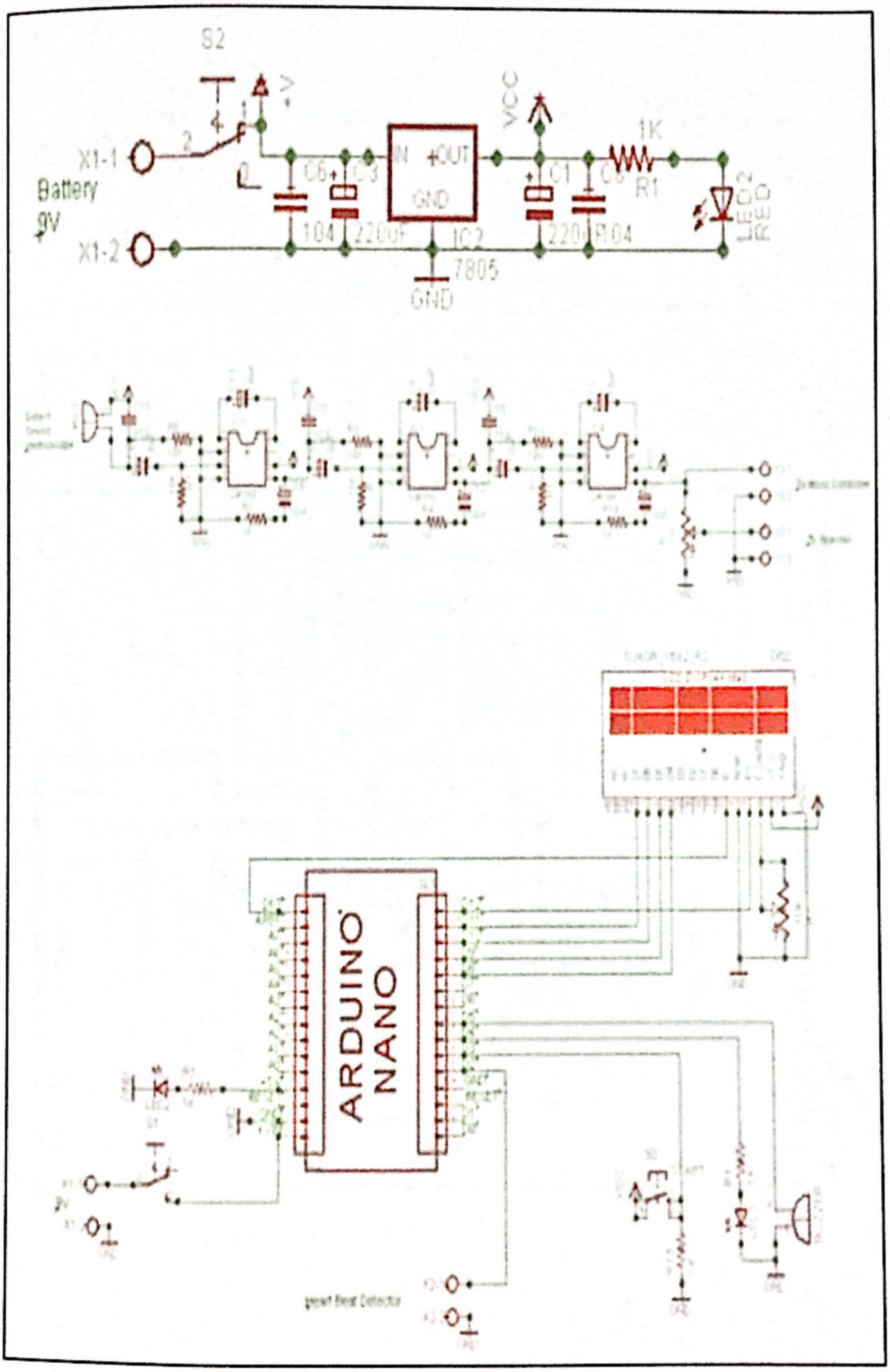


Figure 3.13: Schematic Circuit of AEK

3.8 PCB LAYOUT

Figure 3.14 and Figure 3.15 show the PCB layout by using software Eagle 6.0. Schematics circuit was draw using software Eagle6.0. After it done, Up in the file menu, there's a "Switch to board" selection. Click on it to create the PCB layout. Once the layout had done, print the layout onto a glossy paper. After that, faced the printed sides of the glossy paper to the Board, then iron it until the PCB layout have transfer onto the Board. Proceed to the next step which is etching and drilling process to finish the PCB board.

