DESIGN AND IMPLEMENTATION OF AN ULTRASONIC DISTANCE MEASUREMENT DEVICE

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DEDICATION

This report is dedicated to Almighty God, for his love, guidance and blessing through my stay at the Department of Electrical and Electronics Engineering, Federal University Oye-Ekiti Ikole Campus. To my dearest parents Mr. and Mrs. Bamidele who made my academic success a reality through their moral and financial support.

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CERTIFICATION

This project work titled "Design and Implementation of an Ultrasonic Distance Measurement Device" by Bamidele Oluwatoba Moses , meets the requirements for the award of Bachelor of Engineering (B.Eng.) degree in Electrical and Electronics Engineering Department, Federal University Oye-Ekiti, Nigeria

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ABSTRACT

This Project details the design and implementation of an ultrasonic distance measurement used for measuring distance in the range of 0.5m to 4m with the accuracy of1cm. The measurement of the distance is achieved by using ultrasonic sensors. It works by transmitting ultrasonic waves at 40 kHz. Then, the transducers will measure the amount of time taken for a pulse of sound travel to a particular surfaces and return as the reflected echo. After that, the circuit that have been programmed with ATmega microcontroller will calculate the distance based on the speed of sound at 25°C which an ambient temperature and also the time taken. The distance then will be display on a LCD module. The importance of the project is calculating accurate distance from any obstacle that we want to measure. The device can be used in many different fields and categories like distance calculation in construction field, robots, automatic car critical braking system sensor to detect and avoid obstacles and many other applications

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Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my siblings, whose love and guidance are with me in whatever I pursue. They are the ultimate source of motivation.

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Finally, my profound gratitude goes to all my colleagues for their great support and encouragement during the course of this report.

CHAPTER ONE

INTRODUCTION

1.1 PROJECT BACKGROUND

The system consists of only one main component, a microcontroller unit which acts as the brain of the system. Input and output components such as transmitter unit, receiver circuit, temperature control and LCD modules are connected to the system brain. The figure below shows the components of the system and how they are connected. The transmitter generates a 40 kHz signals and begin the transmission time together with the process of sending signals. While the signals begin to transmit through ultrasonic transducer, the microcontroller will capture the starting point of transmission time and hold it until the receiver gets the echo signal back. The signal will contact with any obstacle ahead and will bounce back to the receiver circuit. When the signal is back, the receiver must detect the echo signal, process & send to the microcontroller. The microcontroller will stop the transmission time immediately and will calculate the range using the transmission time and display the range on LCD modules. If the transmit signal cannot touch any obstacle in front it, or the time is very fast, the system will display error message on the LCD modules, indicating the range is not suitable for the system.

1.2 PROBLEM STATEMENT

In the construction field, the usage of electronic measuring device is still not widely used. Due to the high cost of this equipment at market, an economic way needs to think of in order to create an accurate measuring device with low cost. Nowadays, measuring distance is considered as problem in construction field or indoor measuring activities because this task is made by using measuring tape. The problem will occur when using measuring tape where we need at least 2 persons to measure between two distances.

However, this does not have a perfect accuracy due to parallax and obstacle in their way. Improvement had been done where some products have infrared light emitters and receivers to determine an object's distance. Other devices have laser-based systems which have improved accuracy and precision. Presently, the detection techniques of laser, radar, and infrared ray have been widely applied at the aspect of obstruction detection and distance measurement. Because of the expensive price, the distance measurement system of laser and radar is only set on the minority of instruments. For infrared sensor, the range of the distance that can be measured is very short with only a range of 4-30 cm. Therefore, this project is necessary to do the process of measurement quickly and accurate without doing measurement manually, it also has the advantages to store measurement as many as 32 memories at one time.

1.3 MOTIVATION

I. The inability to discern objects within 0.5 m. is due to the typical specular nature of the ultrasonic waves reflection, only reflecting objects that are almost normal to the sensor acoustic axis which can be accurately detected

II. The motivation for this project is to develop or build an ultrasonic distance measurement device that would take measurement of distance more accurately to reduce or eradicate hazards due to error in measurements.

1.4 AIM &OBJECTIVE

The aim of the project is to design an ultrasonic distance measurement device using an ultrasonic sensor.

The objectives of the projects are:

I. To create an electronic measuring device using ATMega328

II. To determine the distance of object with ultrasonic sensor for indoor use

III. To get an accurate measurement in digital facts and figures.

IV. To inform user about the total distance by displaying on Liquid Crystal Display (LCD).

1.5 SCOPE OF THE PROJECT

This project shows the design and implementation of an ultrasonic distance measurement device to reduce error that may occur while using traditional measuring methods:

1. The major limitation of this project is that it cannot take measurements of distance in kilometers.

2. Another limiting factor as regards the success of this project is the availability of components. At the end of this project the device would be able to detect distance and show result or readings on the LCD.

1.6 PROJECT ORGANIZATION

This project is organized into five chapters: I. Chapter one gives a brief introduction to the project highlighting the problem statement, main objectives, aim, motivation and scope of the project. II. Chapter two presents an overview of the technological analysis and the concept of related work based on the alcohol triggered vehicle engine lock system.. III. Chapter three presents the methodology of the project. It illustrates approaches employed to demonstrate steps used to make this project possible. In addition the chapter presents a description of the research process and explanation of the models used to gather data. The functional block diagram and operational flow chart are also part of this section. IV. Chapter four presents the results and analysis of the design. It gives an insight on the project management, project schedule, risk management and the tests carried out on the project. V. Chapter five is the conclusion and recommendation. This chapter testifies the success of the project. limitations and the suggestion for the future development related to this work.

CHAPTER TWO

LITERATURE REVIEW

2.1 RELATED WORK

Distance measurement is the process of obtaining and comparing variable quantities in our real world. It is one of the important functions in engineering to business activities. There are many types of distance measurement system we use in our environment. In applications, basic concept of electronics distance measurement system is adopted in many areas like aviation, navigation, and many more. (Pawar Priti Arun, 2014-2015). So many reviews of related literatures of this project have been done to ensure more understanding to design and implement an ultrasonic distance measurement device.

Very important work done as regard this project is a work carried out a work carried out on ultrasonic range meter based on ultrasonic transducer pair and using AVR ATmega328-Pu microcontroller. By employing an ultrasonic transducer pair for producing ultrasonic sounds and sensing the reflected sound waves, the objects are detected. The hardware interface of this project uses an Atmel ATmega328-Pu AVR microcontroller to facilitate the generation of 40KHz signals burst which is used in the transmitter circuit, and also to process the received signal for measuring the time of flight of reflected waves and exact distance of the obstruction. The minimum distance this system can measure is 0.2m and the maximum distance is 3.6m. (Suliman, 2011)

A research study carried out on the design of an ultrasonic distance meter using ultrasonic waves at 40KHz for distance measurement, the study uses an ultrasonic transducer to measure the amount of time taken for a pulse of sound to travel to a particular surface and return as the reflected echo. This project calculates the distance based on the speed of sound at 25 degree Celsius ambient temperature and shows it on an LCD display. Using that it can measure up to 2.5meters. (Shamsul Arefin, 2013).

In another project work carried out on the design and development of smart ultrasonic distance measuring device, discusses the measurement of distance without making contact with the target. this is done by generating 40 KHz ultrasonic waves using ultrasonic transducer. Here the distance is calculated on the basis on time taken by the pulse generated by the ultrasonic transducer to travel to the target and return as reflected echo. This project makes use of microcontroller for calculating the distance and displaying it on a seven segment display. The distance up to 2.5m is calculated in air medium at ambient temperature.(Monisha S. 2015)

Distance measurement is an important factor used in almost every field. Distance can be measured using several methods. Generally it is measured using measuring tapes, ropes, rulers etc. Apart from these methods it can also be measured optically and electro-magnetically. Optical measurement was made possible by Sir James watt. In electromagnetic measurement method [H. He, and J. Liu, 2008] distance is measured on the basis of the time taken by the radio wave to travel a certain distance. Measurement of distance by infrared rays is also possible [Xiao Chan, Chenliang Wu, 2011]. Reviews of the previous literatures of ultrasonic distance meter were studied and understood for the development of this project. The conclusion drawn was that the ultrasonic was used in various areas such as under water, sewage blockage detection [A. K. Shrivastava, A. Verma, and S. P. Singh, 2008], measuring the water level [Sabuj Das Gupta, Islam Md. Shahinur, 2012]. The device can also be used in automotive applications [Alessio Carullo and Marco Parvis, 2001].

2.2 REVIEW OF FUNDAMENTAL CONCEPTS

A detailed investigation of ultrasonic sensing technology described in this chapter reveals the fact that ultrasonic technology is increasingly being used in a broad range of applications due to its non-mechanical and contactless nature; robustness in harsh environments; its ability to work with a wide range of chemical substances; compact and flexible size; longer functional life; and lower manufacturing cost. Even though the uses of ultrasonic sensing technology in fluid level measurement systems has produced satisfactory outcomes in a broad range of applications, the literature review has highlighted some of the weaknesses of ultrasonic sensing technology in relation to its accuracy in level measurement particularly in dynamic environments. Level sensing in dynamic environments is characterized by three factors:

- Slosh
- Temperature variation
- Contamination (obstacles and dust)

Solutions to each of these three above mentioned factors have been reviewed in this chapter. However, all these solutions entail either higher production cost because of the requirement for additional sensors, or they provide only marginal improvement in terms of accuracy compared to current systems. To provide a practical and compact solution to the above mentioned problems pertaining to the inaccuracy of ultrasonic level sensing systems in dynamic environments, an intelligent ultrasonic sensor system is to be developed for fluid level sensing with the incorporation of a Support Vector Machine (SMV) based Signal characterization and classification methodology.

