RADAR NAVIGATION SYSTEM BASED UPON ULTRASONIC WAVES

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under the Supervision of
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CERTIFICATE

This is to certify that project report entitled **"Radar Navigation System Based upon ultrasonic waves"**, submitted by **Ashutosh Mishra (061039), Prateek Pandey (061098) and Shailesh Choudhary(061119)** in partial fulfillment for the award of degree of Bachelor of Technology in Electronics and Communication Engineering to Jaypee University of Information Technology, Waknaghat, Solan has been carried out under my supervision.

Date: **Ms. Vanita Rana**

Place: **Lecturer**

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This work has not been submitted partially or fully to any other University or Institute for the award of this or any other degree or diploma to the best of my knowledge and belief..

(Ashutosh Mishra) **(Prateek Pandey)** **(Shailesh Choudhary)**

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It was a real work experience, which will last for a lifetime and the reason why it shall remain engraved in our memories is solely because of the people with whom we had the honor of working.

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(Ashutosh Mishra) **(Prateek Pandey)** **(Shailesh Choudhary)**

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ABSTRACT

The aim of the thesis is to develop a microcontroller based ultrasonic range sensor which measures the distance of the closest object that comes in front of it and display that onto the screen. This will also used as obstacle finder for robotics or for security purposes. Advances in electronic techniques coupled with economical (LOW) prices make ultrasonic range sensor cost-effective with highly accurate and stable performance. This instrument will result in measurement and display of the distance of the closest object that comes in front of it. It will also display the speed with which the object is coming along with its angle of flight.

CHAPTER 1
INTRODUCTION

1.1 Overview

Micro controller based ultrasonic range sensor is used for the mobile robotic application in order to determine the distance of the closest object. Range sensors are used for robot guidance and obstacle avoidance. Ultrasonic are the sound waves that are used to measure the distance from a reference point (usually on the sensor itself) to the objects in the fields of 'view' of the sensor. Range sensors are used for robot guidance and obstacle avoidance where estimating the distance to the closet object is of interest. There are many arrangements for determining the range of objects i.e. optical, ultrasonic, pulsed and continuous-beam laser etc. Optical methods themselves use various techniques like triangulation, structured lightning etc Laser and optical methods are fast and accurate but too cumbersome for robotic applications. There are well known problems of 'hot spots' and 'transparent' objects associated with them.

Ultrasonic method is simple having favorable distance measuring range, requiring little maintenance and is economically viable. Small probes of ultrasonic can be easily mounted on the robot arm.

Robotics is an area, which has had much success over its many years of existence. Mobile robots rely on many sensors to discover their environment and use the information about their environment for adaptation. H.R. Everett has essentially classified sensors into 2 categories: (1) Visual sensors and (2) Non-visual sensors. Sensors are used for a variety of issues such as collision avoidance and position determination. Both of these issues can and have been addressed with ultrasonic sonar's. Ultrasonic time of flight systems, today, is one of the most common techniques used for collision avoidance, primarily due to the availability, cost and ease of use. In collision avoidance systems, generally, an array of ultrasonic sonar's are mounted on the robot and the transmitter is constantly emitting pings (sound bursts) which bounce off potential 'collisions'. The receiver is always 'listening' for the return signal and each return signal received provides a time of flight measurement which is used to determine how close a potential 'collision' is. There are many types of positioning systems available and there are many factors to aid in deciding which one to use. Some examples of various types include the global positioning system (GPS), radio frequency, mechanical, map based, satellite based and ultrasonic. Ultrasonic positioning systems are desirable again for their availability, cost and ease of use. For this thesis, the ultrasonic position measuring system will make use of triangulation theory to determine the position of the transmitter (mounted on the robot) with respect to the known positions of the multiple receivers.

The thesis is based on ATMEL microcontroller AT89C51.The software code is written on the on-chip EEPROM of the microcontroller. The advantages of the ultrasonic range sensor include:

- Measurement of the distance from a reference point
- Used for robot guidance and obstacle avoidance

1.2 Features & Benefits of Ultrasonic Range Sensor

Ultrasonic range sensors are used for measurement of distance, guidance of robots etc [1]. The main features & benefits of ultrasonic range sensor

- Measures distance or proximity
- Short or long range
- Nothing touches the target object
- Work with hard or soft materials
- High sensitivity for 'soft' material like cloth and non-woven
- Unaffected by object color or any other optical characteristic
- Easy setup-both push button and personal computer options are available.

1.3 Block Diagram Description

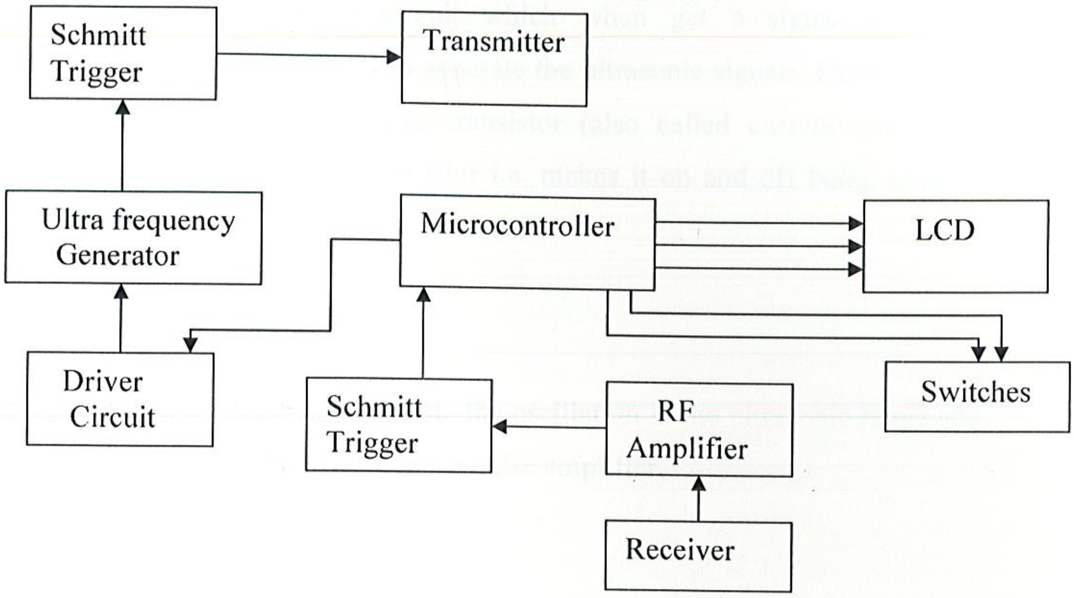

Figure 1.1: Block diagram of basic system

The block wise description is as below:

1.3.1 Microcontroller

89C51 micro controller from ATMEL is being used. We use this because it reduces the amount of external hardware or internal software necessary to process the sensory data. Functions of micro controller in this are:

1) It is used for measurement (for finding the time)

2) Used to do the display

3) It controls the transmitter and receiver

Timers used in this are the 16-bit registers. We will initialize the timer when the ultrasonic is being transmitted. We will stop the timer when an ECHO will be received in the form of an interrupt and then the time is calculated to find out the distance. One of the timer and one of the interrupt sources are being used.

Range is given by R: (t/2)*v (m)

where V=speed of sound in air; range=R

V=331+ (0.6*T) (m/s) &T=temperature (c)

1.3.2 Driver Circuit

The system will have a driver circuit which when get a signal from the microcontroller, starts the transmitter to generate the ultrasonic signals. Driver circuit basically consists of a Darlington pair transistor (also called current amplifier). Switching is the basic property of transistor i.e. makes it on and off being used. It sends the current amplified signal to the transmitter.

1.3.3 Ultrasonic Generator

It has an oscillator in it which will generate the oscillation in the ultrasonic range and that ultrasonic will then be amplified using a pulse amplifier.

1.3.4 Schmitt Trigger

It is connected to the pin of microcontroller to generate the square waves which are given to the transmitter by connecting its pins to the pins of transmitter in order to remove the fluctuations.

1.3.5 Op-Amplifier

It is an amplifier that can do any amplification. It is used for making an audio or pulse amplifier. Now the amplified signals are given to the transmitter.

1.3.6 Transmitter

It is a transducer mainly acts as a main transmitting unit. It converts the electrical signals received from the amplifier into sound signals. Up to transmitter we are actually generating and amplifying the Ultrasonic signals but the actual transmission is done through the transmitter. Transmitter sends the signal to the object that come in front of it by pressing the send signal which sends the ultrasonic signal to the object.

1.3.7 Receiver

After reflection the signals are being received i.e. after striking the obstacle signals are being received on the receiver. The signals are then again converted into electrical signals. Electrical signals are again amplified using an RF amplifier (to increase the volume level) and then send to the filter. Filter will bypass all the signals except ultrasonic and give the ultrasonic to Schmitt trigger.

1.3.8 Schmitt Trigger

Signal from the receiver are given to the Schmitt trigger for generation of square wave pulses and Ultrasonic signals from here are given to the microcontroller as interrupts. On reception of interrupt, the processing on the Timer values will take place and the result in the form of distance will be displayed on the LCD screen.

1.3.9 LCD

Display used here is the LCD display. It is an intelligent LCD. It is a 16*2 LCD, which displays 32 characters at a time 16 will be on the 1st line and 16 will be on the 2nd line. There are two lines on the LCD and it works on extended ASCII code i.e. when ASCII code is send it display it on the screen. On the LCD total no of pins are 16 out of which 14 pins are used by the LCD and 2 are used for backlight. LCD is an edge trigger device i.e. from high to low.

1.4 Distance

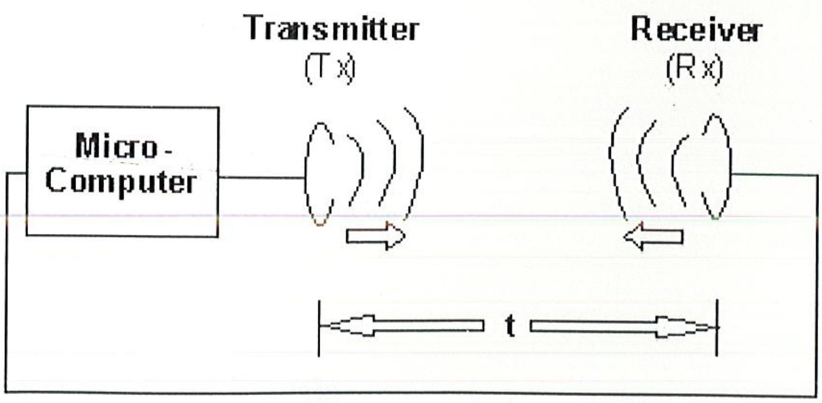

figure 1.2: Distance Measurement

The implementation of a one dimensional system is illustrated in above Figure. Using the measurement of time of flight, t, and the speed of sound in air, v, the position, D, of the transmitter relative to the receiver is given by

D = t * v (m)

where v = 331 + (0.6*T) (m/s) and T = temperature (C).

1.5 Range

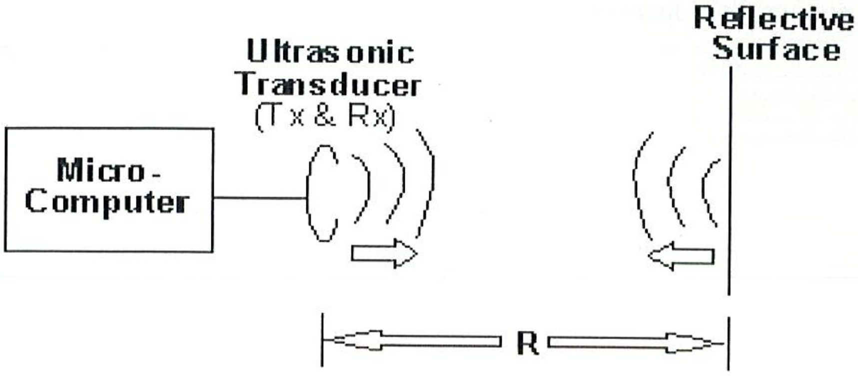

Figure 1.3: Range Measurement

The one dimensional system, using only one ultrasonic module, will provide range information with respect to the module as shown in Figure. Using the measurement of two-way time of flight, t, and the speed of sound in air, v, the range, R, of the reflecting surface is given by

R = (t/2) * v (m)

where v = 331 + (0.6*T) (m/s) and T = temperature (C).