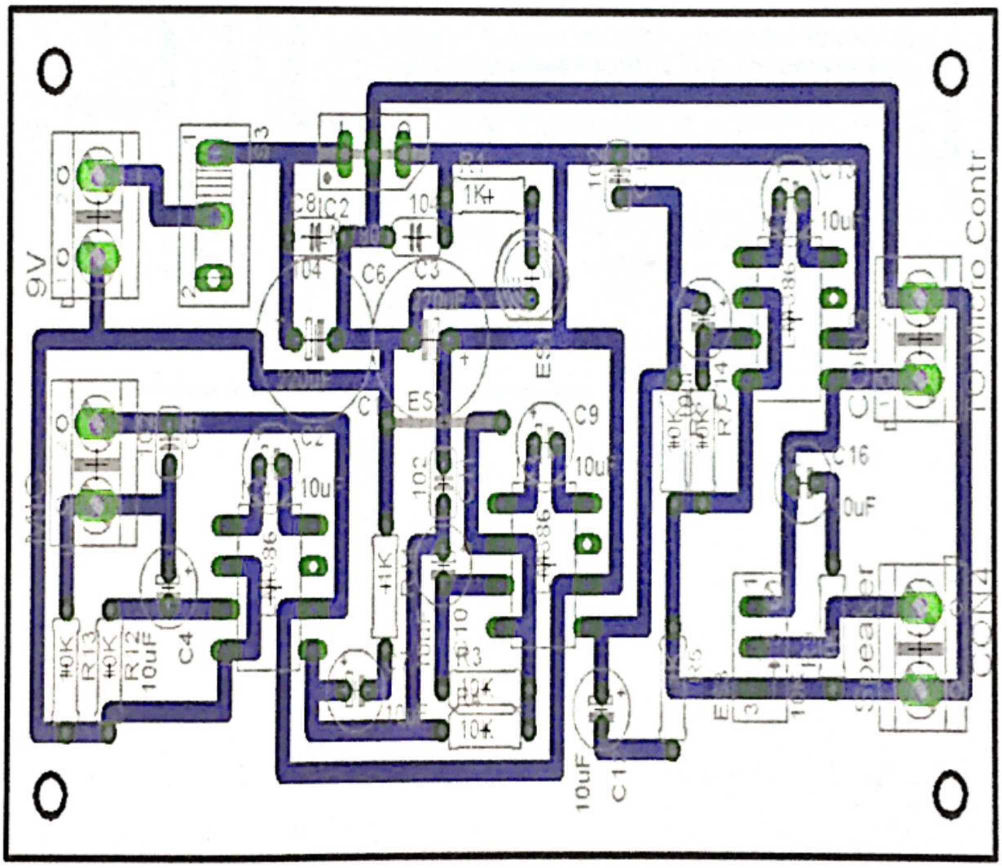


Figure 3.14: Layout of Amplifier Circuit

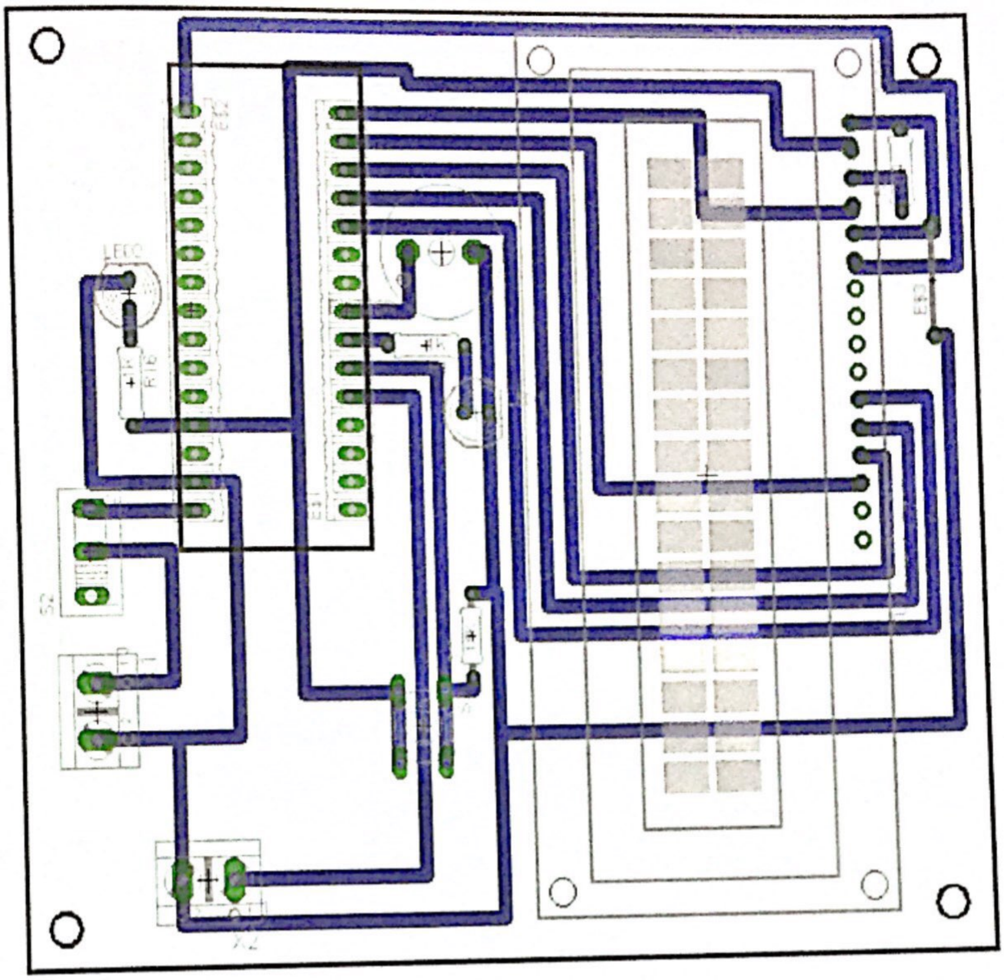


Figure 3.15: Layout of LCD display

3.9 HARDWARE DESIGN

Figure 3.16 shows the design of this project which is Auscultation Education Kit. This hardware include chestpiece which is used to transmit the heart and lung sounds from the patient, microphone that is used to pick up the sound of the heart beat, arduino use to count the heartbeat, LCD display used to diplay the counting heart beat, LM386 Audio Amplifier circuit to greatly