2.3 ULTRASONIC SENSOR

An ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listen for that sound wave to bounce back. An ultrasonic sensor comprises, for example, one ultrasonic transducer which transforms electrical energy into sound and, in reverse, sound into electrical energy, a housing enclosing the ultrasonic transducer or transducers, an electrical connection and an electronic circuit for signal processing also enclosed in the housing. In order to sense a spatial area, respectively, to measure the distance between two points, conventionally an ultrasonic sensor is positioned at a suitable point and is directed onto the corresponding spatial area which is to be sensed, respectively, in which a body to be detected is present the distance of which to a reference point is to be determined. The ultrasonic sensor comprises of an ultrasonic transducer which emits ultrasonic impulses and receives the echo of the ultrasonic impulses reflected at the body. In the case of receiving an echo, the distance between the ultrasonic sensor and the body positioned within the spatial area that has been detected is determined with a computing circuit (echo propagation time measurement). Instead of an ultrasonic transducer a plurality of such ultrasonic transducers can be used whereby the function of the respective ultrasonic transducer may be limited to emitting the ultrasonic impulses, respectively, to receiving the echo of the ultrasonic impulses. An ultrasonic sensor for distance measurement comprises at least one ultrasonic transducer for sending a working sound impulse and for receiving the echo. The ultrasonic transducer is surrounded by a sound deflecting surface onto which the ultrasonic impulses of the ultrasonic transducer are impinged. In the sound reflecting surface of a further ultrasonic transducer. (Suliman, 2011)

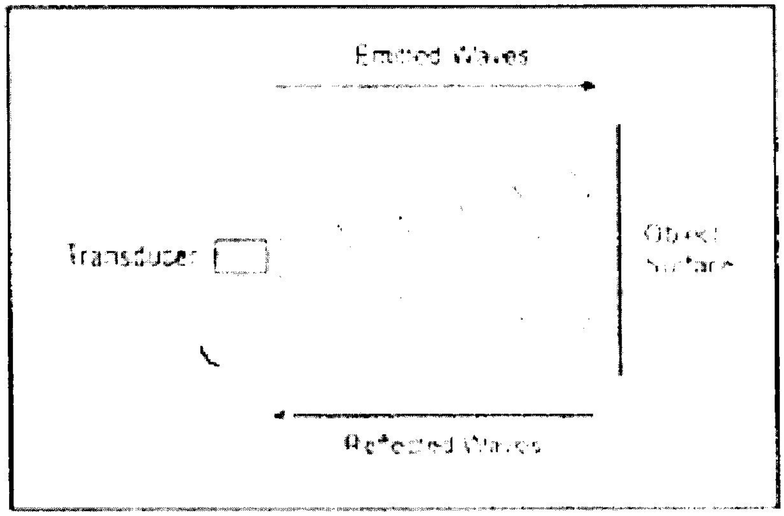


Fig 2.1 An echo received by the transducer (Wikipedia, 2011)

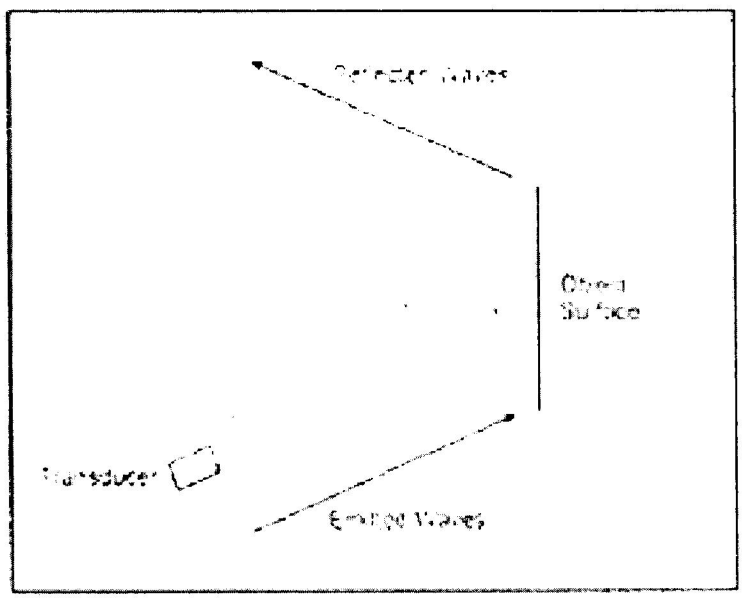


Fig 2.2 Reflected beam misses the tranducer (Wikipedia 2011)

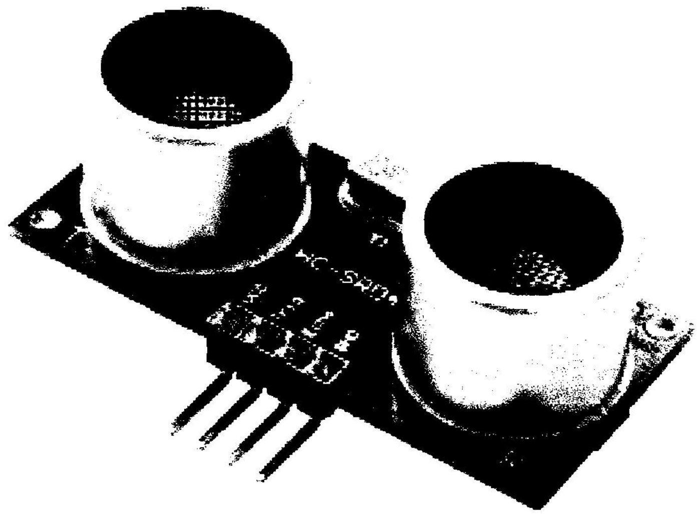


Figure 2.3 Ultrasonic sensor. (Monisha S, 2015)

2.3.1 Advantages of Ultrasonic Sensor

When used for sensing functions, the ultrasonic method has unique advantages over conventional sensors:(Suliman, 2011)

1. Discrete distances to moving objects can be detected and measured.
2. Less affected by target materials and surfaces, and not affected by color. Solid-state units have virtually unlimited, maintenance free life. Can detect small objects over long operating distances.
3. Resistance to external disturbances such as vibration, infrared radiation, ambient noise, and EMI radiation.
4. Excellent long term stability.
5. Low power consumption and low cost realization.
6. Directional sensitivity.
7. High structural resolution due to large bandwidth.

8. Remote measurement, low interference with objects to be detected, sensitivity to virtually all kinds of objects.

9. Imperviousness to wetness, contamination or wear.

2.4ULTRASONIC TRANSDUCER

There are two main types of transducer used to transmit ultrasonic signals. They are the Piezo-type and the electrostatic type. The general transducer design features a Piezo ceramic disc bender that is resonant at a normal frequency of 20 - 60 kHz and radiates or receives ultrasonic energy. They are distinguished from the Piezo ceramic audio transducer in that they produce sound waves above 20 **kHz** which are inaudible to human and the ultrasonic energy is radiated or received in a relatively narrow beam. The open type ultrasonic transducer design exposes the Piezo bender bonded with a metal conical cone behind a protective screen. The enclosed type transducer design has the Piezo bender mounted directly on the underside of the top of cases which then machined to resonant at the desired frequency. Following are the specifications of ultrasonic.

Specifications:

1. Sensitivity: -38dB
2. Impedance: >1k
3. Operating Voltage: 3V - 20V
4. Mounting: solder pad

2.5 ATMEGA328-PU MICROCONTROLLER

A microcontroller is a small and low cost computer built for the purpose of dealing with specific tasks, such as displaying information in a microwave LED or receiving information from a televisions remote control.(Shamsul Arefin, 2013). An ATMega328-pu is a Programmable Integrated Circuit microcontroller, a 'computer-one-chip'. They have a processor and memory to run a program responding to inputs and controlling outputs, so they can easily achieve complex functions which would require several conventional ICs. The ATMega328-pu can receive inputs, stored or registers, processed such as added or subtracted and sent out the output. The ATMega328-pu microcontrollers are based on RISC (Reduced Instruction Set Computer) architecture: therefore use a relatively small number of instructions. Most ATMega328-pu used 35 instructions compared to some general-purpose microprocessors (like Motorola 68000 and Intel 8085) that may have several hundred. Important feature of modem ATMega328-pu devices is the use of electrically erasable and programmable Flash memory for program storage. These Flash memory devices are often denoted as much easier to work with for one-off prototyping because reprogramming is greatly simplified

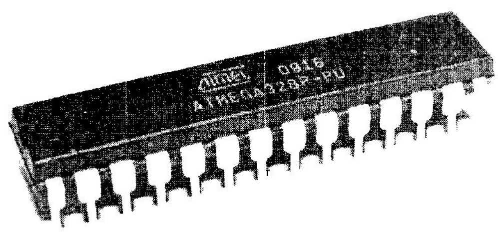


Figure 2.4 ATMega328-pu (Wikipedia 2011)

2.5.1 Feature of ATMega328-pu

High Performance, Low Power Atmel AVR 8-Bit Microcontroller Family

• Advanced RISC Architecture

– 131 Powerful Instructions

– Most Single Clock Cycle Execution

– 32 x 8 General Purpose Working Registers

– Fully Static Operation

– Up to 20 MIPS Throughput at 20MHz

– On-chip 2-cycle Multiplier

• High Endurance Non-volatile Memory Segments

– 32KBytes of In-System Self-Programmable Flash program Memory

– 1KBytes EEPROM

– 2KBytes Internal SRAM

– Write/Erase Cycles: 10,000 Flash/100,000 EEPROM

– Data Retention: 20 years at 85°C/100 years at 25°C

– Optional Boot Code Section with Independent Lock Bits

• In-System Programming by On-chip Boot Program

• True Read-While-Write Operation

– Programming Lock for Software Security

2.6 LIQUID CRYSTAL DISPLAY (LCD)

A liquid-crystal display (LCD) is a flat-panel display or other electronically modulated optical device that uses the light-modulating properties of liquid crystals. LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

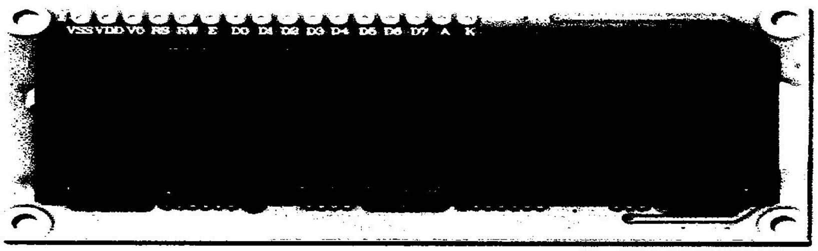


Fig.2.5 LCD Screen (LCD Display 2009)