1.6 Sources of Error

The different sources of error are

- Path loss
- Simultaneous occurrence of two obstacles
- Large Angle of detection

1.7 Organization of the Thesis

Chapter-1: Describes the objective of the study and definition of the topic

Chapter-2: Describes the literature review and relevant theory of different components used & describes various types of sensors.

Chapter-3: It includes the basic theory of ultrasonic ranging system and the transmitter and receiver system and also tells the various applications where the ultrasonic sensor can be used.

Chapter-4: Describes the different hardware components, which are used. The components are explained according to their requirement in the system.

Chapter-5: Conclusion and future scope.

CHAPTER 2
LITERATURE SURVEY

This section is intended to give the reader a background to the work performed in this thesis. The purpose of this thesis is to show the distance by using the ultrasonic sensor. This investigation will be based on a theoretic study and a prototype will therefore have to be built. Focus is to be put on the ultrasonic range sensor; other techniques are investigated for comparison reasons only.

2.1 Previous Work

The probabilistic model of ultrasonic range sensor using back propagation networks trained on experiment data was given by Ricardo Gutierrez [2]. The sensor model provides the probability of detecting mapped obstacle in the environment, given their position and orientation relative to the transducer. This model can help a robot choose the most reliable geometric beacons for localization. The detection probability can be used to compute the location of an autonomous vehicle from those obstacles that are more likely to be detected. Ultrasonic range sensor has gained extensive use in the mobile robot community. One particular transducer the pulse type ultrasonic range finder from Polaroid Corporation has been used for most mobile robot platforms. There are several reasons for its popularity: ease of use, range accuracy, light weight and low cost however this sensor presents some drawbacks i.e.

- It has limited angular resolution
- When the target surface is oriented at unfavorable angles the bulk of acoustic energy is reflected away from the transducer, and the target is undetected and
- If the target is not isolated enough energy can return from multiple surface reflections, creating the illusion of targets at erroneous distances.

Crosstalk is a common problem occurring with arrays of multiple ultrasonic sensors (sonars) in obstacle detection and avoidance systems. This problem is solved by Johann Borenstein [3] that might allow the use of data generated by crosstalk to generate more reliable and accurate object detection. This is accomplished by assigning a unique code to the signals emitted by each sonar, so that the source sonar can be identified even if its signal's echo is received by another sonar. Using geometric interpolation between the various sonars increases the accuracy of the measurement, overcoming their limited resolution. Ultrasonic sensors are widely used for obstacle avoidance with mobile robots. The most common sensor is the Polaroid 6500 sensor Instrument Grade Electronic Transducer. One problem with multiple sonars operating in close proximity is a phenomenon known as crosstalk, where one sonar receives the echo of a signal emitted by adjacent sonars. The receiving sonar has no way of knowing that the echo was not created by its own signal, resulting in inaccurate time of flight measurement. Crosstalk occurs in almost all multiple sonar system, especially in the vicinity of smooth surfaces. Moreover if the firing sequence of the sonars is constant, then the same crosstalk error may occur repeatedly, until the geometry of the reflecting surfaces relative to the robot has changed sufficiently.

Ultrasonic sensors are commonly used in robotics for range measurement in obstacle detection and avoidance systems [4] .They have also been used for localization by map matching techniques. This will show the use of ultrasonic sensors for the measurement of angular position of a mobile robot relative to a known ultrasonic source. The method is based on measurement of the phase difference of an ultrasonic wave by two receivers. The ultrasonic wave was transmitted by an off board SONAR & received by two onboard ultrasonic receivers. The receivers are positioned at the two edges of the mobile robot & therefore the phase difference is proportional to the angular position of the robot. The pose of a planar mobile robot is defined by its lateral (x, y) and angular position. In absolute positioning, both lateral and angular positions are measured relative to pre-defined objects, the locations of which are known in advance. Common methods for absolute positioning are triangulation, trilateration, GPR's etc. In relative positioning, on the other hand, vehicle position is determined relative to the vehicle's previous position, based on its recent motion. The most common method for relative positioning is odometry, which is based on measurements of the vehicle's wheel rotation.

A pocket-PC based electronic travel aid (ETA) that helps a blind individual navigate through indoor environment given by Maroof H. Choudhary[5].The system detects the surroundings obstacles using ultrasonic range sensor and the travel direction using an electronic compass. The acquired information is processed by a pocket-PC to generate a virtual acoustic environment where nearby obstacles are recognizable to the user. This virtual environment is played back through stereo headphones, so that the user can perceive surrounding obstacles. Developing an Electronic Travel Aid (ETA) for blind individuals presents two major challenges - information must be presented in a non-visual form and the navigational information must be updated in real time to ensure user confidence. In addition to this, the device needs to be lightweight, portable and must have low power consumption. Many electronic interfaces for blind assistance utilize an acoustic presentation method. However, in such systems, an additional challenge is to develop an acoustic information presentation method that does not interfere with the user's normal hearing activities. The flow of information needs to be such that the requirement for user attention is minimum.

Here two novel methods for surface profile extraction based on multiple ultrasonic range measurements are described and compared [6]. One of the methods employs morphological processing techniques, whereas the other employs a spatial voting scheme followed by simple threshold. Morphological processing exploits neighboring relationships between the pixels of the generated arc map. On the other hand, spatial voting relies on the number of votes accumulated in each pixel and ignores neighboring relationships. Both approaches are extremely flexible and robust, in addition to being simple and straightforward. They can deal with arbitrary numbers and configurations of sensors as well as synthetic arrays. The methods have the intrinsic ability to suppress spurious readings, crosstalk and higher-order reflections, and process multiple reflections informatively. The performances of the two methods are compared on various examples involving both simulated and experimental data. The morphological processing method outperforms the spatial voting method in most cases with errors reduced by up to 80%. The effect of varying the measurement noise and surface roughness is also considered. Morphological processing is observed to be superior to spatial voting under these conditions as well. The methods presented here are novel ways of processing range data in the form of an arc map which represents angular uncertainties In contrast; approaches based on geometrical or analytical modeling have often been limited to simple, well structured sensor configurations. A commonly noted disadvantage of ultrasonic ranging systems is the difficulty associated with handling spurious readings, crosstalk, higher-order and multiple reflections. The proposed methods are capable of effectively suppressing the first three of these, and have the intrinsic ability to make use of echo returns beyond the first one (i.e. multiple reflections) so that echoes returning from surface features further away than the nearest can also be processed informatively.

In a park or street, we can see many people jogging or walking with their dogs that are chasing their masters. In this study, a pet robot that imitates dog's behavior is developed. The task of robot is to chase a person who is recognized as the master. The physical structure and the sensor system are designed for the task and environment. A three-wheel type locomotion system is designed as the robot's physical structure which can follow a person who is jogging in outdoor environment like a park. A sensor system, which can detect relative position of the master to the robot in highly dynamic and hazardous worlds, is developed [7]. This sensor system consists of a signal transmitter which is held by the master and ultrasonic sensor array which are mounted on the robot. The transmitter emits RF (radio frequency) and ultrasonic signals simultaneously. The ultrasonic sensor array detects the signals and calculates direction and distance between the robot and the transmitter. The reflection type, sensor transmits ultrasonic signal and receives the signal reflecting from an object to recognize the object. However, this type of ultrasonic sensor can not recognize the master reliably. Thus, the opposed type of ultrasonic sensor is chosen. The sensor system is composed of ultrasonic transmitters attached the target and receivers mounted on the robot. By using this type, the robot can detect the master reliably because the target itself transmits ultrasonic signal. When using this opposed type, the receiver and the transmitter must be synchronized using a signal because the receiver must know the time when the transmitter sends ultrasonic signal. The time data is the key parameter to calculate the distance between the transmitter and the receiver.

Many mobile robots use Polaroid ultrasonic sensors for obstacle avoidance [8].In this we focused on a comparison of the "beam width" of single sonar with that of a dual sonar phased array. For the single sonar we found that flat walls trigger echo signals up to an angle of ±42°, which is well beyond the traditional assumed beam width of ±15°. With the dual sonar phased array echo signals were triggered only up to beam widths of ±18°.

A serious problem for visually impaired persons is hardship of walking. Some kinds of conventional aiding methods have been used to solve this problem. The most widely used method is a white stick, which a person should train for a long time to use. The other solution is a guide dog, which is very expensive, but can not provide so much information. Hence during the last several decades, some models of blind mobility aids have been developed. An auditory guidance system for the blind using ultrasonic to audio signal transformation [9]. In this the investigation of the system requirements is done, and designed a simple but useful portable guidance system for the blind. The system derives visual information using multiple ultrasonic sensors, and transforms it to binaural auditory information using suitable techniques. The user can recognize the position of obstacles and the surrounding environment. The system is composed of two types of sensor subsystems. One is glasses type system and the other is cane type with guide wheels. The first functions as an environment sensor, and the latter functions as a clear path indicator. Wide beam angle ultrasonic sensors are used to detect obstacles in broader range. The system is designed for a battery-powered portable model. The design is focused on low power consumption, small size, lightweight, and easy manipulation.

As life becomes more abundant, the desire of human welfare is being increased. Hence interests in the life quality become high not only for normal people but also for handicapped people. Handicapped people that have problems in the sensory systems live through various hardships, since human protect themselves from danger and respond to external stimuli with recognition of environmental information. Visual data contains a large amount of information such as shape, color, roughness, and motion of objects. That is, the visual sensory system receives much more environmental information than any other sensory system. Hence, the visual system is very important for not only handicapped persons but also non-handicapped persons. In this point of view, visually impaired persons can obtain much less information than any other kind of disabled persons. These drawbacks restrict their social and economic activities.

More than three million kilometers of high pressure liquid and gas pipelines are installed all over the world. Generally steel pipelines provide the safest means to transport large quantities of oil, oil related products and natural gas. However, just like any other technical component, they can deteriorate. As a result flaws can appear and grow until the pipeline fails. These flaws must be identified, before they endanger the integrity of the line. A new generation of high resolution inspection tools using ultrasonic to detect, size and locate metal loss and crack-like defects in the body and welds of transmission pipelines [10]. These devices are pumped through the section of pipe to be inspected together with the medium being transported therein. They enable an inspection of the entire circumference and length of the pipe of up to several hundred kilometers in a single run. It is generally accepted that high pressure pipelines provide the safest means to transport large quantities of oil and natural gas. It must be understood, however, that pipelines are exposed to a variety of environmental influences and loading conditions. As a result flaws can appear and grow. In order to assess the integrity of a pipeline or pipeline system, flaws and defects present in the steel must be detected, sized and located. Specialized inspection tools, usually referred to as in-line inspection tools or intelligent pigs, have first been introduced nearly 40 years ago to detect and locate pipeline anomalies such as dents and metal loss. From technical generation-to-generation these inspection tools became more refined and sophisticated providing improved and achieved better and better defect specification. Present day tools have reached a level of sensitivity and accuracy that allows the obtained inspection data to be utilized for advanced fitness-for-purpose calculations and integrity assessments. The major advantage of ultrasonic tools is their ability, unlike magnetic flux leakage tools, to provide quantitative measurements of the pipe wall inspected.

2.2 Ultrasonic Sensor

Ultrasonic waves are often used in various fields. For example, in the field of medical use, they are used as 2-dimensional ultrasound scanner that arrayed many sensors of more than 32x32, and we have various works on reducing the number of sensors with directivity keeping sharp[11]. In the field of robotics, ultrasonic waves whose frequency is lower than medical use are used in order to lengthen their emission able range. The most important weakness of the ultrasonic waves for robot use is that they have wide directivity. Since directivity becomes wider as frequency becomes lower, it is very important to sharpen directivity. When a mobile robot moves at a high speed, it is necessary to increase detectable length for objects. This means that we must radiate the powerful ultrasonic waves whose directivity is sharp. However, small attenuation in propagation and sharp directivity are incompatible with each other. Therefore, usual ultrasonic transmitters are not suitable for detecting far objects.

Ultrasonic sensors provide a cheap, easy implemental and robust solution for distance measurement and presence detection of objects. Most industrial sensors use piezo ceramic elements to generate and detect ultrasonic waves because of their robustness and high performance [12]. They mainly operate in their very distinctive resonance frequency requiring low exciting energies. This leads to very narrowband bursts whose flight times (according to the distance between sensor and object) are measured. Assuming a known speed of sound, the distance to the object is calculated. Echo reception is often done by simple amplitude detection: when the amplitude of the incoming signal rises above a defined threshold, an echo is regarded as received

However, there are some facts to be considered when using this method:

• Ultrasonic signals are strongly attenuated during their time of flight. Applying a fixed threshold detection circuit this leads to systematic errors of the time of detection due to the relative low steepness of the signal envelope. However, due to the known time of flight this effect can be compensated by a time varying signal amplification leading to a distance independent received signal.

