Distance Analysis Using HC-SR04

Mallikarjun Mudda[1]
Electronics and Communication Engineering
Sreenidhi Institute of Science and Technology
mudda77@gmail.com

G Prathyusha, CH Shireesha, A Akshay [2]
Electronics and Communication Engineering
Sreenidhi Institute of Science and Technology

.

ABSTRACT:

In distance measurement using ultrasonic sensor we are measuring distance from the objects by using ultrasonic sensor we can measure distance upto 2.5meters 1% accuracy. we can measure the distance by interfacing 8051microcontroller also but for this special software is needed to dump the program in microcontroller.

In this distance measurement using ultrasonic sensor we are using different methodology i.e.,distance measurement using ultrasonic in air include continous wave and pulse echo technique.by using ardino also we can measure the distance. in this we needed ultrasonic transducer and separate ultrasonic transmitter & sensitive receiver. In this distance measurement using ultrasonic sound and p89c51rd2 we use optical sensor and pizeoeletric effect.in futher we detect the object with shape and size of the objectit is used in medical applications, navigations, militar, in traffic also.

Keywords: **ultrasonic sensor, transducer microcontroller IC's, optical sensor.**

INTRODUCTION

Ultrasonic sensors are ideally suited to accurate, automatic distance measurement in normal and difficult environments. Ultrasonic sensors are particularly suitable for environments where optical sensors are unusable such as smoke, dust and similar. Ultrasonic sensors are very accurate, stable and can be used over large ranges. Ultrasonic sensors can measure the following parameters without contacting the medium to be measured Distance, Level, Diameter, Presence; Position Ultrasonic sensors make accurate measurements in many difficult environments and unusual materials. Measurements are unaffected by Material, Surface, Light, Dust, Mist and Vapor

Ultrasonic dis tance sensors are designed for non-contact distance measurement and these types consist of transmitter and receiver or transceiver which is able to transmit and to receive ultrasonic sound (Figure 1). Main idea is to measure time to fly of ultrasonic sound wave from sensor to detected object. An ultrasonic transmitter sends a sound frequency of above 18 kHz in the air at the speed of 344 meter per second (at 20°C) and the receiver receives the reflected sound from the object. Distance between the transmitter and the object can be calculated by simple calculation by considering the time taken by the ultrasonic wave to travel from transmitter and received back (reflected) by the receiver. Measurement range is up to several meters.

Ultrasonic sensors are great tools to measure distance without actual contact and used at several places like water level measurement, distance measurement etc. This is an efficient way to measure small distances precisely. In this project we have used an Ultrasonic Sensor to determine the distance of an obstacle from the sensor. Basic principal of ultrasonic distance measurement is based on ECHO. When sound waves are transmitted in environment then waves are return back to origin as ECHO after striking on the obstacle. So we only need to calculate the travelling time of both sounds means outgoing time and returning time to origin after striking on the obstacle. As speed of the sound is known to us, after some calculation we can calculate the distance.

PRINCPLE O F ULRASONIC SENSOR

Almost all materials reflect sound waves, so ultrasonic sensors are a fine choice for many tasks. Excellence in the detection and measurement of films, transparent objects, and liquids separate these sensors from their photoelectric counterparts. Target color or frequent color changes also have no effect on ultrasonic sensors.

Due to their use of sound waves, ultrasonic sensors also perform well in dusty, dirty environments. However, they do not operate well with small targets against large backgrounds or targets such as foam batting that are excellent for absorbing sound waves [1, 2, 3, 4].