CHAPTER THREE

DESIGN METHODOLOGY

3.1 INTRODUCTION

The ultrasonic distance meter account for the amount of time taken to measure the distance by taking into account the amount of time taken by the pulse to travel to a target and return as reflected echo and also the speed of the pulse. The device calculates the distance up to 2.5m and at a temperature of 25 degree C and displayed on LCD Screen. Here two ultrasonic transducers are used one each at transmitting and receiving end. A microcontroller ATMega328-pu is used which act as the brain of the device which carries out all the major functioning. The system consists of a transmitter circuit and a receiver circuit. the details of which are described below.(Monisha S. 2015)

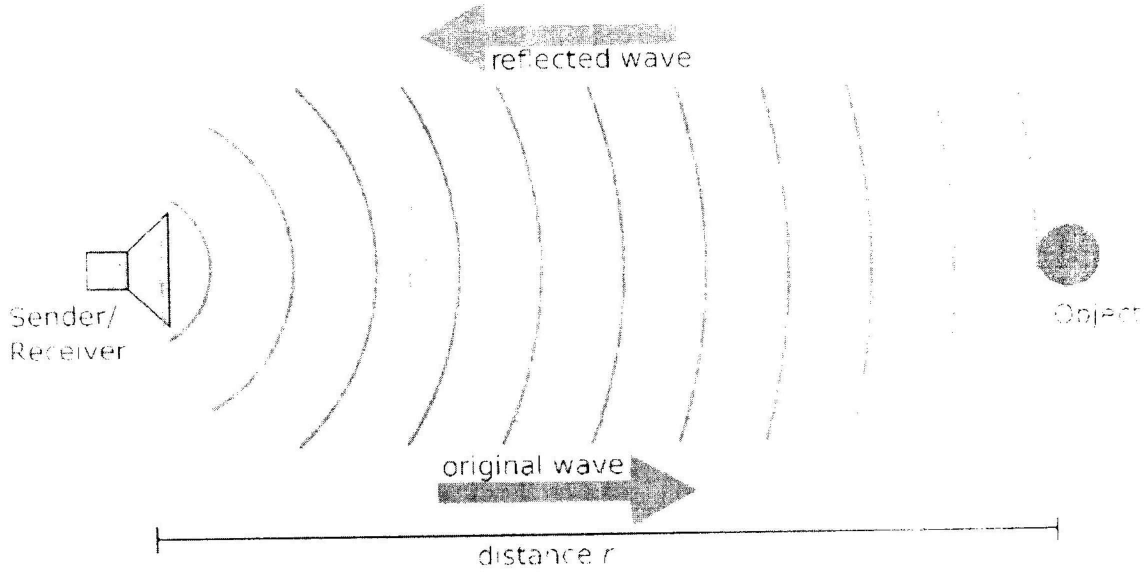


Figure 3.1 Principle of ultrasonic distance meter. (Monisha S. 2015)

The time of flight method is used for finding the distance between the transmitter and the object. The transmitter sends out a burst of pulses and a receiver detects the reflected echo. The time delay between the corresponding edges of the transmitted and received pulses is measured by microcontroller.this gives the time of flight. Substituting the time of delay and the velocity of ultrasound in air (330metres/second) in the following formula we can determine the distance between the transmitter and the target.

Distance = Velocity X Elapsed time

3.2 BLOCK DIAGRAM

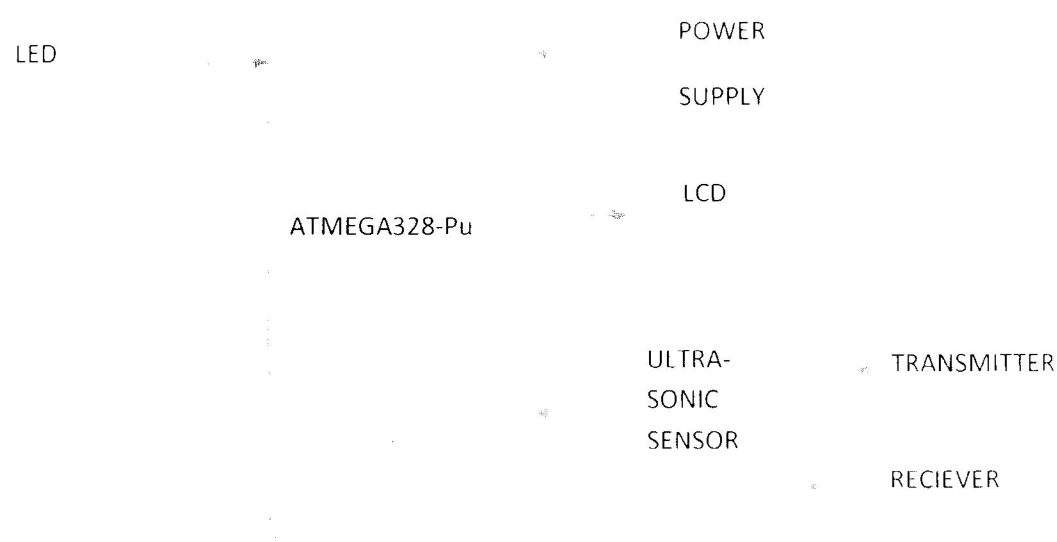


Figure 3.2 Overall Block diagram of the project.

The mode of operation of the measurement device can be easily described using the fig.3.1 above. When the device receives supply from the battery the LED is turned ON and the ultrasonic sensor sends a wave at a frequency of 40khz through the transmitter to the target or object and the receiver of the sensor sends signal back to the ATMega 328-pu for analysis and the result of measurement taken is displayed on the LCD.

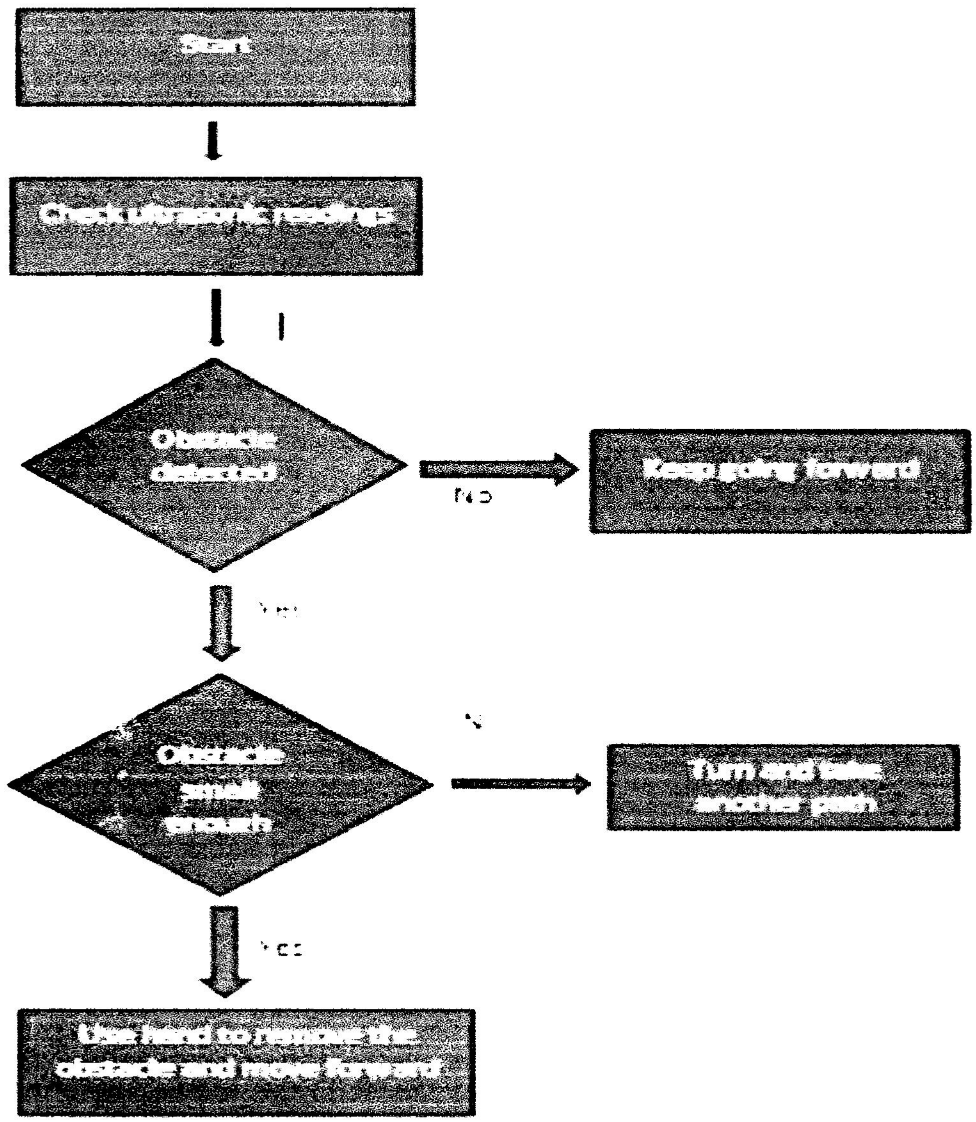


Figure 3.2.1 Operational flow chart of the project

3.2.1 METHODOLOGY:

The technique of distance measurement using ultrasonic in air include continuous wave & pulse echo technique. In the pulse echo method, a burst of pulses is sent through the transmission medium & is reflected by an object kept at special distance. The time taken for the pulse to propagate from transmitter to receiver is proportional to the distance of object. For contact less measurement of distance, the device has to rely on the target to reflect the pulse back to itself. The target needs to have a proper orientation that is it needs to be perpendicular to the direction of propagation of the pulses. The amplitude of the received signal gets significantly attenuated and is a function of nature of the medium and the distance between the transmitter and target. The pulse echo or time-of-flight method of range measurement is subject to high levels of signal attenuation when used in an air medium, thus limiting its distance range.

3.3 COMPONENTS USED

- **Voltage regulator**: Voltage regulator is a commonly used electrical component in an electrical circuit. The function of the voltage regulator is to convert AC or DC Voltage into DC Voltage and to produce a relatively desired constant voltage. The use of voltage depends on the function of the circuit and application. There are two kinds of voltage regulators, passive voltage regulators and active voltage regulators. A passive voltage regulator reduces the input voltage to a desired value and removes the excess energy by means of heat. Normally, a heat sink is attached to the voltage regulator in order to dissipate the heat. Whereas an active voltage regulator increases the input voltage to a desired value. This is achieved by a negative feedback loop to control the voltage.