• The echo amplitude is affected by the geometric shape of the reflecting object: while well aligned planes reflect the majority of the incoming signal energy, edges only reflect a fractional amount. Without a priori knowledge of the reflecting object's properties the sensor cannot compensate this effect and therefore will possibly produce systematic errors dependent on the object form. This problem can be solved by providing a priori knowledge about the object's reflecting properties to the sensor by using only well defined object types.

• The highest signal amplitude and sensor sensitivity is found in direction of the sensor axis. According to the piston membrane model, which describes the radiation pattern of most ultrasonic sensors, the signal amplitude decreases with increasing angle of radiation (at least during the main lobe). As a consequence objects providing strong reflections are detected in a much wider area than those with weak reflection properties. Therefore most datasheets of industrial transducers show measured detection areas for at least two different types of objects.

These problems prevent the use of conventional ultrasonic distance measurement sensors in sophisticated measurement tasks, where the distances to unknown objects, located in different directions in front of the sensor, are precisely measured. Also presence detection of unknown objects in a well defined area with exact borders is hardly to accomplish. In the following a measurement principle is presented that overcomes these problems by providing a sharp and well defined detection area that is independent of the object's reflection properties.

Ultrasonic sensors measure the distance or presence of a target object by sensing a sound wave, above the range of hearing, at the object and then measuring the time for the sound echo to return. Knowing the speed of sound, the sensor can determine the distance of the object from the transducer element. There are two types of sensors as first one is electrostatic ultrasonic sensors. Electrostatic ultrasonic sensors operate similar to an electrical capacitor. These sensors usually are composed of a fixed conductive plate and a free metallic surface coated with a layer of insulation that separates the two plates. When an electric potential is placed across the fixed conductive plate, the free metallic surface is pulled against the fixed plate. When an oscillating electrical potential is applied to the fixed plate, the free plate oscillates at a similar frequency thereby creating acoustic pressure waves. When receiving an ultrasonic signal, the Electrostatic ultrasonic sensors produce a varying capacitance created by the pressure waves hitting the free metallic surface. Second one and used by me in this project is piezoelectric ultrasonic sensors. Piezoelectric ultrasonic Sensors are composed of a Piezo material and an acoustic surface. The Piezo material can either be a crystal or ceramic. The Piezo material is attached to the acoustic surface such that any physical changes in the geometry of the material will affect the acoustic surface. When an electrical potential is placed across the

Piezo material the geometry changes thereby disturbing the acoustic surface. When an oscillating electrical potential is placed across the Piezo material, the acoustic surface generates an acoustic signal. When receiving an ultrasonic signal, the ultrasonic waves strike the acoustic surface thereby compressing the Piezo material. The Piezo material emits electrons when compressed thereby creating an electrical signal. Piezoelectric ceramics are known for what are called the piezoelectric and reverse piezoelectric effects. The piezoelectric effect causes a crystal to produce an electrical potential when it is subjected to mechanical vibration. In contrast, the reverse piezoelectric effect causes the crystal to produce vibration when it is placed in an electric field. Of piezoelectric materials, Rochelle salt and quartz have long been known as single-crystal piezoelectric substances. However, these substances have had a relatively limited application range chiefly because of the poor crystal stability of Rochelle salt and the limited degree of freedom in the characteristics of quartz. Later, barium titanate (BaTiO3), a piezoelectric ceramic, was introduced for applications in ultrasonic transducers, mainly for fish finders [13].

More recently, a lead titanate, lead zirconate system (PbTiO3 · PbZrO3) appeared, which has electromechanical transformation efficiency and stability (including temperature characteristics) far superior to existing substances. It has dramatically broadened the application range of piezoelectric ceramics. When compared which other piezoelectric substances, both BaTiO3 and PbTiO3 · PbZrO3 have the following advantages :

- High electromechanical transformation efficiency
- Suitable for mass production, and economical
- High stability
- High degree of freedom in characteristics design

2.2.1 Applications of piezoelectric ceramics

I) Mechanical power source (electrical to mechanical transducer)

Piezoelectric actuators, piezoelectric fans, ultrasonic cleaners etc

II) Sensors (mechanical to electrical transducer)

Ultrasonic sensors, knocking sensors, shock sensors, acceleration sensors etc

III) Electronic circuit component (transducers)

Ceramic filters, ceramic resonators, surface acoustic wave filters etc

The ultrasonic range sensor uses high quality ultrasonic transducers and a built-in controller to calculate the distance to the closest object or obstruction.

2.3 Types of Sensors

There are multitudes of sensors that become useful in industry settings, especially where factory operations are concerned. Different sensors include temperature sensors, optical sensors, pressure sensors, motion sensors, ultrasonic sensors and many more. Sensors allow for smooth operations and accurate measurements.

1) Bump Sensors

These are switches activated when the robot touches an obstacle. This is a simple, inexpensive method of obstacle detection, but operates only on contact, which makes it useful only for slow moving robots.

2) Infrared Proximity Detectors

These detect the presence of an object in front of the sensor. They consist of a combination of an infrared light emitting device and an infrared light sensor. These sensors are merely proximity detectors; they cannot determine the range of the obstacle in front. The range of these sensors is also limited to a maximum of 80cm.

3) Ultrasonic Range Sensors

Which determine the range of the object in front of it. They work by sending a short burst of ultrasonic waves, and measuring the time taken for the echo to be received. They have a wide beam angle, typically 30±. These sensors have ranges of upto 4m.

4) Laser Range Finders

Which work on the same principle as ultrasonic range sensors, except that they use LASER instead of ultrasound. Laser range finders have a range of up to 30m, and are very accurate, having an angular resolution of up to 0.25±. However, they are very expensive compared to other sensors.

Of these, the ultrasonic range sensor was found most suitable for our requirement because of its low cost and ranging capability [14].

2.4 Types of Ultrasonic Sensors

There are two types of sensors that are to be used in distance measurement. These are

2.4.1 Electrostatic Ultrasonic Sensors

Electrostatic ultrasonic sensors operate similar to an electrical capacitor. These sensors usually are composed of a fixed conductive plate and a free metallic surface coated with a layer of insulation that separates the two plates. When an electric potential is placed across the fixed conductive plate, the free metallic surface is pulled against the fixed plate. When an oscillating electrical potential is applied to the fixed plate, the free plate oscillates at a similar frequency thereby creating acoustic pressure waves. When receiving an ultrasonic signal, the Electrostatic ultrasonic sensors produce a varying capacitance created by the pressure waves hitting the free metallic surface.

2.4.2 Piezoelectric Ultrasonic Sensors

Piezoelectric ultrasonic Sensors are composed of a Piezo material and an acoustic surface. The Piezo material can either be a crystal or ceramic. The Piezo material is attached to the acoustic surface such that any physical changes in the geometry of the material will affect the acoustic surface. When an electrical potential is placed across the Piezo material the geometry changes thereby disturbing the acoustic surface. When an oscillating electrical potential is placed across the Piezo material, the acoustic surface generates an acoustic signal. When receiving an ultrasonic signal, the ultrasonic waves strike the acoustic surface thereby compressing the Piezo material. The Piezo material emits electrons when compressed thereby creating an electrical signal.

The ultrasonic range sensor uses high quality ultrasonic transducers and a built-in controller to calculate the distance to the closest object or obstruction. It returns a value between 0 and 100 that represents the range to the object in half inch units. Table 1 shows the operating range for the ultrasonic sensor[15].

Sensor	Upper bound [meters]	Lower Bound [meters]	Resolution [meters]
Ultrasonic	1.4	0.15	0.01
Infrared proximity	0.20	0.01	0.006

Table 1 – Operating range for sensors

the infrared proximity sensor has a much shorter range than the ultrasonic sensor, although the two ranges overlap. It is a highly sensitive sensor that uses short pulses of bright infrared light. The sensor measures the amount of infrared light reflected from a surface and returns values from 0 to 100, where zero represents no reflection detected. By using infrared pulses instead of visible light, the effect of shadows and room lighting are eliminated, thus providing more accurate readings.

CHAPTER 3

THEORY

3.1 Ultrasonic Ranging System

The development of applications using ultrasonic sensors requires good understanding of its operating principles and its interaction with the environment. They rely on the principle of time of flight or propagation of sound waves in air. The system either measures the echo reflection of the sound from the object (in case where the transmitter and the receiver is on the same device) or the time of flight of the sound wave from the transmitter to the receiver (in case either the transmitter or the receiver is mounted on the object). An Ultrasonic Ranging System is a unit that detects the presence of an object and calculates the distance to that object. This is accomplished by transmitting an ultrasonic (high frequency) sound. This sound is above the range of normal human hearing. Sound travels at a known speed and when the sound strikes an object it are reflected back to the source. This reflected sound is called the "echo." All that is required to calculate the distance to an object is to measure the time between the transmitting of the sound and the return echo. Sound travels at the rate of 1' every 0.0009 s. The Ultrasonic Ranging System (URS) developed by Polaroid to automatically focus cameras is ideally suited to such applications. The system is composed of an electrostatic transducer, which acts as both transmitter and receiver, and a single electronic module containing the drive, receiving, and processing circuitry. To determine the distance to an object, the interval time between the transmitted ultrasonic pulse and the received echo from the object is measured

Ultrasonic sensors measure the distance or presence of a target object by sensing a sound wave, above the range of hearing, at the object and then measuring the time for the sound echo to return. Knowing the speed of sound, the sensor can determine the distance of the object from the transducer element.

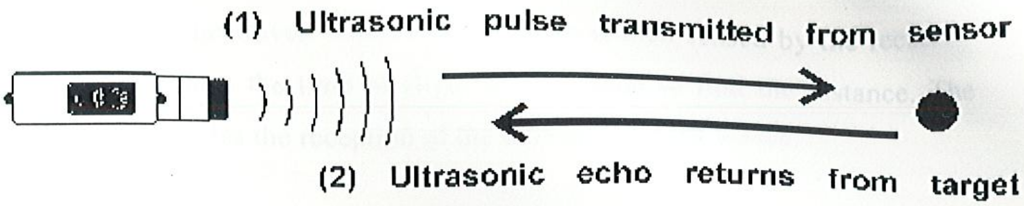

Figure 3.1: Ultrasonic ranging system

1. Ultrasonic Transmitter

The transmitter consists of an electronics circuitry and an electromechanical transducer. The electronic circuitry generates the required frequency electrical signal and the electromechanical transducer converts that electrical signal into the physical form and activates the open medium surface. This oscillating physical surface creates the ultrasonic waves. The oscillating surface creates a pressure variation and ultimately a pressure wave with a frequency equal to that of the surface oscillation. The figure below shows the generation of ultrasonic waves-

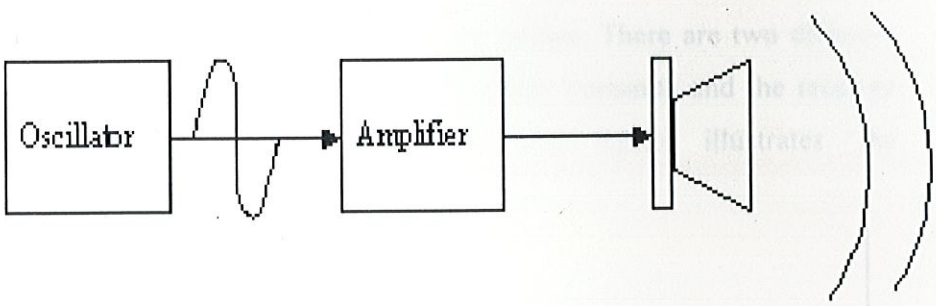

Figure 3.2: Ultrasonic transmitter

2. Ultrasonic Receiver

The receiver also has the same configuration except that it has a receiver electronic circuitry and a transducer, which converts the ultrasonic sound waves into an electrical signal. The sound waves travel into the medium and are reflected by an object in the path of the waves. This reflected wave is then sensed by the receiver, which actually calculates the time of flight of the signal to find the distance. The following figure illustrates the reception of the ultrasonic sound waves.