ampilify the heart sound and speaker for more than one person to listen with adjustable volume.

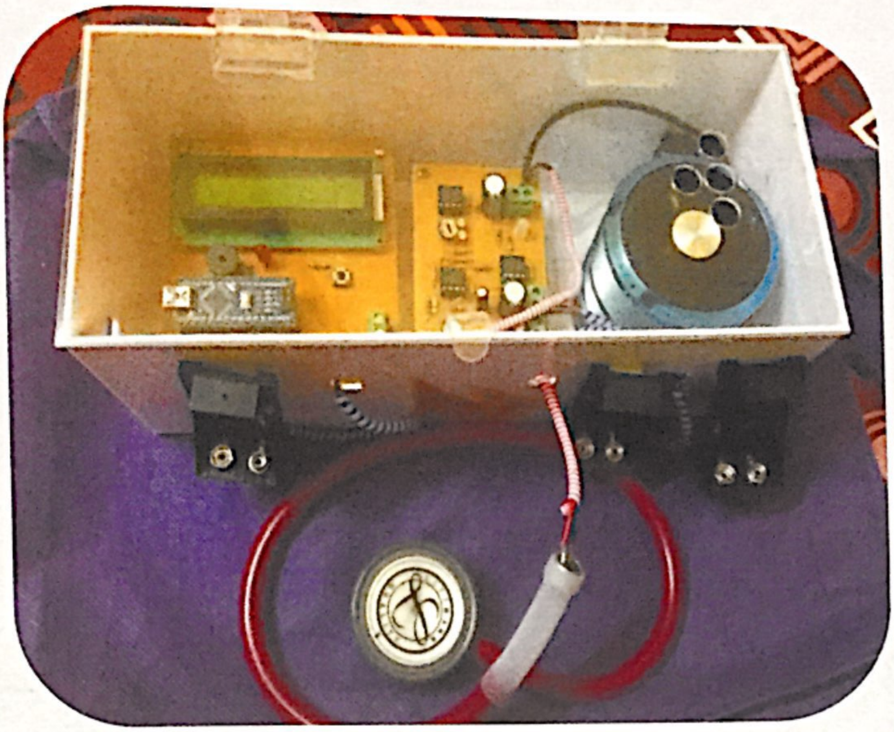


Figure 3.16: Auscultation Education Kit

3.10 PROJECT TESTING

After the hardware is done, Auscultation Education Kit was test on subjects. Project testing was being test to 5 persons of random subject that were from the population of Premier Polytechnic of Sultan Salahuddin Abdul Aziz Shah, Shah Alam student. Purpose of project testing is to ensure the device is functioning and working in good and safe aspect.

