

INFRARED DISTANCE / HEIGHT MEASUREMENT

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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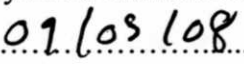
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For My Beloved Family

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ABSTRACT

This project will create a device that will be used for distance and height measurement. The device will feature infrared as a medium to provide the signal and transmission of the measurement. The objective of this project will create a working Infrared Range Finder which is portable using electronic and engineering knowledge that will be implemented into the design. By using Time of Flight principle this can be achieved. Time of flight will count the time taken for the infrared to move from the transmitter and back from the receiver to gain the distance. The time will be calculated and displayed on a display. All this circuit must be integrated into a system that will uses PIC to as controller. The result and the findings will be compiled , discussed and concluded in a report.

ABSTRAK

Projek ini bertujuan untuk menghasilkan alat mengukur jarak and tinggi. Alat ini akan menggunakan Infra merah sebagai medium untuk memancarkan dan menerima signal. Objektif projek ini adalah menghasilkan Pengukur Jarak Inframerah mudah alih yang berfungsi menggunakan pengetahuan kejuruteraan dan elektronik yang akan diterapkan dalam proses pembuatan. Prinsip pengukuran melalui 'time of flight' akan digunakan sebagai model utama untuk projek ini. 'Time of flight' akan mengira masa yang diambil oleh medium untuk pergi dari pemancar dan kembali ke penerima. Masa yang diambil akan ditukar dan dikira dalam jarak menggunakan persamaan. Kemudian jarak itu akan dipaparkan dalam paparan. Kesemua ini mesti diintergrasikan dalam satu sistem yang menggunakan PIC sebagai pengawal dan pemproses. Hasil percubaan and penemuan akan disimpan , diskusi dan dikonklusikan didalam laporan.

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LIST OF ABBREVIATION

IR	-	Infrared
NIR	-	Near infrared
MIR	-	Mid infrared
FIR	-	Far infrared
PIC	-	Programmable integrated circuit
IC	-	Integrated circuit
TOF	-	Time of Flight
LED	-	Light Emitting Diode
PN	-	Positive Negative
IrDA	-	Infrared Data Association

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CHAPTER I

INTRODUCTION

1.1 Project Introduction

The project will be able to simplify height and distance measurement. Infrared (IR) will be used as a medium to predict the distance. By using its properties as a electromagnetic waves, IR will be transmitted and reflected back to the receiver. The time delay will be calculated to determine the total time needed for the IR to travel and back to the receiver. This project is based on the concept of the Infrared (IR) can travel through air and bounce back by it properties of light to the receiver. The time delay will be calculated to determine the total time needed for the IR to travel and back to the receiver. The main concept is similar to the ultrasonic range finder. However this project deals with higher speed of travel due to light travel at 299752458 meters per seconds. All of this operation will be done on a electronic circuit that will contain an electronic circuit that will contain 5 part , an IR transmitter , IR receiver , Controller , Power circuit , and Display. A display is needed to display the measured distance and height. The project will also need to be portable to ensure the system is useable. This requires the power of batteries to drive all the electronic of the project. The project also requires the use of Programmable Integrated Circuit (PIC) to compute the total distance. The total distance will be displayed in Metric Unit (Meters)

1.2 Problem Statement

Measurement can be a hassle if were not done carefully and slowly. Usually the measurement requires precision and consistency. These are the trait of measurement. Distance measurement is usually done by using physical measurement to achieve the 2 characteristic. Most people use measurement tape or ruler to measure the distance. However there are several disadvantages when using physical measurement.

1. Physical measurement requires 2 people in a long range.
2. Physical measurement require a lot of time and energy
3. Physical measurement can be dangerous in certain situation
4. Physical measurement are hard in accessible place and sometimes require additional apparatus such as ladder

However in these modern times due to research and experiment, there are also electronic ways of measuring distance. By using ultrasonic waves distance electronic measurement is possible. Ultrasonic waves are sound waves that are inaudible to human ears due to higher frequency. However sound measurement also have several disadvantage due to its properties as a sound.