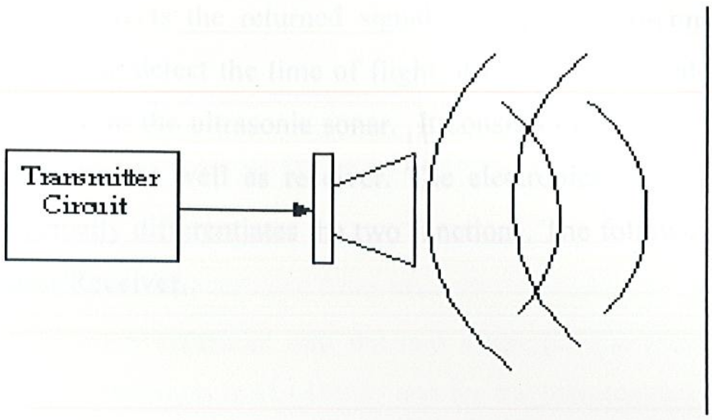

Figure 3.3: Ultrasonic receiver

3.2 Ultrasonic Transducer Configuration

The different configuration of ultrasonic transducer are as follows

3.2.1 Transmitter and Receiver Pair

It consists of a transmitter and receiver pair on the device. There are two different transducers for transmitter and receiver. The transmitter transmits and the receiver waits for the reflected signals. The following figure illustrates the transmitter/receiver pair.

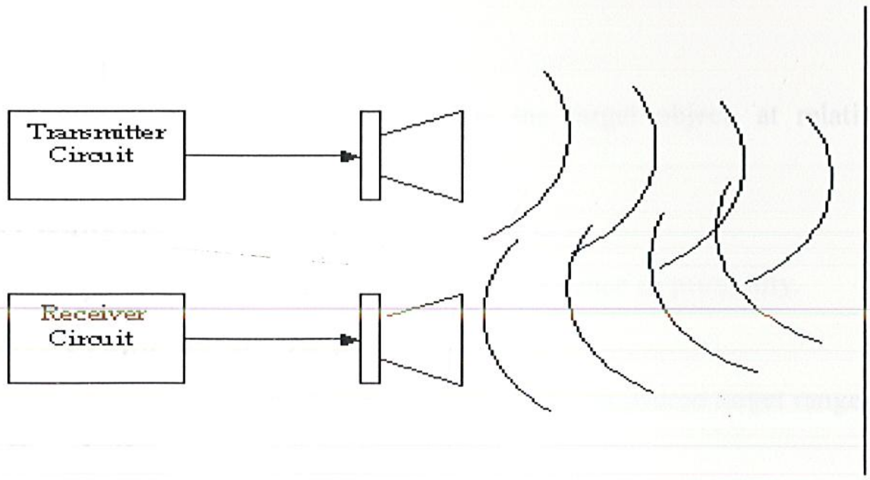

Figure 3.4: Transmitter and receiver pair

3.2.2 Transceiver

Ultrasonic transceivers, traditionally, are mounted with a transmitter and a receiver. The transmitter emits a ping (sound burst) which bounces off the nearest object and the receiver detects the returned signal. Using a micro-computer with a built in timing device to detect the time of flight, it is possible to calculate the range of the object relative to the ultrasonic sonar. It consists of a single transducer, which acts as a transmitter as well as receiver. The electronics circuitry for transmitter and receiver actually differentiates the two functions. The following figure illustrates the Transmitter/Receiver.

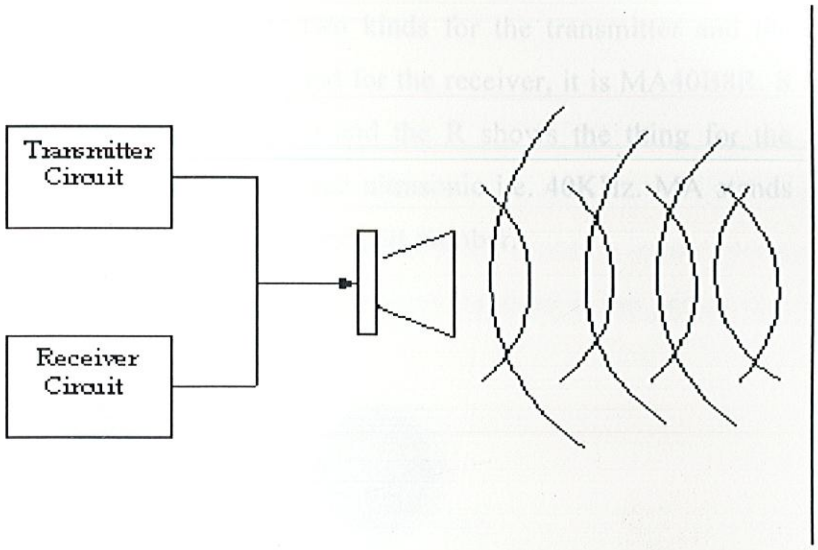

Figure 3.5: Transceiver

3.3 Advantages

Non-contact

Measures through the air without touching the target object, at relatively large distances.

Object Ranging

Object distance is measured rather than just the presence or proximity.

Distance Proportional Output

The sensor's outputs are proportional or related to the measured target range.

High Resolution

Precise discrimination of target position

Unaffected by Target's Optical

The sensor's operation is not sensitive to ambient light levels, the color of the target, or target is optically transparency/reflectivity.

Sensitive

Detects large and small objects

3.4 Ultrasonic Sensors Pair i.e. Transmitter and Receiver

Ultrasonic sensor of piezoelectric type from MuRata Company has been used in this thesis work. This sensor separates into the two kinds for the transmitter and the receiver. For the transmitter, it is MA40B8S and for the receiver, it is MA40B8R. S shows the thing for the transmitter (sounder) and the R shows the thing for the receiver. 40 shows the resonant frequency of the ultrasonic i.e. 40KHz. MA stands for the ultrasonic sensor and the B8 is used for the part number.

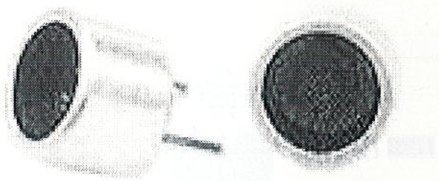

Figure 3.6: Ultrasonic Sensor

The brief specification of the ultrasonic sensor is shown below

Type- open structure type

Dimension (mm)	:	16ϕ * 12h
Detectable range in meter	:	0.2-6
Directivity in degree	:	50
Weight in grams	:	2.0
Allowable input voltage	:	40 KHz
Sensitivity in db	:	-63±3
Resolution in mm	:	9
Operating Temp. Range(°C)	:	–30 to +85

3.5 Applications

There are numerous applications for Ultrasonic Sensors. These products are used in all industries measuring the distance to or size of material objects. That covers a lot of territory, and almost any size and type of object can be measured [17]. Object ranging is essential in many types of systems. One of the most popular ranging techniques is ultrasonic ranging. Ultrasonic ranging is used in a wide variety of applications including auto focus cameras, motion detection, robotics guidance, proximity sensing, and object ranging.

3.5.1 People Detection

A common application is the detection of the presence or absence of people, generally when they approach a kiosk or information display. The display can be activated or changed based on the sensor input. One advantage of ultrasonic sensors in these applications is that the distance of the person could be used rather than just their presence or absence, permitting a different response if the person is arriving, stopped or leaving

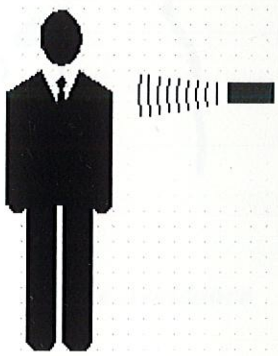

Figure 3.7: People Detection

3.5.2 Presence / Absence

Objects can be monitored for their presence, absence or position. One advantage of ultrasonic sensors is they are not affected by the object's color or any other optical characteristic such as reflectivity, transparency or opacity. Sensors can be used in the dark and are not affected by ambient light.

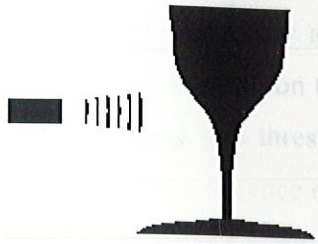

Figure 3.8: Presence/ Absence

3.5.3 Obstacle Avoidance

If you can detect an object, you might want to avoid it! Sensors are used in robotics and guided vehicle applications to maintain proper distances and assist with navigation.

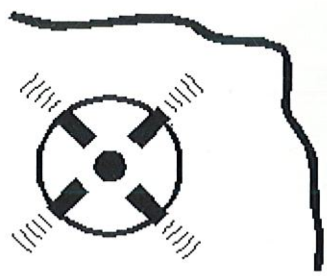

Figure 3.9: Obstacle Avoidance

3.5.4 Proximity Sensing

Light and sound are two natural phenomena, which let every living being recognize their environment without physical contact and over widely varying distances. Ultrasonic proximity sensors use reflected or transmitted ultrasonic waves to detect the presence or absence of a target component. The output is Boolean, that is, the sensor merely detects whether the target is or is not within the design detection range. The measurement of proximity, position and displacement of objects is essential in many different applications: valve position, level detection, process control, machine control, security etc. Proximity sensing is the technique of detecting the presence or absence of an object using a critical distance. A position sensor determines an object's coordinates (linear or angular) with respect to a reference, displacement means moving from one position to another for a specified distance (or angle). In effect, a proximity sensor is a threshold version of a position sensor. It includes the detection of the presence, absence or position of a person or other object of interest. A special sonic transducer is used for the ultrasonic proximity sensors, which allows for alternate transmission and reception of sound waves. The ultrasonic transducer emits a number of sonic waves which are reflected by an object, back to the ultrasonic transducer. After emission of the sound waves, the ultrasonic sensor will switch over to receive mode. The time elapsed between emitting and receiving is proportional to the distance of the object from the sensor [18]. Sensing is only possible within the detection area. The required sensing range can be adjusted with the sensor's potentiometer. If an object is detected within the set area, the output changes its state.

Ultrasonic proximity sensors enable the detection of different objects - irrespective of color and transparency. The sensor will detect the closest object within its beam pattern that reflects ultrasound. Ultrasonic Sensors incorporate a high sensitivity transducer to detect most small and weak-reflecting materials (some reflection is required) such as clothing and some woven and non-woven materials. Small object distances can be measured as close as 5 cm (2 inches), or closer if only their presence/absence is required. The maximum range is about 11 meters (37 feet). Detection of objects at longer ranges requires that the target be larger and oriented to reflect ultrasound back to the sensor. For example, a person can be typically detected reliably at distances up to about 6 meters (20 feet).

3.5.5 Positioning

An Ultrasonic Sensor measures the distance to a remote object. An obvious use for the sensor is therefore to control the positioning of that object based on the sensor's measurement. The measured object can be in open space, or constrained within a channel or tube. Position feedback is available in a variety of analog and digital forms compatible with almost any type of equipment or control

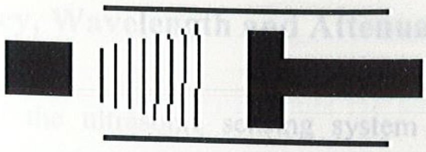

Figure 3.10: Positioning

3.6 Factors Affecting the Performance of Ultrasonic Sensors

Position/distance measurement using ultrasonic sensors is based on the principle of measuring the time of flight of the ultrasonic waves in a particular medium. There are number of factors which affect the accuracy of measurement and therefore should be taken into consideration while designing the ultrasonic sensing system. The following are some of the factors [19]:

3.6.1 Radiation Pattern:

All ultrasonic sensors have their specific radiation pattern associated with it. This acoustic radiation pattern is a function of spatial angle called beam angle. Beam angle, α is defined as the total angle between the points at which the sound power reduces to half its peak value, commonly known as 3 dB points. The spot diameter of the beam can be formulated as –

$$D = 2R.\tan(0.5\alpha)$$

where, D = spot diameter in inches
R = target range in inches
α= beam angle in degrees

Radiation pattern consists of a main lobe and side lobes. Radiation power is dominant mainly in the front region of the sensor, so as to say that the main lobe is directly in front of the sensor, followed by side lobes sidewise with null region in between these lobes. Radiation pattern is mainly determined by factors such as the frequency of operation and the size, shape and acoustic phase characteristics of the vibrating surface. The beam pattern of the transducer is independent of its nature as a transmitter or receiver.