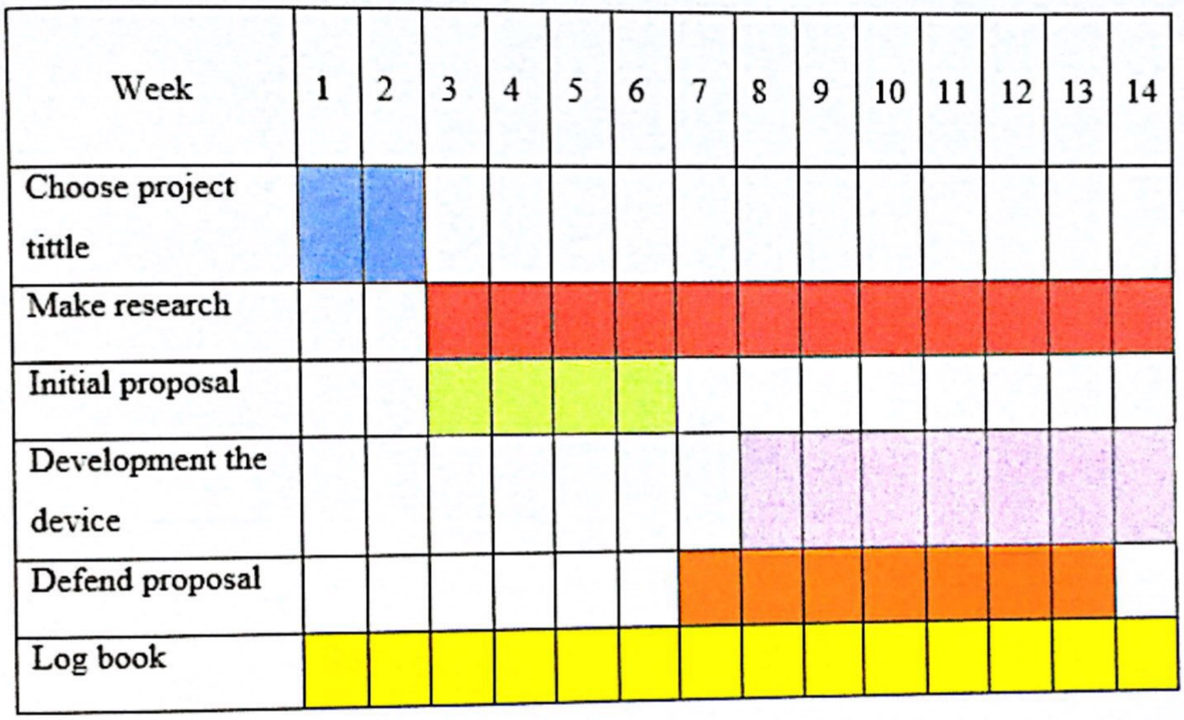
3.11 EVALUATION (SURVEY QUESTION)

The survey question was distribute to 20 person which is staff Premier Polytechnic of Sultan Salahuddin Abdul Aziz Shah and student of Degree of Bachelor of Eletronic Engineering Technology (Medical Electronics) With Honours. This questionaire is to intended to provide feedback on "Auscultation Education Kit".

3.12 GANTT CHART OF THE PROJECT FOR FIRST SEMESTER

The plan to conduct this project as shown in Table 3.1. The selection of project title held on week 1 and 2. On week 3 until 4 is to make a preparation for initial proposal and research about this tittle via variety of source. All collection of data had recorded in logbook. Lastly,week 7 until 13 was planned for a defend proposal.

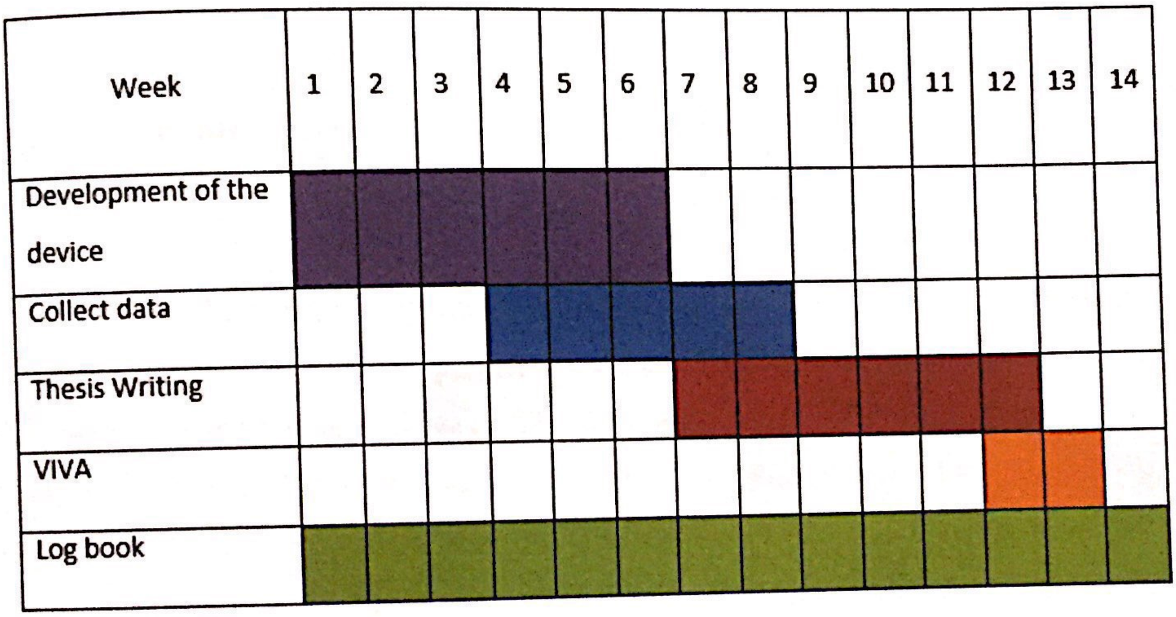
Table 3.1: Gantt chart of the project for first semester



3.13 GANTT CHART OF THE PROJECT FOR SECOND SEMESTER

The plan to conduct this project as shown in Table 3.2. The development progress of project held on week 1 until 6. On week 4 until 8 is to collect the data and also write the report on logbook. On week 7 until 12 was planned for a thesis writing. Week 12 and 13 is for VIVA presentation.

