DISTANCE MEASUREMENT DEVICE USING PROGRAMMABLE INTERFACE CONTROLLER

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"I hereby declare that, except where otherwise indicated, this document is entirely my own work and has not been submitted in whole or in part to any other university."

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Date : 18/6/2012

To my beloved family and friends who, of all that walk the earth, are most precious to me.

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ABSTRACT

This project describes the device that is able to measure the distance from the device to the object with the main objectives that is by using the ultrasonic technology. The system introduces the use of ultrasonic distance measuring system based on microcontroller PIC16F877A. The system will establish communication between Ultrasonic Sensors, Temperature Sensor, LCD Display, and microcontroller. Ultrasonic sensors measure the distance in the sense that the direction of propagation as a sequence of echoes. The measurement is based on the time-of-flight of the reflected echoes. Then this sequence is converted to digital form and is evaluated and interpreted by the microcontroller. The device is able to measure distance within 0.05m to 3m in about ±3cm accuracy. With the temperature sensor, the accuracy of the distance measured is far improved as the temperature sensor can overcome the velocity of sound travelling in different temperature. The ranging value is then displayed through the LCD Display that shows the temperature degree as well. The system can also be used for various applications for distance measurement such as automotives, civil, robotics and variety of applications depends on the use. Thus, one of the objectives is to build and develop the prototype of the distance measurement device. Finally, the project will be commercialized to industries that can make good use of it.

ABSTRAK

Project ini menerangkan fungsi alat yang dapat mengukur jarak dari alat tersebut hingga objek yang dikenalpastikan yang menepati objektif projek ini dengan penggunaan teknologi ultrasonik. Sistem ini memperkenalkan penggunaan ultrasonik pengiraan jarak berdasarkan mikropengawalan PIC16F877A. Sistem tersebut akan mewujudkan komunikasi antara Sensor Ultrasonik, Penderia Suhu, Paparan LCD, dan mikropengawal. Pengukuran jarak diarah perambatan dari sensor ultrasonik di dalam urutan gema. Pengukuran adalah berdasarkan penerbangan masa gema dirambatkan dan dipantulkan. Kemudian, data yang diperolehi akan ditukarkan kepada bentuk digital dan dinilaikan dan ditafsirkan oleh mikropengawal. Selain itu, alat ini mampu mengukur jarak dari 0.05m ke 3m dalam ketepatan ±3cm. Ketepatan bagi jarak yang diukur adalah lebih baik dengan menggunakan sensor suhu kerana halaju bunyi adalah berbeza pada suhu yang berlainan. Bacaan jarak tersebut kemudian akan dipaparkan melalui Paparan LCD berserta dengan bacaan suhu. Sistem ini juga boleh digunakan dalam pelbagai aplikasi untuk ukuran jarak seperti automotif, sivil, robotik dan pelbagai aplikasi lain bergantung kepada pengunaannya. Oleh itu, salah satu daripada objektif projek ini adalah pembinaan prototaip alat ukuran jarak. Akhirnya, projek ini akan dipasarkan ke industri-industri yang dapat mengunakan teknologi ini.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

PIC	-	Programmable Interface Controller
LCD	-	Liquid Crystal Display
LED	-	Light Emitted Diode
SPICE	-	Simulation Program with Integrated Circuit Emphasis
PCB	-	Printed circuit board
DC	-	Direct Current
MCU	-	Microcontroller
IC	-	Integrated circuit
RAM	-	Random Access Memory
ROM	-	Read-Only Memory
EEPROM	-	Electrically Erasable Programmable Read-Only Memory
ADC	-	Analog-to-Digital Converters
DAC	-	Digital-to-Analog Converters
I/O	-	Input/Output
PWM	-	Pulse-width modulation
TOF	-	Time-of-Flight
PCB	-	Printed Circuit Board
PSM	-	Projek Sarjana Mud

CHAPTER I

INTRODUCTION

In this chapter, the introduction of the project and the concept idea will be discussed with the importance of the project and the perspective of this research. The objectives of this project are stated out and will be discussed thoroughly. Besides that, the problem statement of this project will be explained and the scope of this project will be specified. Also, the brief explanation of the methodology will be explained. And finally the common structure of this project will be explained thoroughly.

