HEART SOUND ACQUISITION SYSTEM

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PROJEK SARJANA MUDA II

Tajuk Projek : **HEART SOUND ACQUISITION SYSTEM**

Sesi Pengajian : **2007/2008**

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To my beloved parents, my lovely sisters, friends and colleagues, not forgot UTeM's lecturers.

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ABSTRACT

Human heart sounds are very natural signals, which have been applied in the doctor's auscultation for health monitoring and diagnosis for many years ago. Auscultation techniques can be applied for diagnosing many heart disorders, which is the most reliable and successful tools for early diagnosis. For heart failure or any heart disease which can bring someone to death, heart sound acquisition is the most trustworthy tools. With no software to easily hear and record the patient's heart sound; this might be not helpful for doctors to observe the condition of their patient's heart especially for the patients with chronic cardiovascular decease. This project will be a helpful system to the doctors because the patient's heart sound can be recorded or heard from the personal computer sound system or their laptop speaker. The purpose of this project is to design a system using Visual Basic 6.0 software application which user can hear the similar sound heard at the stethoscope at the speaker, record the sound and can see the waveform of the sound for comparison or analysis. The Graphical User Interface (GUI) for this system have been designed for user friendly operation and making the software easy to use. The heart sound will be captured by electronic stethoscope and will be connected to the sound card in personal computer or laptop by using the phone jack. The sound that has been recorded can be saved for further analysis. This Heart Sound Acquisition System can be a useful tool for the doctors, health practice, educational purpose or and can be used by those who doing any cardiovascular health analysis or experiments.

ABSTRAK

Bunyi degupan jantung manusia adalah suatu isyarat semulajadi, dimana ia telah diaplikasikan oleh para doktor untuk mengawasi kesihatan dan mendiagnosis penyakit suatu ketika dahulu. Cara mendengar bunyi jantung boleh diaplikasi untuk diagnosis banyak penyakit jantung, iaitu cara yang paling berkesan dan berjaya untuk diagnosis awal. Untuk penyakit jantung yang boleh membawa maut ataupun penyakit kegagalan jantung, cara mendengar bunyi jantung adalah teknik yang boleh dipercayai pada masa kini. Dengan tiada alat atau perisian untuk mendengar dan merakam bunyi jantung pesakit, ini mungkin tidak menolong para doktor untuk memerhati keadaan penyakit pesakit jantung terutamanya bagi mereka yang menghidap penyakit jantung yang kronik. Projek ini mungkin akan menjadi projek yang dapat menolong para doktor kerana bunyi jantung pesakit dapat dirakam dan didengari daripada sistem bunyi komputer atau komputer riba. Tujuan projek ini adalah untuk merekabentuk satu sistem menggunakan perisian Visual Basic 6.0 dimana pengguna boleh mendengar bunyi yang sama jika menggunakan stetoskop pada pembesar suara, merakam bunyi tersebut dan boleh melihat gelombang bunyi tersebut untuk membuat perbezaan atau analisis. Paparan Pengguna Grafik (GUI) sistem ini telah direka bentuk untuk mesra pengguna dan menjadikan sistem ini suatu perisian yang mudah. Bunyi jantung akan diambil menggunakan stetoskop elektronik dan akan disambungkan pada kad bunyi komputer peribadi menggunakan "phone jack". Bunyi yang telah dirakam boleh disimpan untuk analisis. Sistem Mendengar Bunyi Jantung ini sangat berguna kepada para doktor, pengamal perubatan, tujuan pendidikan atau boleh digunakan oleh mereka yang menjalankan eksperimen atau analisis berkaitan kesihatan jantung.

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LIST OF ABBREVIATION

BPM	-	Beats per Minute
PSM	-	Projek Sarjana Muda
GUI	-	Graphical User Interface
PC	-	Personal Computer
PDA	-	Patent Ductus Arteriosus
VSD	-	Ventricular Septal Defects
AS	-	Aortic Stenosis
PS	-	Pulmonary Stenosis
MR	-	Mitral Regurgitation
TR	-	Tricuspid Regurgitation
AI	-	Aortic Insufficiency
PI	-	Pulmonic Insufficiency
MV	-	Mitral Valve
TV	-	Tricuspid Valve
LLSB	-	Left Lateral Sternal Border
DSP	-	Digital Signal Processing
ADC	-	Analog to Digital
DAC	-	Digital to Analog
STFT	-	Short Time Fourier Transform
BASIC	-	Beginners All-purpose Symbolic Instruction Code
TRS	-	Tip, Ring, and Sleeve
TS	-	Tip and Sleeve
TRRS	-	Tip, Ring, Ring and Sleeve
UK	-	United Kingdom
US	-	United States
IBM	-	International Business Machines Corporation

CD - Compact Disk

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CHAPTER 1

INTRODUCTION

Generally, the heart sounds produced by the healthy hearts are identical and any abnormal sound always narrates with some abnormalities. Thus, the heart sounds are diagnostically useful, as it provides an indication of heart rate, blood pumping and valve action. Heart auscultation is the most important tool in monitoring and diagnosing human heart disease. It is a fundamental component in cardiac diagnosis. However, doing heart sound diagnosis is difficult and only experts can do this technique successfully. This technique can be applied to diagnose many heart disease and heart failures.