A typical ultrasonic sensor (Figure 2) comprises a clock (signal) generator and a controller to excite the transducer, then a processor and output amplifier to handle the return signal [4]

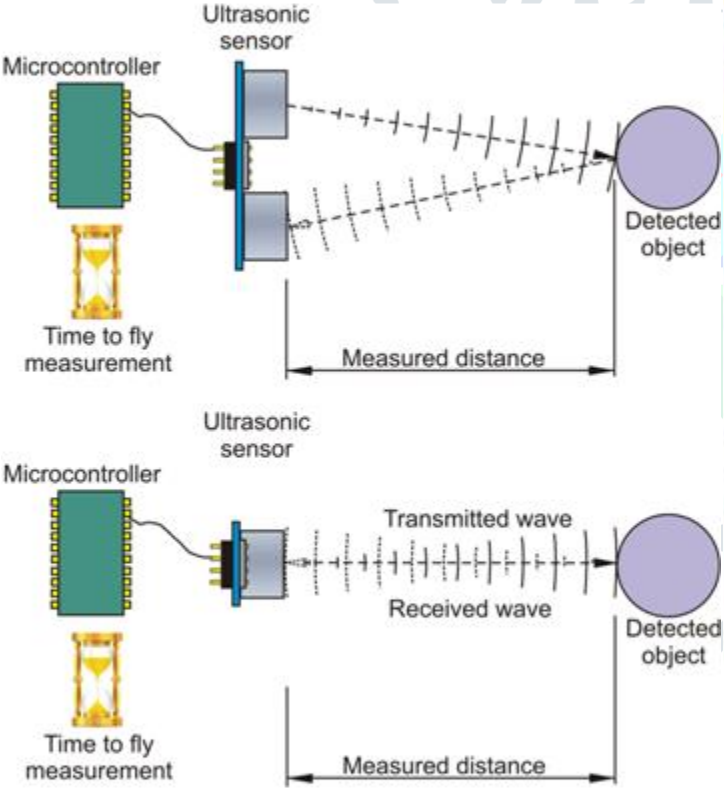

Figure 1: At a glance

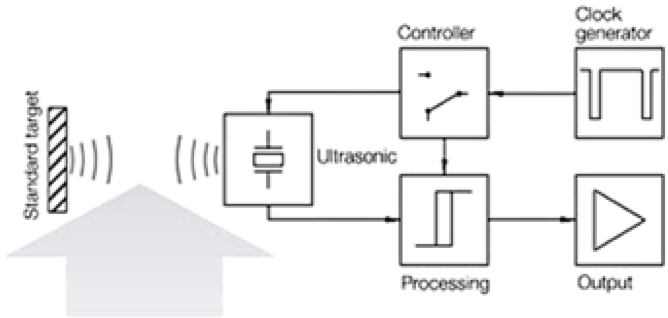

Figure 2: **A typical ultrasonic sensor**

Besides the time of flight principle also they are used physical principles based on Doppler Effect and the attenuation of sound waves.

Frequently application is as navigation sensor for mobile robots for obstacle avoiding [5].

Figure 3: Tukebot robot

Ultrasonic sensors have been used in Tukebot robot (Figure 3, Figure 4) built for "puck collecting competition" at RobotChallenge. RobotChallenge is one of the biggest competitions for self-made, autonomous and mobile robots worldwide. Competitive robots have to collect small discs ("pucks") on the field according to color. To robots compete against each other on a 250 x 250 cm field. The aim is to collect all pucks of the assigned color and carry them to the own home base. The first robot which collects all the assigned pucks wins [5, 6].

Locomotion microcontroller obtains signals from infrared distance sensor, from collision bumper touch sensors and from ultrasonic distance sensors (Figure 4). On the base of these sensors, locomotion microcontroller plans next locomotion and control it through drives of both wheels. These sensors enable to recognize, where the other rival robot is and where these assigned pucks are. It means that robot is still looking for assigned pucks and it avoids the rival robot [5, 6].