1.1 Introduction of Project

With the development of today's technology in the modern industry, ultrasonic has been widely used as a detection technology and many applications have been using the system overtime. The distance measurement with ultrasonic is a non-contact measurer which have many good features with the combination of electronics such as microelectronics technology.

Factors such as electromagnetic waves, light, and dust will not affect the ultrasonic distance measurement. With its simple, fast and low cost information processing, it is widely used by automation and robotics applications. Besides that, it is also used as obstacles avoidance, navigation and vehicle positioning, liquid level measurement and many more.

The aim of this project features the implementation of non-contact measurement of distance using the ultrasonic technology with the use of PIC 16F877A. In this project the microcontroller PIC16F877A acts as the brain and does the arithmetic functions for the ultrasonic ranging and also emits a series of pulses to the transmitter part for the output of ultrasonic whereas the receiver part captures the signal which is reflected from the object that we desired to measure the distance.

After the captured signal has been retrieved and processed, the PIC calculates the distance between the object and transmitter by using the time travelled of the ultrasonic signal. Finally, the distance between the device and the object is displayed on the LCD display.

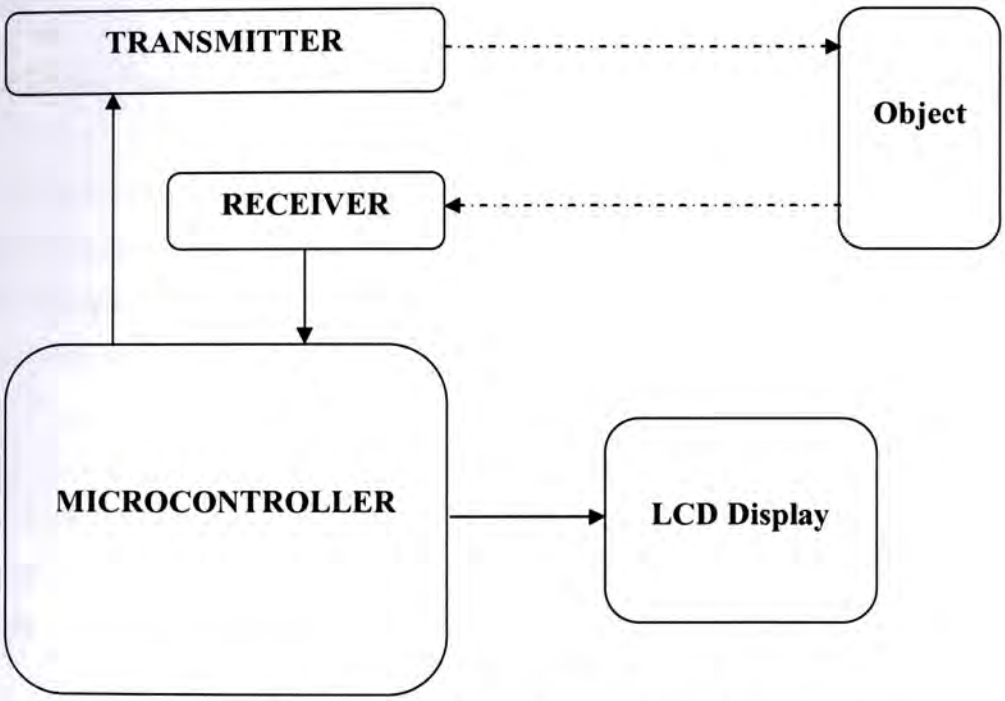

Figure 1.1: The Basic Idea of Project Block Diagram

The difference of this project from existing project is the use of IC16F877A instead of other type of microcontroller and this project is done using C Language as the programming codes compare to some project that uses Assembly Language and other type of language to program. Besides that, in this project, LCD Display is used compared to 7 segments or other display system. And a temperature module is added by using LM35 in order to increase the precision compare to other existing project that either does not use a temperature sensor or they are using other type of sensor.

