DEVELOPMENT OF OPTIMAL PHOTOSENSORS BASED HEART PULSE DETECTOR

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This report is submitted in partial fulfillment of the requirements for the award of Bachelor of Electronic Engineering (Industrial Electronics) With Honors'

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PROJEK SARJANA MUDA II

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This thesis had dedicated to my parents and my supervisor who have supported me all the way since the beginning of my study. Other than that, this thesis also dedicated to my friends who had been a great source of motivation and inspiration.

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ABSTRAK

Pembangunan ‘Photosensors yang Optimal Berasaskan Pengesan Denyutan Jantung " adalah satu projek yang terdiri daripada ‘photosensor’ yang digunakan untuk mengukur denyutan nadi dengan mengukur perubahan dalam aliran darah. Tahap kesihatan yang optimum adalah sangat penting. Melalui degupan jantung pelbagai maklumat berkaitan dengan tahap kesihatan boleh diperolehi. Kadar denyutan jantung yang normal pada waktu rehat biasanya antara 60 hingga 100 BPM. Walau bagaimanapun, denyutan jantung ini bergantung pada umur dan tahap kecergasan seseorang individu. Tujuan projek ini dilaksanakan untuk membantu dan membolehkan orang ramai untuk memantau kesihatan mereka secara berterusan tanpa perlu untuk pergi ke klinik atau hospital bagi membuat sebarang pemeriksaan kesihatan. Hal ini lebih memudahkan, khususnya kepada warga tua dan golongan kurang upaya. Dari senario ini, skop projek telah diperoleh di mana litar mikroelektronik telah digunakan sebagai pemprosesan isyarat dan unit mikro pengawal. Idea untuk projek ini adalah mereka bentuk instrumen yang selesa dan hasil yang tepat bagi menyukat nadi jantung dengan berlandaskan kepada faktor kos yang rendah. Projek ini bermula dengan membuat kaji selidik daripada projek sebelumnya. Seterusnya, kajian untuk membina litar, ujian litar dan juga menganalisis hasil keluaran dilakukan. Komponen-komponen projek dipilih dan elemen-elemen kawalan diprogramkan menggunakan mikro pengawal. Akhir sekali, projek akan dibuat dengan litar sebenar dan menggunakan sensor yang optimal.

ABSTRACT

The ‘Development of Optimal Photosensors Based Heart Pulse Detector” is one project that consists of a photosensor which is used to measure the pulse by measuring the change in blood flow. Normal heart rate at rest is usually between 60 to 100 BPM. However, the normal value for heart rate depends on the age and the fitness level. The purpose of this project is to help and allow the people to monitor their health constantly without need to visit the clinic or Hospital for a checkup, especially for the elderly. From this scenario, the scope of this project is available. This project used microelectronic circuit that is used as a signal processing and microcontroller unit. The idea of this project is to design a comfortable instrument, which is reliable with accurate result to develop a heart pulse detector using low cost equipment. This project begins with the research from previous project. The next part is the experiment to construct circuit, test the circuit and analyze the output is necessary. After that, the components of this project tenses. The control elements were programmed using the microcontroller. The project will be constructing the actual circuit with using the best sensor.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONN

PIC	Programmable Integrated Circuit
LCD	Liquid Crystal Display
Bpm	Beat per minute
HR	Heart Rate
LED	Light Emitting Diode
IR	Infrared
LDR	Light Dependent Resistor
PIR	Passive Infrared
ADC	Analog to Digital signal
OSC	Oscilloscope
ECG	Electro-cardiogram
IEEE	The Institute of Electrical and Electronics Engineers
HBMD	heart beat monitoring device
PPG	mode Photoplethysmography
CdS	Cadmium Sulfide
CO	Carbon Monoxide
O_2	Oxygen

CHAPTER 1

INTRODUCTION

1.1 Review of electromagnetic spectrum

Figure 1.1 shows the wavelength of electromagnetic spectrum. The spectrum could be dividing into two categories which is the wavelength or frequency part and secondly is in term of their physical properties. The wavelength is the distance between peaks where each wave has a certain shape and length. In other hand, frequency is a value of waves in one second. Besides that, Figure 1.1 shows the wavelength of gamma rays, X-rays, ultraviolet, visible light, infrared, microwave and radio. This figure shows that the low frequency will produce a high wavelength.

