DISTANCE MEASUREMENT USING ULTRASONIC SENSOR

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ABSTRACT :

This project is about measuring distances between two objects or in which one of the objects is a moving body and another object is stationary. It is mainly used in household applications where we use an ultrasonic sensor in a water tank which measures the water level where it is connected to the inner lid or at the top of the water tank. As the ultrasonic sensor monitors the distance the water level can be detected. In this case overflow of the water can be avoided and wastage is being reduced.

KEYWORDS : Ultrasonic Sensor, Arduino Uno

INTRODUCTION

An ultrasonic sensor houses a transducer that emits high-frequency, inaudible acoustic waves in one direction when the transducer element vibrates. If the waves strike and bounce off an object, the transducer receives the echoed signal. The sensor then determines its distance from the object based on the length of time between the initial sound burst and the echo's return. Ultrasonic sensors require fairly accurate timing circuitry, so acoustic sensors really require a processor of some sort to drive them. Ultrasonic sensors should be a first choice for detecting clear objects, liquids, dense materials of any surface type (rough, smooth, shiny) and irregular shaped objects. This makes them one of the most ideal choices for measuring the height of containers which could be of different shapes, sizes, color and material.

The transmitter transmits the ultrasonic waves towards the object and according to the time taken by echo from the transmitter to object and object to receiver, the distance is calculated. If the obstacle is in the designated range the comparator sends the signal to the microcontroller which in turn sends an output signal.

Time of flight (TOF) estimation method. TOF represents the time in which the ultrasonic wave propagates from the transmitter to the target and then back to the receiver. TOF divided by 2 is the time required to get the distance from the emitter and target.

This is a very economic technology and can be used in several other fields as well, few are listed as below:

1. Can be used as parking assistance systems in vehicles with high power ultrasonic transmitters.
2. Can be used as a burglar alarm with suitable additional software for homes and offices.

EXISTING MODEL:

Two sensors based on R 100 waveguides with a standard plain and a choke flange for contactless ultra-short distance measurement application were experimentally investigated in the frequency band from 8 GHz to 12.4 GHz. Both sensors at selected frequencies enable to achieve a quasi-linear dependence of the measured reflection coefficient phase on the distance to target with no ambiguities. The distances from zero up to more than a half wavelength can be measured. The sensor using the open waveguide with the standard flange with the choke enables to achieve from 4 to 10 times greater value of amplitude of the measured reflection coefficient in comparison with sensors known up to now for the same measured distances. The results can be extrapolated to different frequencies up to mm wave bands, waveguide dimensions and target distances.

The experimental investigation of two sensors for ultra-short distance measurements proceeded at frequency band 8-12.4 GHz. R 100 waveguides with a standard plain flange and a standard flange with a waveguide choke at their ends were used as the sensors, see Fig. 1. Both sections of waveguides had identical lengths. The measurement set up, consisting of a VNA Agilent E8364A connected to the sensor and a target – metal sheet placed on a precise micrometric positioner, is depicted in Fig. 2. The width of the target formed by a section of radiator is 112 mm. Calibration of the system was realized at the reference plane of the flange without a choke using the TRL method. The test fixture holding waveguides was covered with an absorber material to decrease possible multiple reflections. The reflection coefficient for both sensors was measured at distances from 0 mm up to 20 mm with a step 0.5 mm in frequency band from 8 GHz up to 12.4 GHz. The measured sets of data are displayed in Fig. 3 with a distance step 4 mm. Each curve corresponds to S11 in the reference plane for different distances from the target. The uncertainty of the VNA increases for the amplitudes of signals lower than 0.5. Apparently, for the sensor with the flange with a choke there are reasonably high amplitudes for more measuring distances in comparison to the sensor with the plain flange. However, both sensors can be potentially used for distance measurement at some suitable operating frequency.

