HEART RATE MONITOR

MASYUMI HUSSAIN

MARCH 2005

'I/We certified that I/We have read this work and in my/our opinion the report fulfill the scope and quality to be graded Bachelor of Electrical Engineering (Industrial Power)'

Signature : 

Supervisor's I : **Mr Kasrul Abdul Karim**

Date : **09 March 2005**

"I agree that this report is my own work except the quotation and summary, each that I mentioned the source"

Signature : 

Writer's Name: Masyumi Hussain

Date : **09 March 2005**

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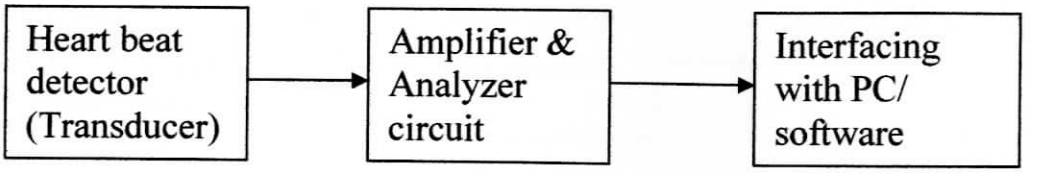
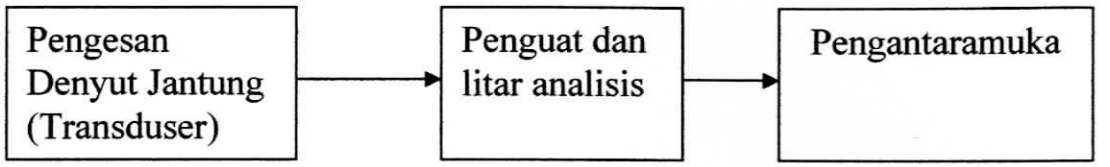
Abstract



The proposed project is to build a medical device which will be able to detect and display human heartbeat graphically on computer screen. There will be two parts of the project that is the hardware and software. Hardware part begins with the transducer to detect the heartbeat on fingertip, followed by amplify and analyses the signal and then interfacing it with the computer. Transducer well works as an optical sensor consist of LED as light source and LDR as receiver/ detector. Amplifier and analyzer circuit may consist of several op- amps that serve the function of amplifier, differentiator, and integrator components. The purpose is to count the signal to voltage form, amplify and convert it into suitable form that can be read by software through parallel port. The software part begins when the heartbeat signal from the computer port is read and calculates as a heart rate. This software is suggested to be written in C or C++ as it is an easy to learn programming language and lot of example from internet that can be refer to as a guide.

Abstrak



Projek yang dicadangkan adalah bagi menghasilkan satu peralatan perubatan yang mampu mengesan dan mempamerkan denyut jantung manusia secara grafik di skrin komputer. Terdapat dua bahagian dalam projek ini iaitu bahagian perkakasan ('hardware') dan bahagian perisian ('software'). Bahagian perkakasan bermula dengan satu transduser bagi mengesan isyarat denyut jantung di hujung jari diikuti dengan litar penguat dan analisis bagi menguatkan dan menganalisis isyarat terbabit dan seterusnya mengantaramukakan isyarat tersebut dengan komputer. Transduser yang bertindak sebagai pengesan optik terdiri daripada LED sebagai sumber cahaya dan LDR sebagai penerima/ pengesan.Litar penguat dan analisis terdiri daripada beberapa penguat kendalian berfungsi sebagai komponen penguat, pembeza dan pembanding. Tujuannnya ialah mengira isyarat denyutan terlibat ke dalam bentuk bacaan voltan, menguatkannya dan menukarkannya ke dalam satu bentuk yang sesuai bagi tujuan anataramuka dengan perisian menerusi *parallel port* kepada komputer. Bahagian perisian bermula apabila isyarat denyut jantung yang disambung kepada komputer dibaca oleh program dan dikira sebagai kadar denyut jantung. Perisian ini dicadangkan ditulis dengan menggunakan bahasa pengaturcaraan C atau C++ memandangkan kedua-duanya lebih mudah dipelajari dan terdapat banyak contoh di internet yang boleh dirujuk sebagai panduan.

Project Objectives:

At the end of the project schedule, the objectives that are going to be achieved are:

1. To design the transducer that will be able to detect heart beat signal from human fingertip.
2. To amplified the signal using amplifier circuit
3. To analyses the signal and convert it into suitable form to be feed to PC.
4. To write software that will be able to read signal from parallel port (Computer port).
5. To display the signal output on screen (monitor)/ to be able to monitor the gained signal.

