ULTRASONIC RANGE METER

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BORANG PENGESAHAN STATUS LAPORAN

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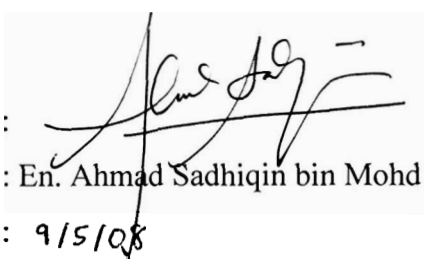
Signature : 

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Special dedication to my loving mum Pn Juminah bt Sarbini, my dad En Abdul Hamid bin Hj Sidek, my brother, my kind hearted supervisor En Ahmad Sadhiqin bin Mohd Isira, and my dearest friends.

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ABSTRACT

The Ultrasonic Range Meter is designed to measure any distance to the object in between 0.25m to 8m using standard 40 kHz transducer. It is useful for the robotic project such as mobile robot. This project is divided into two important parts, which involve the design of hardware application circuit and software development. Hardware implementation is to transfer the software part of the circuit of Ultrasonic Range Meter onto the printed circuit board. The software is developed by using PIC 16F873 as a microcontroller. The measured distance is displayed on the LED seven segment connected to the PIC. The time taken by the ultrasonic signal sent is measured. The propagation speed of the sound changes with the temperature. The control system is done by using PIC.

ABSTRAK

Ultrasonic Range Meter merupakan satu alat yang digunakan untuk mengukur jarak diantara objek. Jarak yang dikehendaki adalah diantara 0.25m sehingga 8m. Ia amat berguna apabila diaplikasikan untuk robot contohnya seperti mobile robot. Projek ini terbahagi kepada dua bahagian iaitu *hardware* dan *software*(perisian). Bahagian *hardware* adalah untuk membina litar Ultrasonic Range Meter di atas PCB. Manakala perisian untuk software menggunakan PIC 16F873 sebagai mikropengawal. Jarak yang diambil bacaan akan dipaparkan di *seven segment*. Cara untuk mengira jarak dengan mengambil masa yang diambil ketika pemancar(*transmitter*) memancarkan isyarat ke objek dan isyarat tersebut dipantul balik dan diterima oleh penerima(*receiver)*. Penyebaran kelajuan bunyi berubah mengikut suhu. Semua sistem kawalan ini akan dikendalikan oleh PIC.

CONTENT

RESULT

DISCUSSION AND CONCLUSION

REFERENCES

LIST OF TABLE

LIST OF FIGURE

ABREVIATION

PIC – Programmable Integrated Circuit

PCB – Printed Circuit Board

UV – Ultra Violet

LIST OF APPENDICES

CHAPTER I

INTRODUCTION

1.1 Introduction of Project

The Ultrasonic Range Meter is designed to measure the distance of any object in between 0.25m to 8m using standard 40 kHz transducer. It is useful for the robotic project. The measured distance is displayed on the seven segment connected to the Programmable Integrated Circuit(PIC). The time taken by the propagation of the ultrasonic signal sent to the object or place where it will take the effect of temperature change as well in order to determine the distance. The propagation speed of the sound changes with the temperature. All of those controls are done by the software of PIC. The type of PIC used for this project is 16F873.

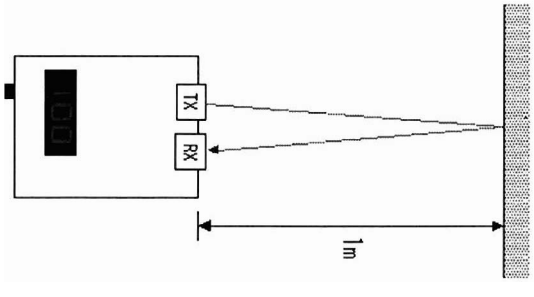

Figure 1.1: Ultrasonic Range Meter

1.2 Objectives

The objectives of this project are:

i) To design the Ultrasonic Range Meter using hardware and software (PIC programming).
ii) To design and create and seven segment displayed distance measurement device.
iii) To study and familiarize with PIC programming.
iv) Study and familiarize with the transducer, signal amplification circuit, detection circuit, signal detector and other signal conditioners.

1.3 Problem statement

The purpose of the Ultrasonic Range Meter is to measure the distance. Nowadays ultrasonic application is only applied in short distances. Hence, this project is upgraded for long distances. It is applicable since some sensors that are used in the system application are not sensitive to the effect of temperature, humidity, and others. It is hoped that a best Ultrasonic Range Meter will be produced at the end of the project duration.

1.4 Scope of project

Four steps taken to develop this device:

1. Literature review for the Ultrasonic Range Meter
   - Information gathering from books, internet and discussion with the supervisor.
   - Analysis about the project.
   - Study about the PIC programming and the operations of circuit.