3.6.2 Frequency, Wavelength and Attenuation

The frequency of the ultrasonic sensing system is determined by the resonant frequency of the ultrasonic transducer. The selection of this transducer is made considering number of factors such as transducer size, measurement resolution, measurement range, background noise and attenuation. The wavelength of the ultrasonic wave can be found out with the following formula,

$\lambda = C/f$

where, λ = wavelength

C = velocity of sound

f = frequency

C, velocity of sound varies with variation in temperature, pressure, medium type, humidity, air turbulence, conventional currents etc. So, before calculating the wavelength the speed of sound is required to be calculated and the following formula can be used-

$C_T = C_0 \text{ sqrt}(1 + T/273)$

where, C_0 = speed of sound at 0° C

C_T = speed of sound at T° C

T = temperature in degree C

3.6.3 Environmental Factors

The attenuation of sound power depends on the speed of sound, which depends on many environmental factors like temperature, medium, pressure, humidity, acoustic interference, radio frequency interference, etc.

3.6.3.1 Temperature

The velocity of sound in a medium varies with temperature. So, the time taken by the sound to echo back to the receiver will vary and since this time of flight is proportional to the measured distance. The measured distance will vary with the variation in temperature. Thus the variation in temperature introduces errors in the measurement.

3.6.3.2 Medium

Velocity of sound depends on the kind of medium the sound travels. Sound speed varies with different medium. The following table summarizes some of the medium with the sound velocity in it.

	Medium	Speed, in./s at 10°C
1	Air	13,044
2	Ammonia	16,332
3	Argon	11886
4	Carbon-di-oxide	10,152 (low frequency) 10,572 (high frequency)
5	Carbon Disulfide	7,272
6	Carbon Monoxide	13,272
7	Chlorine	8,088
8	Ethylene	12,360
9	Helium	38,184
10	Hydrogen	49,980
11	Methane	17,004
12	Neon	17,124
13	Nitric Oxide	12,792
14	Nitrogen	13,152
15	Nitrous Oxide	10,308
16	Oxygen	12,492

Table 2 - Medium with Velocity

3.6.3.3 Pressure and Humidity

As the pressure reduces, the density of particle in the medium decreases thus providing less and less resistance to the traveling wave. Thus although slightly but pressure effects the velocity of sound wave. Humidity which is defined as the moisture content in the medium basically has a very little effect on the velocity of sound but it actually effect the radiating surface.

3.6.3.4 Acoustic Interference

If the environment contains number of objects that generates background noise and if this background noise falls in the sensitive frequency of the receiver of the ultrasonic sensing system, it will result in erroneous measurement. This error is more pronounced when the amplitude/power of the background noise is more then the echo itself resulting in very low SNR (signal to noise ratio), which is undesirable.

Typically, the background noise is less at higher frequency and so narrow beam angles works best in an area where background noise is high.

3.6.3.5 Radio Frequency Interference

Radio frequency signal present in the environment also affects the ultrasonic sensing system.

3.6.4 Target Consideration

The principle of ultrasonic sensing is based on transmission of sound wave followed by the reflection of the echo. These echo are summed up at the receiver. The return echo is a function of target distance, geometry, surface, size, composition, orientation of object/sensor etc.

1. Composition

Some of the objects are good reflector and some are good absorber. So the amount of echo returned back depends on the kind of material the object is composed of. This finally effects the measurement as it varies from object to object for the same fix distance of the target from the sensor.

2. Size and Shape

Size and shape affects the amount of echo reflected back to the receiver. For example, for large planner object (object size >> beam size) almost all the ultrasonic wave will be reflected back to the receiver. Whereas in case where the object is very small as compared to the beam size, then part of the ultrasonic sound wave will be reflected to the receiver and the rest will be lost. The shape determines the angle at which the ultrasonic wave will be reflected.

3. Position and Orientation

If the size of object is small as compared to the beam size, then the measurement depends on the position of the object in the beam region. When object is on the main lobe axis, the reflected echo reaching to the receiver will be very strong and if it is out of axis, the reflected echo will be weak.

CHAPTER 4
HARDWARE DESCRIPTION

4.1 Power Supply

A power supply is a vital part of all electronic systems. Most digital IC's including microprocessors; microcontroller operates on a ±5V supply. A regulated power supply is a power supply whose output voltage remains fairly constant even though the load and/or the input voltage changes. A load is any electrical circuit, appliance, device that is connected to the output of the power supply.

The components used in the circuit are:

- Transformer (9-0-9 V)
- Rectifiers IN4007
- Regulators LM7805
- Capacitors 1000μF, 25V

In the power supply 9V a.c is obtained from the step down transformer that is fed to the rectifier circuit to obtain d.c voltage. This pulsating d.c is filtered using the shunt capacitor of 1000μf. The ripple free voltage is then fed to the 7805-voltage regulator, which gives constant +5V. Then +5V is given to controller circuit and other chips.
The power supply supplies the required energy for both the microcontroller and the associated circuits. It is the most essential part of the circuit because to run its constituent IC's circuit has to be provided with power. These IC's can run on DC power. Hence the required D.C supply has to be generated. The main parts of a power supply unit and their function are as follows:

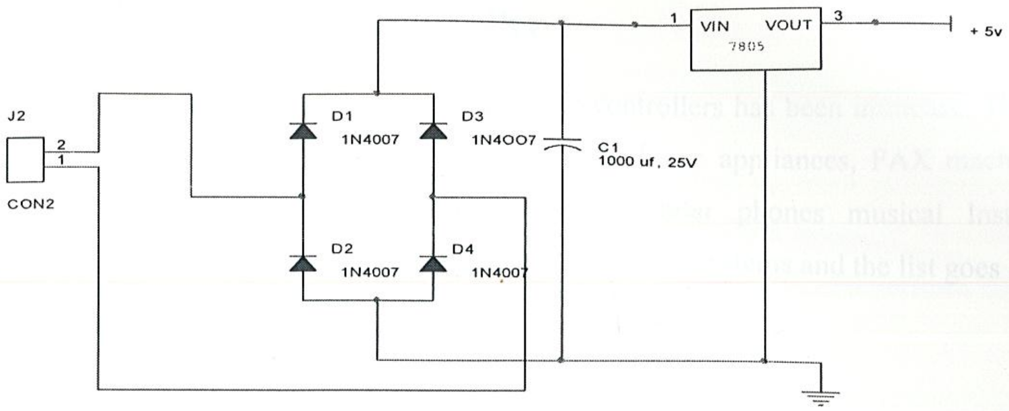

Figure 4.1: Power supply

- **Transformer:** The function of the transformer is to step down the voltage level from the available A.C.220V to the desired voltage. The 9-0-9 rating of the transformer upon the requirements of the IC's in the circuit is used. The secondary has a center tapping which forms the neutral terminal.
- **Bridge rectifier:** The function of the rectifier is to convert the alternating voltage signal into a unidirectional one. This function is provided by semiconductor diodes connected in bridge configuration. Diodes 1N4007 are used as rectifier.
- **Ripple Rejection:** The output voltage of the rectifier is unidirectional but pulsating. A capacitor of 1000µf is used for ripple rejection.
- **Regulation:** To obtain a constant voltage specific IC's are used as voltage regulator. Voltage regulator LM7805 is used. These IC's have three terminals an input, an output and a ground terminal.

4.2 Optoisolator

In electronics, an **opto-isolator** (or **optical isolator, optocoupler, photocoupler**, or **photoMOS**) is a device that uses a short optical transmission path to transfer a signal between elements of a circuit, typically a transmitter and a receiver, while keeping them electrically isolated — since the signal goes from an electrical signal to an optical signal back to an electrical signal, electrical contact along the path is broken

4.3 The Microcontroller

In our day to day life the role of micro-controllers has been immense. They are used in a variety of applications ranging from home appliances, FAX machines, Video games, Camera, Exercise equipment, Cellular phones musical Instruments to Computers, engine control, aeronautics, security systems and the list goes on.

4.3.1 Microcontroller versus Microprocessor

What is the difference between a microprocessor and microcontroller? The microprocessors (such as 8086,80286,68000 etc.) contain no RAM, no ROM and no I/O ports on the chip itself. For this reason they are referred as general- purpose microprocessors. A system designer using general- purpose microprocessor must add external RAM, ROM, I/O ports and timers to make them functional. Although the addition of external RAM, ROM, and I/O ports make the system bulkier and much more expensive, they have the advantage of versatility such that the designer can decide on the amount of RAM, ROM and I/o ports needed to fit the task at hand. This is the not the case with microcontrollers. A microcontroller has a CPU (a microprocessor) in addition to the fixed amount of RAM, ROM, I/O ports, and timer are all embedded together on the chip: therefore, the designer cannot add any external memory, I/O, or timer to it. The fixed amount of on chip RAM, ROM, and number of I/O ports in microcontrollers make them ideal for many applications in which cost and space are critical. In many applications, for example a TV remote control, there is no need for the computing power of a 486 or even a 8086 microprocessor. In many applications, the space it takes, the power it consumes, and the price per unit are much more critical considerations than the computing power. These applications most often require some I/O operations to read signals and turn on and off certain bits. It is interesting to know that some microcontrollers manufactures have gone as far as integrating an ADC and other peripherals into the microcontrollers.

4.3.2 Microcontroller for embedded systems

In the literature discussing microprocessors, we often see a term embedded system. Microprocessors and microcontrollers are widely used in embedded system products.

An embedded product uses a microprocessor (or microcontroller) to do one task and one task only. A printer is an example of embedded system since the processor inside it performs one task only: namely, get data and print it. Contrasting this with a IBM PC which can be used for a number of applications such as word processor, print server, network server, video game player, or internet terminal. Software for a variety of applications can be loaded and run. Of course the reason a PC can perform myriad tasks is that it has RAM memory and an operating system that loads the application software into RAM and lets the CPU run it. In an embedded system, there is only one application software that is burned into ROM. An PC contains or is connected to various embedded products such as the keyboard, printer, modem, disk controller, sound card, CD-ROM driver, mouse and so on. Each one of these peripherals has a microcontroller inside it that performs only one task. For example, inside every mouse there is a microcontroller to perform the task of finding the mouse position and sending it to the PC.

Although microcontrollers are the preferred choice for many embedded systems, there are times that a microcontroller is inadequate for the task. For this reason, in many years the manufacturers for general-purpose microprocessors have targeted their microprocessor for the high end of the embedded market.

4.4 Introduction to 8051

In 1981, Intel Corporation introduced an 8-bit microcontroller called the 8051. This microcontroller had 128 bytes of RAM, 4K bytes of on-chip ROM, two timers, one serial port, and four ports (8-bit) all on a single chip. The 8051 is an 8-bit processor, meaning the CPU can work on only 8- bit pieces to be processed by the CPU. The 8051 has a total of four I/O ports, each 8- bit wide. Although 8051 can have a maximum of 64K bytes of on-chip ROM, many manufacturers put only 4K bytes on the chip.

The 8051 became widely popular after Intel allowed other manufacturers to make any flavor of the 8051 they please with the condition that they remain code compatible with the 8051. This has led to many versions of the 8051 with different speeds and amount of on-chip ROM marketed by more than half a dozen manufacturers. It is important to know that although there are different flavors of the 8051, they are all compatible with the original 8051 as far as the instructions are concerned. This means that if you write your program for one, it will run on any one of them regardless of the manufacturer. The major 8051 manufacturers are Intel, Atmel, Dallas Semiconductors, Philips Corporation, Infineon.

4.5 AT89C51 From Atmel Corporation

This popular 8051 chip has on-chip ROM in the form of flash memory. This is ideal for fast development since flash memory can be erased in seconds compared to twenty minutes or more needed for the earlier versions of the 8051. To use the AT89C51 to develop a microcontroller-based system requires a ROM burner that supports flash memory: However, a ROM eraser is not needed. Notice that in flash memory you must erase the entire contents of ROM in order to program it again. The PROM burner does this erasing of flash itself and this is why a separate burner is not needed. To eliminate the need for a PROM burner Atmel is working on a version of the AT89C51 that can be programmed by the serial COM port of the PC.

FEATURES OF AT89C51

- 4K on-chip ROM
- 128 bytes internal RAM (8-bit)
- 32 I/O pins
- Two 16-bit timers
- Six Interrupts
- Serial programming facility
- 40 pin Dual-in-line Package

4.5.1 Pin Description

The 89C51 have a total of 40 pins that are dedicated for various functions such as I/O, RD, WR, address and interrupts. Out of 40 pins, a total of 32 pins are set aside for the four ports P0, P1, P2, and P3, where each port takes 8 pins. The rest of the pins are designated as Vcc, GND, XTAL1, XTAL, RST, EA, and PSEN. All these pins except

PSEN and ALE are used by all members of the 8051 and 8031 families. In other words, they must be connected in order for the system to work, regardless of whether the microcontroller is of the 8051 or the 8031 family. The other two pins, PSEN and ALE are used mainly in 8031 based systems.