Experimental reports

Ultrasonic distance sensor with analogue output 0 – 10V has been selected for testing. The sensor uses 300 kHz sound frequency. Measurement range is from 120 mm up to 1000 mm and it has linear characteristic. Repeat accuracy is ±0.15% and resolution is 0.037 mm

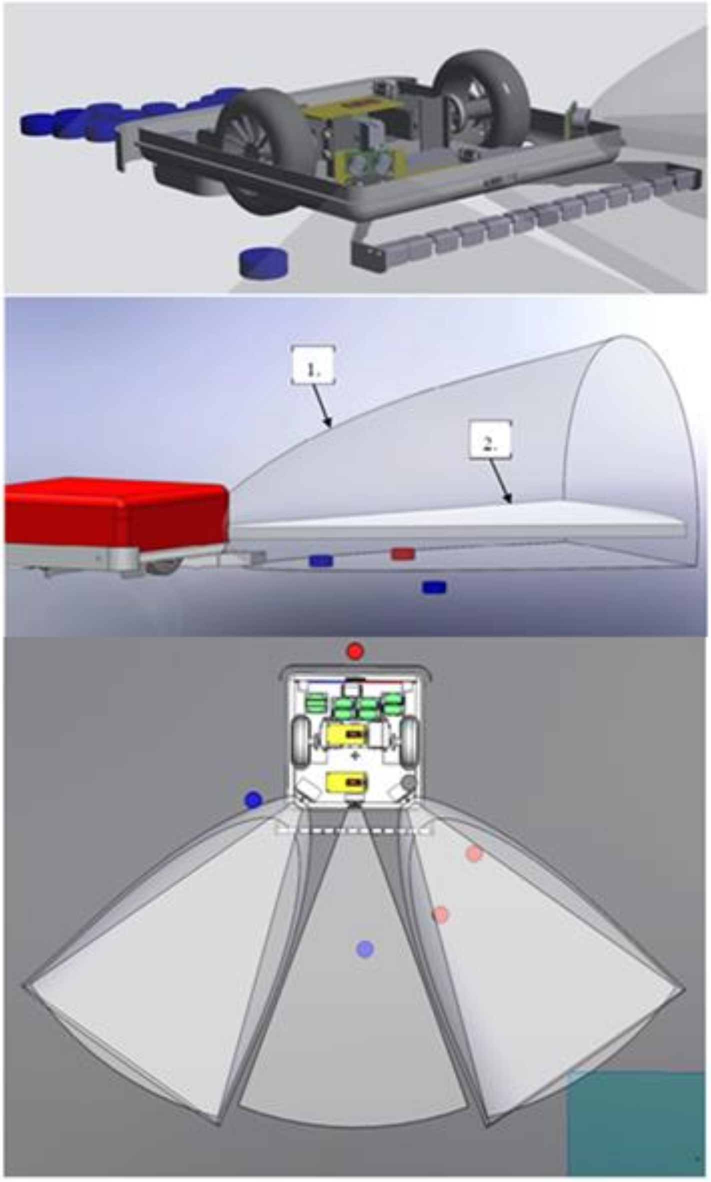

Figure 4: Ultrasonic distance sensor

.

