THE DEVELOPMENT OF HEART RATE MONITOR BY USING FINGER DETECTOR

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This report is submitted in partial fulfillment of requirements for the award of Bachelor of Electronic Engineering (Computer Engineering)

Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer
Universiti Teknikal Malaysia Melaka

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FAKULTI KEJURUTERAAN ELEKTRONIK DAN KEJURUTERAAN KOMPUTER

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DEDICATION

I would like to thank the God, as with His blessings, as I managed to complete this Final Year Project. I would also like to convey my heartiest appreciation to my project supervisor Encik Mazran Bin Esro for him advise, precious guidance and cooperation. Under her guidance, I have developed, improved and achieved the completion of the project. He always gives me the wisdom to think and work independently. Besides that, I would also like to thank other lecturers and technicians in Electronic Engineering and Computer Engineering Faculty for giving me the advices and the opportunity to handle this project as well as their encouragement. Thanks also to my friends who have lend me their helping hand that made the task of the project much easier and able to complete on time. At last but not least, I would like to express my gratitude to both of my parents who had provided me with financial support and encouragement throughout my course of studies.

"THANK YOU"

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ABSTRAK

Kadar jantung adalah satu bahagian yang penting dan berguna dalam usaha untuk menentukan kesesuaian dan keamatan fisiologikal seseorang. Oleh itu, pengawasan kadar jantung merupakan komponen penting kardiovaskular penilaian kesihatan dan program-program latihan. Elektrokardiogram (ECG) dan Holter adalah antara peranti yang agak tepat dalam menentukan tekanan jantung tetapi ianya melibatkan kos yang tinggi dan operasi yang merumitkan serta menyusahkan pengguna. Oleh itu, projek ini ditubuhkan untuk mereka bentuk dan membangunkan satu sistem yang dapat memaparkan kadar jantung dalam badan seseorang dengan menggunakan satu PIC mikropengawal yang bersesuaian dengan rekabentuk litar berpangkalan. Kadar jantung tersebut akan dipaparkan melalui siri kabel yang dihantar daripada litar PIC kepada paparan VB melalui MAX232. Sistem ini adalah kaedah yang mudah dan senang untuk mengukur kadar jantung disamping kos yang murah.

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ABSTRACT

Heart rate is a useful indicator of physiological adaptation and intensity of effort. Therefore, heart rate monitoring is an important component of cardiovascular fitness assessment and training programmes. The electrocardiogram (ECG) and Holter monitoring devices are accurate, but they are not appropriate for use in field settings due to cost, size and complexity of operation. This project is to design and develop of heart rate monitors by using an advanced PIC microcontroller based circuit design it provides an easy way to measure and monitor heartbeat rate. The instrument uses infrared sensor that using heartbeat sensor circuit which can easily be scan the finger ends to detect the heartbeat by finger plythysmography technology. The unit is lightweight, easy to handle, extremely durable.The detachable Infra-Red sensor is designed to get the best results in all type of pulse rate measurement applications.The value of heart rate is measures and will be display in Visual Basic connected to the computer through serial cable.

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LIST OF ABBREVIATIONS

LED	-	Light Emitting Diode
BPM	-	Bit Per Minutes
LDR	-	Light Dependent Resistor
ECG	-	Eelectrocardiogram
AV	-	Atrioventricular Valves
CPU	-	Central Processing Unit
I/O	-	Input/Output
RAM	-	Random Access Memory
EEPROM	-	Electrically Erasable Programmable Read Only Memory
EXE	-	Executable File
PCB	-	Printed Circuit Board
UART	-	Universal Asynchronous Receiver Transmitter
VB	-	Visual Basic
GUI	-	Graphical User Interface