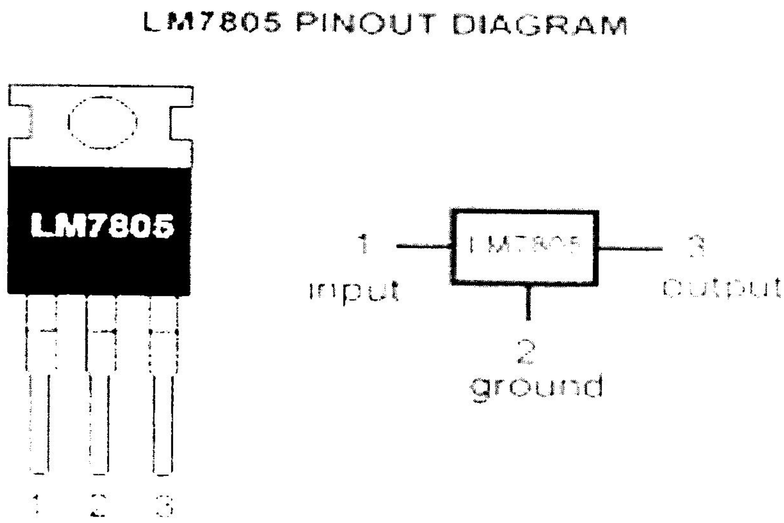


Fig 3.3.1 voltage regulator (Wikipedia. 2009)

For this project, LM7805 is chosen as the voltage regulator shown in figure above. It is connected straight to AC power where a DC power adapter then supplies to the voltage regulator so the voltage regulator can provide a constant output voltage of 5V and the maximum output current is 1A to power up the circuit.

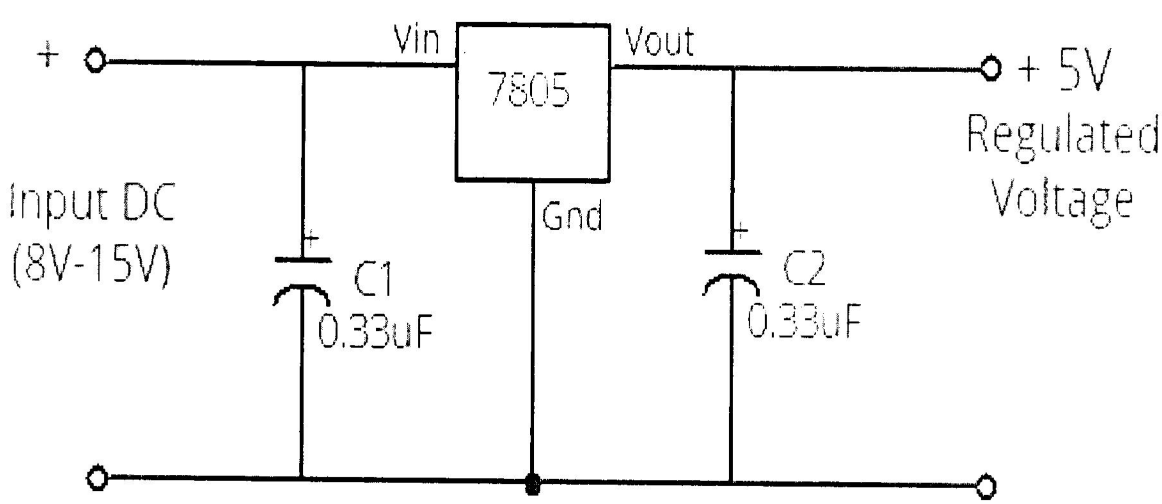


Fig 3.3.2 Voltage regulator (Wikipedia. 2010)

- **Capacitor**: Capacitors are widely used in an electrical circuit. It serves as a device which stores energy in the form of an electrostatic field. It is used for several functions such as smoothing power output, blocking direct current and only allowing alternating current to pass through.

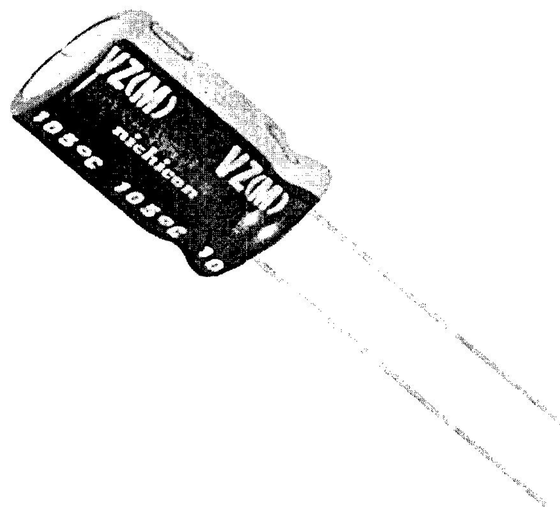


Fig 3.3.3 capacitor (Wikipedia,2009)

- **LCD (Liquid Crystal Display) screen**: is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on. A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD.

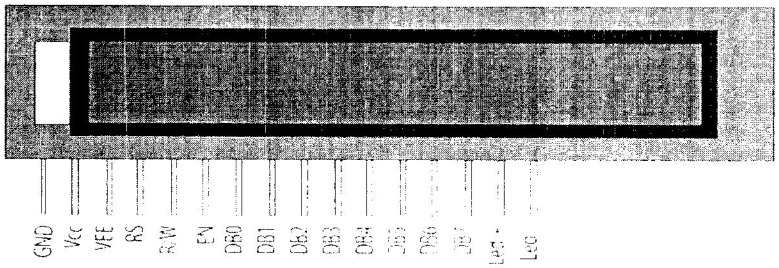


Fig 3.3.4: Pin diagram for 16X2 LCD Display (LCD Display, 2009)

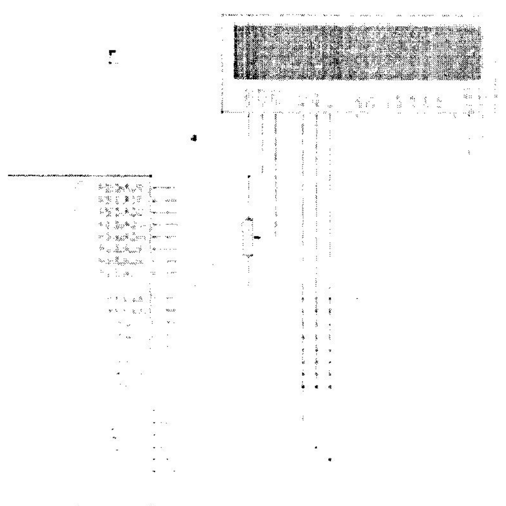


Fig 3.3.5: circuit diagram of the LCD Display Unit (LCD display, 2009)

Table 3.1: Pin description: The functions of each pin of the LCD

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8- bit data pins	DB0
8	8- bit data pins	DB1
9	8- bit data pins	DB2
10	8- bit data pins	DB3
11	8- bit data pins	DB4
12	8- bit data pins	DB5
13	8- bit data pins	DB6
14	8- bit data pins	DB7
15	Backlight Vcc (5V)	Led +
16	Backlight Ground (0V)	Led -

3.4 TRANSMITTER

The transmitter section consists of a transistor which amplifies the 40 KHz pulse generated by the microcontroller. The ultrasonic transducer which is used as a transmitter is driven by an inverting buffer. A set of three parallel inverter are used to increase the transmitted power. The output of this set of parallel inverters are given as input to the another set of parallel inverters. Then the output of both these parallel inverters is given as input to the two terminals of the ultrasonic transducer at the transmitting end. One of the inputs given to the terminal of the transducer is the positive going pulse and the other terminal is given 180 phase shift of the same input. This is done in order to increase the transmitted power. Thus the ultrasonic transducer at the transmitting end generates a 40 KHz pulse which hits the target and return back as reflected echo. (Monisha S. 2015)

3.5 RECEIVER

The reflected echo from the target is picked up by the receiver. The echo received by the receiver is very weak and is amplified through various stages of amplifier. The first stage is a buffer with a unity fed to its non-inverting terminal. The first stage is coupled to the second stage through a capacitor. The second stage is an inverting amplifier and the third stage is a precision rectifier amplifier. The output of the amplifier is filtered and then given to the pin12 of microcontroller which is an analogue comparator. pin 13 is another terminal of the microcontroller. For displaying a particular digit on segment display the microcontroller provides segment data and display enable signal in a time multiplexed mode. A switch is used here to reset the microcontroller which drives the reset signal through a set of capacitor and resistor. The arrival of the echo signal from the target makes port3.6 of the microcontroller high which is sensed by the microcontroller. Hence the timer is read and the 16 bit number is divided from the velocity of sound to obtain the four digit number. This four digit number is displayed on the seven segment display which indicates the distance of target with sound to obtain the four digit number. This four digit number is displayed on the LCD Screen display which indicates the distance of target.(Monisha S, 2015)

3.5 PRINCIPLE OF OPERATION

Ultrasonic transducer uses the physical characteristics and various other effects of ultrasound of a specific frequency. It may transmit or receive the ultrasonic signal of a particular strength. These are available in piezoelectric or electromagnetic versions. The piezoelectric type is generally preferred due to its lower cost and simplicity to use. The Ultrasonic wave propagation velocity in the air is approximately 340 m/s at 15°C of air or atmospheric temperature, the same as sonic velocity. To be precise, the Distance Measurement of an Object or Obstacle by Ultrasound Sensors using P89C51RD2 A. K. Shrivastava, A. Verma, and S. P. Singh ultrasound velocity is governed by the medium and its temperature hence the velocity in the air is calculated using the formula below (1). V= 340+0.6(t-15) m/s (1) temperature. (

In this study, a room temperature of 20°C is assumed; hence the velocity of ultrasound in the air is taken as 343 m/s, because the travel distance is very short, the travel time is little affected by temperature. It takes approximately 29.15μsec for the ultrasound to propagate waves through 1cm distance; therefore it is possible to have 1cm resolution in the system. Basically, the user sends a trigger pulse to the module which sends out an ultrasonic wave. After a period of time the receiver gets back a reflection. The duration determines the distance (Shrivastava A.K. 2010).