Figure 5: Testing of ultrasonic sensor

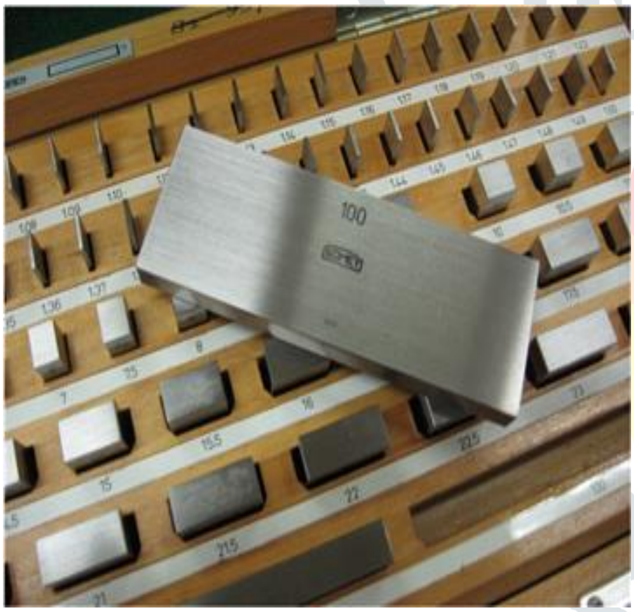

Figure 6:Guiding of ultrasonic sensor

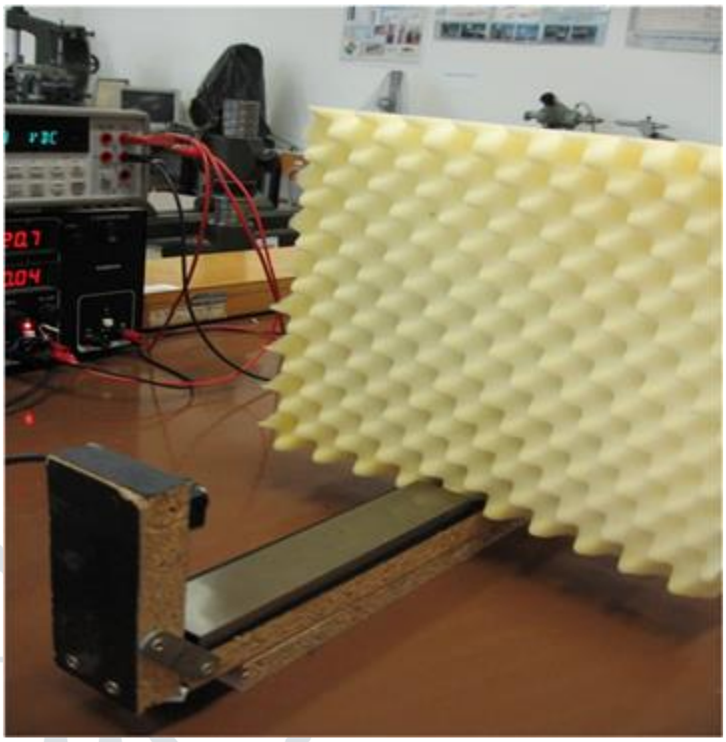

Figure 6: Testing with complete obstacle

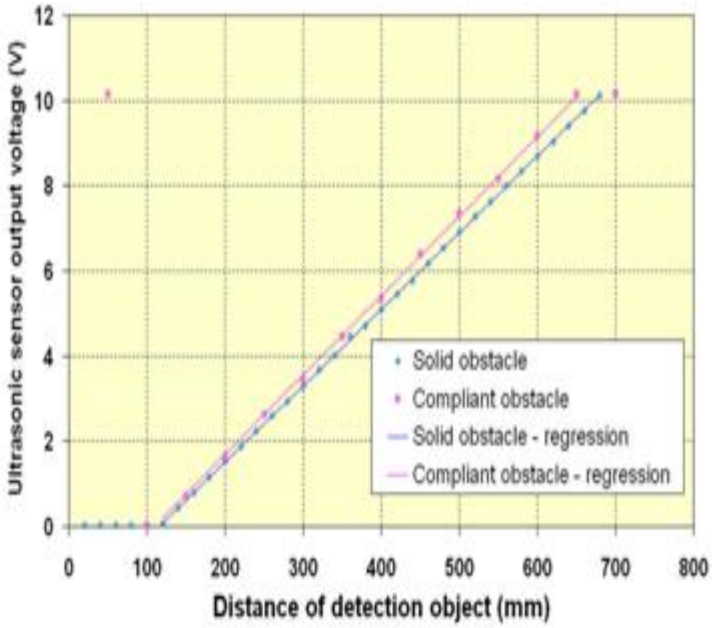

Figure 7 (a): Graph of sensor output with distance

Ultrasonic Transfer characteristics $ Ultrasonic Calibration characteristic

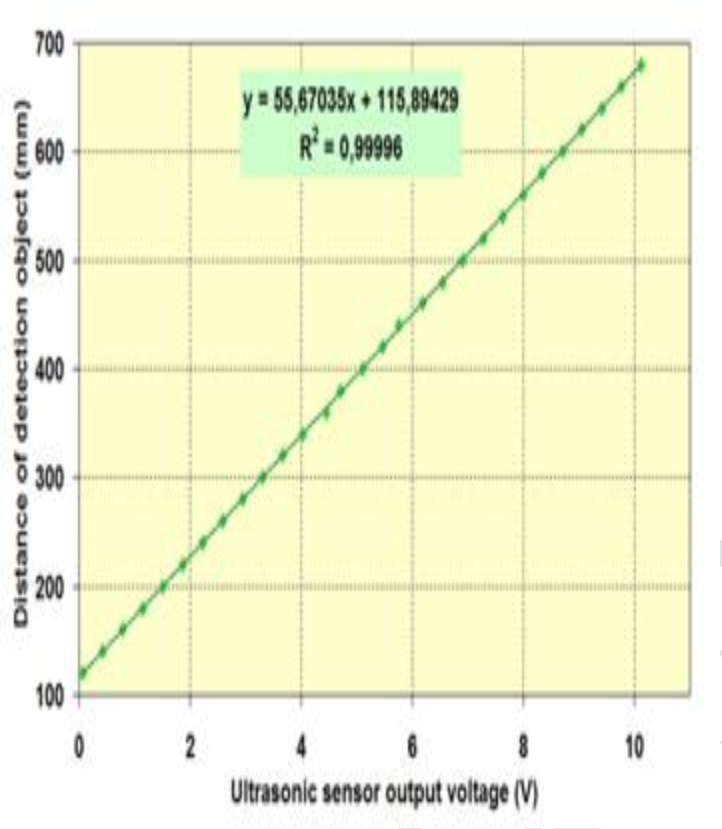

Figure 7 (b): Graph of detected object with sensor output

Almost all materials reflect sound waves, so ultrasonic sensors are a fine choice for many tasks. Excellence in the detection and measurement of films, transparent objects, and liquids separate these sensors from their photoelectric counterparts. Target color or frequent color changes also have no effect on ultrasonic sensors.

Due to their use of sound waves, ultrasonic sensors also perform well in dusty, dirty environments. However, they do not operate well with small targets against large backgrounds or targets such as foam batting that are excellent for absorbing sound waves [1, 2, 3, 4].

A typical ultrasonic sensor (Figure 2) comprises a clock (signal) generator and a controller to excite the transducer, then a processor and output amplifier to handle the return signal [4]

Project description and block diagram

Components Used

1. Arduino Uno or Pro Mini
2. Ultrasonic sensor Module
3. 16x2 LCD
4. Scale
5. Bread board
6. 9 volt battery
7. Connecting wires

