INFRARED DISTANCE / HEIGHT MEASUREMENT

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Special dedication for my parents, family, friends and electronic engineering education.

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ABSTRACT

The objective of this project is designing and building an infrared system that can measure distance or height and display the reading on LCD display. Infrared (IR) radiation is electromagnetic radiation of a wavelength longer than that of visible light, but shorter than that of radio waves. Infrared radiation spans has wavelengths between approximately 750 nm and 1 mm. Infrared is the most common way for remote controls to command appliances. However, commonly ultrasonic and laser are used in application for measuring distance while infrared is suitable for measuring temperature. The purpose of this project is to perform an analysis comparing the real distance and to get a reading that has minimum error. The Electronic Measuring tape is perfect for anyone who needs to quickly measure square footage of a home, determine the distance or estimate the deep when digging hole. The Electronic Tape Measure sends out narrow beams of signal pulses that bounce off solid objects back to the hand-held receiver. A triangle between the point of reflection, the emitter, and the detector vary based on the distance to the object, and from those angles, the distance to the object can be calculated. Custom electronics and a microprocessor then convert elapsed time into a distance measurement and display it on the LCD.

ABSTRAK

Objektif projek ini ialah merekabentuk dan membina suatu sistem inframerah yang dapat mengukur jarak atau ketinggian dan memaparkan bacaan pada paparan LCD. Pancaran inframerah ialah jarak gelombang bagi pancaran elektromagnetik yang lebih panjang daripada cahaya nampak, tetapi lebih pendek daripada gelombang radio. Tempoh bagi pancaran inframerah ialah di antara kira-kira 750nm dan 1mm. Inframerah paling biasa digunakan pada kawalan jauh mengarahkan sesuatu peralatan. Bagaimanapun, kebiasaannya ultrasonik dan laser digunakan di dalam aplikasi untuk mengukur jarak sementara inframerah adalah sesuai untuk mengukur suhu. Tujuan projek ini ialah untuk melakukan analisis membandingkan jarak sebenar dan untuk mendapatkan ralat minima pada bacaan. Pita pengukur elektronik adalah lengkap bagi sesiapa yang perlu untuk mengukur kaki persegi rumah dengan cepat, menentukan jarak atau menganggar kedalaman apabila menggali lubang. Pita pengukur elektronik menghantar keluar isyarat denyut yang akan dipantulkan semula oleh objek pejal kepada penerima. Segi tiga di antara titik balikan, pemancar dan pengesan membezakan berdasarkan jarak objek dan daripada sudut tersebut jarak ke objek dapat dikira. Mikroprosessor kemudian akan menukarkan masa yang tinggal kepada pengukuran jarak dan memaparkannya pada LCD.

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IR	-	Infrared
LCD	-	Liquid Crystal Display
PCB	-	Printed Circuit Board
PIR	-	Passive Infrared
LED	-	Light Emitting Diode

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

This chapter introducing the Infrared Distance/Height Measurement project with a description of project background, project objective, scopes, research methodology, and the thesis summary. There were brief explanations about the project progress before it would describe clearly in the next chapter.

1.2 PROJECT BACKGROUND

This project will design an infrared system to measure distance or height. In the beginning of this project, it would need to research the application of the IR. From the data, more research about the signal being transmitted by the IR is needed to match it with the receiver. The suitable IR circuit constructed with and added signal generator circuit to further enhancing the measurement method. The analysis will be performing to the suitable infrared circuit by using Multisim and Proteus software. An infrared transmission system is comprised of three components, the transmitter, the infrared emitter (also called radiator) and the receiver. The transmitter modulates the audio signal onto a carrier frequency using F.M. or digital techniques. The emitter takes the modulated signal and converts it into infrared light. The receiver decodes the infrared signal and coverts it back to an audio signal. The distance or height of certain object is measured based on time of transmitted IR signal being bounced back to the receiver.