1. Sound waves are affected by ambient temperature changes in the environment.
2. Sound waves is affected by the volume of air in the environment
3. Sound waves travel is not possible in vacuum as sounds travel in a medium.
4. Sound waves sometimes affected by the sound in the environment (wave cancellation and amplification)

By using IR these disadvantages can be avoided. As a light, IR are not affected as it uses electromagnetic waves to travel will not require a medium to travel. There are also several advantages when using electronic IR measurement These problems can be overcome by using IR. IR an electromagnetic waves have all the necessary properties of a waves can be reflected and having the same properties of the light. This can provide the advantages such as :-

1. Measuring times can be reduced
2. Manpower required to measure can be reduced.
3. Inaccessible Places can be measured.
4. The system will calculate the distance automatically

1.3 Project Objective

To successfully complete this project, there are several objective that must be completed. Each objective brings significant results and addition that will affect the project. The objectives are as follows:-

1. To research about IR properties and implement it into measurement application
2. To design a working transmitter ,receiver and display circuit for IR measurement
3. To simulate and analyze the circuit using simulation software's
4. To create a working hardware of the devices with the ability to display measured values
5. To create a working hardware that will be calibrated

1.4 Project Scope

The project scope will determine what that will be covered inside the project. This is to ensure the project is on track. The project will cover all the theories needed to implement IR into measuring instrument devices. The project will need to find a suitable IR transmitter and receiver circuit . The circuit will need to be tested and simulation needs to be done to make sure the circuit is working. After testing all the circuits the most suitable circuit need to be chosen. The controller and display circuit are also needed to be designed. The system is also need to be combined and tested to make sure the system is working. The system also needs to be portable. This requires the power from batteries. Also the system must be able to be calibrated to ensure the system is correct.

1.5 Project Methodology

In order to make the project is completed , there are several step that need to be taken care as we move along the project. This will be done according to stages . The stages are :-

Literature review: - The project will start by researching by looking through books and journal / website on IR application on various fields. The research will also on looking on IR sensor and transmitter properties including sensitivity , wavelength , current and voltage rating , circuit cost and sample of simple IR transmitter and receiver circuit ,.

Design: - After various researching, The basic prototype circuit of the project can be designed . The circuit must contain 4 important parts , transmitter , receiver , controller and display. The signal from the transmitter and receiver must be processed to display the distance measured. The basic flowchart of programming sample is needed to make sure all is computed automatically and correctly.

Simulation , Testing and Data Collection: - After coming up with a design , The prototype must me simulated and tested by using computer simulation software to measure various condition and make sure circuit is working perfectly. If the circuit is not working properly , the circuit must be modified or redesigning the whole circuit to achieve a working circuit .After simulation the circuit also must be tested in a real environment .The circuit will be assembled temporarily to be tested . The noise effect and operability under normal condition , heat effect will be watched to ensure there is no hardware failure. Various reading and data needs to be collected to be compiled to findings

Hardware Construction: - After creating a working circuit . The circuit now can be assembled on a circuit board. The circuit can be assembled on a Printed Circuit Board to achieve lower noise effect.

Hardware Testing, Data Collection 2 and Calibration: After assembling the circuit , another testing and debugging must be done to ensure the circuit is really working after assembly. After testing, the unit needs to be calibrated to ensure the data is correct. Another data will be collected to include in findings

Hardware Finishing: After testing the finishing product can be done. The circuit can be enclosed on a casing.

CHAPTER II

LITERATURE REVIEW

2.1 Introduction

A literature review is very important to tackle all the theories needed to make the project possible. The section will include the infrared characteristic and its application in the industries. Also the section will tackle the principle of the operation and all the research of this technique.

2.2 Infrared

Electromagnetic waves are energy transported through space in the form of periodic disturbances of electric and magnetic fields. All electromagnetic waves travel through space at the same speed, $c = 2.99792458 \times 10^8$ m/s, commonly known as the speed of light. An electromagnetic wave is characterized by a frequency and a wavelength. These two quantities are related to the speed of light by the equation,

$$\text{speed of light} = \text{frequency} \times \text{wavelength}$$

The frequency (and hence, the wavelength) of an electromagnetic wave depends on its source. There is a wide range of frequency encountered in our physical world, ranging from the low frequency of the electric waves generated by the power transmission lines to the very high frequency of the gamma rays originating from the atomic nuclei. This wide frequency range of electromagnetic waves constitutes the Electromagnetic Spectrum.