Table 3.2: Gantt chart of the project for second semester



CHAPTER 4

RESULT AND ANALYSIS

4.1 INTRODUCTION

This chapter constitutes the results from the data gathered. The findings presented here were based on project testing and questionnaires. This chapter only focuse to the most data collection. The data were collected at Polytechnic Sultan Salahuddin Abdul Aziz Shah. Data project testing was done by tested the Auscultation Education Kit for 30 random subjects. The data evaluation of questionnaires are distributed to the 20 person which is staff Premier Polytechnic of Sultan Salahuddin Abdul Aziz Shah, and student of Bachelor of Eletronic Engineering Technology (Medical Electronics) With Honours. The result was showed in a table and graph was plotted to analyze the results.

4.2 QUESTIONNAIRE

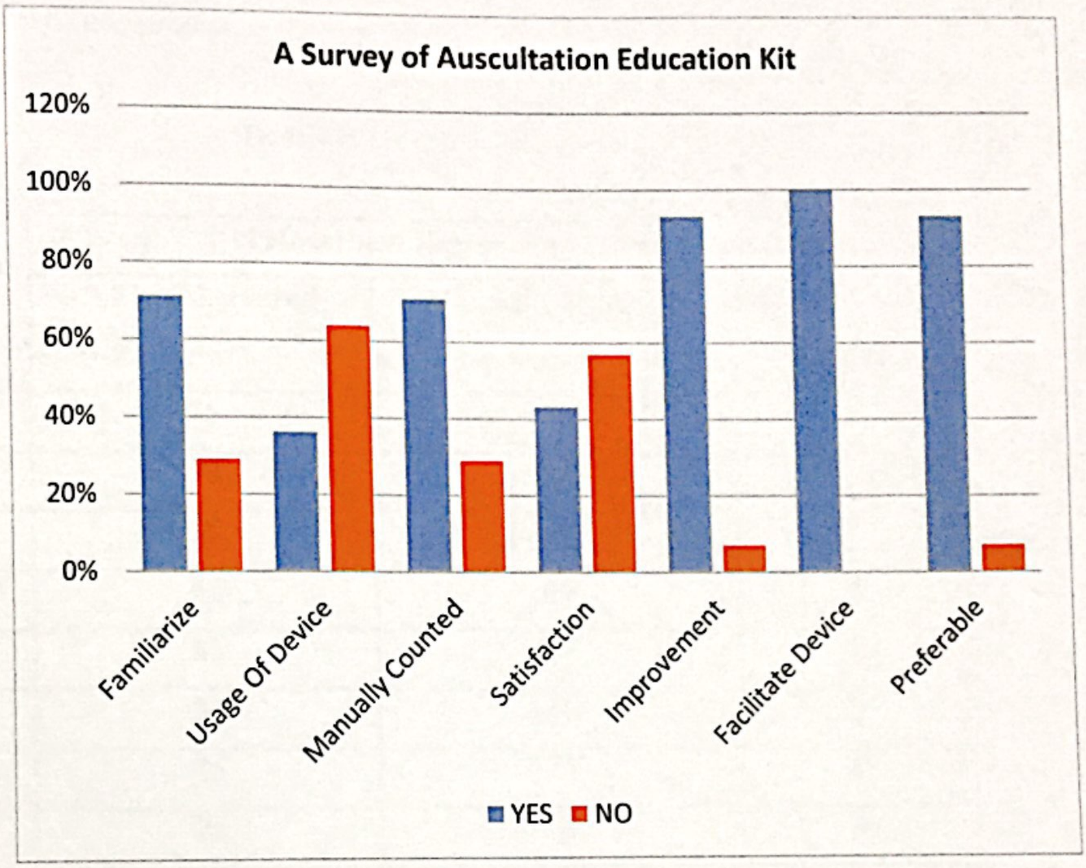


Figure 4.1: Graph of a survey of Auscultation Education Kit

This survey was distributed to 20 respondents, categorized students and educators. From the data obtained, 71% familiarize about electronic stethoscope. Only 36% was ever used electronic stethoscope. Third, 71% agree that there is needs to count heart beat manually. 43% satisfy with the current stethoscope in learning process. 93% want the improvement in current stethoscope. 100% agree the implementation of this education kit can help in learning process. Lastly, 93% prefer to use electronic stethoscope to count heart beat automatically rather than manually.

4.3 DATA ANALYSIS

Table 4.1 show the data collected from 30 subjects to check the reliability of this project.