BLOCK DIAGRAM

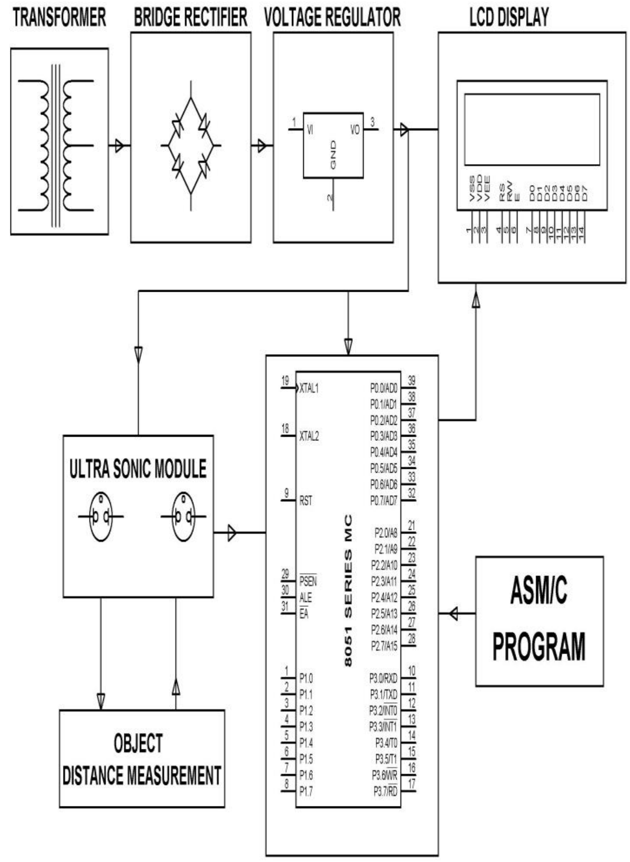

Figure 8: Block diagram of Proposed System

Ultrasonic Sensor Module

Ultrasonic sensor HC-SR04 is used here to measure distance in range of 2cm-400cm with accuracy of 3mm. The sensor module consists of ultrasonic transmitter, receiver and the control circuit. The working principle of ultrasonic sensor is as follows:

1. High level signal is sent for 10us using Trigger.
2. The module sends eight 40 KHz signals automatically, and then detects whether pulse is received or not.

3. If the signal is received, then it is through high level. The time of high duration is the time gap between sending and receiving the signal.

Distance= (Time x Speed of Sound in Air (340 m/s))/2

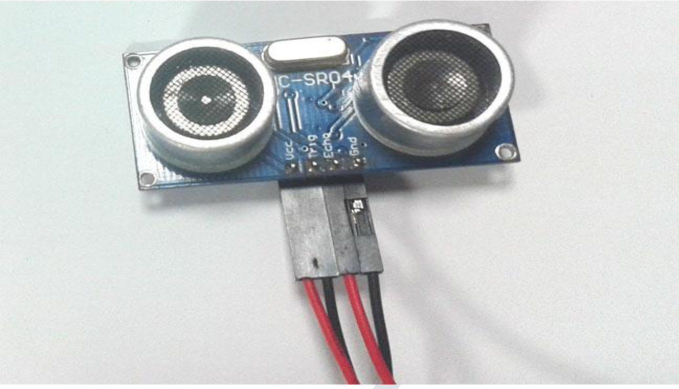

Figure 10: HC-SR04 Sensor

Timing Diagram

The module works on the natural phenomenon of ECHO of sound. A pulse is sent for about 10us to trigger the module. After which the module automatically sends 8 cycles of 40 KHz ultrasound signal and checks its echo. The signal after striking with an obstacle returns back and is captured by the receiver. Thus the distance of the obstacle from the sensor is simply calculated by the formula given as

Distance= (time x speed)/2.

Here we have divided the product of speed and time by 2 because the time is the total time it took to reach the obstacle and return back. Thus the time to reach obstacle is just half the total time taken.