Most of the distance or height measurement equipment in the market today is using ultrasonic application. Basically, both ultrasonic and infrared would be suitable to detect the objects at those ranges. Ultrasonic travels at the speed of sound relatively slow. So the time between emitting and receiving can be measured. It is easy to calculate the distance knowing the speed of sound and the time. Infrared travels at the speed of light. The way to measure distance, it is base on time delay of transmitted IR signal being bounced back to the receiver. The other way is with vary the voltage of the emitter and see what voltage is for the collector sensed. The higher the voltage means, the closer the object or beam is. This requires calibration to measure actual distance. If comparing the time respond of both IR and ultrasonic, IR would be faster. The signal being bounce back is faster detect by transmitter if comparing to the ultrasonic. Ultrasonic is sending a wave to the object and would take time slower than IR to receive the bounced back wave. So, by using IR this will decrease the time in detect the signal bounce back and faster measurement reading would be collect.

1.3 PROJECT OBJECTIVE

The purpose of this project is to introduce the possibilities for setting acquire knowledge and hands-on experience in optical communication via infrared and design skills. The title of this project is Infrared Distance/Height Measurement. Delineated within this goal are three specific objectives:

i. This project requires designing and building an infrared system that can measure distance or height and display the reading on LCD display;
ii. To perform an analysis using Multisim and Proteus for simulation circuit, using oscilloscope for the completed circuit designed and comparing the real distance; and

iii. To get a reading that has minimum error so that the reading nearest to the real value.

1.4 SCOPES OF WORK

The analysis will be performing to the suitable infrared circuit by using Multisim software. The distance or height of certain object is measured based on time of transmitted IR signal being bounced back to the receiver. The transmitter sending out signal pulses and receiver received the returned signal that are reflected from an object or beam. If the IR light reflects off an object, it returns to the detector and creates a triangle between the point of reflection, the emitter, and the detector. The angles in this triangle vary based on the distance to the object, and from those angles, the distance to the object can be calculated.

This infrared system not only just to measure distance and height, but also can perform to move it to another places, so that the infrared system will be design as simple portable infrared distance/height measurement.

1.5 RESEARCH METHODOLOGY

The references sources like journal are important to making a comparison in producing the project. Base on the information and fact gain, a good designation circuit can be constructing to keep up the quality and the efficiency of the circuit. The library offers the outline as one possible approach to legal research. For the factual elements, all the words that might describe the particular fact from the most general are listed to the most specific. These will help in constructing searches in books, journal, article and sources and in determining later what the important factual elements are to this project. By consult the sources using engineering dictionaries, dictionaries and thesauri this will help with jargon and terms of the fact.

Research evaluation is to identified and make sure that the questions have already been answered and facts supporting the result of developing project. Update research is if there is unsure currency of material and to identify new developments. Update research can be done while the project is in progress until the project done.

The result from analysis is presenting in form of square wave and table to support this project. This is because to make the data more systematic, regular and easy to understanding.

1.6 REPORT STRUCTURE

This report includes five chapters that would explain in details about the project. First chapter is an introduction that briefly describes the project objective, scopes and research methodology.

Second chapter will explaining a research and information about the project. Each fact and information obtained from different source and references will be discussing for choosing the best method for the project. The next chapter is to explain in details the technique and methods choose from chapter two to perform the project. The technique that has been chose is divided into two part specifically hardware and software be used.

The fourth chapter is a part for analysis and result. A result like graph, the measurement reading, and a comparison with the exact result will further discuss in this chapter. The analysis process is from the simulation circuit and the exact circuit to the real environment.

The last chapter in this report is a conclusion and suggestion. In this chapter, the conclusion is performed base on the achievement and learning that has been gain at the moment the project is performed from the beginning until success. Beside, the suggestion is performed to keep up the level of project operation so that it can be improve in future.