Table 4.1: The data collection of 30 subjects

No.	Heartbeat (bpm)		Tolerance |AEK - Manual|
	AEK (Measured Value)	Manual (Accepted Value)	
1	75	78	3
2	78	77	1
3	80	81	1
4	66	69	3
5	85	87	2
6	89	80	9
7	75	75	0
8	75	69	6
9	78	68	10
10	77	75	2
11	60	66	6
12	88	80	8
13	80	71	9
14	64	73	9
15	80	70	10
16	67	63	4
17	75	75	0
18	86	88	2
19	70	65	5
20	87	84	3
21	78	83	5
22	89	85	4

23	89	87	2
24	84	87	3
25	88	89	1
26	70	65	5
27	82	83	1
28	89	90	1
29	84	77	7
30	90	87	3
Total	**2378**	**2327**	
Total Average	**79.3**	**77.6**	

As shown in Figure 4.2, a graph is builted to show data variables and trends clearly and help to making a prediction about the results of data not yet recorded.

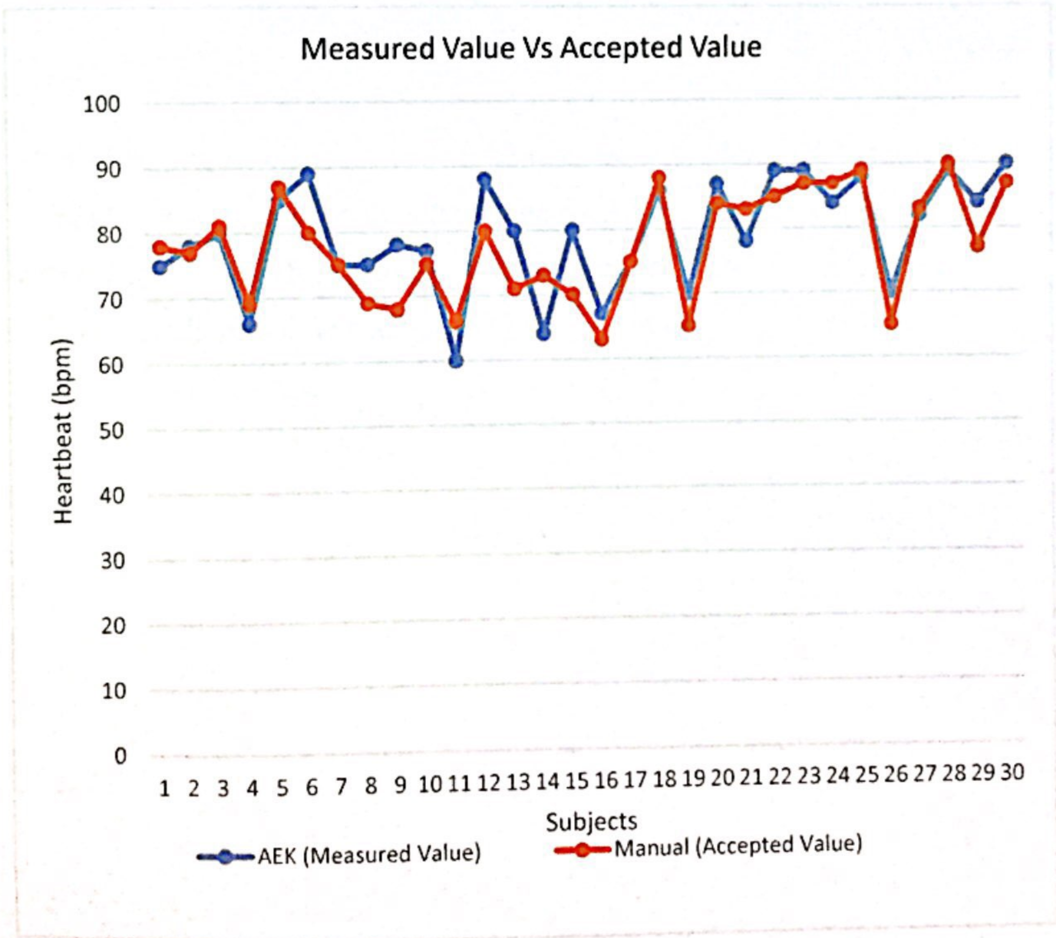


Figure 4.2: The graph of 30 subject results

4.4 ACCURANCY TEST

The project has been tested to 30 subject. Purpose of this test is to see the accurancy of the project. The formula of percent of error has been used to check the percentages error of the education kit.

Percent of error:

$$Percent\ error = \frac{Experimental\ value - Accepted\ value}{Accepted\ value}\ X\ 100$$

$$Percent\ error = \frac{79.3 - 77.6}{77.6}\ X\ 100$$

Percentage of accuracy = 100 - 2.2

= 97. 8%

After obtaining resuls from system device, the subject also determined their heart rate by holding two fingers on their hand and record the number of beats per minute as shown on Figured 4.3. It is used as data collection to get the difference between counted heart beat in real-time and by using the education kit.

