EC280 MINI PROJECT

Project Title:

RADAR using Arduino and Ultrasonic sensor

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INTRODUCTION:

Radar is an object detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. It can be used to detect aircraft, ships, spacecraft, guided missiles, motor vehicles, weather formations, and terrain. The radar dish or antenna transmits pulses of radio waves or micro waves which bounce off any object in their path. The object returns a tiny part of the wave's energy to a dish or antenna which is usually located at the same site as the transmitter.

The modern uses of radar are highly diverse, including air traffic control, radar astronomy, air-defence systems, antimissile systems, marine radar start locate landmarks and other ships, aircraft anti- collision systems; ocean surveillance systems, outer space surveillance and rendezvous systems; meteorological precipitation monitoring, altimetry and flight control systems; guided missile target locating systems, and ground-penetrating radar for geological observations.

High tech radar systems are associated with digital signal processing and are capable of extracting useful information from very high noise levels. The Arduino based project requires an ultrasonic sensor, the sensor released the waves which we want to measure the distance of a object. The microcontrollers of the Arduino board can be programmed using C and C++ languages. When a code is written in Arduino UNO IDE software and connected to the board through a USB cable, Arduino boards have lot of applications in the present-day scenario, so we have decided to do a small project on them.

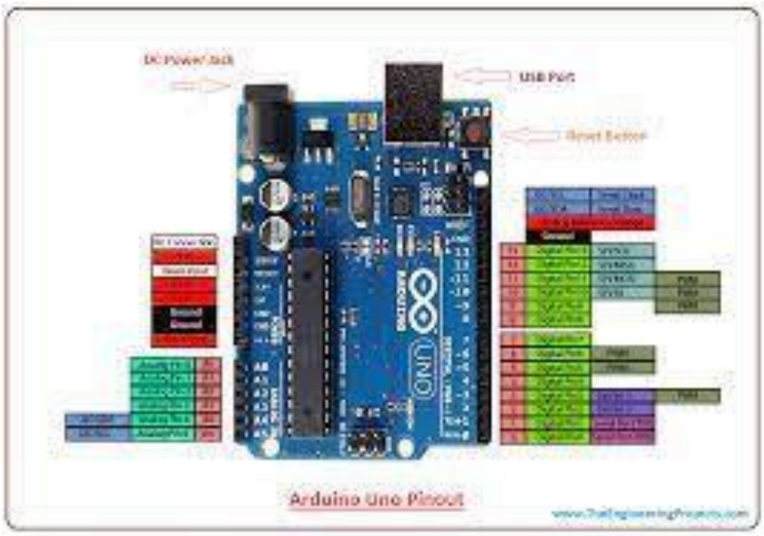
Target detection is easier when an object is near or easily visible. But, the same doesn’t stand true when the object is far away or is not visible due to weather conditions. The history of radar actually dates back to the 1880s, when Heinrich Hertz showed that radio waves exist and could be both generated and detected. American physicists Gregory Breit and Merle Tuve developed usable radar in 1925, but its use remained limited until shortly before World War II. During the Second World War, technological advances by Germany, England, and the United States resulted in significant improvements to radar in terms of technology, reliability, and power. One of the most common application of ultra-sonic sensor is range finding. It is also called as sonar which is same as radar in which ultrasonic sound is directed at a particular direction and if there is any object in its path it strikes it and gets reflected back and after calculation time taken to come back we can determine distance of object. in real life this method is used by bats.

In this project, we are going to design an Arduino radar project using Ultrasonic Sensor for detection. An Arduino microcontroller makes electronics more discipline.

This Arduino radar project aims to achieve a radar system prototype based on an Arduino board that detects stationary and moving objects. The radar system has different performance specifications, and it is also available in a variety of sizes.

Now, let us study about the components in detail about the arduino

1. ARDUINO UNO



Arduino is an open-source platform used for building electronics projects. Arduino consists of both a physical programmable circuit board (often referred to as a microcontroller) and a piece
of software, or IDE (Integrated Development Environment) that runs on your computer, used to write and upload computer code tothe physical board.