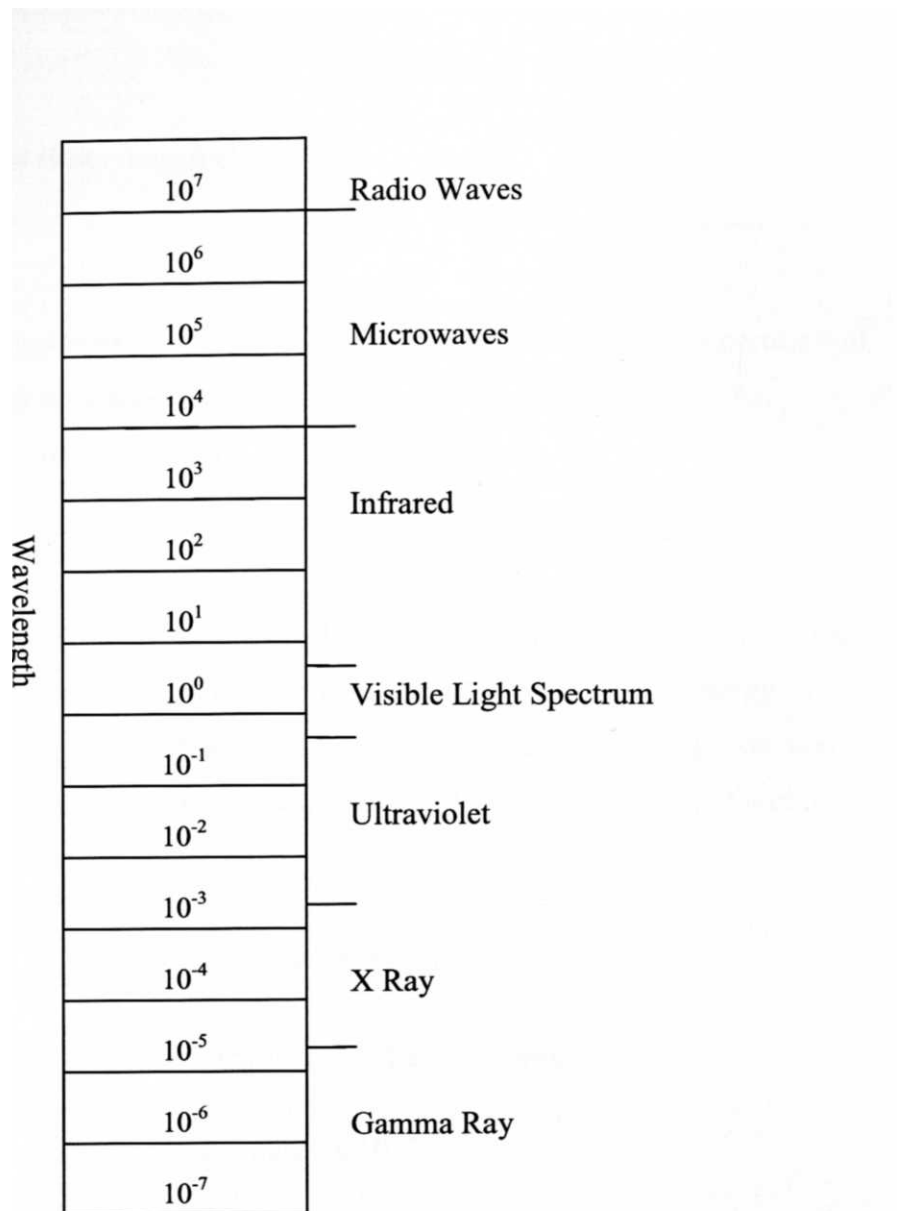


Figure 2.1 Electromagnetic Wave Spectrums

Infrared (IR) radiation is electromagnetic radiation of a wavelength longer than that of visible light, but shorter than that of microwaves. The name means "below red" (from the Latin *infra*, "below"), red being the color of visible light with the longest wavelength. Infrared radiation has wavelengths between about 750 nm and 1 mm, spanning five orders of magnitude [1]. The magnitude is used to identify the visibility and the wavelength of the infrared. The classifications are:-

- Near Infrared (NIR): 0.7 to 1.5 μm .
- Short Wavelength Infrared (SWIR): 1.5 to 3 μm .
- Mid Wavelength Infrared (MWIR): 3 to 8 μm .
- Long Wavelength Infrared (LWIR): 8 to 15 μm .