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CHAPTER 1

Introduction

Literature Review

1.1 Basic Principle of Human Heart

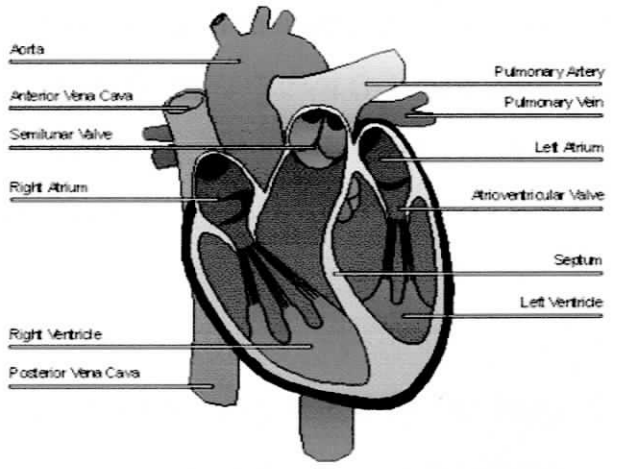

Figure1.1.1: Human Heart

The heart is one of the most important organs in the entire human body. It is really nothing more than a pump, composed of muscle which pumps blood throughout the body, beating approximately 72 times per

minute of our lives. The heart pumps the blood, which carries all the vital materials which help our bodies function and removes the waste products that we do not need.

For example, the brain requires oxygen and glucose, which, if not received continuously, will cause it to loose consciousness. Muscles need oxygen, glucose and amino acids, as well as the proper ratio of sodium, calcium and potassium salts in order to contract normally. The glands need sufficient supplies of raw materials from which to manufacture the specific secretions. If the heart ever ceases to pump blood the body begins to shut down and after a very short period of time will die.

Used blood, that is blood that has already been to the cells and has given up its nutrients to them, is drawn from the body by the right half of the heart, and then sent to the lungs to be reoxygenated. At this stage the heart cycle is call diastole.

Blood that has been reoxygenated by the lungs is drawn into the left side of the heart and then pumped into the blood stream. This cycle is the systole of the heart. The pressure in the right half of the heart is lower than the pressure at the left half of the heart due to the types of blood that they carry; the right half carries the blood without the oxygen and the left half carry the blood with the oxygen. **Refer Figure 1.1.2**

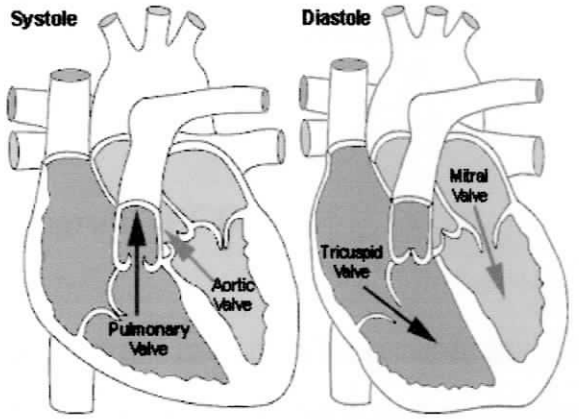

Figure 1.1.2: Cardiac Cycle

The activity of the heart (systole and diastole), produce heart beat. The proposed project start with a sensor that can detect this heart beat signal at the human fingertip. **Refer Figure 1.1.3**.

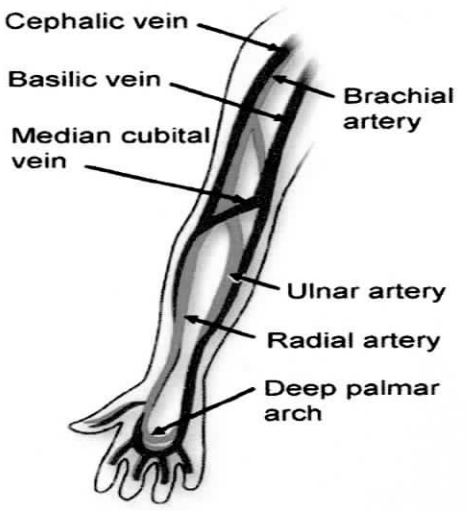

Figure 1.1.3: Blood Circulation in Human Arm Where the Heart Beat Signal Will Be Detected

1.2 Method in Monitoring the Heart Beat/ Rate

1.2.1 Electrocardiogram (ECG)

An electrocardiogram is a test that records the electrical activity of the heart. It is used to measure the rate and regularity of heartbeats as well as the size and position of the chambers, the presence of any damage to the heart and the effects of drugs or devices used to regulate the heart (such as peacemakers).