CHAPTER II

LITERATURE STUDY

2.1 INTRODUCTION

This chapter discussing about the theory and concept the whole application to be used and relevance to the project. The purpose of the discussion is to explain the perspective and method in the research for the understanding. This is important as a guide in any research and development. The result of certain research can't be evaluated without comparing it with the theory. So, this will be as a proven to support the answer and reason.

2.2 INFRARED, ULTRASONIC, LASER AND PASSIVE INFRARED OVERVIEW

There are many such technologies/standards and the most notable among them are Bluetooth, Infrared, HomeRF, IEEE 802.11b (WiFi) and HyperLAN 2. These technologies compete in certain fronts and are complimentary in other areas. We shall start with an overview of infrared, ultrasonic, laser and passive infrared is used for high-speed, short-range, line-of-sight and point-to-point data transfer. The range of infrared is longer than one meter. It requires a narrow angle (30 degree) point-and-should operation. The maximum data transfer speed is 4 Mbps and 16

Mbps is under development. It doesn't interfere with other wireless communication and also is immune to interference from others. The detail discussion is towards comparing these technologies from a certain criteria and a number of recommendations will be stated for the paper research purposes. Infrared, ultrasonic, laser and passive infrared is an electro-optics component that commonly used in many application such as to detect the presence of any object. Basically, the circuit would connect to object counters, interruption counters, RPM counters, display, bell etc. To construct the circuit base on these components, the factor should be take note is about the affect from environment and type of signal emitted. These influence the quality of signal to be emitted and received. This is because the high sensitivity character of these type component.

2.2.1 Infrared

Infrared is a means of using light to transmit a signal over distance. Infrared radiation (IR) or the term infrared alone refers to energy in the region of the electromagnetic radiation spectrum at wavelengths longer than those of visible light, but shorter than those of radio waves. The light frequency used in infrared is above the range of visible light in the red end of the light spectrum. Correspondingly, the frequencies of IR are higher than those of microwaves, but lower than those of visible light. Scientists divide the IR spectrum into three regions. The wavelengths are specified in microns (symbolized μ, where 1 $\mu = 10^{-6}$ meter) or in nanometers (abbreviated nm, where 1 nm = 10^{-9} meter = 0.001 μ). The near IR band contains energy in the range of wavelengths closest to the visible, from approximately 0.750 to 1.300 μ (750 to 1300 nm). The intermediate IR band (also called the middle IR band) consists of energy in the range 1.300 to 3.000 μ (1300 to 3000 nm). The far IR band extends from 2.000 to 14.000 μ (3000 nm to 1.4000 x 104 nm) [6].

Infrared is used in a variety of wireless communications, monitoring, and control applications. A few of the applications include home-entertainment remote-control boxes, wireless local area networks, links between notebook computers and desktop computers, cordless modems, intrusion detectors, motion detectors, and fire sensors [7].

2.2.2 Ultrasonic

Ultrasonic sounds are the sounds that human ear cannot hear. Our ears cannot read these sound waves. Ultrasonic instruments use ultrasonic sounds to generate desired results.

Ultrasonic material analysis is based on the measurement of parameters of ultrasonic waves propagating through the sample. This provides information on the interaction of the ultrasonic waves with the sample interior, thus enabling analysis of its physical and chemical properties. The ultrasonic wave is a wave of oscillating pressure and associated longitudinal deformation.

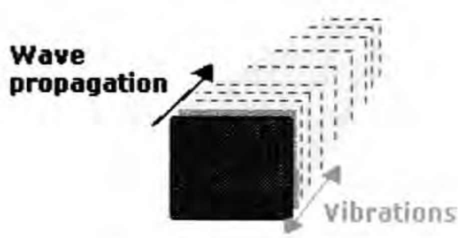

Figure 2.1: Propagation of ultrasonic waves.