- Far Infrared (FIR): longer than 15 μm .

Infrared is useful due to its light and electromagnetic properties. The properties will give the infrared all the advantages need to be a medium in this project. The properties will be explained below.

2.2.1 Photon

According to quantum physics, the energy of an electromagnetic wave is quantized, it can only exist in discrete amount.. In accordance to emitting the energy in large unit is called quanta[2]. The basic unit of energy for an electromagnetic wave is called a photon. From the statement we can establish that the energy E of a photon is proportional to the wave frequency f ,

$$E = hf$$

where the constant of proportionality h is the Planck's Constant,

$$h = 6.626 \times 10^{-34} \text{ J s.}$$

2.3 Infrared Application

Infrared have been in a lot of application in industry. The infrared can be use for a lot of application such as imaging, communication and astronomy. Infrared have given a lot of contribution to the field of engineering and science. Among their application are :-

2.3.1 Night vision

Infrared is used in night vision equipment when there is insufficient visible light to see. Night vision devices operate through a process involving the conversion of ambient light photons into electrons which are then amplified by a chemical and electrical process and then converted back into visible light. Infrared light sources can

be used to augment the available ambient light for conversion by night vision devices, increasing in-the-dark visibility without actually using a visible light source.

2.3.2 Communication

IR data transmission is also employed in short-range communication among computer peripherals and personal digital assistants. These devices usually conform to standards published by IrDA, the Infrared Data Association. Remote controls and IrDA devices use infrared LED to emit infrared radiation which is focused by a plastic lens into a narrow beam. Infrared lasers are used to provide the light for optical fiber communications systems. Infrared light with a wavelength around 1,330 nm (least dispersion) or 1,550 nm (best transmission) are the best choices for standard silica fibers.

2.3.3 Astronomy

Astronomers observe objects in the infrared portion of the electromagnetic spectrum using optical components, including mirrors, lenses and solid state digital detectors. For this reason it is classified as part of optical astronomy. The sensitivity of Earth-based infrared telescopes is significantly limited by water vapor in the atmosphere, which absorbs a portion of the infrared radiation arriving from space outside of selected atmospheric windows. This limitation can be partially alleviated by placing the telescope observatory at a high altitude, or by carrying the telescope aloft with a balloon or an aircraft. Space telescopes do not suffer from this handicap, and so outer space is considered the ideal location for infrared astronomy. Infrared light is also useful for observing the cores of active galaxies

2.4 Photodiode

Photodiode is a diode that is sensitive to the exposure of Electromagnetic Radiation. The principle of operation can be described when the photon is impinging the PN

junction which will alter the reverse current versus voltage characteristic of the diode. In this case the voltage will be generated when the depletion region where the material band gap due to diode properties appeared. Thus the electron will move to the positive charge space in N-side where holes will go to the P-side.

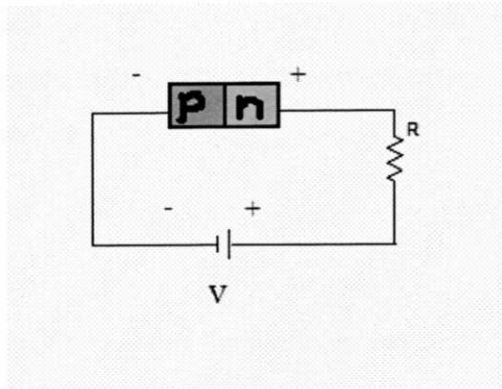


Figure 2.2 PN Junction in Photodiodes

The Current generated from this effect will be linear with light intensity. This can be expressed through figure 2.3 which is on the reverse bias side of the region.