1.1 Introduction

Human heart sounds are very natural signals, which have been applied in the doctor's auscultation for health monitoring and diagnosis for many years ago. Auscultation techniques can be applied for diagnosing many heart disorders, which is the most reliable and successful tools for early diagnosis. Heart auscultation (the interpretation by a physician of heart sounds) is a fundamental component in cardiac diagnosis. It is, however, a difficult skill to acquire.

1.2 Objective

To make sure this project successfully achieved, certain objectives were outlined. The objectives of this project are firstly to study human heart sound mechanism, its production, the heart sound components and other related topics. This project are also to design a system which is user can monitor heart sound waveform in real time, record the sound and playback for further analysis. This project also to study and identify what is the processing technique suitable for analyzing human heart sound and the cardiovascular decease based on the heart sound.

1.3 Problem Statement

Currently, there is no software that can be used for the doctors or health officers that can monitor and record their patient's heart sound for further analysis or monitoring their patient's health time by time. Besides that, the heart sound that has been recorded can be used by anyone who is doing analysis on human heart sound for their valuable data. By developing this system by using stethoscope and Visual Basic 6.0 GUI, this can make ease to the doctors and health examiners to hear and monitor the heart sound other than using the conventional way which is the stethoscope itself with added function.

1.4 Project Scope

Many kind of method can be used in developing this system and for this project, the project scope are:

1. Input for this system, human heart beat sound (from the chest piece) using 3M Littman ® Electronic Stethoscope Model 4100.
2. Monitoring the heart sound waveform in real time.
3. Record and save the heart sound.
4. Display and play the recorded heart sound waveform for further analysis.
5. Use Visual Basic 6.0 for GUI development in PC.

1.5 Methodology

This part is the explanation for the procedures and methods that will be used to complete the project. It will explain step by step the process build the project until it finished. The first step until the last step is defining the project title, collecting the project information, doing research and understanding the human heart sound and Visual Basic 6.0 software, developing the GUI, compiling and debugging the system, system testing and completing thesis writing.

For Chapter I, it will explain the overall project with simplest way. It will explain about the literature review of the project, follow by the purpose as the definition of the objective this project has to do. Other than that, there are also the summary for the project method such as what is the procedure have been used.

For Chapter II, it will discuss the literature review of the project. It will focused on the explanation about the heart sound, its components, stethoscope which is the device used for auscultation of heart sound, the analysis which can be used to analyzed the heart sound.

In Chapter III, it will discuss the methods used for completing this project; Project methodology is about what processes are being done to complete the project. It emphasizes the details on the processes that are used. All these methodology should be followed for a better performance. Many figures were inserted for more understanding for the project.

Chapter IV will discuss the results which have been done for the project. The result consist figures with some explanation and covers the output for this project.

Lastly for Chapter V, it will discuss the conclusion form overall project including the study implementation which have been used and suggestion for future development and modification.

CHAPTER 2

LITERATURE REVIEW

Heart sound, also called heartbeat captured from the human chest by using stethoscope. It consists of two sounds, "lub-dup" which is the sound, will be heard from the stethoscope, but this sound differs from different person if they have any cardiac problem. The principle of the heart sound is from the vibrations set up in the blood inside the heart by the closure of valves and leakage of blood flow. Heart consists of two sounds, which known as first and second heart sound.

2.1 Human Heart Anatomy

The heart is a muscular organ responsible for pumping blood through the blood vessels by repeated, rhythmic contractions, or a similar structure in the annelids, mollusks, and arthropods.[1] The term *cardiac* (as in cardiology) means "related to the heart" and comes from the Greek, *kardia*, for "heart." The heart is composed of cardiac muscle, an involuntary muscle tissue which is found only within this organ [2]. Human heart consists of four chambers. The chambers are *atria*, which is the two upper chamber and ventricles which two lower chambers. In the heart itself, there are valves located between the atria and ventricles and also there are have major arteries from the heart. A wall of muscle called the septum separates the left and right atria and the left and right ventricles. Figure 2.1 below shows the human heart's anatomy.

