

**DESIGN AND IMPLEMENTATION OF LOW COST WIRELESS
STETHOSCOPE**

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In the name of Allah the most gracious and most merciful.

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ABSTRACT

Auscultation is technique which medical professions use to listen the internal body sounds such as heart and lungs sounds by using stethoscope in order to do diagnosis. But the Auscultation method is very complicated to diagnose and check the situation of the heart, this method requires to give more training to the medical professions in order acquire accurate results from heart.

Furthermore, there is main problem with acoustic stethoscope which is the sound level is very low, therefore, in this project it has been designed and developed Electronic stethoscope which has capability to amplify the heart sounds and solve the main problem of the acoustic stethoscope.

Therefore, this project was developed Electronic stethoscope which consist of Electret condenser microphone which pick up the heart sounds and convert to electrical signal, amplification circuit that has the ability to amplify the detected signal from heart. After amplification of the detection heart sounds it has been heard by using headphones. It also transmitted via wireless by using Bluetooth Module which has a range of wireless transmission of 30 feet. And it have lower cost compare to the wireless electronic stethoscope which currently available in the markets.

Similarly, the signal has presented in a format that can make very easy to visualize and analysis by the users through Graphic user interface (GUI) using matlab software. Besides the signal can be recorded and stored for future analysis.

ABSTRAK

“Auscultation” ialah satu teknik yang digunakan dalam bidang perubatan untuk mendengar bahagian dalaman badan seperti jantung dan paru-paru dengan menggunakan stetoskop bagi tujuan pemeriksaan. Cara “Auscultation” adalah sangat rumit untuk tujuan pemeriksaan keadaan jantung kerana cara ini memerlukan latihan lebih banyak dalam bidang perubatan bagi tujuan mendapatkan keputusan yang lebih tepat daripada jantung.

Sehubungan dengan itu, terdapat masalah utama ketika menggunakan “Akustik Stetoskop” iaitu di mana tahap bunyi adalah sangat rendah oleh kerana itu, projek ini telah direka dan telah menghasilkan “Elektronik Stetoskop” yang mempunyai keupayaan untuk menguatkan bunyi jantung disamping dapat menyelesaikan masalah “Akustik Stetoskop”.

Menerusi projek ini, ia telah membangunkan “Elektronik Stetoskop” yang mempunyai “Electric Condenser Microphone” dimana ianya digunakan untuk mengesan bunyi jantung dan menukarnya kepada isyarat elektrik, litar penguatan yang mempunyai keupayaan untuk menguatkan isyarat daripada jantung yang telah dikesan. Selepas penguatan dikesan daripada bunyi jantung yang telah didengari dengan menggunakan fon kepala. Ia akan menghantar isyarat dengan menggunakan wayarles dan “Modul Bluetooth” yang mempunyai pelbagai penghantaran wayarles dalam jarak 30 kaki. Ia juga menggunakan kos yang lebih rendah berbanding “Stetoskop Elektronik Wayarles” yang terdapat di pasaran. Isyarat yang ditunjukkan dalam satu format yang memudahkan untuk digambarkan dan di analisis oleh pengguna menerusi “Permukaan Grafik Pengguna” yang menggunakan perisian matlab. Disamping itu, isyarat boleh direkodkan dan disimpan bagi tujuan analisis pada masa hadapan.

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LIST OF ABBREVIATIONS

S1	First heart sound
S2	Second heart sound
GUI	Graphic User Interface
LCD	Liquid Crystal Display
PC	Personnel Computer
STFT	Short time fourier transform
PDA	Personel digital assitant
RA	Right atrium
SA	Sino-atrial
ECG	Electrocardiogram
CAD	Coronary artery diseases
BPM	Beat per minute
FET	Field Effect Transistor
SPL	Sound pressure levels
FIR	Finite impulse response
IIR	Infinite impulse response
DSP	Digital Signal Processor
ADC	Analog digital converter
DAC	Digital to analogue converter

LED	Light Emitting Diode
IDE	Integrated Development Environment
mm Hg	millimeters of Mercury
RX	Receive
TX	Transmit
RF	Radio frequencies
IR	Infrared
UWB	Ultra wideband
WPAN	Wireless personal area network
GND	Ground
SPB	Serial port Bluetooth



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CHAPTER I

INTRODUCTION

1.1 Background of study

Auscultation is a method that medical professional use to check the well being of the heart by listening to heart sounds. However, in order to diagnose the heart sound, the Stethoscope is used which has the ability to distinguish the normal and abnormal heart sounds [1].

On the other hand, Stethoscope is one of the most important medical devices that medical experts use to diagnosis and listen to the internal sounds in human body particularly heart and lung sounds [1]. Furthermore, it can be also used to hear the intestines sounds and blood flow in veins and arteries. All types of heart sounds are very essential for human body's physical signals, because it indicates the physical and pathological characteristics of the patient [2].