2. Software design
   - Design the PIC program by using assembly language.
   - Test run and troubleshoot the program

3. The circuit and hardware design and construction.
   - The circuit is designed by using Multisim for the simulation of circuit.
   - The circuit is constructed and measured to know the differences between the simulation results.
   - The hardware is built and some adjustment are made for troubleshooting purpose.
4. Test run and troubleshoot
   - The hardware and the software are integrated.
   - The device is tested and troubleshooting process is done with respect to any problem.

CHAPTER II

LITERATURE REVIEW

2.1 Ultrasonic

Ultrasonic is the sound that refers to anything above the frequencies of audible sound, and nominally includes anything over 20,000 Hz.

Ultrasonic can be used to locate objects by means similar to the principle by which radar works. High-frequency acoustic waves reflect from objects, even comparatively small ones, because of the short wavelength. The distance to an object can be determined by measuring the delay between the transmission of an ultrasound pulse and the return of the echo. This is the well-known facts by which bats navigate in darkness. It is also believed to be used underwater by cetaceans such as dolphins and whales. Ultrasonic can be used in sonar systems to determine the depth of the water in a location, to find schools of fish, to locate submarines, and to detect the presence of SCUBA divers.

In an ultrasonic intrusion detection system, a constant, high-frequency acoustic signal is transmitted by a group of transducers. The ultrasound waves flood the protected area. Receiving transducers monitor the ultrasound reflected by objects in the protected zone. If anything moves, it produces a change in the security applications. It is also used in medicine to view internal organs of the body.

2.2 Type of Ultrasonic Transducer

There are two types of ultrasonic transducer:

2.2.1 Piezoelectric

Crystals which acquire a charge when compressed, twisted or distorted are said to be piezoelectric. This provides a convenient transducer effect between electrical and mechanical oscillations. Quartz demonstrates this property and is extremely stable. Quartz crystals are used for watch crystals and for precise frequency reference crystals for radio transmitters. Rochelle salt produces a comparatively large voltage upon compression and was used in early crystal microphones. Barium titanate, lead zirconate, and lead titanate are ceramic materials which exhibit piezoelectricity and are used in ultrasonic transducers as well as microphones. If an electrical oscillation is applied to such ceramic wafers, they will respond with mechanical vibrations which provide the ultrasonic sound source. The standard piezoelectric material for medical imaging processes has been lead zirconate titanate (PZT). Piezoelectric ceramic materials have found use in producing motions on the order of nanometers in the control of scanning tunneling microscopes.

2.2.2 Magnetostrictive

The magnetostrictive transducers can be used to produce high intensity ultrasonic sound in the 20-40 kHz range for ultrasonic cleaning and other mechanical applications. There is a magnetic analogue where ferromagnetic material responds mechanically to magnetic fields. This effect, called magnetostriction, is responsible for the familiar hum of transformers and other AC devices containing iron cores.

2.3 The differences Ultrasonic Transducer between others transducer

Table 2.1: The differences of transducers

DESCRIPTION	ULTRASONIC	INFRA RED
Accuracy	High	Low
Range	Above 8 meter	300 cm
Power Supply	3V to 5V	5V to 24V
Frequency	Above 20kHz	4×10^{14} Hz

2.4 The factors effects when measuring the distance

The factors effects when measuring the distance are:

1. Temperature
2. The propagation speed of the sound
3. Time
4. Distance

2.5 The propagation speed of the sound

The speed of sound describes how much distance such a wave travels in a given amount of time. In Earth atmosphere the speed varies with atmospheric conditions; the most important factor is the temperature. The formula for the speed of sound in air is:

$C_{sound\ in\ air} = 331.5\ t\ 0.6\ T_c$,where T_c is Celsius temperature (2.1)

Calculation;

Assume $Tc = 25\ °C$,

$$C_{sound\ in\ air} = 331.5\ t\ 0.6\ T_c$$
$$= 346.5°C$$

Table 2.2: The speeds of sound

Temperature of air °C	The speeds of sound c in m/s
-10	325.5
-5	328.5
0	331.5
5	334.5
10	337.5
20	343.5
25	346.5
30	349.5
40	355.5

This range meter calculates a distance by dividing the propagation time which was measured by the capture feature. The calculation for determine the time when measure a distance is showed as below:

Assume Tc = 30 °C, and the distance to measure is 1 meter.

$$C_{sound\ in\ air} = 331.5 + 0.6t_c \qquad (2.2)$$

$$= 349.5°C$$

$$Time, t = \frac{1m}{349.5°c} \qquad (2.3)$$

$$= 2.861\ ms$$