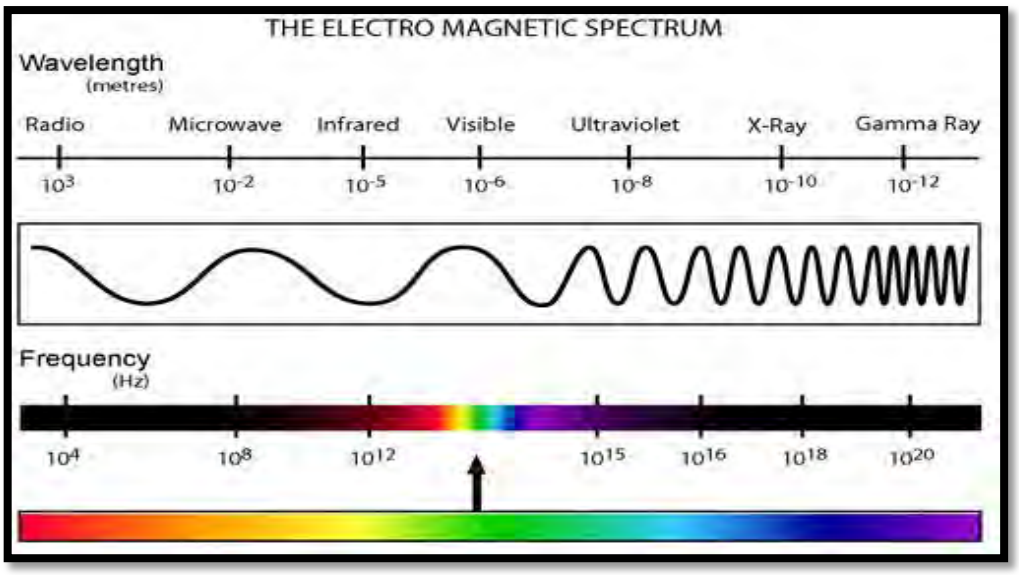

Figure 1.1 : Electromagnetic spectrum

Moreover, the electromagnetic waves generated from the motion of electrically charged which called as 'electromagnetic radiation' that produced from oscillating electric and magnetic fields. The wave of energy generated via vibrations moves through the space by using the speed of light. The visible light is one form of electromagnetic (EM) radiation.

1.2 Visible Light

Figure 1.2 shows the visible light waves from the Electromagnetic spectrum. The visible light is one of the bands that appear in the electromagnetic spectrum. It is a small range wave that able to seen in the form of light. The colors that available in the visible light are red, orange, yellow, green, blue, indigo and violet. Each color has different

wavelength. The red color has the longest wavelength and the violet color has the shortest wavelength. The combination of all color will produce white color.

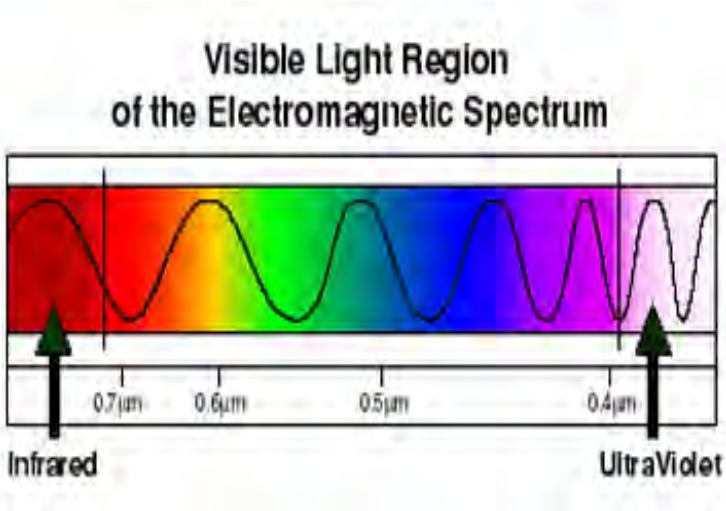

Figure 1.2 : Visible light waves

Meanwhile, the wavelength of the visible light is around 400-700 nanometers. Human eye is not capable to see radiation wavelength outside of this range. However, it is good factors because a high lighting rate will cause the retina in the human eye become damage. The Table 1.1 below shows an approximate range of wavelengths corresponding to the various colors in the visible spectrum.

Table 1.1 : Range of wavelengths color in the visible spectrum

Approximate Wavelengths of Colors (in *nm*)											
700	650	650	600	540	590	540	490	490	440	440	400
Red		Orange		Yellow		Green		Blue		Violet	

1.3 Infrared Radiation

By referring on Figure 1.1 on the EM spectrum, the visible light is in the middle ranges of the infrared (IR) and ultraviolet. The IR region of the electromagnetic spectrum is also divided into three segments which are near, mid and far- infrared. A near infrared refers to the part of the infrared spectrum that closed to visible light and far-infrared refers to the part that closed to ultraviolet. The mid-infrared is the range between these two categories. Besides, the infrared waves have wavelength longer than visible light and their frequency is lower than visible light.