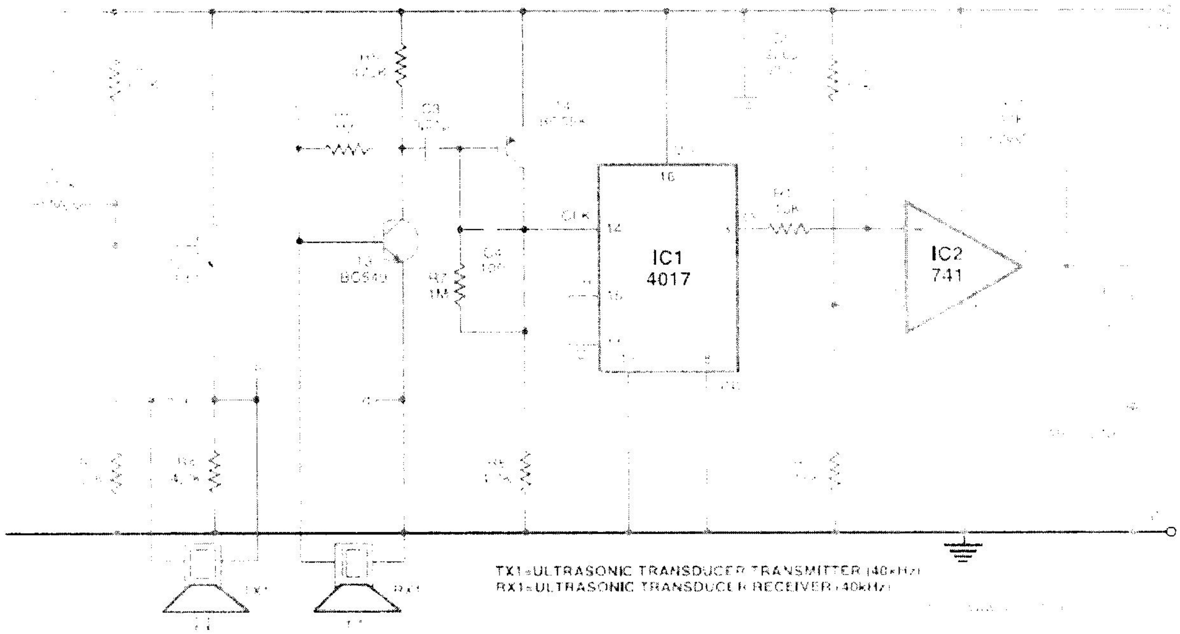


Fig 3.3.6 circuit diagram of ultrasonic sensor (ultrasonic sensor datasheet.2012)

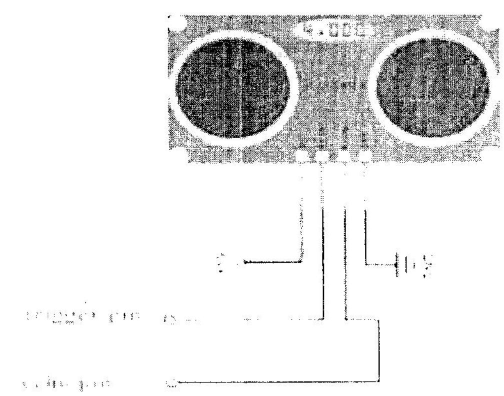


Fig 3.3.7 ultrasonic sensor (Wikipedia. 2009)

CHAPTER FOUR

CONSTRUCTION TESTING AND RESULT

4.1 CONSTRUCTION

In constructing any electronics circuit, a circuit diagram is first drawn after then all components and materials needed for the circuit project are purchased. The components are then connected on a solder less board which provides a temporary process to construct a circuit and make sure that the circuit is functional as desired before it is transferred and soldered on the permanent vero board platform for the construction. The circuit diagram that makes up this project is shown below in fig. 4.1.

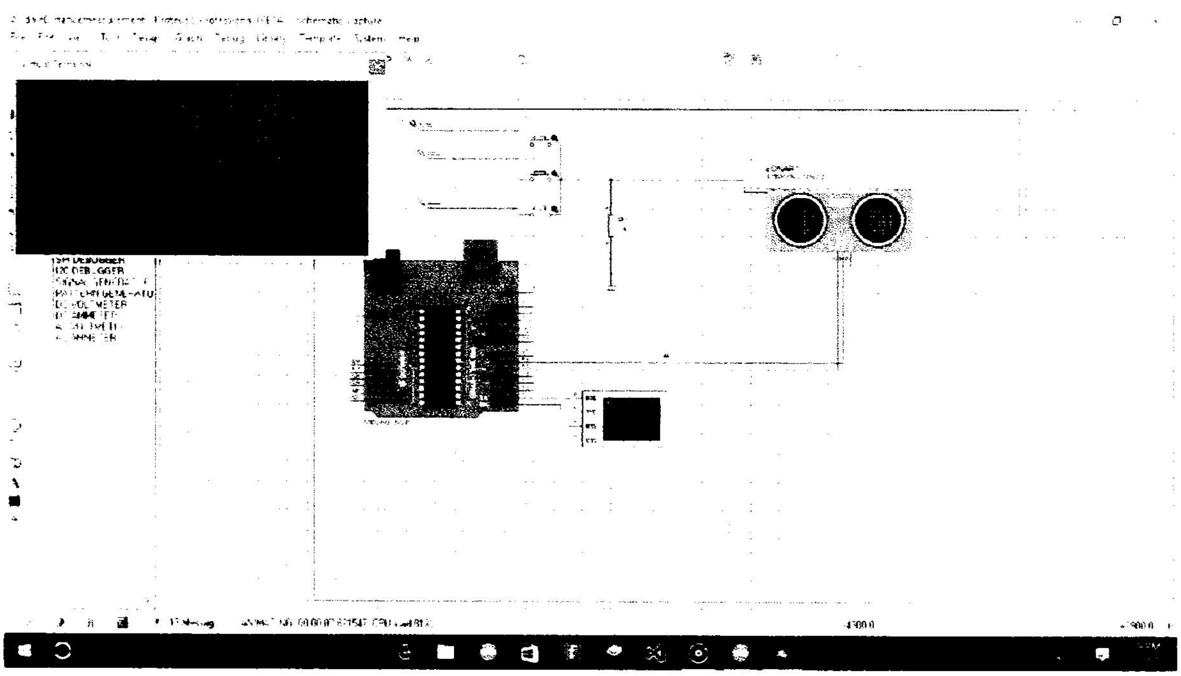


Fig 4.1 Circuit diagram of the project

4.2 HARDWARE IMPLEMENTATION

- The circuit was first constructed on a bread board to ensure the operation of the project as shown below in figure 4.2.1

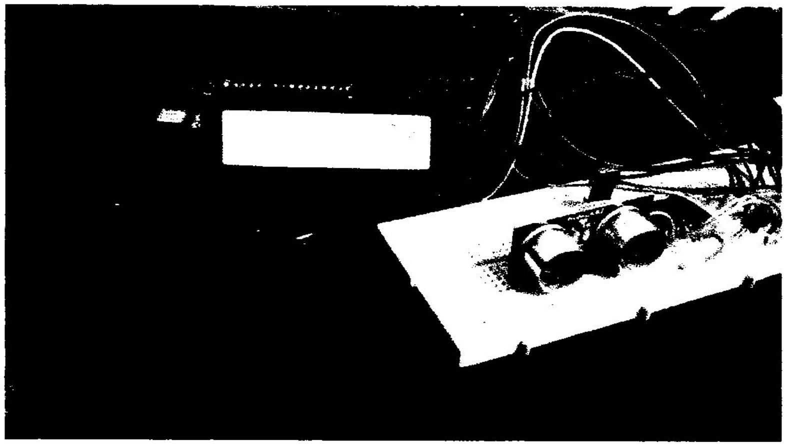


Fig 4.2.1 Circuit on breadboard

- Afterwards the circuit was interconnected with the LCD, Aurdino board and ultrasonic sensor on a permanent Vero board as shown below in fig. 4.2.2

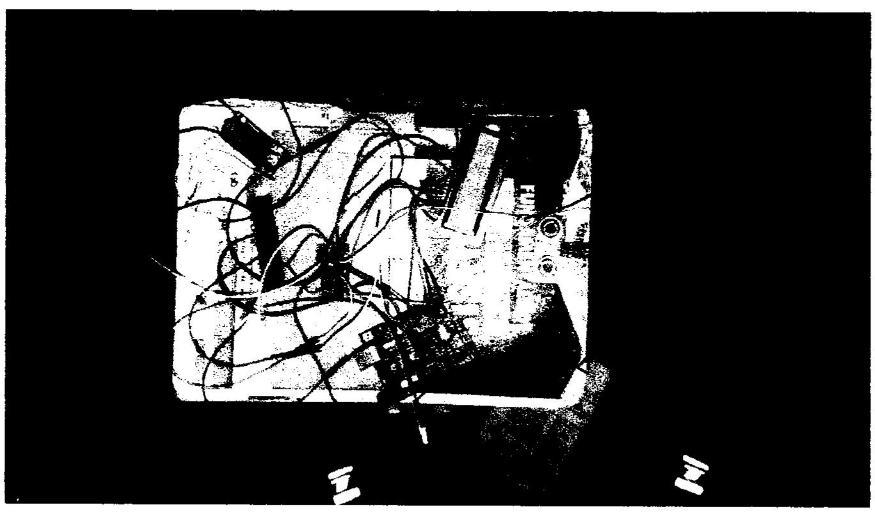


Fig 4.2.2 Circuit on vero board

4.3 TESTING

The testing of the various components of the project was confirmed with result and functional.