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CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Measuring heart and pulse rates in living subjects has become a valuable tool in physical exercise and health monitoring. A pulse rate is measured by counting the rate of pulsation of a subject's artery. Individuals who want to increase their endurance or performance may wish to exercise while maintaining target heart rates. Conversely, subjects with a history of heart disease or other heart related condition should avoid exceeding a certain heart or pulse rate to reduce unnecessary strain on their heart. The heart rate and pulse rate of a subject are related. Heart rate may be defined as the number of heart contractions over a specific time period, usually defined in beats per minute. A pulse is defined as the rhythmical dilation of a vessel produced by the increased volume of blood forced through the vessel by the contraction of the heart. Since heart contractions normally produce a volume of blood that can be measured as a pulse, heart rate and pulse rate are ideally the same. However, a pulse rate may differ from the heart rate during irregular heart beats or premature heart beats. In this case, a heart contraction may not force enough blood through a blood vessel to be measured as a pulse [1].

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Usually heart rate calculated as the number of contractions (heart beats) of the heart in one minute and expressed as "beats per minute" (bpm). Normally the heart beats between 60-100 times per minute. When resting, the adult human heart beats at about 70 bpm (males) and 75 bpm (females), but this rate varies between people. However, the reference range is nominally between 60 bpm (if less termed bradycardia) and 100 bpm (if greater, termed tachycardia). Resting heart rates can be significantly lower in athletes. The infant/neonatal rate of heartbeat is around 130-150 bpm, the toddler's about 100-130 bpm, the older child's about 90-110 bpm, and the adolescent's about 80-100bpm [2].

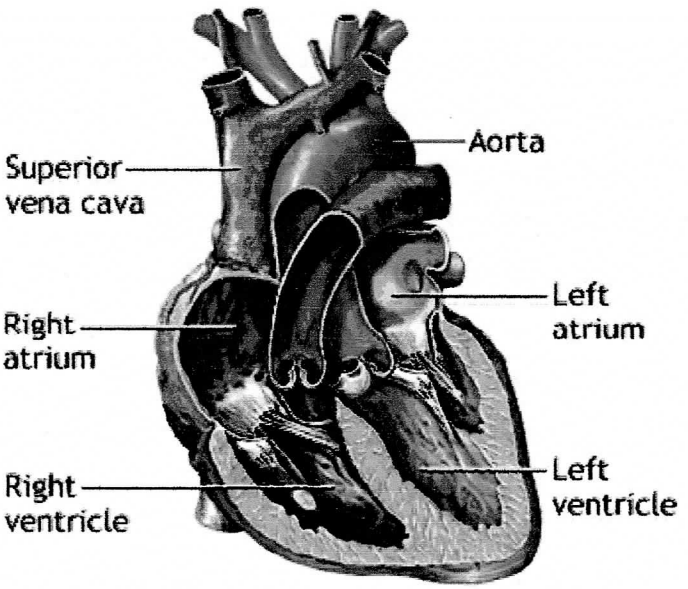

Figure 1.1: Type of chamber

The heart consists of four chambers in which blood flows. Blood enters the right atrium and passes through the right ventricle. The right ventricle pumps the blood to the lungs where it becomes oxygenated. The oxygenated blood is brought back to the heart by the pulmonary veins which enter the left atrium [3].

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From the left atrium blood flows into the left ventricle. The left ventricle pumps the blood to the aorta which will distribute the oxygenated blood to all parts of the body [3].

The body can increase the heart rate in response to a wide variety of conditions in order to increase the cardiac output (the amount of blood ejected by the heart per unit time). Exercise, environmental stressors or psychological stress can cause the heart rate to increase above the resting rate [3].

1.2 OBJECTIVE

The main objective of this project is to develop a heart rate monitor using finger detector. It is a portable hardware that can extract and display the heartbeat in analog and digital form. The signal is extracted from the fingertip placed in between Light Dependent Resistor (LDR) and high density Light Emitter Diode (LED). The signal must be strong enough to be displayed, therefore the hardware must include amplifier to increase the weak signal from the input signal. Any unwanted signal (noise) is maximally removed by filtering process leaving only the heartbeat signal.