1.2 Objectives of Project

The objectives of this project are stated as below:

1. To use the ultrasonic technology that can measure the range between the object and device.
2. To use and implement the PIC 16F877A microcontroller as a controller circuit.
3. Establish communication between Ultrasonic Sensors, Temperature Sensor, LCD Display, and microcontroller.
4. To build and develop the prototype of Distance Measurement Device.
5. To be apply in the civil industry and automotive industry.

1.3 Problem Statement

In today measurement device, the time taken when measuring distance manually using normal measurement device such as measuring tape is time consuming. Also, a result is obtained through several readings and by measuring manually, it would require a lot of time to keep repeating the same procedure.

Besides that, the accuracy of the reading is affected when user measure a longer distance. This is because a measuring tape does not have that kind of length to achieve a full reading. So, the user have to measure part by part of that specific distance and this causes an error when user using this method of measuring.

The safety of individuals during handling measurement tools and when measuring distance in narrow area or dangerous area are affected as well. This is because when user is handling the tools, such as steel ruler, it might causes injury because of the sharp metal that can cut the finger of the user. Also, when measuring distance in narrow area and dangerous area such as radioactive plant or chemical waste area, it will risk the health and safety of the users.

Also, there is inaccurate reading on most ultrasonic distance measurement device. This is because the speed of sound varies with temperature and the current ultrasonic device

is either does not use a temperature sensor or the speed of sound is assumed in certain temperature.

1.4 Scope of Project

In order to achieve the objective of this project, there are several points that have been outlined. The scopes of this project are:

1. Develop the Distance Measurement Device that can measure the distance with reading based on PIC16F877A microcontroller.
2. Use ultrasonic technique to measure the distance between object and device.
3. The device range is within 0.05m to 3m with the accuracy of ±3cm.
4. Using PIC16F877A as a microcontroller and LCD Display to display the readings.
5. Use C language as the program code.

1.5 Brief Explanation of Methodology

This project is divided into three stages where the first section is to be done on the first semester and the second and third stage is to be done on the following semester. In the first stage, this project is started by having discussion with supervisor and discussion about the general ideas and concepts that would be used throughout this project is discussed. Then the literature review is studied together with the background of this project and by doing research by referring to various sources such as reference books, I.E.E.E journals, in the internet and related data sheets. Then the project is followed by seeking the related information regarding the components, sensors, and microcontrollers and so on. With the result of the searching, the most suitable parts would be selected and be used in this project development. Then, the type of programming language is studied and the most suitable programming language will be chosen as the programming codes for the system. Also, studies on software that is used for simulation is done so that the project can be simulated before proceeding into the hardware.

Then on the next stage, hardware interfacing would be studied with studies and research on hardware, equipment and component used. Then, after the hardware for this project is built and assembled, the project will proceed to the system testing. If there are error resulted, troubleshooting would be needed until it reaches the desired result. Once we have fulfilled the desired results of this system with the project requirements and specification, this project is considered successful and is ready to proceed to the final stage.

On the final stage, the project would be finalize and presented. Finally, we would proceed to the thesis writing on the overall project

1.6 Report Structure

The overall of this report comprises of 5 chapters. It delivers the activities done, ideas generated, concepts applied, and the prototype of the project.

Chapter 1 contain with the basic introduction of the project. This chapter includes the introduction, objectives, and problem statements, scopes of work, methodology and report structure of the project.

Chapter 2 is the literature review on theoretical concepts applied in this project. Studies include the background of ultrasonic technology, software used and programming language used. In addition, it also explains on how the ultrasonic is used in implementing it on distance measurement. Besides that, this chapter will review on the idea about the project design, concept and other related information to improve on this project.

Chapter 3 introduces the methodology of the project. In this chapter, flow chart will be included which explains the overall method used along the implementation of this project. The factor that is taken into consideration on choosing the method is discussed and its advantage over other method is stated clearly.