4.3.1 TESTING OF ULTRASONIC SENSOR

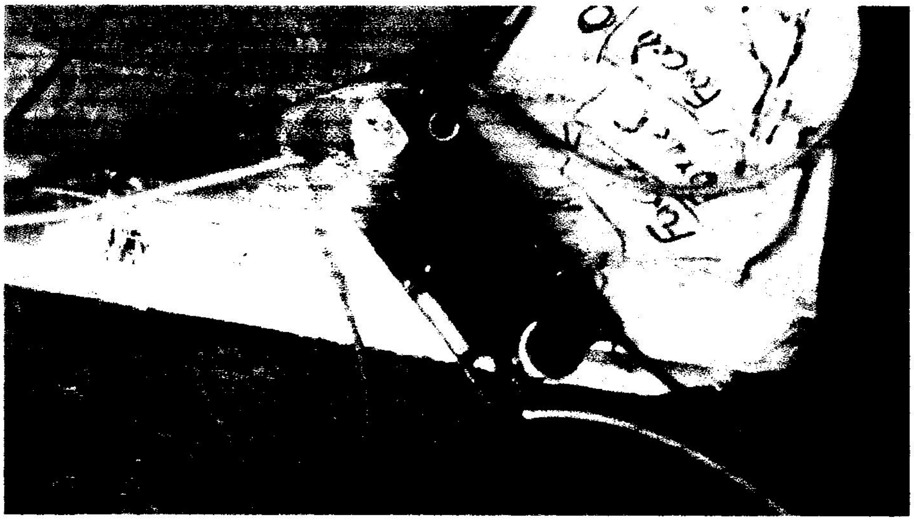


Fig 4.3.1 Ultrasonic sensor.

4.3.2 TESTING THE ARDUINO UNO BOARD

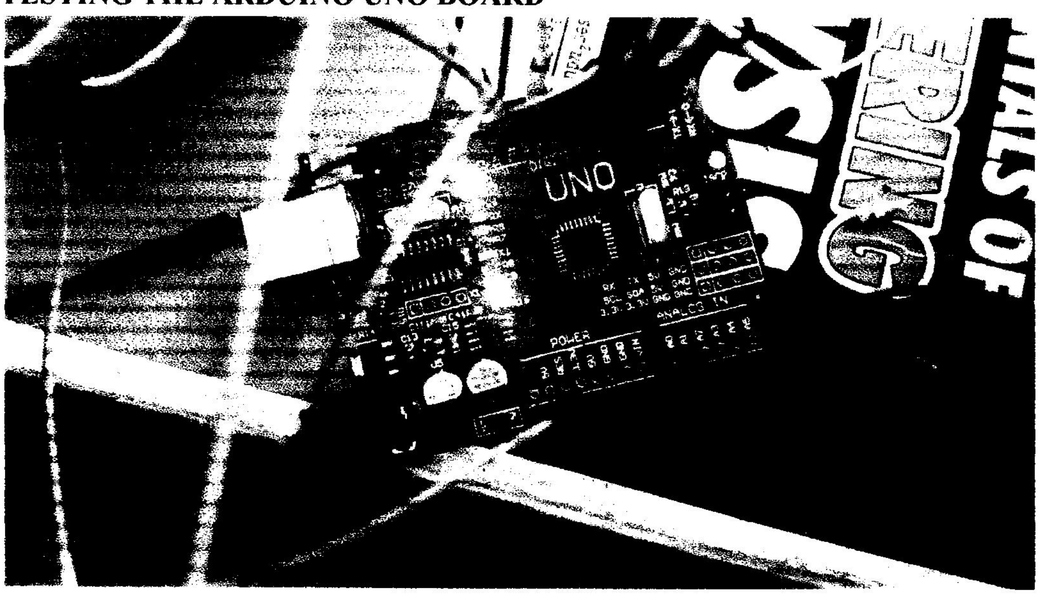


Fig 4.3.2 Arduino Uno Board

4.3.3 TESTING THE INTERCONNECTED COMPONENTS

Fig 4.3.3 Interconnect components

4.3.4 TESTING THE POWER SUPPLY WITH A DC BATTERY

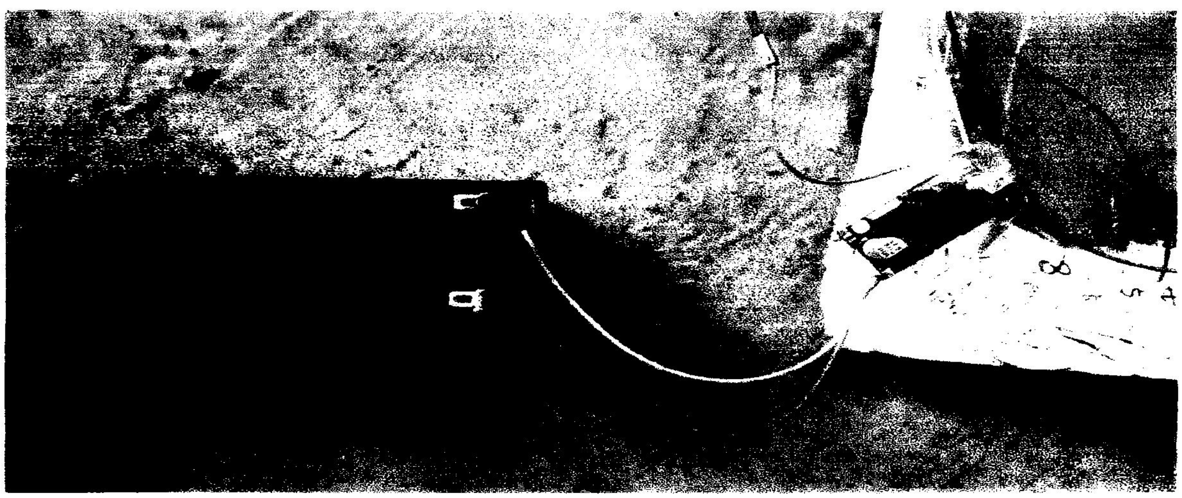


Fig 4.3.4.1 DC Battery

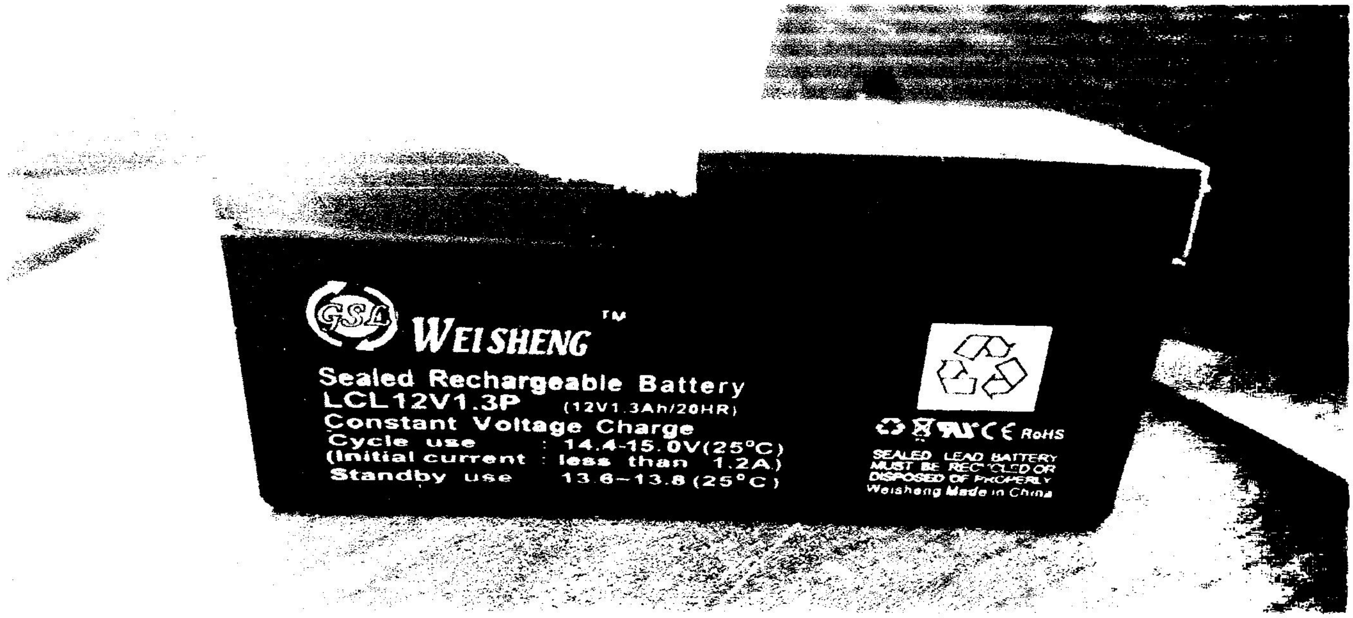


Fig 4.3.4.2 DC Battery

4.3.5 HOUSING

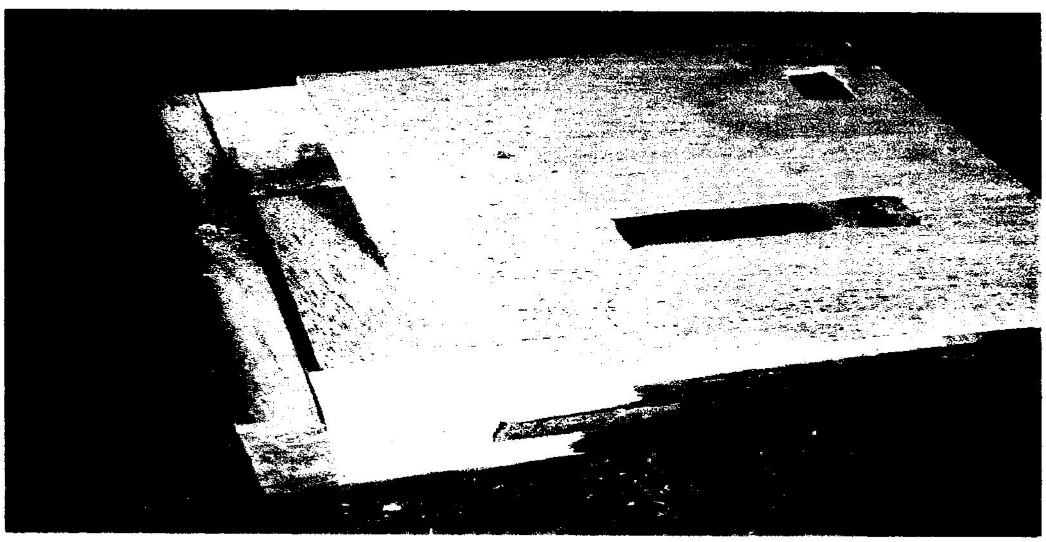


Fig 4.3.5.1 device housing.