The Arduino platform has become quite popular with people just starting out with electronics, and for good reason. Unlike most previous programmable circuit boards, the Arduino does not need a separate piece of hardware (called a programmer) in order to load new code onto the board we can simply use a USB cable.
Additionally, the Arduino IDE uses a simplified version of C++, making it easier to learn to program. Finally, Arduino provides a standard form factor that breaks out the functions of the micro- controller into a more accessible package.

The most important thing about this board is that the board has more input-output pins so it is very beneficial for the Advanced Users or the people who want more pins for their projects.

Vin: This is the input voltage pin of the Arduino board used to provide input supply from an external power source.

5V: This pin of the Arduino board is used as a regulated power supply voltage and it is used to give supply to the board as well as onboard components.

3.3V: This pin of the board is used to provide a supply of 3.3V which is generated from a voltage regulator on the board

GND: This pin of the board is used to ground the Arduino board.

Reset: This pin of the board is used to reset the microcontroller It is usedto Resets the microcontroller.

Analog Pins: The pins A0 to A15 are used as an analog input and it is in the range of 0-5V. The analog pins on this board can be used as a digital Input or Output pins.

Serial pins: It is used for communication between the Arduino board and a computer or other devices.

The TXD and RXD are used to transmit & receive the serial data resp. It includes serial 0, Serial 1, serial 2, Serial 3 as follows:

1. Serial 0: It consists of Transmitter pin number 1 and receiver pin number 0
2. Serial 1: It consists of Transmitter pin number 18 and receiver pin number 19
3. serial 2: It consists of Transmitter pin number 16 and receiver pin number 17
4. Serial 3: It consists of Transmitter pin number 14 and receiver pin number 15

External Interrupts pins: This pin of the Arduino board is used to produce the External interrupt and it is done by the pin numbers 0,3,21,20,19,18.

I2C: This pin of the board is used for I2C communication.

1. Pin number 20 signifies Serial Data Line (SDA)and it is used for holding the data.
2. Pin number 21 signifies Serial Clock Line (SCL) and it is used for offering data synchronization among the devices.

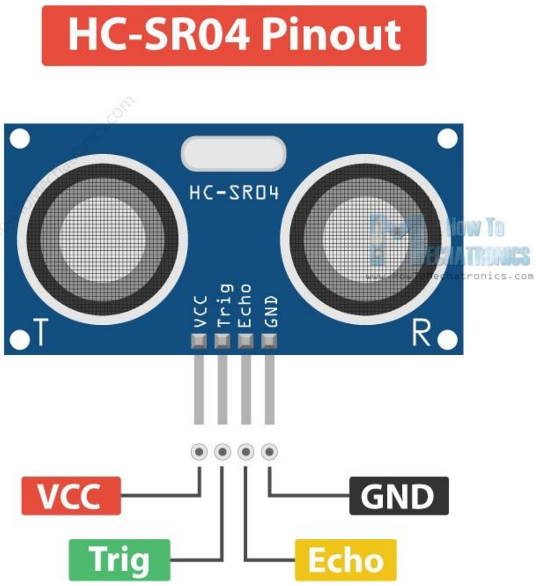
SPI Pins: This is the Serial Peripheral Interface pin, it is used to maintain SPI communication with the help of the SPI library. SPI pins include:

1. MISO: Pin number 50 is used as a Master In Slave Out
2. MOSI: Pin number 51 is used as a Master Out Slave In
3. SCK: Pin number 52 is used as a Serial Clock
4. SS: Pin number 53 is used as a Slave Select

LED Pin: The board has an inbuilt LED using digital pin-13. The LED glows only when the digital pin becomes high.

AREF Pin: This is an analog reference pin of the Arduino board. It is used to provide a reference voltage from an external power supply.