Vcc

Pin 40 provides supply voltage to the chip. The voltage source is +5 V.

GND

Pin 20 is the ground.

XTAL1 and XTAL2

The 8051 have an on-chip oscillator but requires external clock to run it. Most often a quartz crystal oscillator is connected to input XTAL1 (pin 19) and XTAL2 (pin 18). The quartz crystal oscillator connected to XTAL1 and XTAL2 also needs two capacitors of 30 pF value. One side of each capacitor is connected to the ground.

It must be noted that there are various speeds of the 8051 family. Speed refers to the maximum oscillator frequency connected to the XTAL. For example, a 12 MHz chip must be connected to a crystal with 12 MHz frequency or less. Likewise, a 20 MHz microcontroller requires a crystal frequency of no more than 20 MHz. When the 8051 is connected to a crystal oscillator and is powered up, we can observe the frequency on the XTAL2 pin using oscilloscope.

RST

Pin 9 is the reset pin. It is an input and is active high (normally low). Upon applying a high pulse to this pin, the microcontroller will reset and terminate all activities. This is often referred to as a power –on reset. Activating a power-on reset will cause all values in the registers to be lost. Notice that the value of Program Counter is 0000 upon reset, forcing the CPU to fetch the first code from ROM memory location 0000. This means that we must place the first line of source code in ROM location 0000 that is where the CPU wakes up and expects to find the first instruction. In order to RESET input to be effective, it must have a minimum duration of 2 machine cycles. In other words, the high pulse must be high for a minimum of 2 machine cycles before it is allowed to go low.

EA

All the 8051 family members come with on-chip ROM to store programs. In such cases, the EA pin is connected to the Vcc. For family members such as 8031 and 8032 in which there is no on-chip ROM, code is stored on an external ROM and is fetched by the 8031/32. Therefore for the 8031 the EA pin must be connected to ground to indicate that the code is stored externally. EA, which stands for "external access," is pin number 31 in the DIP packages. It is input pin and must be connected to either Vcc or GND. In other words, it cannot be left unconnected.

PSEN

This is an output pin. PSEN stands for "program store enable." It is the read strobe to external program memory. When the microcontroller is executing from external memory, PSEN is activated twice each machine cycle.

ALE

ALE (Address latch enable) is an output pin and is active high. When connecting a microcontroller to external memory, potr 0 provides both address and data. In other words the microcontroller multiplexes address and data through port 0 to save pins. The ALE pin is used for de-multiplexing the address and data by connecting to the G pin of the 74LS373 chip.

4.5.1.1 I/O port pins and their functions

The four ports P0, P1, P2, and P3 each use 8 pins, making them 8-bit ports. All the ports upon RESET are configured as output, ready to be used as output ports. To use any of these as input port, it must be programmed.

Port 0

Port 0 occupies a total of 8 pins (pins 32 to 39). It can be used for input or output. To use the pins of port 0 as both input and output ports, each pin must be connected externally to a 10K-ohm pull-up resistor. This is due to fact that port 0 is an open drain, unlike P1, P2 and P3. With external pull-up resistors connected upon reset, port 0 is configured as output port. In order to make port 0 an input, the port must be programmed by writing 1 to all the bits of it. Port 0 is also designated as

AD0-AD7, allowing it to be used for both data and address. When connecting a microcontroller to an external memory, port 0 provides both address and data. The microcontroller multiplexes address and data through port 0 to save pins. ALE indicates if P0 has address or data. When ALE=0, it provides data D0-D7, but when ALE=1 it has address A0-A7. Therefore, ALE is used for de-multiplexing address and data with the help of latch 74LS373.

Port 1

Port 1 occupies a total of 8 pins (pins 1 to 8). It can be used as input or output. In contrast to port 0, this port does not require pull-up resistors since it has already pull-up resistors internally. Upon reset, port 1 is configures as an output port. Similar to port 0, port 1 can be used as an input port by writing 1 to all its bits.

Port 2

Port 2 occupies a total of 8 pins (pins 21 to 28). It can be used as input or output. Just like P1, port 2 does not need any pull-up resistors since it has pull-up resistors internally. Upon reset port 2 is configured as output port. To make port 2 input, it must be programmed as such by writing 1s to it.

Port 3

Port 3 occupies a total of 8 pins (pins 10 to 17). It can be used as input or output. P3 does not need any pull-up resistors, the same as P1 and P2 did not. Although port 3 is configured as output port upon reset, this is not the way it is most commonly used. Port 3 has an additional function of providing some extremely important signals such as interrupts. Some of the alternate functions of P3 are listed below:

P3.0 RXD (Serial input)

P3.1 TXD (Serial output)

P3.2 INT0 (External interrupt 0)

P3.3 INT1 (External interrupt 1)

P3.4 T0 (Timer 0 external input)

P3.5 T1 (Timer 1 external input)

P3.6 WR (External memory write strobe)

P3.7 RD (External memory read strobe)

4.5.2 Memory Space Allocation

1. Internal ROM

The 89C51 has a 4K bytes of on-chip ROM. This 4K bytes ROM memory has memory addresses of 0000 to 0FFFh. Program addresses higher than 0FFFh, which exceed the internal ROM capacity will cause the microcontroller to automatically fetch code bytes from external memory. Code bytes can also be fetched exclusively from an external memory, addresses 0000h to FFFFh, by connecting the external access pin to ground. The program counter doesn't care where the code is: the circuit designer decides whether the code is found totally in internal ROM, totally in external ROM or in a combination of internal and external ROM.

2. Internal RAM

The 1289 bytes of RAM inside the 8051 are assigned addresses 00 to 7Fh. These 128 bytes can be divided into three different groups as follows:

1. A total of 32 bytes from locations 00 to 1Fh are set aside for register banks and the stack.
2. A total of 16 bytes from locations 20h to 2Fh are set aside for bit addressable read/write memory and instructions.
3. A total of 80 bytes from locations 30h to 7Fh are used for read and write storage, or what is normally called a scratch pad. These 80 locations of

RAM are widely used for the purpose of storing data and parameters by 8051 programmers.

4.6 LCD Display

Liquid crystal displays (LCD) are widely used in recent years as compares to LEDs. This is due to the declining prices of LCD, the ability to display numbers, characters and graphics, incorporation of a refreshing controller into the LCD, their by relieving the CPU of the task of refreshing the LCD and also the ease of programming for characters and graphics. HD 44780 based LCDs are most commonly used.

4.6.1 LCD pin description

The LCD discuss in this section has the most common connector used for the Hitatchi 44780 based LCD is 14 pins in a row and modes of operation and how to program and interface with microcontroller is describes in this section.

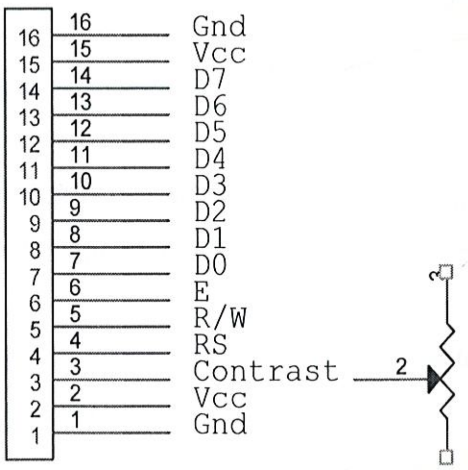

Fig 4.2 LCD Pin Description Diagram

V_{CC}, V_{SS}, V_{EE}

The voltage V_{CC} and V_{SS} provided by +5V and ground respectively while V_{EE} is used for controlling LCD contrast. Variable voltage between Ground and Vcc is used to specify the contrast (or "darkness") of the characters on the LCD screen.

RS (register select)

There are two important registers inside the LCD. The RS pin is used for their selection as follows. If RS=0, the instruction command code register is selected, then allowing to user to send a command such as clear display, cursor at home etc.. If RS=1, the data register is selected, allowing the user to send data to be displayed on the LCD.

R/W (read/write)

The R/W (read/write) input allowing the user to write information from it. R/W=1, when it read and R/W=0, when it writing.

EN (enable)

The enable pin is used by the LCD to latch information presented to its data pins. When data is supplied to data pins, a high power, a high-to-low pulse must be applied to this pin in order to for the LCD to latch in the data presented at the data pins.

D0-D7 (data lines)

The 8-bit data pins, D0-D7, are used to send information to the LCD or read the contents of the LCD's internal registers. To displays the letters and numbers, we send ASCII codes for the letters A-Z, a-z, and numbers 0-9 to these pins while making RS =1. There are also command codes that can be sent to clear the display or force the cursor to the home position or blink the cursor.

We also use RS =0 to check the busy flag bit to see if the LCD is ready to receive the information. The busy flag is D7 and can be read when R/W =1 and RS =0, as follows: if R/W =1 and RS =0, when D7 =1(busy flag =1), the LCD is busy taking care of internal operations and will not accept any information. When D7 =0, the LCD is ready to receive new information.

4.7 Interfacing of LCD with Microcontroller

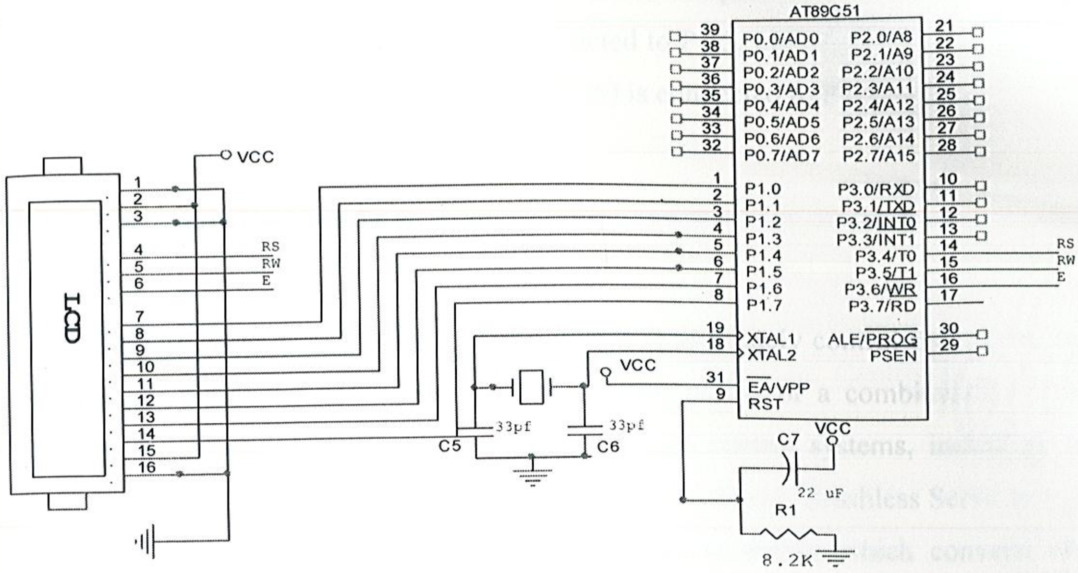

Figure 4.3: Interfacing of LCD with microcontroller

Pin	Symbol	I/O	Description
1	VSS	-	Ground
2	VCC	-	+5V power supply
3	VEE	-	Power supply to control contrast
4	RS	I	RS=0 to select command register, RS=1 to select data register.
5	R/W	I	R/W=0 for write, R/W=1 for read
6	E	I/O	Enable
7	PB0	I/O	The 8 bit data bus
8	PB1	I/O	The 8 bit data bus
9	DB2	I/O	The 8 bit data bus
10	DB3	I/O	The 8 bit data bus
11	DB4	I/O	The 8 bit data bus
12	DB5	I/O	The 8 bit data bus
13	DB6	I/O	The 8 bit data bus
14	DB7	I/O	The 8 bit data bus

Table 3 - LCD pin description

Port 1 of microcontroller is used for 8 bit data display on the LCD. Data lines of the LCD Pin no.7 to pin no 14 are connected to the port 1 of the microcontroller. The control pin no.4 register select is connected to P3.5, pin no.5 of LCD for Read/write is connected to P3.6 and the enable pin (6) is connected to P3.7 of microcontroller.

4.8 Stepper Motor

Motion Control, in electronic terms, means to accurately control the movement of an object based on either speed, distance, load, inertia or a combination of all these factors. There are numerous types of motion control systems, including; Stepper Motor, Linear Step Motor, DC Brush, Brushless, Servo, Brushless Servo and more.