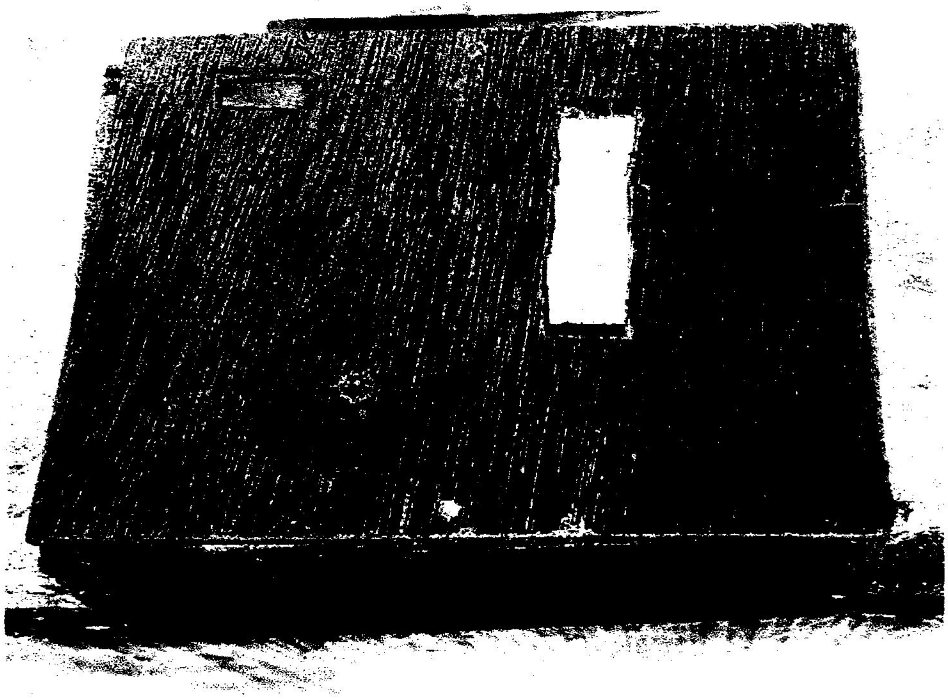


Fig 4.3.5.1 painted project case.

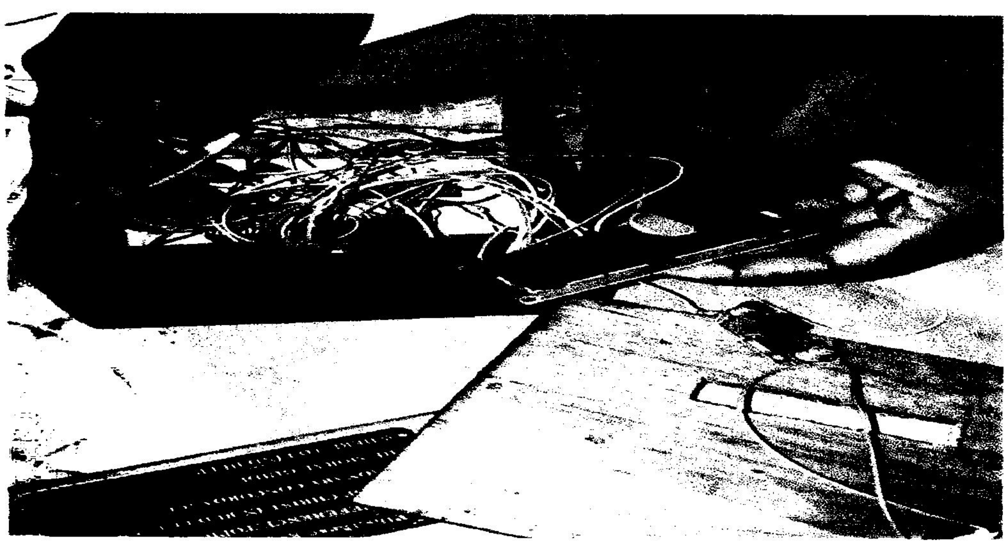


Fig 4.3.5.3 inserting components in the housing.

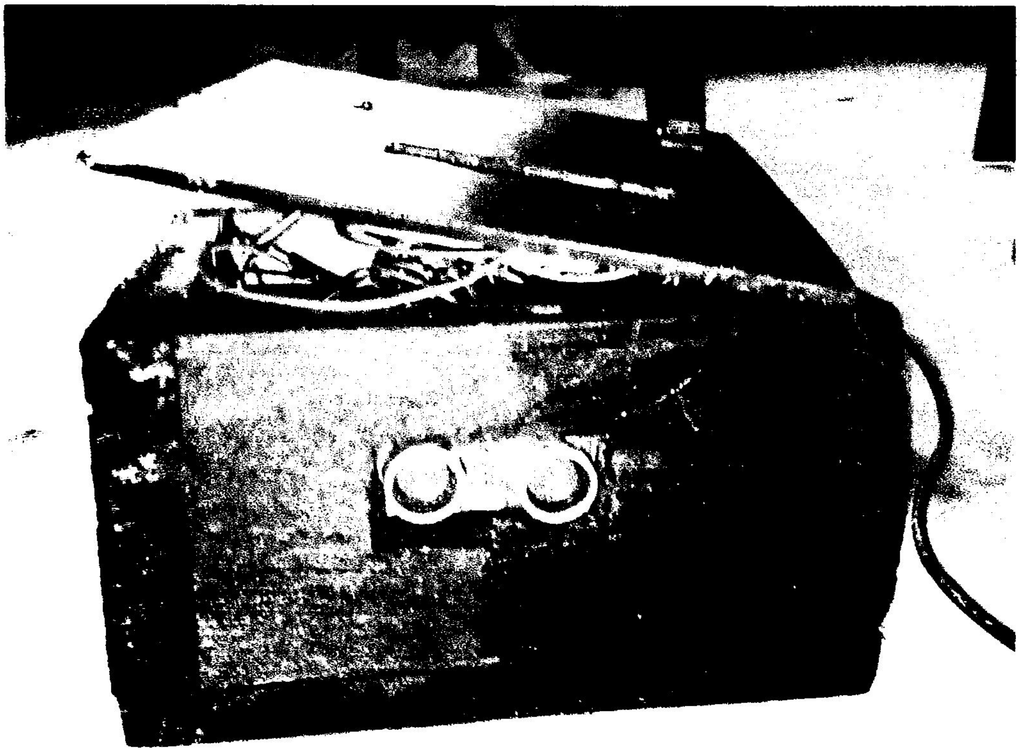


Fig. 4.3.5.4 complete project.

4.4 ANALYSIS AND DISCUSSION

The system consists of a transmitter and a receiver module controlled by a microcontroller ATMEG328-PU. During the design of this project the performance measurement was conducted, however the ultrasonic distance detector was able to measure a distance between the desired ranges, due to space constraint, the device was only tested on 150cm range without any obstruction.

4.5 RESULT

A record of the transmitted and received waveforms of the ultrasonic signal as displayed on an LCD Screen is taken. Measurements of travel time have been taken for a number of distances at intervals of 5 cm. Three measurements have been made for each distance. The

Results of the measurement are shown in Table 4.1 below. The table shows the average of the three travel time measurements.

Table 4.1 Result of the measurement taken.

S.N.	Actual distance (cm)	Travel time microseconds (us)	Measured distance (cm)	Percentage error %
1	5	400	6.86	37.20
2	10	690	11.83	18.34
3	15	1050	18.01	20.05
4	20	1250	21.44	7.19
5	25	1650	28.30	13.19
6	30	1930	33.10	10.33
7	35	2180	37.39	6.82
8	40	2400	41.16	2.90
9	45	2700	46.31	2.90
10	50	3000	51.45	2.90

[illegible] experimental results for the distance measurement are shown in the table above. The figure [illegible] below shows the graph between actual distance and measured distance. It was observed that [illegible] considerable error in the measured distance as compared to the actual distance. The [illegible] column also shows similar results. The error is especially large at lower distances of the [illegible]. The same error is also observed in the graph of the Fig.4.5 below between actual [illegible] and measured distance.