Chapter 4 shows the result for the project outcome. This chapter includes the findings of the research and the result the project is seen through the objective perspective and the problem statement. Also, the project progress is discussed.

Chapter 5 will be the conclusion of the project where summary is stated. This chapter also includes some recommendations that can be implemented in the future and knowledge gain throughout this project.

CHAPTER II

LITERATURE REVIEW

This chapter will review on the related projects and systems in order to obtain idea about the project design, concept and other related information to improve on this project. Besides that, other related elements are also included, such as the software used, Programming Language, microcontroller used, Ultrasonic Technology and so on.

2.1 Studies on PROTEUS Software

With Proteus Simulation Software, it enables the co-simulation of microprocessor software within a mixed mode SPICE simulator which available for PIC, 8051, MSP430, AVR, HC11, ARM7/LPC2000 and Basic Stamp processors [1]. Also, it works with most of the assembler and compilers.

Proteus Software is software for PCB design where it combines the ISIS schematic capture and ARES PCB layout programs. This combination of both programs is to provide a integrated, powerful, and easy to use suite of tools for designing PCB. Besides that, Proteus is used for microprocessor simulation where we actually do not need to build the real prototype to test our program codes and the functionality of the circuit.

ISIS Schematic Capture is used to design the circuit and simulations. This software includes style templates and full customisations of schematic appearance where we can

specify its line widths, colours, fill styles, fonts, and so on. It has the hierarchical design where it includes the parameter of the sub-circuit component values. With its multi-element parts including connectors and continually expanding and large component libraries with over 10,000 parts, the software is most complete with its ready to use simulator models.

Besides that, it have unique visual design explorer where it allows user to cross probe and navigate between the netlist, schematic, and PCB databases. Also, it can make an output to any printer device whether in colour or monochrome and user can choose to export the design in graphical formats such as BMP, WMF, EPS, DXF, and HPGL formats.

ARES PCB Layout features designing PCB layout database where it is capable of representing the most difficult of PCB designs. For its templates and technology data, ARES allows user to create several templates representing common projects and then initialise new layouts from template to preload all of the configured information.

Furthermore, it have manual route placement and editing where user can place tracks any way we wish and made the connections where it looks like it is actually completed. Also, ARES provides 3D visualisation where it shows the layout preview and view the board as it is actually to appear in real life.

2.2 Studies on Programming Language

In general, programming languages are used for controlling the actions of machine. There are many types of programming language and in this project; one of the programming language will be chosen. In the table below is the comparison between Assembly Language, C, and C++ in terms of general and technical information.

Table 2.1: The Comparison between Assembly Language, C, and C++

	Assembly Language	**C**	**C++**
Paradigms	any, imperative	imperative, procedural	generic, imperative, object-oriented, procedural
Intended Use	General	System	Application, System
Speed	Greater speed but insufficient execution speed	Faster to compile and execute	Generally slower at runtime, and are much slower to compile
Platforms	Not cross-platform, separate implementation for each supported platform will be required	Almost anything, requires recompile	Any, but libraries used can make it limited
Typing Discipline	Un-typed	Static, Weak	Static, Unsafe, Nominative
Execution Flow	Flow is sequential manner	Top to Bottom	Bottom to Top
Programming-String type	Support usual symbolic addressing and the definition of character strings or hex strings	Cannot use string type but declare it as an array of characters	Can use string type

Based on the comparisons above, the language to be implemented is by using C language. Writing the program in C is much faster than writing it in assembly. For C++, it is about the same time to write the program is C. Also, the speed for C to compile is faster than C++ and has faster execution time than Assembly Language. Since the platforms for C is almost anything, it eases the work of the programmer to develop the project. For the programming string type, although C cannot use string type but it is able to declare it as an array of characters.

The use of C in Microcontroller applications has been brought about by manufacturers providing larger program and RAM memory areas in addition to faster operating speeds [2].