3. ULTRASONIC SENSOR

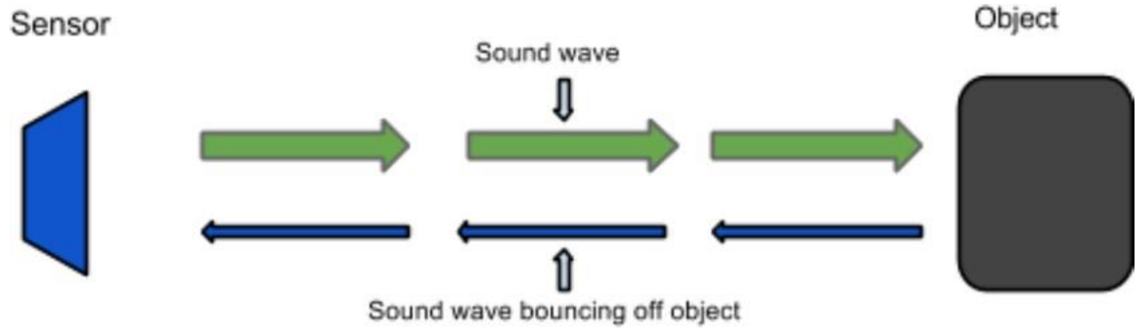


The ultrasonic sensor used in out project is HC-SR04.

Let us understand this in detail,

1.Working

Ultrasonic sensors use sound to determine the distance between the sensor and the closest object in its path. How do ultrasonic sensors do this? Ultrasonic sensors are essentially sound sensors, but they operate at a frequency above human hearing.



The sensor sends out a sound wave at a specific frequency. It then listens for that specific sound wave to bounce off of an object and come back (Figure 1). The sensor keeps track of the time between sending the sound wave and the sound wave returning. If you know how fast something is going and how long it is traveling you can find the distance travelled with equation

Equation 1:

$$d = v \times t$$

The HCSR04 Specifications are listed below. These specifications are from the Cytron Technologies HCSR04 User’s Manual (source 1).

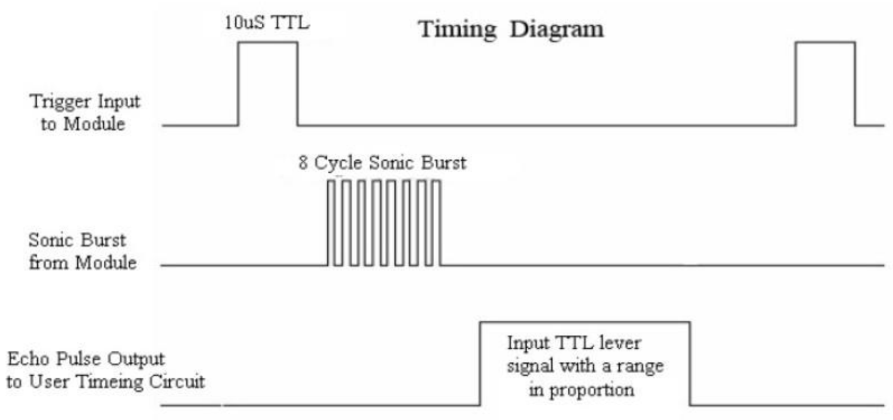
- Power Supply: +5V DC
- Quiescent Current: <2mA
- Working current: 15mA
- Effectual Angle: <15º
- Ranging Distance: 2400 cm
- Resolution: 0.3 cm
- Measuring Angle: 30º
- Trigger Input Pulse width: 10uS
- Dimension: 45mm x 20mm x 15mm
- Weight: approx. 10 g

The HCSR04's best selling point is its price; it can be purchased at around $2 per unit.

Taking Distance Measurements

The HCSR04 can be triggered to send out an ultrasonic burst by setting the TRIG pin to HIGH. Once the burst is sent the ECHO pin will automatically go HIGH. This pin will remain HIGH until the the burst hits the sensor again. You can calculate the distance to the object by keeping track of how long the ECHO pin stays HIGH. The time ECHO stays HIGH is the time the burst spent traveling. Using this measurement in equation 1 along with the speed of sound will yield the distance travelled. A summary of this is listed below, along with a visual representation in Figure 2.

1. Set TRIG to HIGH
2. Set a timer when ECHO goes to HIGH
3. Keep the timer running until ECHO goes to LOW
4. Save that time
5. Use equation 1 to determine the distance travelled



Source 2

4. Wiring the HCSR04 to a Microcontroller

This section only covers the hardware side. For information on how to integrate the software side, look at one of the links below or look into the specific microcontroller you are using.