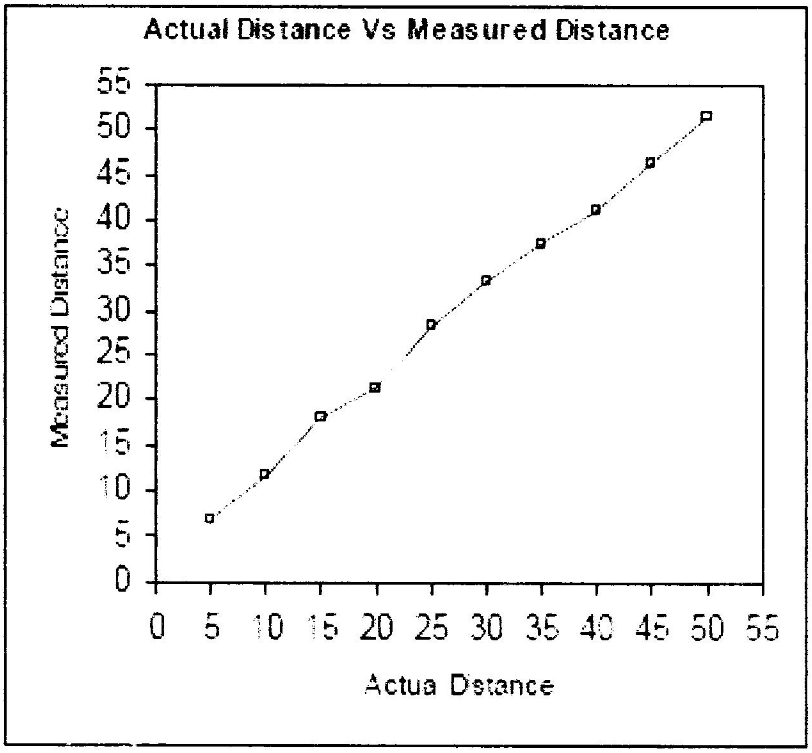


Fig 4.5 graph showing actual distance and measured distance

4.5.1 RESULT OF DISTANCE MEASURED ON LCD SCREEN

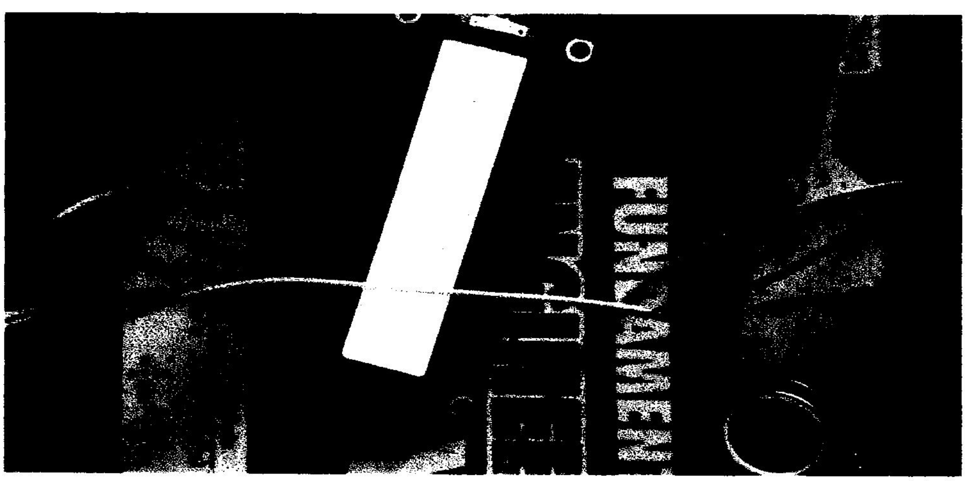
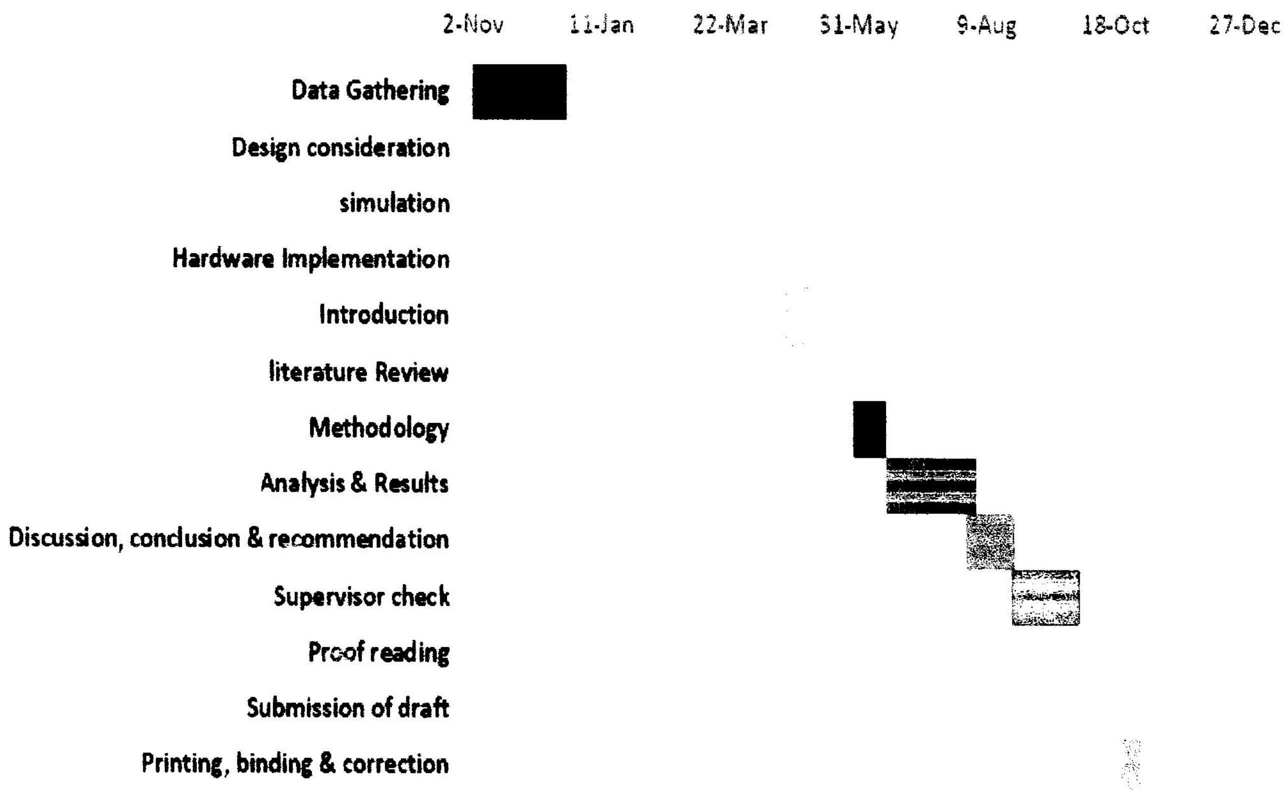


Fig 4.5.1 Liquid Crystal Display.

4.6 PROJECT MANAGEMENT

4.6.1 Gantt Chat



4.7 COST EVALUATION

Table 4.7 Cost evaluation table

S/N	COMPONENT	QUANTITY	AMOUNT #	TOTAL #
1	LCD	1	3000	3000
2	ULTRASONIC SENSOR	1	2500	2500
3	VERO BOARD	1	100	100
4	JUMPER CABLES	1	100	100
5	ARDUINO BOARD	1	10000	10000
6	ATMEGA328 MICROCONTROLLER	1	2500	2500
7	CASING	1	6000	6000
8	RESISTORS	5	10	50
9	CAPACITOR	5	10	50
10	DC BATTERY	1	6000	6000
	GRAND TOTAL			N30,300

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

5.0 CONCLUSION

The objective of this project is to design & implement an Ultrasonic Distance Measurement device. In this project, a system is developed that can detect objects & calculate the distance of the tracked object. With respect to the requirements for an ultrasonic range finder the followings can be concluded.

The system is able to detect objects within the sensing range.

• The system can calculate the distance of the obstruction with sufficient accuracy.

• This device has the capability to interact with other peripheral if used as a secondary device. This can also communicate with PC through its serial port.

• This offers a low cost and efficient solution for non-contact type distance measurements

The Range finder has numerous applications. It can be used for automatic guided vehicles, positioning of robots as well as measuring generic distances, liquid levels in tanks, and the depth of snow banks. The device can serve as a motion detector in production lines.

The design and construction of this project with the micro-controller and LCD makes it friendly and can be embedded in a single unit. The circuit has been implemented on bread ... tested for its functionality by varying the distance between the transducer and the ... target surface needs to be perpendicular to the impinging ultrasound waves. However, ... of the signal is too low for long range. The objective of the project was to design ... an ultrasonic distance measurement.

5.1 CONTRIBUTIONS TO KNOWLEDGE

This project has significant improvement compared to previous related work on distance measurement. The whole system is being supplied with a 12volts battery and results are displayed on a LCD.

In summary, the project was successfully completed having a unique ability to take distance measurement in real time and more accurately with just few limitations as highlighted subsequently in section 5.2.

5.2LIMITATIONS

The major limitations of this project are listed below:

I. This project cannot be used to measure a distances entering kilometers.

II. This project cannot be used in locations with too many obstructions.

5.3 FUTURE WORK

In the future several improvements can be made in order to make the project more user friendly and to give it more advantages:

- The range can be considerably increased by using high power drive circuit.
- Using temperature compensation, it can be used over wide temperature range.
- The resolution of the measurement can be improved by incorporating phase shift method along with time of flight method.
- It can be used as parking assistance system in vehicles with high power ultrasonic transmitter.

- The 40 kHz signal can be generated using microcontroller itself which will reduce hardware.

5.4 CRITICAL APPRAISAL

The design and construction of an ultrasonic distance measurement device is a prototype based project which can be adopted for use of taking distance accurately in places where traditionally means of measurement would fail using ultrasonic sensors to also ensure ease of work. This project was done in such a way that it would be the exact replica of what would be on ground if to be implemented in real time.

In the process of the design and implementation of this project, it could have been done in a more simple way having in mind that it is just a prototype, but due to the desire of something different, standard and declarable as the next best technology in measuring distance. This device can be used domestically and also industrially. A lot of challenges was encountered in the process of making this project a success which helped widen my knowledge on both time and material management.

5.5 RECOMMENDATIONS

- It is recommended that an Ultrasonic Range Finder should be applied on a car with a buzzer or a beeper which is a signaling device that can be used to show the distance of the car with the obstacles behind it. The faster tone of the beep of buzzer means the distance of obstacles and car are closer.
- It is recommended that an Ultrasonic technology should be used to detect moving object on the basis of Doppler frequency shift principle using sensor with high rang mounting on a stepper motor. Hence it acts as radar. This type of ultrasonic radar can also be used [illegible] and civilian applications and military.

- In future I will recommend the use of an upgrade micro-controller that can accommodate high signal power level for a long-distance range.

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APPENDIXES 1

PROGRAM CODE

```
#include <LiquidCrystal.h>

LiquidCrystal lcd(12, 9, 5, 4, 3, 2);

const int trigPin = A4;

const int echoPin = A5;

const int ledPin =6;

long duration;

int distanceCm, distanceInch;

void setup() {

lcd.begin(16,2);

pinMode(trigPin, OUTPUT);

pinMode(echoPin, INPUT);



void loop() {

digitalWrite(ledPin, HIGH);

digitalWrite(trigPin, LOW);
```

```
delayMicroseconds(2);

digitalWrite(trigPin, HIGH);

delayMicroseconds(10);

digitalWrite(trigPin, LOW);

duration = pulseIn(echoPin, HIGH);

distanceCm= duration*0.034/2;

distanceInch = duration*0.01 33/2;

lcd.setCursor(0,0);

lcd.print("Distance: ");

lcd.print(distanceCm);

(Monisha S, 2015)'lcd.print(" cm");

delay(10);

lcd.setCursor(0,1);

lcd.print("Distance: ");

lcd.print(distanceInch);

lcd.print(" inch");

delay(10);
```

Appendix B

COST EVALUATION

S/N	COMPONENT	QUANTITY	AMOUNT #	TOTAL #
1	LCD	1	3000	3000
2	ULTRASONIC SENSOR	1	2500	2500
3	VERO BOARD	1	100	100
4	JUMPER CABLES	1	100	100
5	ARDUINO BOARD	1	10000	10000
6	ATMEGA328 MICROCONTROLLER	1	2500	2500
7	CASING	1	6000	6000
8	RESISTORS	5	10	50
9	CAPACITOR	5	10	50
10	DC BATTERY	1	6000	6000
	GRAND TOTAL			N30,300

Appendix C

Operational flow chart