1.4 Photodetector

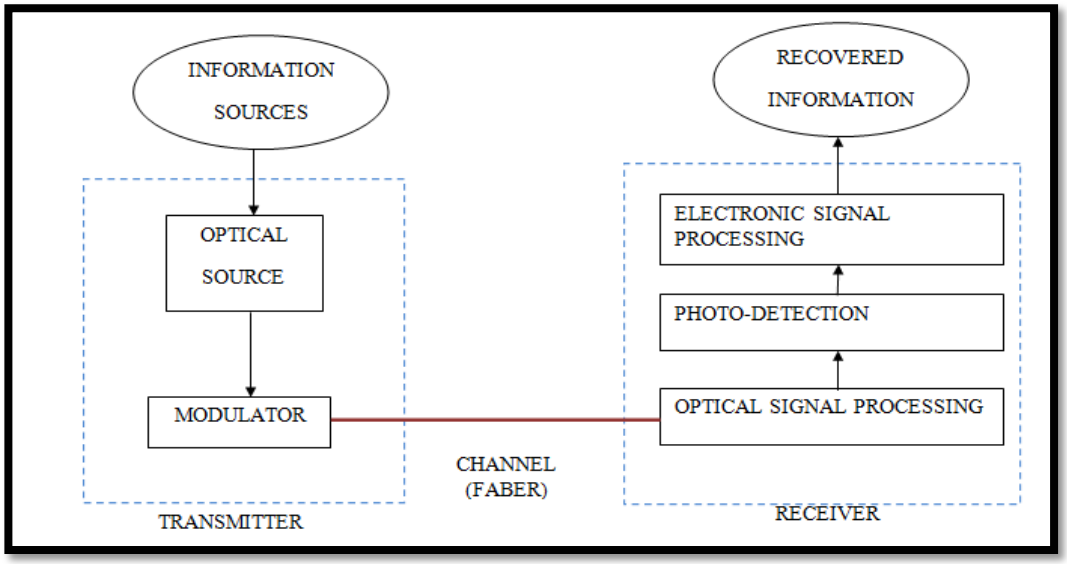

Figure 1.4 : Overview of Photodetector

Figure 1.4 shows the process flow of how to convert optical signal into an electrical signal. In other words, the detectors receive transmitted optical pulse and converted weather to electronic signal processing, photodetection or optical signal processing. Apart from that, the photodetectors are suitable to be use in optical communication system.

A photodetector is an important part in any application of light. It will sense light from photon that used to produce the electrons and it is important for conduction. The photodetector operate by converting the signal into a voltage or current form. The junction that acts as an illumination window will absorb the light photon. Meanwhile, the photodetector have seven basic requirements. These are sensitivity, efficient conversion, fast response, low noise, sufficient area, high reliability and last in term of

cost. From the researched, there are many types of photodetector, which are photoconductive cell, also called as light dependent resistor (LDR) or as photocell. Other types of photodetector are photovoltaic detector, photodiode and phototransistor.

1.5 Significant of Oxygen Saturation

Oxygen (O_2) is an important part in human body. Without O_2 each cell in the human body cannot function and will be damaged. When the oxygen flows into the lungs, it will pass on into blood. The blood will carry the oxygen to the each organ in human body. For example, the Oximetry is a device that measures the oxyhemoglobin (HbO_2) Saturation in blood. It measured by using a basic concept which is the light will transmit through a blood. After that it will determine the amount of light absorbed by oxygenated and deoxygenated hemoglobin. In addition, the oxygenated blood especially red color whereas deoxygenated blood has a dark blue coloration. Physically, the blood was detected when the finger placed on the probe. The light will pass through the finger to reach the detector. The amount of light that absorbed in finger depends on some factors such as concentration of the light, length of light path, oxyhemoglobin and deoxyhemoglobin.

The optical property of blood in the visible and near –infrared spectral regions depends on the amount of O_2 carried by blood. Otherwise, the absorption of the light also depends on the both skin thickness and blood concentration. The change in blood volume can be detects in peripheral parts of the body such as fingertip and earlobe.

1.6 Project Background

The 'Development of Optimal Photosensors Based Heart Pulse Detector" project consists of a photosensor which is used to measure the pulse by measuring the change in blood flow. The research concern is to review the best photo-sensor such as Light Emitting Diode (LED), Infrared (IR), and Light Dependent Resistor (LDR), need to be used in order to produce significant heart pulse signal detected from human finger. The biggest significant between the wavelength is the best of photosensor.

Other than that, this project also used microcontroller where the microcontroller will be programmed to calculate the heart rate and control the LCD display to indicate the pulse rate. The heart pulse will be display on a LCD display for easy monitoring.

1.7 Objective of Project

The objectives of this project as below:

i. To develop a biggest significant between photosensor (LED, IR and LDR) by using a suitable testing.

ii. To develop a simple equipment that is easy to use and make sure each person can monitor their health everywhere

iii. To develop a comfortable instrument, reliable, accurate result to develop of heart pulse using a low cost equipment (photosensors).