The HCSR04 has 4 pins: VCC, GND, TRIG and ECHO.

1. VCC is a 5v power supply.This should come from themicrocontroller
2. GND is a ground pin. Attach to ground on the microcontroller.
3. TRIG should be attached to a GPIO pin that can be set to HIGH.
4. ECHO is a little more difficult.

The HCSR04 outputs 5v, which could destroy many microcontroller GPIO pins (the maximum allowed voltage varies). In order to step down the voltage use a single resistor or a voltage divider circuit. Once again this depends on the specific microcontroller you are using, you will need to find out its GPIO maximum voltage and make sure you are below that.

LITERATURE SURVEY:

Subsequent to experiencing a portion of the papers with respect to usage utilizing ultrasonic sensors and ARDUINO, it was found that this idea is searched a lot and is a mainstream idea which is still in advance. The advances utilized were not just productive and solid yet in addition financially achievable.

A. American Association For The Advancement Of Science Heinrich Rudolf Hertz was a brilliant German physicist and a enthusiastic experimentalist who demonstrated that the electromagnetic waves predicted by James Clerk Maxwell actually exist. Hertz is also the man whose peers honored by attaching his name to the unit of frequency; a cycle per second is one hertz. Hertz used a simple homemade.

Experimental apparatus, involving an induction coil and a Leyden jar (the original capacitor) to create electromagnetic waves and a spark gap between two brass spheres to detect them. The gaps were difficult to see, and required that the he perform his investigations in a darkened room.

For the sparks are microscopically short, scarcely a hundredth of a millimetre; they last only about a millionth of a second. It almost seems absurd and impossible that they should be visible; but in a perfectly dark room they are visible to an eye which has been well rested in the dark. Upon this thin thread hangs the success of our undertaking," said Hertz.

In later experiments, he was able to calculate the speed of the radio waves he created, and found it to be the same as the speed of light. [3]

PROBLEM STATEMENT:

- For smooth travelling of air vehicles, there was need of a system to detect the obstacles and air-traffics.
- Hence to overcome this, scientists have invented RADAR system.

OBJECTIVES:

- The objective of this project is to detect the obstacle using ultrasonic sensor and Arduino.
- Specifically in aircrafts to warn the pilots about any obstacles in theway.

METHODOLOGY:

In order to testify the working of this system, after its designing, construction and programming we placed few objects in front of the ultrasonic sensor. As the motor started to rotate, our monitor started to display the output through processing IDE. Hence, when the sensor crossed over the object it showed a red segment with the distance and angle where the object is paced. The first object was placed at the distance of 30.5cm measured through a ruler and the system measured the distance at 32cm.While the second object was placed at a distance of 20 cm and the system measured it as 21cm. Hence the calculated efficiency turned out to be 95%.

System Overview:

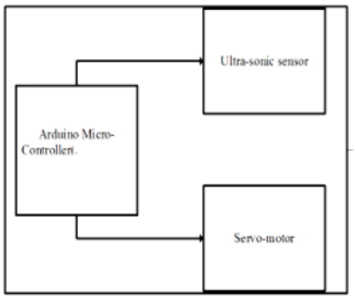


Figure 1. System hardware description.

The above figure represents a brief overview of this radar system. Here, as it is shown the controller, we are using is Arduino, with the input Ultrasonic sensor and the output is the servo motor which rotates 180 degrees. The microcontroller controls all the operations of this system, from rotation of the motors to the obstacle detection of the ultrasonic and representation of the result on the screen.

System Block Diagram:

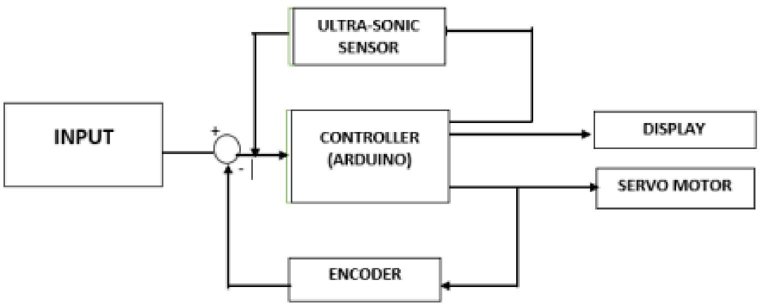


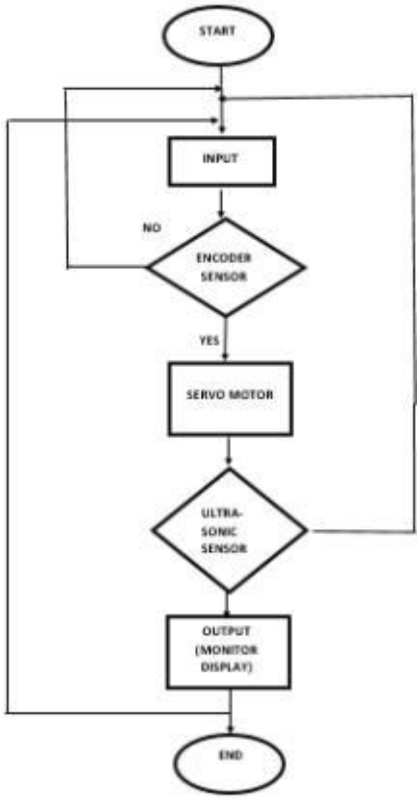
Figure 2. Block Diagram of Radar System.

Figure 2 represents the system's block diagram. Here, it can be seen how the work flow in this radar system. The sensor is going to sense the obstacle and determine the angle of incident and its distance from the radar. The servo motor is constantly rotating to and fro, hence making the sensor move. The data obtained is encoded and fed to the processing IDE which represents it on the screen. The results are displayed further in this paper. All these operations are done by Arduino microcontroller from the rotation of the servo, data collection from the sensor, feeding the data to encoder to transferring it to the display.

WORKING:

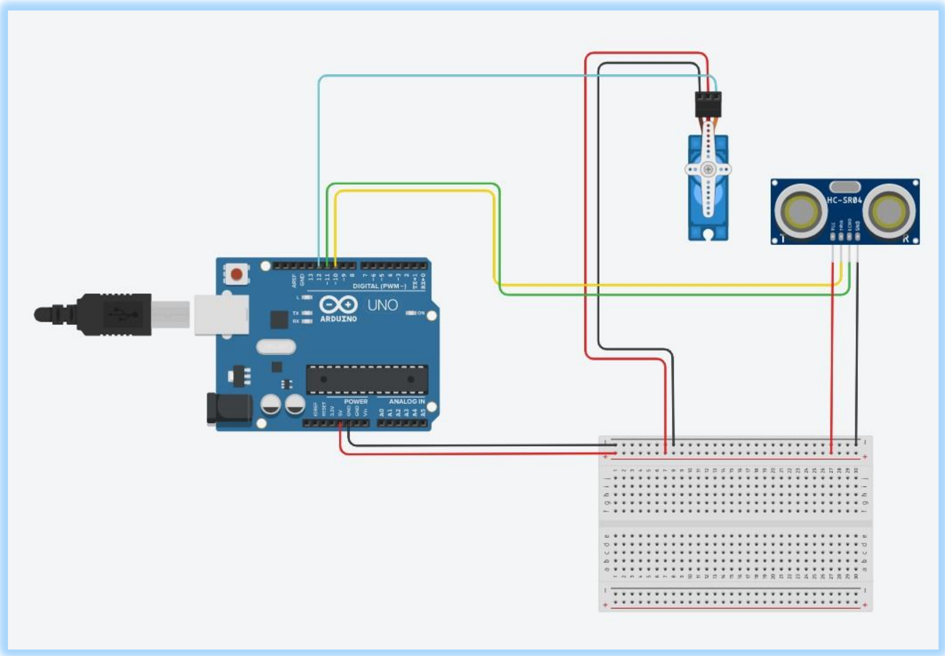
The basic objective of our design is to ascertain the distance position and speed of the obstacle set at some distance from the sensor.Ultrasonic sensor sends the ultrasonic wave in various ways by rotating with help of servo motors. This wave goes in air and gets reflected back subsequent to striking some object. This wave is again detected by the sensor and its qualities is analyzed and output is shown in screen indicating parameters, for example, distance and position of object.