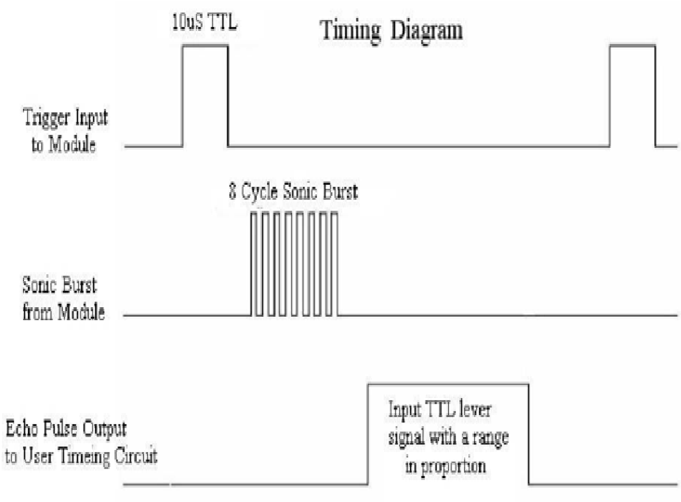

Figure 9: Timing Diagram

The circuit diagram for arduino and ultrasonic sensor is shown above to measure the distance. In circuit connections Ultrasonic sensor module's "trigger" and "echo" pins are directly connected to pin 18(A4) and 19(A5) of arduino. A 16x2 LCD is connected with arduino in 4-bit mode. Control pin RS, RW and En are directly connected to arduino pin 2, GND and 3. And data pin D4-D7 is connected to 4, 5, 6 and 7 of arduino.

First of all we need to trigger the ultrasonic sensor module to transmit signal by using arduino and then wait for receive ECHO. Arduino reads the time between triggering and Received ECHO. We know that speed of sound is around 340m/s. so we can calculate distance by using given formula:

Distance= (travel time/2) * speed of sound

Where speed of sound around 340m per second.

A 16x2 LCD is used for displaying distance.

Arduino Ultrasonic Code for Distance Measurement

```
digitalWrite(trigger,HIGH);
delayMicroseconds(10);
digitalWrite(trigger,LOW);
delayMicroseconds(2);
time=pulseIn(echo,HIGH);
distance=time*340/20000;
lcd.clear();
lcd.print("Distance:");
lcd.print(distance);
lcd.print("cm");
```

```
#include <LiquidCrystal.h>

#define trigger 18
#define echo 19

LiquidCrystal lcd(2,3,4,5,6,7);

float time=0,distance=0;

void setup()
{
 lcd.begin(16,2);
 pinMode(trigger,OUTPUT);
 pinMode(echo,INPUT);
 lcd.print(" Ultrasonic");
 lcd.setCursor(0,1);
 lcd.print("Distance Meter");
 delay(2000);
 lcd.clear();
 lcd.print(" Circuit Digest");
 delay(2000);
}

void loop()
{
 lcd.clear();
 digitalWrite(trigger,LOW);
 delayMicroseconds(2);
 digitalWrite(trigger,HIGH);
 delayMicroseconds(10);
 digitalWrite(trigger,LOW);
 delayMicroseconds(2);
 time=pulseIn(echo,HIGH);
 distance=time*340/20000;
 lcd.clear();
 lcd.print("Distance:");
 lcd.print(distance);
 lcd.print("cm");
 lcd.setCursor(0,1);
 lcd.print("Distance:");
 lcd.print(distance/100);
 lcd.print("m");
 delay(1000);
}
```

RESULTS:

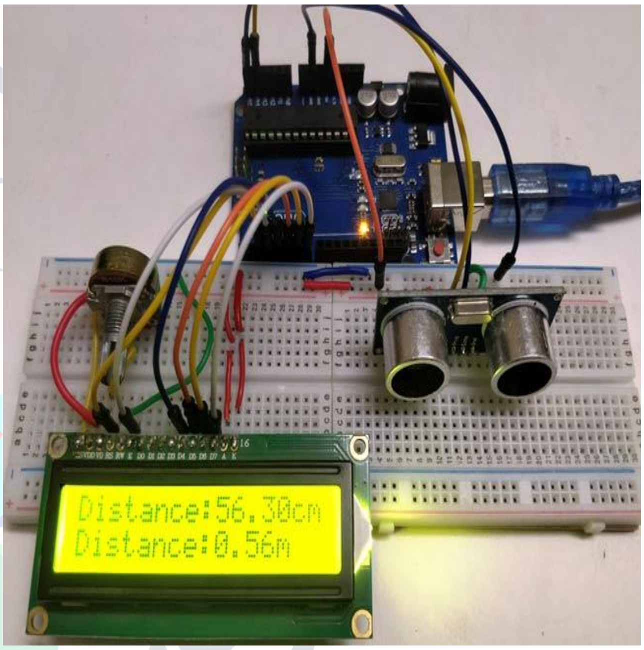

Figure 11: Proposed system

CONCLUSION:

Ultrasonic sensors have variety application as distance measurement, obstacle avoiding and anti-collision detection, robot navigation, measurement in automotive parking assistance systems, measurement of air flow velocity - anemometer, medical ultrasonography, non-destructive testing, piezoelectric transducers, level measurement, pallet detection on forklifts, vehicle detection in barrier systems etc.