You are asked to lie and electrodes are affixed to each arm and leg and to the chest. The standard number of leads attached is 12 to 15 for a diagnostic ECG but may be as few as 3 to 5 for a monitoring procedure.

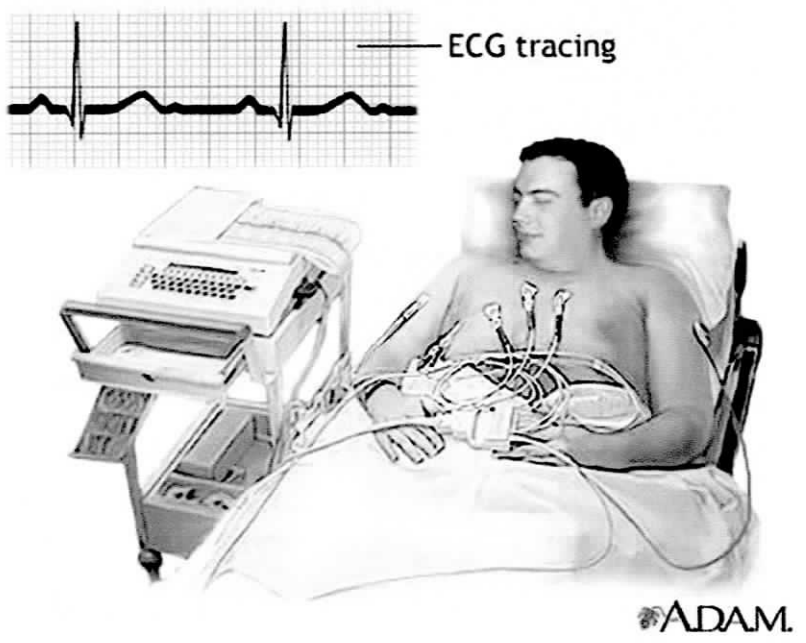

Figure 1.2.1: ECG Application

1.2.2 Heart Card

Heart card is a lightweight and portable design capable of ECG analysis. The device is the size of a credit card, features a one button design. When a patient is feeling the onset of symptoms, the card is held up to the chest, and the "record" button is pushed. The data is stored, and the patient proceeds to send the information via modem telephone to the doctor. The ECG rhythm data can be printed out through any standard ECG machine.

Figure 1.2.2: Heart Card

1.2.3 Impedance Plethysmography Measurements

Impedance plethysmography is a measurement technique that measures the change in blood volume (venous blood volume as well as the pulsation of the arteries) for a specific body segment. As the blood volume changes, the electrical impedance (resistance) also changes. This electrical impedance is measured by passing a small amount of

alternating current (AC) through the body segment. This technique is noninvasive because the amount of AC current is so small that the patient does not feel any sensation from the probe. The impedance cardiograph signal is acquired via 8 electrodes, 4 on the neck and 4 on the thorax, as indicated in figure.

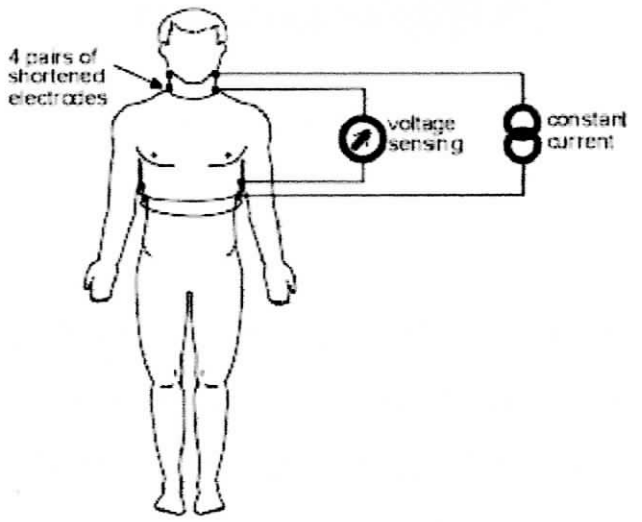

Figure 1.2.3: Principle of Impedance Plethysmography

CHAPTER 2

EXPERIMENT SETUP

In order to develop each part of the devices, a few experiments must be carried out to observe and to study the characteristic of it. This is the main and the most important part in the whole project.