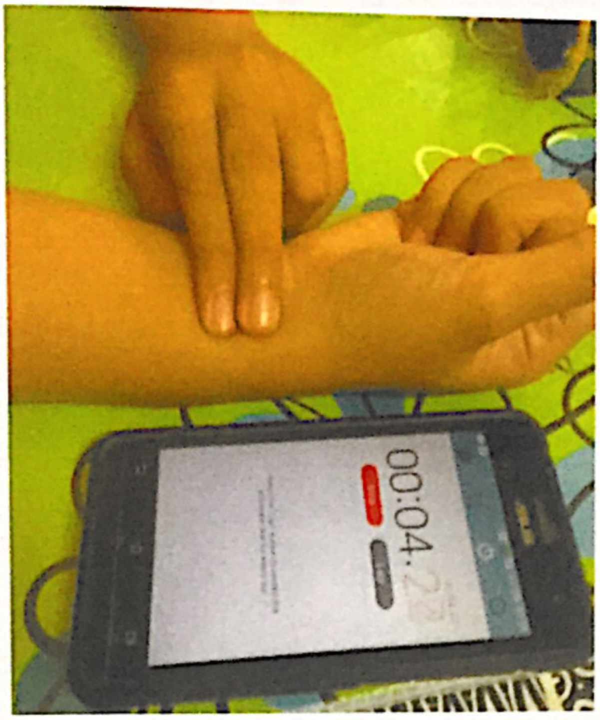


Figure 4.3: Manually measured heartbeat

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

At this chapter, the conclusion was divided to three subdivision which is summary to discuss overall achievement of project, recommendation of the future project and commercialization potential.

5.2 SUMMARY

As conclusion, most of the objective in which is 90% of this project was achieved. At the end, the innovation of this project may help instructor to use this project as a practical tools and facilate medical student in hearing heart sound for analyzing heart and lung disease. The usage of audio amplifier circuit was succeed to amplified the heart sound with adjustable volume. So that, there is still much space for futher development.

5.3 RECOMMENDATION

After carrying out the project Auscultation Education Kit, there is some weakness. First, the device developed does not provide clear sound and the noise still exist. Second, the heartbeat counting have slightly difference value between real-time counting and automatic calculated of this education kit. Last, the design requirements still do not have a suitable casing.

Therefore, to overcome this weakness of this project, several recommendation were made. First, add filteration circuit to filter the noise and to make sure the device provide clear sound. Else, it need an improvent by analyzing the accurate peak of the heart sound signal in programming. Besides that, upgrade the design of this Auscultation Education Kit with a suitable casing so that it will look more interesting in feature.

In future study, this project could be upgrade with additional function, such as compare the performance of this system with availabe automated system. The outputs of real-time audio signal can be heard through headphone and speaker. In addition, it will be realible device if could show the graph waveform of heart and record the heart sound for reference and study for medical students to learn in future. Obviously, this is addin up features to a very compact device and give portability advantages.

5.4 COMMERCIALIZATION POTENTIAL

A stethoscope is a primary device used by medical doctors. Medical student spend months, and even years, learning to listen to the internal organ of the human body to become a good doctor. Thus, this device is extremely important for easy and faster process teaching and learning to listen the heart sounds.

Therefore, Auscultation Education Kit are highestly commercially potential for teaching and learning. Auscultation Education Kit can help medical students hear certain sounds in patient bodies that cannot otherwise be heard with just the ear.

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APPENDIX A

Questionnaire

KEMENTERIAN PENDIDIKAN MALAYSIA

POLITEKNIK Sultan Salahuddin Abdul Aziz Shah

A Survey for Final Year Project

QUESTIONAIRS

A Survey of " Auscultation Education Kit "

1. Gender: Male ☐ Female ☐

2. Occupation: Doctor ☐
   Nurse ☐
   Lecturer ☐
   Student ☐

3. Have you ever wondered what your heart beat sounds like?
   Yes ☐ No ☐

4. Have you heard about electronic stethoscope?
   Yes ☐ No ☐

5. Have you ever used electronic stethoscope?
   Yes ☐ No ☐

6. Have you ever counted your heart beat manually?
   Yes ☐ No ☐

7. Are you satisfy with the current stethoscope in learning process?
   Yes ☐ No ☐

8. Do you want to improve in current stethoscope?
   Yes ☐ No ☐

9. Do you think this education kit can help you in learning process?

Yes ☐ No ☐

10. Do you prefer to use electronic stethoscope to count your heart beat automatically rather than manually?

Yes ☐ No ☐

Approved by,

....

(Madam Wee Soo Lee)

Student,

....

(Rina Rozianah Binti Pauzi)

APPENDIX B

Consent Form

Consent Form

Title of Study: Auscultation Education Kit

I understand about the information of this study and received explanation from the investigator about the purpose of the investigation including benefits and risks

I am ____. Matrix number _______________________. Phone number__________________________. "Agree/Disagree to participate in the studies as described above.

Signature,

____________________,

Date:

Borang Kebenaran

Tajuk kajian: Auscultation Education Kit

Saya memahami mengenai maklumat kajian ini serta mendapat penjelasan lanjut daripada penyelidik mengenai tujuan penyelidikan termasuk faedah dan risikonya.

Saya ____. Kad Matrix _______________________. Nombor telefon ____________________. "Bersetuju / Tidak Bersetuju" untuk menyertai kajian yang dinyatakan seperti diatas.