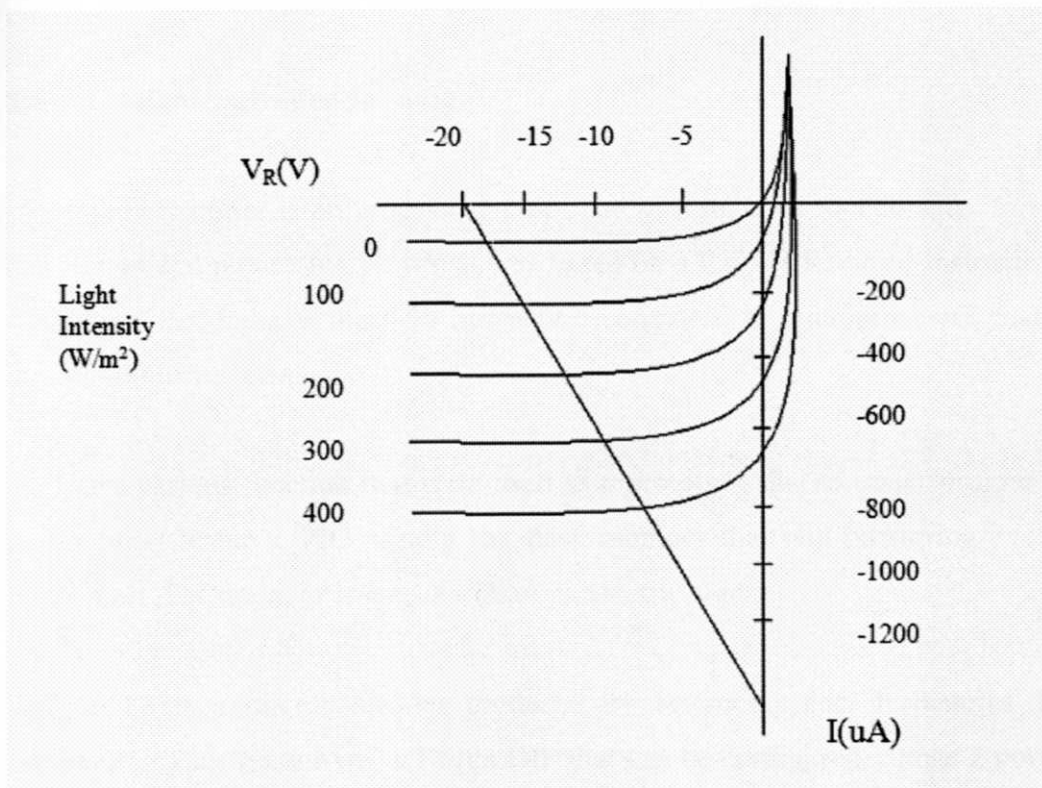


Figure 2.3 Voltage versus Current Characteristic

2.5 Time of Flight Measurement

Time of flight measurement has been used in many application such as military and industry. The TOF principle is based on measurement of the transit time of a short pulse to a target and back [3]. The pulse generated will be transmitted and bounced back due to wave's properties that will bounce back when it hit a solid object. The equation can be expressed as

$$D = \frac{V \times t}{2}$$

Where D= Distance of the medium traveled
 V= Velocity of the medium
 t= Time taken to travel

The medium of choice is usually ranging from sound waves (Ultrasonic) and Electromagnetic Waves (Infrared and Ultraviolet).

2.6 PIC Microcontroller 16F88

PIC microcontroller is an processing chip that with reduced functionality to simple calculation and processing power. It was based on a RISC (Reduced Instruction Set Computer) that have at most 50 instruction compared to microprocessor that have almost 400 instruction.

PIC have various function that were used as a prototype due to easier programming and burning features. PIC usually has flash memory that will be storing execution instruction. The memory is erasable through electric signal.

PIC 16F88 is a microcontroller produced by Microchip Inc. It features 16 bit programming instruction on a 18 pin DIP that can be configured.. It has 2 ports that will serve as an input and output. The PIC also integrated an on board oscillator.