Moreover, heart sounds is usually produced when the specific cardiac activities happen in each heart cycle. Basically, heart sound consists of two main components which are first heart sound S1 and second heart sound S2. Even though some time

there is a third heart sound and fourth heart sound, along with two common sounds [3].

However, first heart sound which is commonly termed S1, is produced by the closing of mitral and tricuspid valves, and S2 is produced when aortic valves and pulmonary valves are closed. There is also third and fourth heart sounds but these sounds have very low intensity and are usually inaudible and it is a very rare heart sound which occurs just after normal two heart sounds (S1 and S2). Besides, the third heart sound is created by inflow of the blood to the ventricles. Similarly, fourth heart sound is created by the forceful contraction of the atria [1]. The Heart Murmurs which are produced as the result of turbulence of the flow of strong blood during each cardiac beat [1].

Furthermore, Murmurs are defined as systolic or diastolic according to their timing in the cardiac cycle. Thus, a murmur heard after the first heart sound and before the second is a systolic murmur, and which comes after the second and before the first is a diastolic murmur [20].

However, in order to detect heart sounds, the auscultation device which is known as Stethoscope is used. The stethoscope is derived from two Greek words, "stethos" meaning chest, and "stethos" meaning examination or inspections [4]. The first Stethoscope was invented by a French physician known as Dr. Rene Laennec and the first stethoscope of Dr. Rene was made by rolling up a sheet of paper and putting one end over the patient's chest to detect the heart and lungs sounds and the other end on his ear to hear the sounds. In later additions, he changed the paper rolling up with wooden [4].

Furthermore, in 1829, Dr. Charles Williams made a significant improvement to the original stethoscope by dividing it into two main parts which allows the medical professionals to stand in a more comfortable position during examination, and it also minimized the pressure of the patient on chest [2,4]. Moreover, the main problem with acoustic stethoscope is that the level of the sound is very low to be heard by the medical professionals such as doctors and nursing [6].

1.2 Problem statement

Most of the stethoscopes which are currently available in the markets are acoustic devices that are purely passive mechanical parts in order to isolate and focus the sounds produced by the body. This method has been used for many centuries.

However, the traditional stethoscope has very low sound quality which leads to the sounds not being heard properly and might be deceived by some subjective factors. Particularly in adverse circumstances, for example in emergencies rooms, with ambulance noise, it is really difficult to make effective analysis by using traditional stethoscope. Moreover, these devices are also difficult to interface with modern technologies such as computers for recording and analyzing body sounds.

Similarly, the limitation of acoustic stethoscope sometimes results in wrong data records from the patient which may cause a big problem to the patient's health, so improving the quality of the conventional stethoscope is vital to patients.

Therefore, in order to overcome this disadvantage of acoustic stethoscope, a digital electronic stethoscope has been developed, which has the ability to amplify the heart sounds and to look at the heart sound wave on the Computer screen. However, most digital electronic stethoscopes which are available in the markets are very costly, so this project will be about designing an electronic stethoscope which is inexpensive compared to stethoscopes available in the market.

Furthermore, both traditional and electronic stethoscopes have a common disadvantage which is the limitation of the transmission cable that can reach only short distance in order to measure the patient heart and lung function. Due to the short distance between the patient and health professionals, it can cause transmitting of germs from patient to medical personnel or to those who are examining and checking the situation of the patient. Therefore, in this project, the solution came out to stop spreading the germs and diseases from patient to medical professionals, and so the proposed stethoscope therefore has been considered to have a wireless data transmission which will replace the traditional wired transmission cable.

1.3 Objectives of study

The overall objective of this project is to design and implement a digital Electronic stethoscope with wireless transmission system. The objective details are listed below:

1. To design and implement wireless digital stethoscope by using Arduino Microcontroller.
2. To develop a low cost and user friendly electronic stethoscope.
3. To verify the result by using other methods for detecting heart sounds.

1.4 Scope of Study

The main focus of this project is to improve and develop a low cost electronic stethoscope with wireless transmission remote monitoring system which is more affordable and user friendly. In order to detect the heart sound it have been used elecrect conducer sensor which pickup the heart beat analog signals than it converts into electrical signals, it is amplified and filtered by using Arduino Microcontroller.

Furthermore, data is transmitted via wireless transmission by using Bluetooth Module which send the data and receive it. The result is displayed on personal computer to show heart beat in signal form, to display heart sounds by using headphone and it also display heart beat per minute on Graphic User Interface (GUI) by using MATLAB software.