PROBLEM STATEMENT

In general, the waveguide sensors are not easy to carry; they are very bulky in size and weight. The sensor is not economical. The R100 waveguide sensors are not suitable for operations at lower frequencies due to increased dimensions. The setup which is made for measuring distances is not portable and its applications are limited only for stationary objects

Our main objective of this project is to measure distance between a moving body and a stationary body which is used in household applications for the water tank. Here my project deals with detecting the water level by using an ultrasonic sensor and displaying the output.

PROPOSED MODEL:

The proposed model deals with distance measurement using an ultrasonic sensor and a microcontroller that is an Arduino uno. Ultrasonic sensor sends out sonic waves when the sonic waves touch an obstacle the sonic waves are reflected back and then they reach back to the ultrasonic sensor then the time is calculated. Here the time is being halved because the wave travels for the same distance two times so the time is being reduced to half.

The Ultrasonic Sensor sends out a high-frequency sound pulse and then times how long it takes for the echo of the sound to reflect back. The sensor has 2 openings on its front. One opening transmits ultrasonic waves, (like a tiny speaker), the other receives them, (like a tiny microphone).

The speed of sound is approximately 341 meters (1100 feet) per second in air. The ultrasonic sensor uses this information along with the time difference between sending and receiving the sound pulse to determine the distance to an object. It uses the following mathematical equation:

Distance = Time x Speed of Sound divided by 2

FUNCTIONING:

The ultrasonic sensor emits a high-frequency sound pulse and calculates the distance depending upon the time taken by the echo signal to travel back after reflecting from the desired target. The speed of sound is 341 meters per second in air. After the distance is calculated it is displayed.

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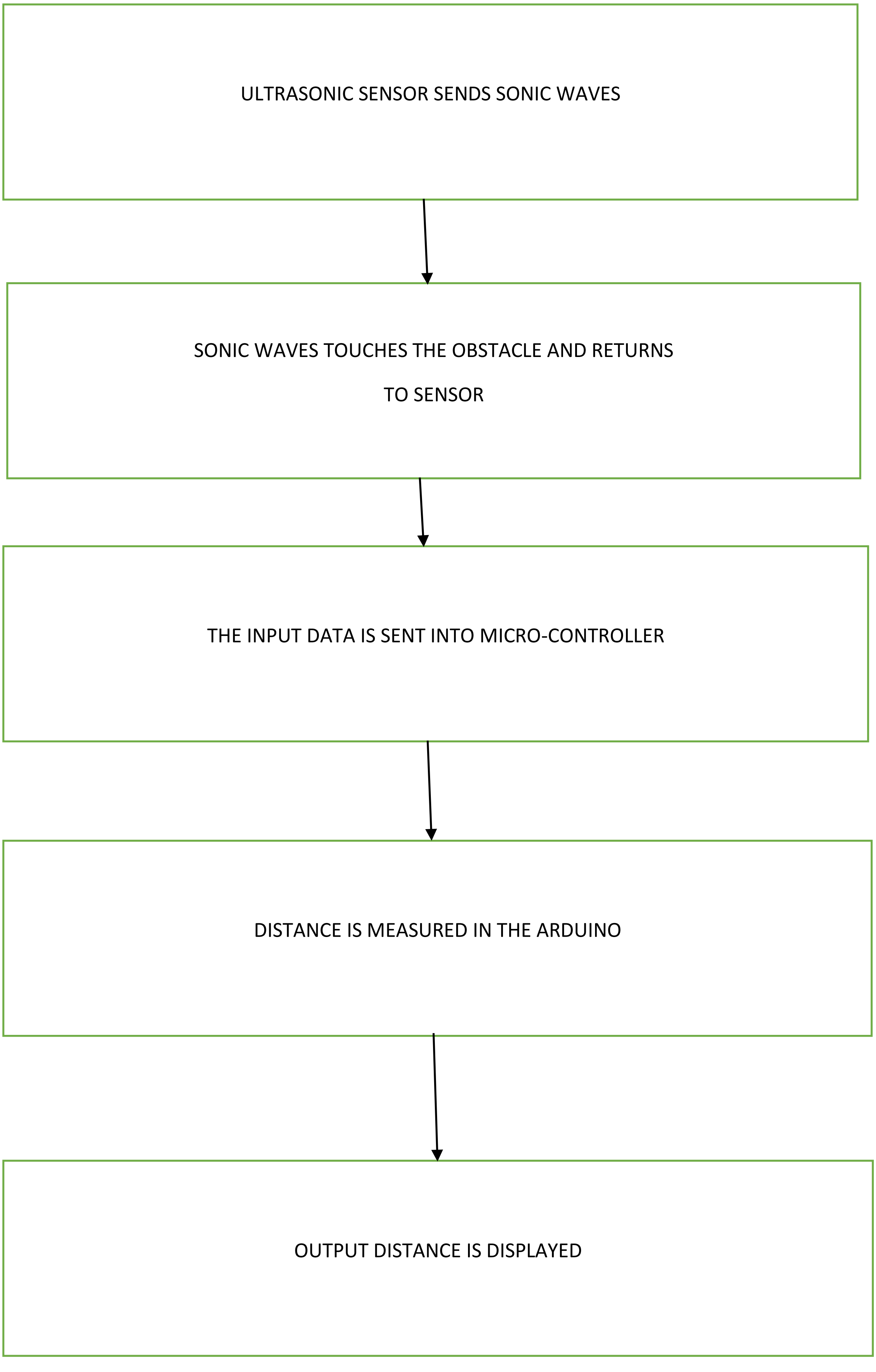
FLOW CHART :