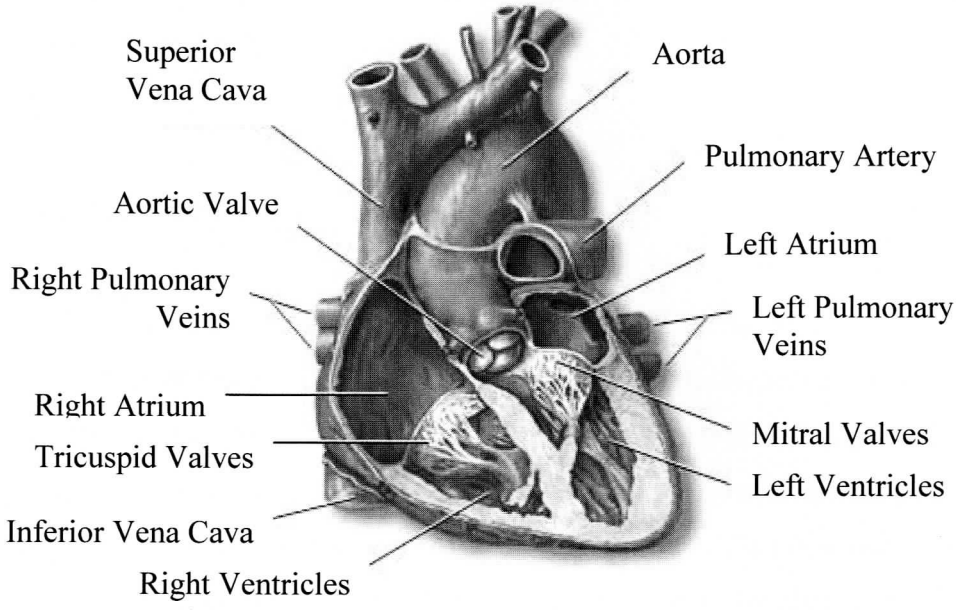

Figure 2.1: Human Heart Anatomy [3]

The average human heart beating at 72 BPM will beat more than 3.5 billion times by the end of a long life. The heart weighs between 7 and 15 ounces (200 to 425 grams) and is a little larger than the size of our fist [4]. Each day, the average heart beats 100,000 times, pumping about 2,000 gallons (7,571 liters) of blood. Human's heart location is between the lungs (in the middle of the chest), behind and slightly to the left of the breastbone (sternum). Pericardium, a double layered membrane surrounds the heart like a sac. The pericardium outer layer surrounds the roots of the heart's major blood vessels and it is attached by ligaments to the spinal column, diaphragm, and other parts of our 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, yet still be attached to the body [4].

There are four types of valves in human's heart, regulating blood flow through the heart. The first valve is the tricuspid valve, which regulates blood flow between the right atrium and right ventricle. Secondly, the pulmonary valve controls blood flow from the right ventricle into the pulmonary arteries, which carry blood to the lungs to pick up oxygen. The mitral valve lets oxygen-rich blood from the lungs pass from the left atrium into the left ventricle. Lastly, the aortic valve opens the way for oxygen-rich blood to pass from the left ventricle into the aorta, the body's largest artery, where it is delivered to the rest of the body. The four cardiac valves are

classified into two types - the atrioventricular (mitral and tricuspid) and the semilunar (aortic and pulmonic) valves.

2.2 Mechanism of Heart Sound Production

In human's heart, there are valves located between the atria and ventricles, and between the ventricles and the major arteries from the heart [5]. These valves close and open periodically to allow blood flow in only one direction [6]. When the upper chambers (the right and left atria) collect blood, the heart's natural pacemaker sends an electrical signal which causes the atria to contract. This contraction pushes blood through the tricuspid and mitral valves into the lower chambers (the right and left ventricles). This part of the two-part pumping phase (the longer of the two) is called diastole (Figure 2.2) [7].

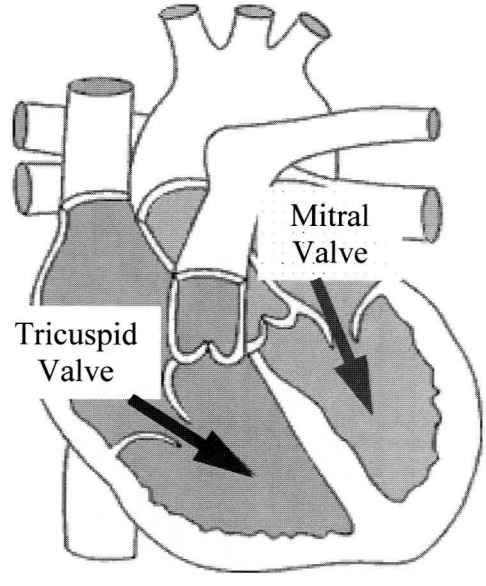

Figure 2.2: Diastole of the heart [7]

After that the ventricles are full of blood. The electrical signals from the heart's natural pacemaker travel along a pathway of cells to the ventricles, causing them to contract. This is called systole (Figure 2.3) [7]. When the tricuspid and mitral valves shut tight to prevent a back flow of blood, the pulmonary and aortic valves are pushed open. While blood is pushed from the right ventricle into the lungs to pick up