1.5 Significance of the Study

The significance of this project is categorized into three main categories: designing heart sound detection circuit, displaying the heart sound by using headphones, sending the data via wireless by using Bluetooth Module and finally displaying the heart sound wave and heart beat per minute on GUI interface.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

In this chapter the history of the stethoscopes and its progress stages will be discussed, along with a comparison of the difference between those different types of stethoscope which were discovered and designed by different scientists, those who were living centuries ago.

Likewise, it also will be compared the two common types of stethoscope their similarities and differences in terms of functionality and structures. The previous studies and research about designing of electronic stethoscope wirelessly will be also deliberated in this chapter.

The word Auscultation comes from a Latin verb which means to listen to the internal sounds of the body, and this normally involve Stethoscope. Furthermore, auscultation is done in order to examine the respiratory and circulation system.

2.2 History of Stethoscope

The history of Stethoscope began in the early of eighteenth century with young French Physician Dr. Rene Laennec. The first stethoscope was a simple rolled of three pieces of papers, formed in a cylindrical form, where one end is placed on patient's chest while other end is put on over his ear of the to hear the heart sound. But the rolled up piece of paper was soon replaced by a hollow wooden tube [6].

In 1852 a Doctor George P. Cammann of New City has invented the Cammann Binaural stethoscope which was the first stethoscope for commercial use. That means that all previous stethoscopes were only for a study stage not for saleable purposes. This type of stethoscope was made with Ivory Earpieces which were linked with metal tube and joined together with simple hinge joints. It also applied a tension to make it more elastic and flexible [5].

The invention of the stethoscope resulted in, without precedent, the most widely spread diagnostic instrument in the history of biomedical engineering. The stethoscope has evolved over the years, but the underlying technology remains the same.

However, stethoscope best stages of development were in the twentieth century and it became a very important tool in medicine which most doctors require to have, in order to check patients well being. Besides the beginning of this century, the electronic stethoscopes has been developed for the first time, and this was marked by the introduction of the electronic stethoscope to check the heart beat as well as lung, to listen the lung sounds [9].

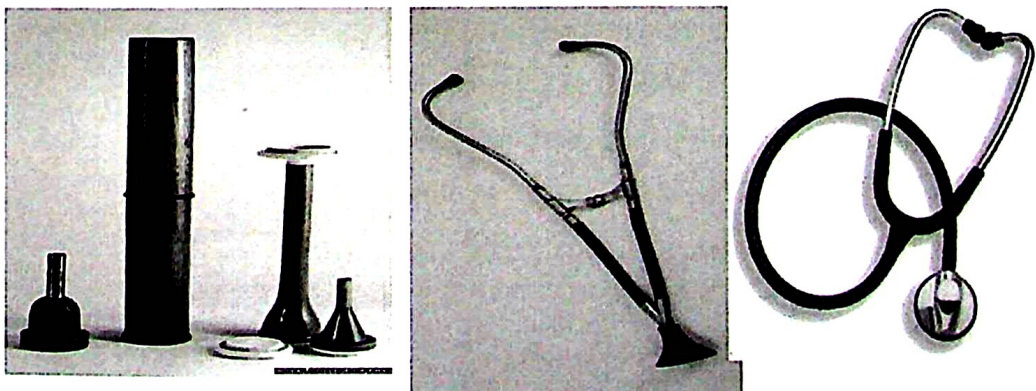


Figure 2.1 early monaural stethoscopes (1860), Camman's binaural stethoscope (1870), a modern binaural stethoscope and a modern electronic stethoscope (from left to right).

Then it continued to be modified from the pre-existing designs as well as getting introduction of new designs, some of which were considered impractical while others proved to be useful. Nevertheless, the designing of the binaural stethoscope in the 1850's has become very popular throughout that century, as this ingenious invention is more or less representing the modern day form that is used today [9].

The table 2.1 shows the stages of stethoscope development from the beginning of the stethoscope until the modern stethoscopes. That stethoscope was developed and enhancements have been done afterwards, in terms of functionality, flexibility, material contents, appearance and structural.

Table 2.1 the development of Stethoscope:

Year	The development of Stethoscope
1816	By a French Physician known as Dr. Rene Laennec, which was a simple cylindrical wood to hear internal sounds of the body , it was approximately 15 to 22cm length
1829	Medical student Nicholas P.Comins has invented trumpet shaped Mohogany chest piece which was screwed into a join which two lead pipes led to the ears
1840	Marc Hector Landouzy of Paris created a stethoscope which was made in gum elastic tubes, and was closely resembling today's stethoscope
1851	Arthurin Dublin has improved the previous prototypes
1852-1860	His instrument, considered to be the best of the time, had ivory or ebony knobs as earpieces, and these had springs attached to hold them more securely in the ear. The tubes were made of coils of wires sandwiched between rubber that was then coated with silk or cotton.

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