Arduino IDE is utilized to compose code and transfer coding in Arduino and causes us to detect position or angle of servo motor and it is communicated through the serial port alongside the covered distance of the nearest object in its way. Output of all of this working is shown in the software called processing, it will display the input/output and the range of the object [4]. Implementations of the sensors are done in such a way that ultra-sonic sensor is attached on top of the servo motor because it have to detect the object and its distance. Arduino (micro- controller) will control the ultra-sonic sensor and servo motor and also powered will be given to both of them through micro-controller.



The above flow chart explains the working and the decision flow of this framework. As it can be seen the system starts with an input i.e. when the ultrasonic sensor detects an object, or does not detects any object, at any condition the encoder feeds the information in the controller while the servo keeps constantly rotating. As soon as any obstacle/object is detected by the ultrasonic sensor the data is immediately processed by the controller and is fed to the IDE which shows it on the display screen. Here the process ends with an estimated distance of the object from the system with the angle at which it is placed.

CIRCUIT DIAGRAM:



CODE:

Arduino:

```
#include <Servo.h>const int trigPin = 10;

const int echoPin = 11;

long duration;

int distance;

Servo myServo;

void setup() {

  pinMode(trigPin, OUTPUT);

  pinMode(echoPin, INPUT);

  Serial.begin(9600);

  myServo.attach(12);

}

void loop() {

  for (int i = 15; i <= 165; i++) {
```

```
    myServo.write(i);

    delay(30);

    distance = calculateDistance();


    Serial.print(i);

    Serial.print(",");

    Serial.print(distance);

    Serial.print(".");

  }

  for (int i = 165; i > 15; i--) {

    myServo.write(i);

    delay(30);

    distance = calculateDistance();

    Serial.print(i);

    Serial.print(",");

    Serial.print(distance);

    Serial.print(".");

  }

}

int calculateDistance() {


  digitalWrite(trigPin,  LOW);

  delayMicroseconds(5);

  digitalWrite(trigPin, HIGH);

  delayMicroseconds(10);

  digitalWrite(trigPin, LOW);
```

```
  duration = pulseIn(echoPin, HIGH);

  distance = duration * 0.034 / 2;

  return distance;

}
```

RESULTS AND DISCUSSIONS:

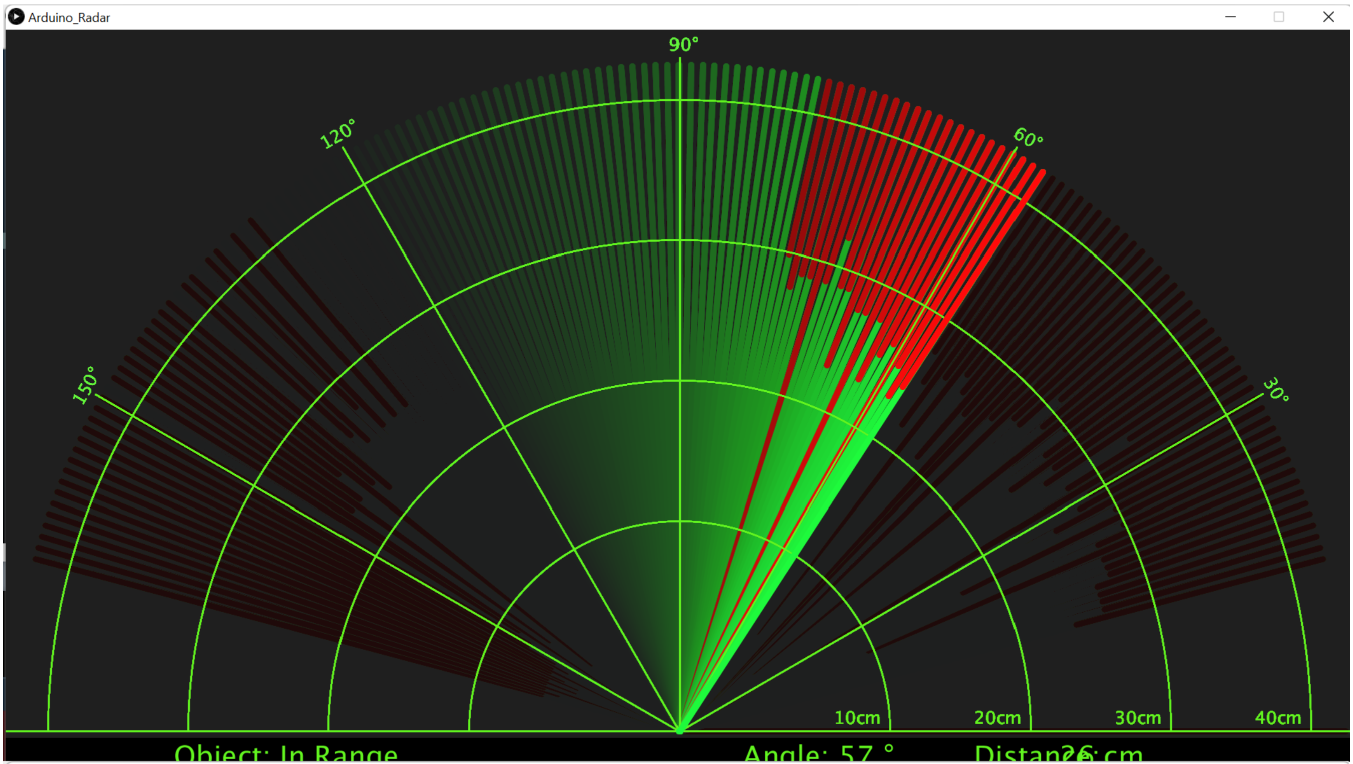
Begin with uploading the code to Arduino after interfacing all the components and completing all the connections. It is observed that the servo is sweeping from 0^0 to 180^0. Reading are displayed below:

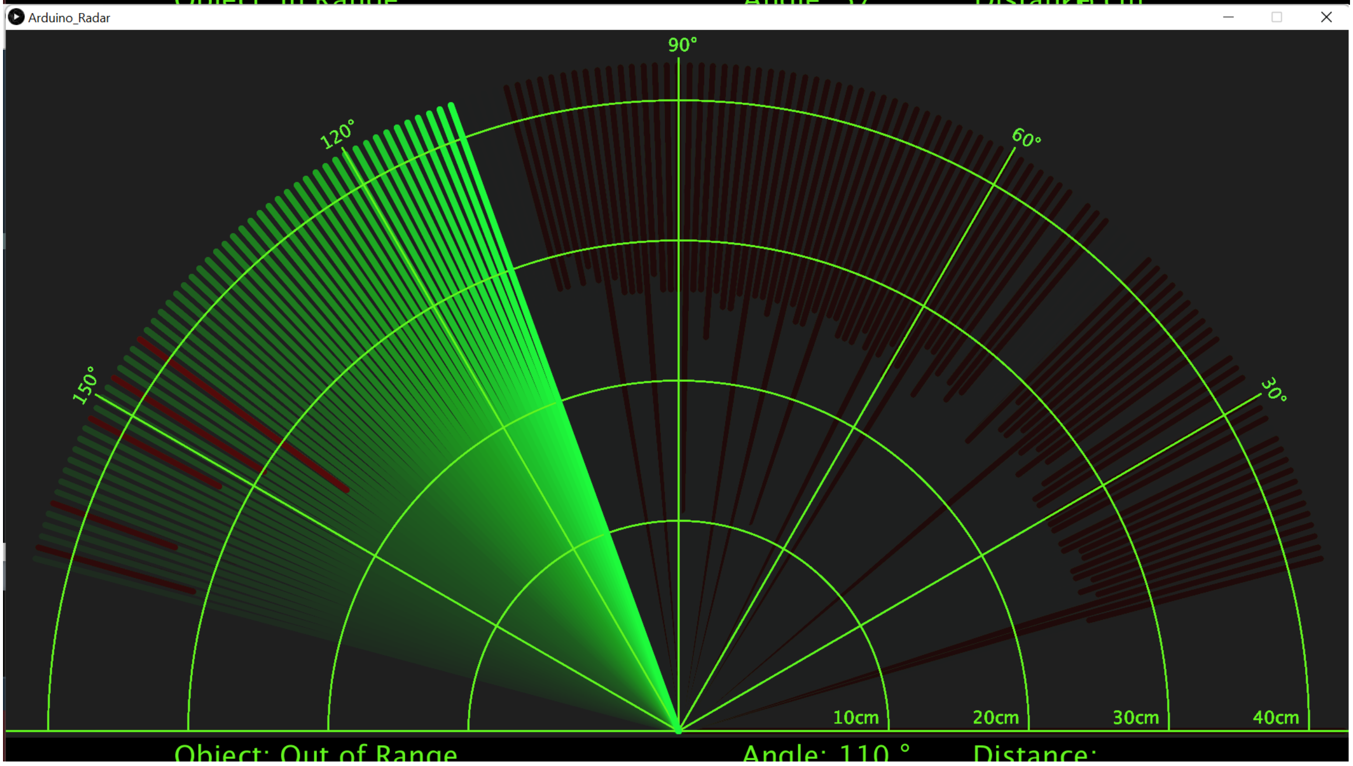
Angle observations:

Actual Angle (degrees)	**Angle measured by sensor (degrees)**	**Error (%)**
40	41	2.5%
80	82	2.5%
120	122	1.6%
160	165	3.2%

Distance observations:

Actual Distance (cms)	Distance measured by sensor (cms)	Error (%)
10	10	0%
15	15	0%
20	19	5%
25	26	4%


Arduino_Radar
90°
120°
60°
150°
30°
10cm
20cm
30cm
40cm
Object: In Range
Angle: 57 °
Distance: 26 cm


Arduino_Radar
90°
120°
60°
150°
30°
10cm
20cm
30cm
40cm
Object: Out of Range
Angle: 110 °
Distance:

CONCLUSION:

Numerous advanced control methods gave designers to have more command over different advanced applications. In our paper, the recommended mapping method of whole system is assessed on small principles or scale. The field that we have chosen for our design “Radar System” is a very vast field and future scope of this technology is very high. We have tremendous applications in which radar system have been implemented or used. There is a lot of future scope of this design because of its security capacity. It can be used in many applications.

This framework can also be developed or modified according to the rising needs and demand.

As we have designed a short-range radar therefore our research was specified and limited. This system can only detect objects from 0 to 180 degrees only because the servo motor that we have used can rotate only to this range. So, due to this limitation our design cannot be applied to places or areas for obstacle detection on a larger scale. Usage of a 360 degrees rotating servo motor can make the system more efficient. We look forward to modify this system and enhance our research work by using a fully 360 degrees rotating servo and a higher ranged ultrasonic sensor. We can further add features to this system i.e. making it mobile, mounting an alarm system to it which turns on when obstacle is detected. Further modifications could be an obstacle avoiding robot with surveillance system.

FUTURE SCOPE:

We have represented a project on Radar using Ultrasonic Sensor for human or object interference in short range. There is a lot future scope of this project as modification with Wifi connection between Arduino and Android can be introduced in order to monitoring through internet.

GPS can be introduced for security purpose. The project can be developed and modified according to the rising need and demands.

REFERENCES:

[1] Simon Monk, Programming Arduino: Getting started with sketches.

[2] A. Dimitrov and D. Minchev, “Ultrasonic sensor explorer, “ 2016 19th International Symposium on Electrical Apparatus and Technologies (SIELA), 2016, pp. 1-5, doi: 10.1109/SIELA.2016.7542987.

[3] Y. A. Badamsi, “ The working principle of an Arduino,” 2014 11th International Conference on Electronics, Computer and Computation (ICECCO), 2014, pp, 1-4, doi:10.1109/ICECCO.2014.6997578.

[4] A. U. Kulkarni, A. M. Potdar, S. Hegde and V. P. Baligar, “RADAR based Object Detector using Ultrasonic Sensor,” 2019 1st International Conference on Advances in Information Technology (ICAIT), 2019,pp. 204-209,doi: 10.1109/ICAIT 47043.2019.8987259