Ultrasonic sensors are non-intrusive in that they do not require physical contact with their target, and can detect certain clear or shiny targets otherwise obscured to some vision-based sensors. On the other hand, their measurements are very sensitive to temperature and to the angle of the target. Temperature and humidity affect the speed of sound in air. Therefore, range finders may need to be recalibrated to make accurate measurements in a new environment. Temperature variations and air currents can create invisible boundaries that will reflect ultrasonic waves, so care must be taken to avoid these. For the transmitted wave to echo back to the receiver, the target surface must be perpendicular to the transmitter. Round objects are therefore most easily sensed since they always show some perpendicular face. When targeting a flat object, care must be taken to ensure that its angle with respect to the sensor does not exceed a particular range.

Ultrasonic sensors typically have a "dead zone" immediately in front of them in which objects cannot be detected because they deflect the wave back before the receiver is operational. (This is because reverberations from the transmitter force the receiver to pause a moment before beginning to listen for the echo). Some materials are more absorbent than others, and these will reflect less ultrasound. This complicates using the attenuation method to measure the distance of arbitrary objects.

Actually by using ultrasonic range finder with ardino we can find out only distance we can detect the object shape so by using robot we can detect the object shape and size with distance but compre to that this have high cost of the project but by using this is robot this can be used in security applications also.

References:

1. A. K. Shrivastava, A. Verma, and S. P. Singh "Distance Measurement of an Object or Obstacle by Ultrasound Sensors using P89C51RD2" International Journal of Computer Theory and Engineering, Vol. 2, No. 1 February, 2010 1793-8201,

2. Yang, X., Liu, X.: "Design of Ultrasonic Wave Distance Measuring System Based on Microprocessor. Machine Tool & Hydraulics" 39(8), 106–108 (2011)

3. Kodwani, Amitabh Deo (2009) "Competency Mapping". Paradigm (Institute of Management Technology) Vol. 13 Issue 2, p117-118, 2p.

4. 2. Naqvi, Farah (January 2009), "Competency Mapping and Managing Talent." ICFAI Journal of Management Research, Vol. 8 Issue 1, p85-94, 10p, 1 Chart.

5. Rice, James A. (Dec 2006) "Career and Competency Mapping." Healthcare Executive, Vol. 21 Issue 6, p52-55, 4p.

6. Sahu R.K 2009 Competency mapping Ed 1 New Delhi Excel Books.

7. Sanhgvi. S (2007) The Handbook of Competency Mapping: Understanding, Designing and Implementing Competency Models in Organizations, 2 edition New Delhi, Sage Publications Pvt. Ltd.

8. Object recognition with ultrasonic s ensors M.Ihsan Ecemiş and Paolo Gaudiano Boston University Neurobotics Laboratory DeptCognitive and Neural Systems, 677 Beacon St., Boston MA 02215 .EDU

Author Profile: Mallikarjun Mudda received his B.Tech

degree from Electronics and Communication Engineering from Visvesvaraya Technological University, India, in 2008, and then he received M.Tech degree from Digital Communication Engineering from Visvesvaraya Technological University, India, in 2012, and he is Completed Ph.D. from Electronics Engineering, Jain University, and Bangalore, India. He is currently a faculty member of Sreenidhi institute of science and technology, JNTU. His research interests areas are medical image processing, satellite image processing, digital communication, wireless network security, mobile computing.