A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. Stepper motor is a form of ac. motor .The shaft or spindle of a stepper motor rotates in discrete step increments when electrical command pulses are applied to it in the proper sequence. The motors rotation has several direct relationships to these applied input pulses. The sequence of the applied pulses is directly related to the direction of motor shafts rotation. The speed of the motor shafts rotation is directly related to the frequency of the input pulses and the length of rotation is directly related to the number of input pulses applied [39].

For every input pulse, the motor shaft turns through a specified number of degrees, called a step. Its working principle is one step rotation for one input pulse. The range of step size may vary from 0.72 degree to 90 degree. In position control application, if the number of input pulses sent to the motor is known, the actual position of the driven job can be obtained.

A stepper motor differs from a conventional motor (CM) as under:

a. Input to SM is in the form of electric pulses whereas input to a CM is invariably from a constant voltage source.
b. A CM has a free running shaft whereas shaft of SM moves through angular steps.
c. In control system applications, no feedback loop is required when SM is used but a feedback loop is required when CM is used.

d. A SM is a digital electromechanical device whereas a CM is an analog electromechanical device [40].

4.8.1 Open Loop Operation

One of the most significant advantages of a stepper motor is its ability to be accurately controlled in an open loop system. Open loop control means no feedback information about position is needed. This type of control eliminates the need for expensive sensing and feedback devices such as optical encoders. Control position is known simply by keeping track of the input step pulses [39].

Every stepper motor has a permanent magnet rotor (shaft) surrounded by a stator. The most common stepper motor has four stator windings that are paired with a center-tapped common. This type of stepper motor is commonly referred to as a four-phase stepper motor. The center tap allows a change of current direction in each of two coils when a winding is grounded, thereby resulting in a polarity change of the stator. Notice that while a conventional motor shaft runs freely, the stepper motor shaft moves in a fixed repeatable increment which allows one to move it to a precise position. This repeatable

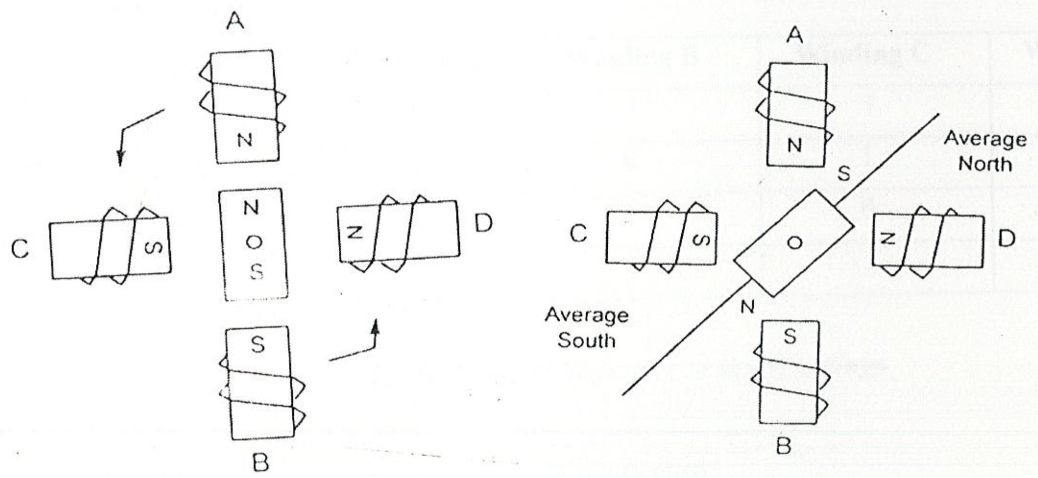

Fig 4.4: Rotor Alignment

fixed movement is possible as a result of basic magnetic theory where poles of the Same polarity repel and opposite poles attract. The direction of the rotation is dictated by the stator poles. The stator poles are determined by the current sent through the wire coils. As the direction of the current is changed, the polarity is also changed causing the reverse motion of the rotor. The stepper motor used here has a total of 5 leads: 4 leads representing the four stator windings and 1 common for the center tapped leads. As the sequence of power is applied to each stator winding, the rotor will rotate. There are several widely used sequences where each has a different degree of precision. Table shows the normal 4-step sequence. For clockwise go for step 1 to 4 & for counter clockwise go for step 4 to 1.

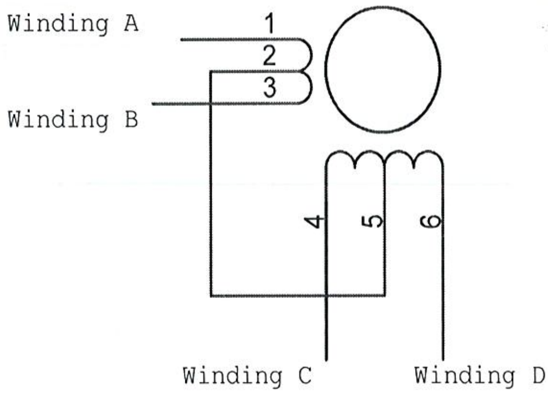

Fig 4.5: Stator Windings Configuration

Step	Winding A	Winding B	Winding C	Winding D
1	0	1	1	1
2	1	0	1	1
3	1	1	0	1
4	1	1	1	0

Table 4: Input Sequence to the Windings

4.8.2 Step Angle & Steps per Revolution

Movement associated with a single step, depends on the internal construction of the motor, in particular the number of teeth on the stator and the rotor. The step angle is the minimum degree of rotation associated with a single step.

Step per revolution is the total number of steps needed to rotate one complete rotation or 360 degrees (e.g., 180 steps * 2 degree = 360) [31].

Since the stepper motor is not ordinary motor and has four separate coils, which have to be energized one by one in a stepwise fashion. We term them as coil A, B, C and D. At a particular instant the coil A should get supply and then after some delay the coil B should get a supply and then coil C and then coil D and so on the cycle continues. The more the delay is introduced between the energizing of the coils the lesser is the speed of the stepper motor and vice versa.

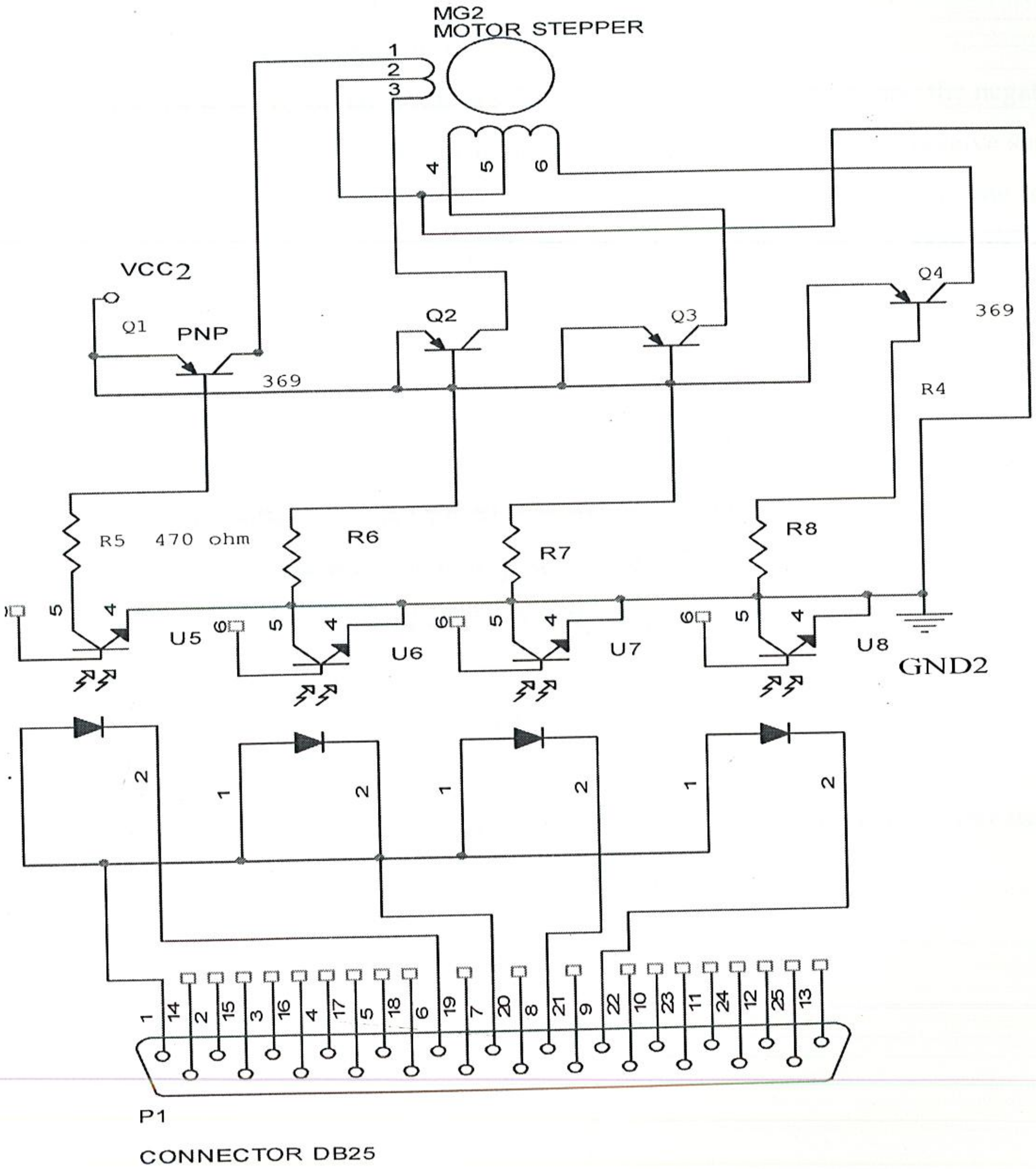

Figure 4.6: Stepper motor interfacing

4.9 Max 232

The MAX232 is an electronic circuit that converts signals from a serial port to signals suitable for usage in e.g. microprocessor circuits.

When communicating with various micro processors one needs to convert the RS232 levels down to lower levels, typically 3.3 or 5.0 Volts. Serial RS-232 communication works with voltages -15V to +15V for high and low. On the other hand, TTL logic operates between 0V and +5V . Modern low power consumption logic operates in the range of 0V and +3.3V or even lower.

Thus the RS-232 signal levels are far too high TTL electronics, and the negative RS-232 voltage for high can't be handled at all by computer logic. To receive serial data from an RS-232 interface the voltage has to be reduced. Also the low and high voltage level has to be inverted. The level converter uses a Max232 and five capacitors.

Power supply	5V DC, 1A
Schmitt trigger	74HC used for generation of square wave pulses
Microcontroller	AT89C51 with external clock frequency of 11.0592MHz
Low power transistor	Medium power NPN transistor BC549 rated at 30V
LCD	LMB162 A with 16 pin ,2 line, 8 bits/ character, 5x10 dots/ Character
Range	0.2 ~ 3meters
Transmitter	MA40B8S sensor transmits signal at 40 KHz
Receiver	MA40B8R sensor receives the echo generated by transmitter

Table 5: Specificaton of products

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 Conclusion

Advances in electronic technology, coupled with economical (low) prices, make monitoring cost- effective and a powerful tool in measurement of parameter. The reliability, sensitivity and accuracy of the instrument are considerably enhanced by the use of AT89C51 micro controller for controlling various functions. Ultrasonic sensor has been used for the displacement of the distance of the object comes in front of it. To provide safety in system the ultrasonic sensors are used which help in giving the accurate result of the distance. The system is capable of measuring distance with the help of the transmitter section, receiver section and which are interfaced with the microcontroller. These products are used in all industries measuring the distance to or size of material objects. That covers a lot of territory, and almost any size and type of object can be measured. The complete implementation and testing of the system has been done. Finally it is concluded that the aesthetically and ergonomically designed is versatile and user-friendly intelligent system for distance measurement, which can be used in the field of robotics for finding out the obstacle and the circuit designed is highly accurate and the product is easy to operate.

5.2 Future Scope

Although ultrasonic range sensor for the measurement of the distance of the obstacle that comes in its path has been developed in this thesis work, but some more features can be added to increase its utility. The system can be enhanced by making some modification.

- It can be used to provide the robot with more intelligence and advanced sensor system in order to deal with various situations like losing its master and avoiding collision with an obstacle. This will be implemented by providing a motor which make turn towards the strongest signal which comes from its master.