2.1 Experiment 1: Testing Of the Voltage Divider Circuit

2.1.1 Objectives:

1. To find the most suitable voltage divider circuit to be connected to the LED
2. To determine the resistance value of the voltage divider

2.1.2 Material / Equipment:

1. Component as in Figure
2. Multimeter
3. Jumper wire
4. Power supply
5. Breadboard

2.1.3 Procedure:

1. Connect circuit as in figure.
2. R1 and R2 are connected in series and the value for both resistors is determined by experiment.
3. R1 is a fixed resistor while R2 is a variable resistor. The value of R2 will be adjusted so that the intensity of light produce by the LED is as required.
4. The value for both resistances is determined.

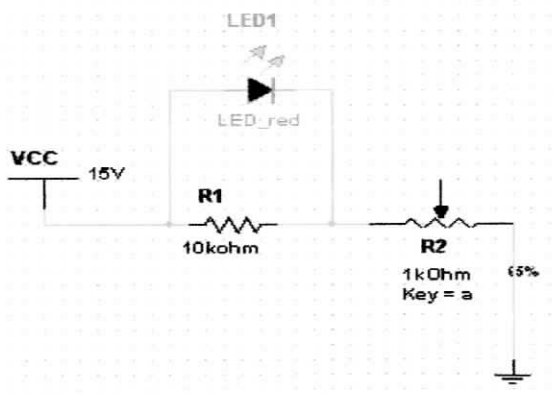

Figure 2.1.3: Voltage Divider Circuit

2.1.4 Results

$V_{in} = 15V$

R1= 10 kΩ

R2= 1.5 kΩ

$V_{out} = 1.9$ V

2.1.5 Discussion

The value or R2 must be identified to make sure that the LED will not blow because of over voltages. Sufficient light intensity from the LED is needed in order to gain the best output difference from the detector circuit. This is because the changes that can be detected at the fingertip are very small. R1 and R2 serve a function as a voltage divider to supply suitable voltage value to the LED.

During the experiment, the value of R2 is being adjust (the variable resistor is used here) to certain value and the LED light intensity is being observed until the best output is obtained (As in Result).

2.2 Experiment 2: Testing the LDR Possible Circuit

2.2.1 Objective:

1) To determine the LDR possible circuit
2) To identified the resistance value best used for the circuit

2.2.2 Equipment/ Material:

1. Resistance(Various value), LDR
2. Breadboard for circuit construction
3. Multimeter
4. Connector probe
5. Jumper wire

2.2.3 Procedure:

a) Light Detector Circuit

1) Connect circuit as in Figure 1.
2) Supply the circuit with 15V input.
3) Record the Voltage output in light and shade.

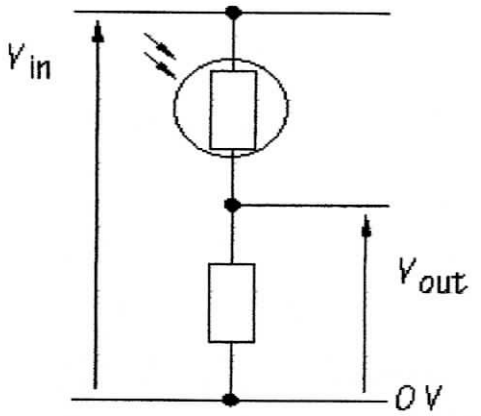

Figure 2.2.3 (a): Light Detector Circuit

b) Dark Detector

1) Connect circuit as in Figure 2.
2) Supply the circuit with 15V input.
3) Record the Voltage output in light and shade.

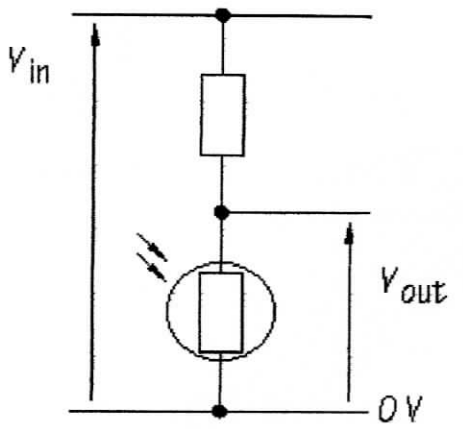

Figure 2.2.3 (b): Dark Detector Circuit