Propagation of ultrasonic waves is determined by ultrasonic velocity and ultrasonic attenuation. The Ultrasonic Scientific HR-US spectrometers employ a principle where the path length of the ultrasonic wave in the sample exceeds the size of the sample. The use of modern advances in ultrasonic design, electronics and digital processing allow the attainment of ultrasonic measurements with record resolution (down to ±0.2mm/s for ultrasonic velocity) in a broad range of the sample volumes, down to a single droplet. This technology is subject to protection by granted patents and pending patent applications. Travelling through samples, the ultrasonic wave loses it energy (a decrease in amplitude) and changes its velocity.

This decrease in amplitude and change in velocity are analysed as characteristics of the material.

The general principles of high-resolution ultrasonic measurements are shown in the figure 2.2 below. Piezoelectric transducers transform electrical signal into the oscillations of pressure, the ultrasonic wave. A second piezotransducer then transfers the received ultrasonic wave into an electronic signal, for subsequent analysis.

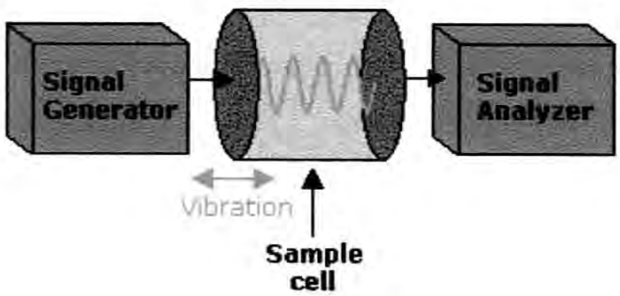

Figure 2.2: General principles of high-resolution ultrasonic.

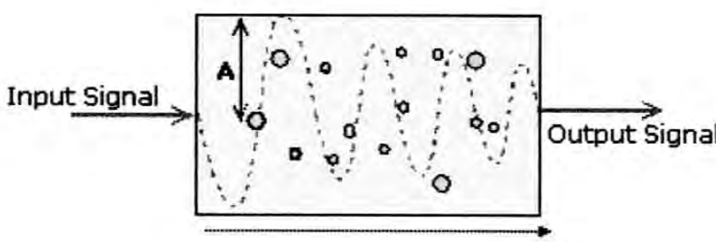

Figure 2.3: The ultrasonic wave movement

The basic principle behind ultrasonic is that high-frequency sound waves are easily transmitted across a transducer gap in the presence of a liquid medium, but are severely attenuated when the gap is dry. The transducer uses a pair of piezoelectric crystals at the tip of the transducer. The transmit crystal converts an electrical signal into an ultrasonic signal. When liquid is present in the gap, the receive crystal is able to sense the ultrasonic signal from the transmit crystal and convert it back to an electrical signal. This signal is sent to the electronics to indicate the presence of liquid in the transducer gap. When there is no liquid present, the ultrasonic signal is attenuated, and the receive crystal is not able to sense the sound waves from the transmit crystal [1].

Not as popular now, the role of the ultrasonic detector has been largely superseded by the PIR. The ultrasonic detector uses the Doppler effect the apparent shift in frequency which occurs when energy waves (whether sound, light or some other form) are emitted by a moving object. When this object is moving towards you the waves which it produces will always appear to be of a higher frequency than they actually are. If the object is moving away then there will be an apparent drop in frequency. If a room contains a source of sound, then the sound being reflected from a person moving towards the listener has an apparently higher pitch, whilst the sound is being reflected from a receding target has an apparent lower pitch. The effect of a person moving around a room is not adequate to produce a significant change in pitch that can be detected by human hearing, although this Doppler shift can be picked up by electronic devices [1].

The ultrasonic detector utilizes very high-frequency sound, higher than that which can be detected by the human ear - ultrasound. The frequencies of detectors vary between 23 and 40 kHz (16 kHz is the upper range of human hearing). The person being detected is thus on aware of the detector's operation although the normal motion of the target person creates a perceptible Doppler effect, the detector circuit having been engineered to detect variations in pitch of the sound when reflected from a moving person. Figure 2.4 illustrate the basic arrangement.