- One suitable approach is to use multiple range sensors. This can be useful to overcome the inaccuracies observed in the range measurements due to limitations in the sensor specifications. More no. of sensors providing the capability of individual range measurement results from any of the sensors, at any time. Flexibility was also achieved in terms of enabling the future addition of more sensors, of similar or different types.
- Ultrasonic range system has lack of positional information. This is well known to be a major problem of which much work has been focused. Dead reckoning using the encoders will be used to avoid such problem. Landmark recognition may be a good resolution for such problem.
- Ultrasonic range sensors measure range using time-of-flight of sound i.e 330 m/sec in air. But now work is going on Laser range finders i.e. LADAR measure time-of-flight of light i.e. 300,000,000 m/sec in vacuum. Here we see a lot more gap in between the two types of range sensors. Thus improvement in the range will be possible.
- It can be used in the application to measure the liquid level in a closed or open top tank and to measure dry material level in bins or hoppers to provide sufficient ultrasonic echo for reliable detection.
- The distance, speed and angle detection of the coming object can be used for security purpose of historical monuments.

APPENDIX A

SOFTWARE MODULE 1

```
#include"C:\keil\c51\inc\reg51.h"
#include<intrins.h>
#define DATA P1

#define RS    P35
#define RW   P36
#define E     P37

#define s1 P20

#define msk P22

unsigned char flag;

void displaypval(unsigned long int);

void lcd_initialize();
void lcd_cmd();
void lcd_datawrite();
void lcd_busy();
void lcd_display(char *,char);

void ms_delay(unsigned int);
void secdelay(unsigned char);

unsigned long int intcount,timer,datax,distance;

void extern0(void) interrupt 0 using 2
{
```

```
        TR0=0;
flag=1;
}
void timer0(void) interrupt 1 using 2
{
        timer++;
}
void displaypkval(unsigned long int getval)
{
   unsigned long int getvala;
        char val[6]={0,0,0,0,0,0};
        char count;
        getvala=getval;
        for(count=0; count<=5; count++)
        {
         val[count]=getvala%10;
    getvala=getvala/10;
        }
        for(count=5; count>=3; count--)
        {
                ACC=val[count]+48;
                lcd_datawrite();
        }
                ACC='.';
                lcd_datawrite();
                for(count=2; count>=0; count--)
        {
                ACC=val[count]+48;
                lcd_datawrite();
        }
  }
  void displaypmval(unsigned long int getval)
  {
     unsigned long int getvala;
```

```
        char val[8]={0,0,0,0,0,0,0,0};
        char count;
        getvala=getval;
        for(count=0; count<=7; count++)
        {
         val[count]=getvala%10;
  getvala=getvala/10;
        }
        for(count=7; count>=6; count--)
        {
                ACC=val[count]+48;
                lcd_datawrite();
        }
                ACC='.';
                lcd_datawrite();
                for(count=5; count>=0; count--)
        {
                ACC=val[count]+48;
                lcd_datawrite();
        }
}
void main()
{

                s1=1;
                IE=0x83;
                IT0=1;
                TMOD=0x22;
//              TH1=0xe8;
//              TL1=0xe8;

                TH0=0x19;
                TL0=0x19;
                        msk=intcount=0;
```

```
unsigned int distancef,distance,distance,mask;
                lcd_initialize();
                        ACC=0x01;
                        lcd_cmd();
                        ACC=0x80;
                        lcd_cmd();
                                secdelay(3);
                        ACC=0x01;
                        lcd_cmd();
while(1)
{
ACC=0x01;
lcd_cmd();
if(msk==0)
mask++;
while(s1==0);
                TR0=1;
while(flag==0);
                ACC=0x80;
                        lcd_cmd();
        lcd_display("",5);
                ms_delay(15);
                distance=289*timer;
                        ACC=0x80;
                        lcd_cmd();
                        if(mask==1)
                                {
                                        if(distance>=100)
                                                {
                                displaypval(distance);
                        ACC=0x88;
                        lcd_cmd();
                        lcd_display("Mt",2);
        distancef=distance*33;
```

```
ACC=0xC0;
lcd_cmd();
displaypvalf(distancef);
ACC=0xC8;
lcd_cmd();
lcd_display("ft",2);
}

}
if (mask==2)
{
if(distance>=200)
{
displaypval(distance);
ACC=0x88;
lcd_cmd();
lcd_display("Mt",2);
distancef=distance*33;
ACC=0xC0;
lcd_cmd();
displaypvalf(distancef);
ACC=0xC8;
lcd_cmd();
lcd_display("ft ",2);
}

}
if(mask==3)
{
if(distance>=300)
{
displaypval(distance);
ACC=0x88;
lcd_cmd();
lcd_display("Mt",2);
distancef=distance*33;
```

```
ACC=0xC0;
lcd_cmd();
displaypvalf(distancef);
ACC=0xC8;
lcd_cmd();
lcd_display("ft",2);
}
}
if(mask==4)
{
if(distance>=400)
{
displaypval(distance);
ACC=0x88;
lcd_cmd();
lcd_display("Mt",2);
distancef=distance*33;
ACC=0xC0;
lcd_cmd();
displaypvalf(distancef);
ACC=0xC8;
lcd_cmd();
lcd_display("ft",2);
}
}
if(mask==5)
mask=1;
secdelay(1);
}
}
void displaypval(unsigned long int getval)
{
unsigned long int getvala;
char val[4]={0,0,0,0};
```

```
        char count;
        getvala=getval;
        for(count=0; count<=5; count++)
        {
         val[count]=getvala%10;
    getvala=getvala/10;
        }
        for(count=5; count>=3; count--)
        {
                ACC=val[count]+48;
                lcd_datawrite();
        }
ACC='.';
lcd_datawrite();
for(count=2; count>=0; count--)
        {
                ACC=val[count]+48;
                lcd_datawrite();
        }
lcd_display("mt",2);
}
void displaypvalf(unsigned long int getval)
{
   unsigned long int getvala;
        char val[5]={0,0,0,0};
        char count;
        getvala=getval;
        for(count=0; count<=4; count++)
        {
         val[count]=getvala%10;
    getvala=getvala/10;
        }
        for(count=5; count>=4; count--)
        {
```

```
                ACC=val[count]+48;
                lcd_datawrite();
        }
lcd_display("ft",2);
for(count=2; count>=0; count--)
        {
                ACC=val[count]+48;
                lcd_datawrite();
        }
lcd_display("in",2);
}
void lcd_initialize()
{
ms_delay(20);
ACC=0x38;
lcd_cmd();
ms_delay(20);
ACC=0x0c;
lcd_cmd();
ms_delay(20);
ACC=0x01;
lcd_cmd();
ms_delay(20);
ACC=0x06;
lcd_cmd();
ms_delay(20);
}
void lcd_cmd()
{
unsigned char temp;
temp=ACC;
lcd_busy();
DATA=temp;
RS=0;
```

```
RW=0;
E=1;
E=0;
}
void lcd_datawrite()
{
unsigned char temp;
temp=ACC;
lcd_busy();
RS=1;
RW=0;
E=1;
DATA=temp;E=0;
}
void lcd_busy()
{
 unsigned char x;
do
{
 DATA=0xFF;
 RS=0;
 RW=1;
 E=1;
 x=DATA;
 E=0;
 x=x & 0x80;
  }
while(x!=0);
DATA=0x00;
}
void lcd_display(char *s,char len)
{
char i;
  for(i=0;i<len;i++)
```

```
 {
  ACC=*s;
  lcd_datawrite();
 ms_delay(5);
  s++;
 }
}
void ms_delay(unsigned int x)
{
unsigned int i,j;
j=x*70;
for(i=0;i<j;i++)
 {
  _nop_();
 }
}
void secdelay(unsigned char num)
 {
 unsigned int f,m;
 f=num*1000;
 for(m=0;m<=f;m++)
        {
                ms_delay(1);
        }
 }
```

APPENDIX B

SOFTWARE MODULE 2

```
#define DATA P1
#define RS P35
#define RW P36
#define E P37
#include<math.h>
#include<lcdrout.h>
#include<serial.h>
#include<us_distance.h>
#define st1 P20
#define st2 P21
#define st3 P22
#define st4 P23
#include<stepper.h>
void main()
{
unsigned int temp,speed,angle,loc1,loc2;
unsigned char t=0,flag=0;
code unsigned int check=40;

            init_serial(9600);
            lcd_initialize();
            lcd_display("Ultrasonic Based",16);
            lcd_display("Radar",5);
    secdelay(3);
            clrscr();
            while(1)
            {
      temp=distance();
      ACC=0x80;
      lcd_cmd();
```

```
lcd_display("Distance",8);
displaypval(temp);

ACC=0xc0;
lcd_cmd();

lcd_display("Angle",5);
ACC=0xcb;
lcd_cmd();
lcd_display("T:",2);
displaypval(t);
secdelay(2);
while(temp > check)
{       mov_fwd(1);
        temp=distance();
        if(temp <check)
                break;
        lcd_cmd1(0x88);
        displaypval(temp);
        if(flag==1)
                        t++;
        ACC=0xcd;
        lcd_cmd();
        displaypval(t);
        angle=angle+4;
        ACC=0xc0;
        lcd_cmd();
        lcd_display("Angle",5);
        displaypval(angle);
        send_int(temp);
        send_int(angle);
if(angle>=360)
        angle=0;
}
```

```
flag++;
LED=Buzz=0;
clrscr();
lcd_puts("Detected");
secdelay(1);
clrscr();

ACC=0x80;
lcd_cmd();
lcd_display("Distance",8);
displaypval(temp);


ACC=0xc0;
lcd_cmd();
lcd_display("Angle",5);
displaypval(angle);
lcd_puts("*");
        if(flag==1)
        {
                clrscr();
                lcd_puts("Loc1=");
                loc1=distance();
                loc1=loc1;///100;
                displaypval(loc1);
                secdelay(2);
                clrscr();
                flag=1;

        }
        else if(flag==2)
                {
                loc2=temp;
                clrscr();
```

```
                    lcd_puts("Loc1=");
                    displaypval(loc1);
                    lcd_puts("Loc2=");
                    loc2=distance();
                    loc2=loc2;///100;
                    displaypval(loc2);
                    if(loc1>loc2)
                    speed=(loc1-loc2);
                    else
                    speed=(loc2-loc1);
                    lcd_cmd1(0xc5);
                    lcd_puts("Speed");
                    speed=speed*100;
                    speed=speed/t;
                    displaypval(speed);
                    secdelay(2);
                    clrscr();
                    flag=0;
            }
        }
}
```

APPENDIX C
KEIL SOFTWARE

The software design is a key element in the development of a project. For visualization of the distance parameter on the LCD display, assembly language software is developed. The microcontroller chosen for the development of the system was the AT89C51. The AT89C51 has 4K of program memory and has the capability to write to its own memory. The use of a FLASH device for development also provides the option to use FLASH microcontrollers in the final design making the system fully up gradable. This allows modification of the microcontroller software to support expansion.

5.5.1 Keil Software

Keil software is used for the software implementation of the developed system. µVision2 Integrated Development Environment is an IDE that encapsulates a project manager, make facility, tool configuration, editor and a powerful debugger. µVision2 is used to write and compile the programs using the tools. It can transfer the assembly language as well as, C code into the hex file. Keil software consists of a Linker Control File, Map File, Project Target, Source File Group, Toolset. Linker Control File

i) Linker control file

It is a text file that µVision passes to the linker when linking. The control file includes all directives and names of object files and library files to include in the output file.

ii) Map File

The Map File is a listing file generated by the linker.

iii) Project Target: In a project, a target is an executable program that is generated. A project may generate a target that runs on an 8051. Targets may be created for builds with no optimization and for builds with full optimization.

iv) Source File Group: In a project, a group is a number of source files that compose the project target. Although you may individually specify the toolset options for a file, a group lets you apply the same options to a group of source files. The options for a group may be different from the options for the target.

v) Toolset: A toolset include an assembler, compiler, linker, HEX converter, debugger, and the other associated tools for a particular device family like the 8051. All of the tools or programs in a toolset are dedicated to generating target code for a specific family of chips.

To evaluate the software for correct operation the file was programmed into the microcontroller on the relevant development board. Programming of the microcontroller was achieved using the VPL-SPROG programmer. It is a handy serial programmer. This permits hexadecimal files to be loaded into the microcontroller. Initially the microcontroller was programmed by removing it from the socket on the board and inserting it into the multi-pin socket on the programmer.

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