Tandatangan.

____________________,

Tarikh:

APPENDIX C

Source Code

```
//define io pin
#define Beat A0
#define StartBut 3
#define Led 4
#define Buzzer 5
//define lcd
#include <LiquidCrystal.h>
#include <MsTimer2.h>
//defne variables
char msec, sec, minutes, hours;
int pulse;
int count, flag;
char txt[10];
char group;
char temp;
char start_flag;
char sec_flag;
unsigned int ip1;
//assign lcd port
LiquidCrystal lcd(12, 13, 8, 9, 10, 11);
//tmer counter every 1sec
int Minutes = 1, Seconds;
char jump = 0;
int newpulse = 0, latestpulse = 0;

void flash()
{
 sec++;
 sec_flag = 1;
```

```
if (sec >= 60)
{
 sec = 0;
 minutes++;
 if (minutes >= 60)
 {
  minutes = 0;
  hours++;
 }

void beep()
{
 digitalWrite(Buzzer, HIGH);
 delay(100);
 digitalWrite(Buzzer, LOW);
 delay(100);
}
void setup() {
 MsTimer2::set(1000, flash); // 500ms period
 MsTimer2::start();
 pinMode(Beat, INPUT);
 pinMode(StartBut, INPUT);
 pinMode(Led, OUTPUT);
 pinMode(Buzzer, OUTPUT);
 Serial.begin(9600);
 lcd.begin(16, 2);
 lcd.setCursor(0, 0);
 lcd.print("HeartBeat Count");
```

```
 lcd.setCursor(0, 1);
 lcd.print("Stethoscope Sys");
 delay(1000);
 lcd.clear();
 lcd.print("Press Start");
 sec = 0;
 count = 0;
 pulse = 0;
 start_flag = 0;
 group = 0;
}

void stepDown() {
 if (Seconds > 0) {
  Seconds -= 1;
 } else {
  if (Minutes > 0) {
   Seconds = 59;
   Minutes -= 1;
  } else {
   jump = 1;
  }
 }
}
void loop()
{
 if (digitalRead(StartBut))
 {
  beep();
  lcd.begin(16, 2);
```

```
  lcd.setCursor(0, 0);
  lcd.print("HeartBeat Count");
  start_flag = 1;
  delay(2000);
  lcd.clear();
}
if (start_flag)
{
  if (jump == 1) {
    start_flag = 0;
    count = 0;
    jump = 0;
    //pulse = pulse * 2;
    latestpulse = latestpulse;
    if (latestpulse >= 60 && latestpulse <= 100)
    {
      beep();
      lcd.clear();
      lcd.begin(16, 2);    //16x2
      lcd.setCursor(0, 0);
      lcd.print("Bpm:");
      lcd.print(latestpulse);
      lcd.setCursor(0, 1);
      //      lcd.print("Normal");  //hardware issue
      delay(5000);
    }
    else if (latestpulse >= 101 )
    {
      beep();
      lcd.clear();
```

```
lcd.begin(16, 2);    //16x2
     lcd.setCursor(0, 0);
     lcd.print("Bpm:");
     lcd.print(latestpulse);
     lcd.setCursor(0, 1);
     lcd.print("High");
     delay(5000);
   }
   else if (latestpulse < 60)
   {
     beep();
     lcd.clear();
     lcd.begin(16, 2);
     lcd.setCursor(0, 0);
     lcd.print("Bpm:");
     lcd.print(latestpulse);
     lcd.setCursor(0, 1);
     lcd.print("Low");
     delay(5000);
   }
  lcd.clear();
  delay(1000);
  lcd.begin(16, 2);
  lcd.setCursor(0, 0);
  lcd.print("Standby");
  pulse = 0;
  newpulse = 0;
  latestpulse = 0;
  Minutes = 1;
}
```

```
//     while (1) {
//       ip1 = analogRead(Beat) / 4;
//       Serial.println(ip1);
//     }

  ip1 = analogRead(Beat) / 4;
  //  delay(200);
  if (ip1 > 20)
  {
   digitalWrite(Led, HIGH);
   while (1)
   {
    if (sec_flag)
    {
     sec_flag = 0;
     count = count + 1;
     lcd.setCursor(0, 0);
     (Minutes < 10) ? lcd.print("0") : NULL;
     lcd.print(Minutes);
     lcd.print(":");
     (Seconds < 10) ? lcd.print("0") : NULL;
     lcd.print(Seconds);
     lcd.display();
     stepDown();
    }
    if (jump == 1)
     break;

    ip1 = analogRead(Beat) / 4;
    if (ip1 == 0)
    {
```

```
        pulse++;
        newpulse = pulse;
        latestpulse = newpulse / 18;
        digitalWrite(Led, LOW);
        digitalWrite(Buzzer, LOW);
        lcd.setCursor(0, 1);
        lcd.print("Pulse:");
        lcd.setCursor(6, 1);
        lcd.print(latestpulse);
        break;
      }
    }
  }
 }
}
```