ULTRASONIC SENSOR SENDS SONIC WAVES
SONIC WAVES TOUCHES THE OBSTACLE AND RETURNS
TO SENSOR
THE INPUT DATA IS SENT INTO MICRO-CONTROLLER
DISTANCE IS MEASURED IN THE ARDUINO
OUTPUT DISTANCE IS DISPLAYED

CODE:

```
const int out=12;
const int in=13;
void setup(){
Serial.begin(9600);
pinMode(in, INPUT);
pinMode(out, OUTPUT);
}
void loop()
{
long dur;
long dis;
long tocm;
digitalWrite(out,LOW);
delayMicroseconds(2);
digitalWrite(out,HIGH);
delayMicroseconds(10);
digitalWrite(out,LOW);
dur=pulseIn(in,HIGH);
tocm=microsecondsToCentimeters(dur);
Serial.println(String(tocm));
delay(100);
}
long microsecondsToCentimeters(long microseconds)
{
return microseconds / 29 / 2;
```

}

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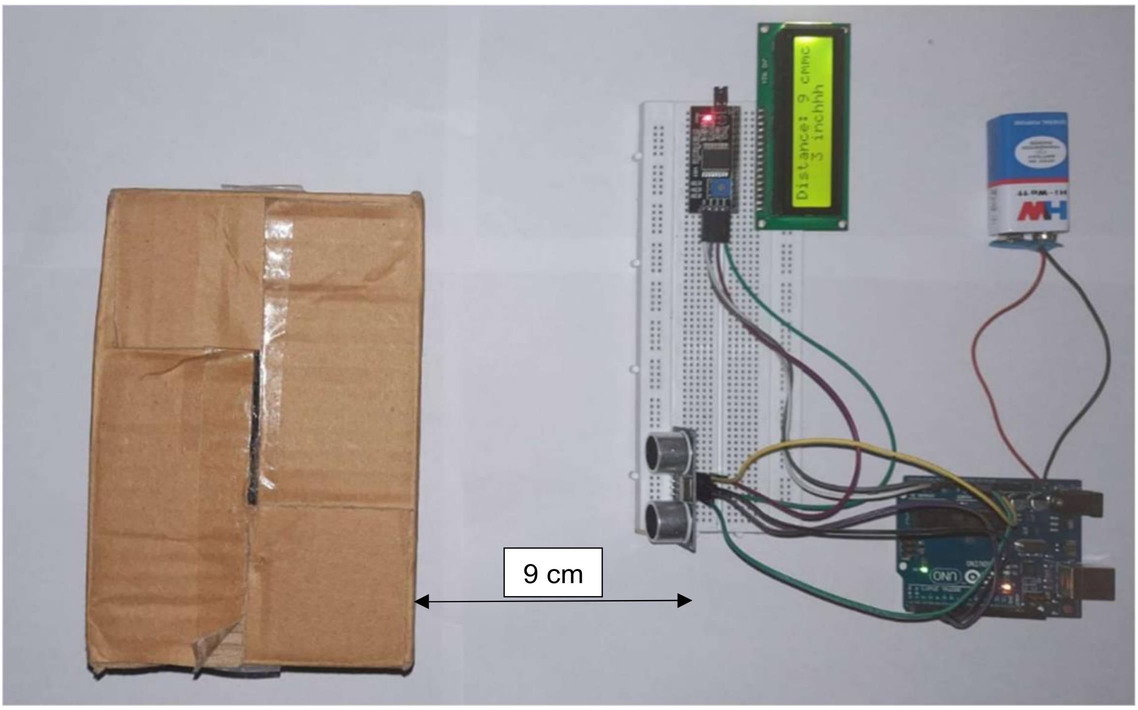
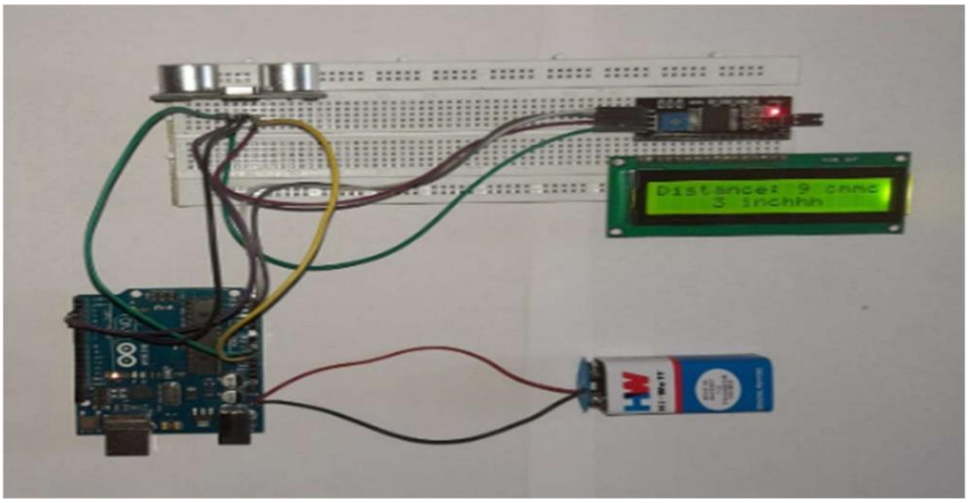
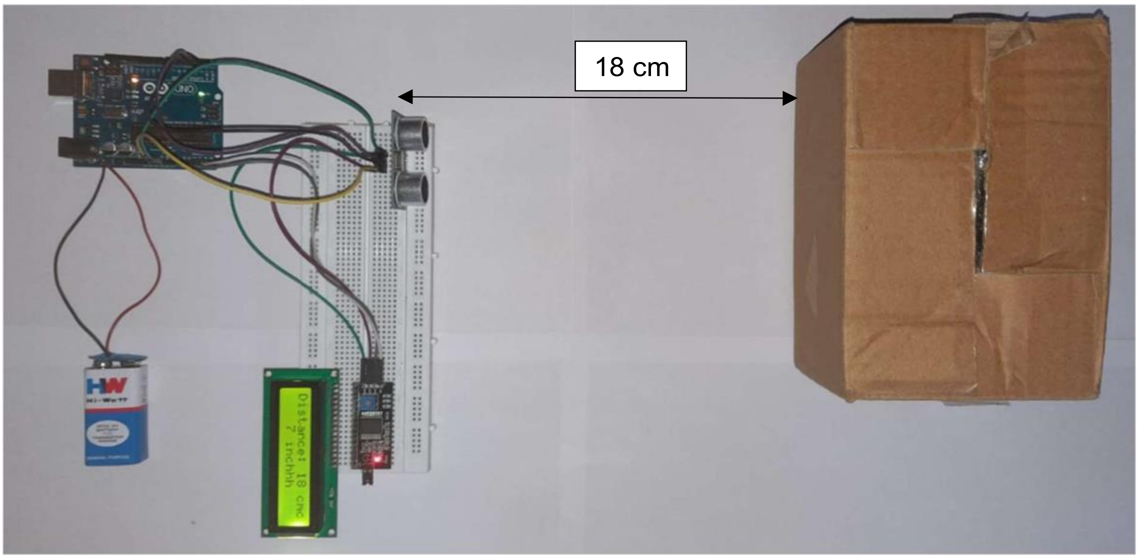
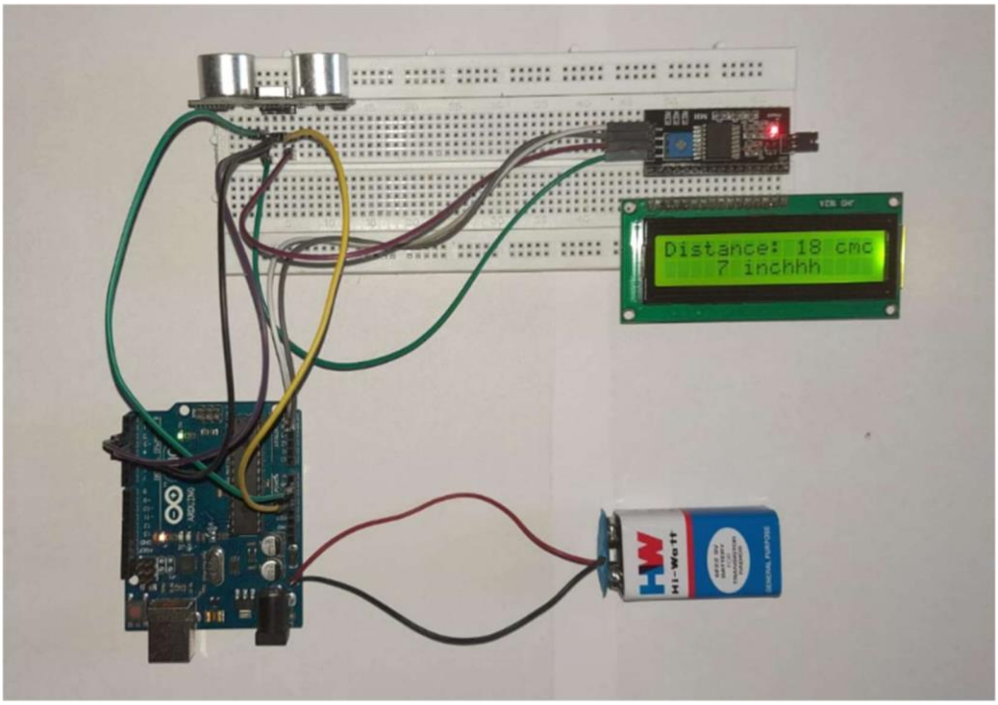
Result:









The project hardware is designed and the distance is measured from sensor to the box which is considered as an obstacle in this case. The output can be observed on the LCD display in centimetres and inch.

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Conclusion:

The distance between two objects using the proposed system is verified successfully. The output has been verified. The obtained distance and the displayed distance on the LCD are same. We can conclude that this method can be used to measure accurate distances between two objects.

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Future scope:

The proposed method can be used in household applications. Where the sensor is connected at the top of the water tank and LCD screen is placed inside to know the depth or water level. A small setback in this project is the ultrasonic works differently based on the type of surface from which the sonic wave is reflected back. It is one of its primary setbacks.