1.3 PROBLEM DESCRIPTION

A traditional approach of heart monitoring has always meant that people is going to hospital where a doctor or cardiologist will examine the patient for any heart sickness. The equipment needs to perform such examination is expensive. The standard 12 lead ECG (electrocardiogram) machine normally found in big hospitals due to its high value and requires a specialist to verify the condition of the heart. 12 lead ECG requires the position of 10 electrodes making it uncomfortable for some patients. The development of a heart rate monitors

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using finger detector hardware for ECG extraction will be the foundation that could be further developed as an inexpensive portable ECG machine. This hardware would benefit the user where they can monitor their heart rate at home or any place, and easy to use, also portable.

1.4 SCOPE OF WORK

The purpose of this project is to obtain the output signal from the finger detector. The heart rate sensor is used to measure the cardiovascular pulse wave that is found throughout human body. This pulse wave will result in a change in the volume of arterial blood with each pulse beat. This change in blood volume can be detected in peripheral parts of the body such as fingertip using a technique called Photoplethysmosgraphy [4]. The heart rate sensor monitors the light level transmitter through the vascular tissue of the fingertip and the corresponding variations in light intensities that occurs as the blood volume changes in the tissue. The sensor consists of:

- An infrared LED which illuminates the tissue and
- A light dependent resistor (LDR), which can detect the amount of light transmitted from the tissue.

The infrared light emitted by the LED is diffusely scattered through the fingertip. A light dependent resistor (LDR) positioned on the surface of the skin on the opposite side can measure light transmitted through at a range of depths. Infrared light is absorbed well in blood and weakly absorbed in tissue. Any changes in blood volume will be registered since increasing or decreasing volume will cause more or less absorption. Assuming the subject does not move the level of absorption of the tissue and non-pulsating fluids will remain the same [4]. Then the signal will be amplified using LM358 Dual Operational Amplifier. By using PIC16F73 as a microcontroller, the value of heart rate in beat per

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minutes (BPM) will be displayed on the Visual Basic by analog waveform that is interacted by serial cable RS232.

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CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter presents the theory and the concept that related with this project to complete the project using right method. The reason of this discussion is to clarify the perspective and method that have been used, so that this project can be studied and build according to the theory. This chapter is also as the reference to the available theory in resolves the problem of the project.

2.2 INTRODUCTION OF HEART RATE

2.2.1 The Heart Rate Monitors

Heart rate is a useful indicator of physiological adaptation and intensity of effort. Therefore, heart rate monitoring is an important component of cardiovascular fitness assessment, training programs and so on. The electrocardiogram (ECG) and Holter's monitoring devices are accurate, but not feasible for use in field settings due to cost, size and complexity of operation. Light-weight telemetric heart rate monitors equipped with

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conventional electrodes have been available since 1983 and have proved to be accurate and valid tools for heart rate monitoring and registering in field measurements.

A heart rate monitor is a device that allows a user to measure his or her heart rate in real time.

The heart rate monitor was invented by the Australian physicist, Robert Treffene. He appeared on the television show The New Inventors with his device that made with swimmers in mind.

The first ECG accurate wireless heart rate monitor was invented by Polar Electro in 1977 as a training tool for the Finnish National Cross Country Ski Team. The concept of "intensity training" by heart rate swept the athletic world in the eighties. By the 1990's individuals were looking to heart rate monitors not only for performance training needs, but also for achieving everyday fitness goals. Today, the same concept of heart rate training is being used by world-class athletes as well as everyday people [5].

2.2.2 The Limits of the Heart Rate

The heart rate monitor helps to chart the heart rate limits characteristic for each person in rest and in various forms of activity. These limits are connected with age so that the peak readings of the heart rate are decreased by age. The heart rate of a 20 years old adult at the starting phase of light exercise is 100–120 beats/minute, a heart rate intensity of 50–60 per cent of the maximum. The area suitable for efficient weight loss is 120–140 beats/minute whereby the exercise should last for half an hour and up. Fitness training requires exercise with a heart rate of 140–160 and athletic training exercise with a heart rate of 160–200.

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