WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

SHORT-RANGE RADAR SYSTEM

Akash Chandrappa Guruvannavar[1], Puneeth M[2], Dr. S Sudarshan[3]

[1,2]UG Students, Department of Electronics and Communication Engineering, K S Institute of Technology, Bangalore, Karnataka, India

[3]Professor, Department of Electronics and Communication Engineering, K S Institute of Technology, Bangalore, Karnataka, India

A B S T R A C T

RADAR is nothing but Radio Detection and Ranging. RADAR is basically used for surveillance. It can also be called as an object detection system that makes use of the radio waves to determine range, altitude, direction, or speed of an objects. The radar has an antenna in it, plays a role here that transmits pulses of radio waves which bounce off only when there is any object in their path. Arduino is robust microcontroller board to be made using in electronics for multidisciplinary projects. This mini project aims at making a small RADAR system which shows the working principle of the actual working of it.

Keywords: Arduino, processing, ultra-sonic, radar, positioning, surveillance, obstacle detection.

1. INTRODUCTION

In this project, it is shown how to design a simple Radar system using Arduino and Processing. This Arduino Radar Project is implemented with the help of Processing Application along with Arduino IDE. Radar may be a long-range object detection system that uses radio waves to determine certain parameters of an object like its range, speed and position. Radar technology is used in various fields of application such as aircrafts, missiles, marine, weather predictions and automobiles. Technically the project is predicated on Sonar technology as it's will be able to be using an Ultrasonic Sensor to work out the presence of any object during a particular range.

2. LITERATURE SURVEY

[1] , Heinrich Rudolf Hertz was a wonderful German physicist. He was also an experimentalist who demonstrated that the electromagnetic waves predicted by James. Clerk Maxwell actually exist. Hertz was an additional person here. The gaps were difficult to establish, and required that the he perform his investigations during a darkened room. It almost seems absurd and impossible that they got to be visible; but during a superbly dark room they're visible to a watch fixed which has been well rested within the dark.

[2] , Christian Hulsmeyer was actually a German inventor. He was often credited with the invention of radar but couldn't directly measure distance to a target. The Telemobiloscope was, however, the primary patented device using radio waves for detecting the presence of distant objects like ships.

First Patent – Telemobiloscope : Hulsmeyer happened to be filed with his¨ patent with the German title in the succeeding english patent called as Hertzianwave It was for Projecting and Receiving Apparatus Adapted to Indicate.

Plan Position Indicator: Hulsmeyer mainly suceed to be invented an electro mechanical device. It was to transmit the azimuth angle to pontoon bridge. He named it as "Kompass". It was a predecessor initially which is of the later PPI, the Plan Position Indicator.

Patent: Ranging: Hulsmeyer happened to be recognised that it would¨ be of the great if it is to determine the direction of the target along with the distance where it is located and named it as "Ranging", in "RADAR". Christian Hulsmeyer was the primary who demonstrated and patented the core of radar principle, namely to detect distant objects by the reflection of electromagnetic waves.

* *Corresponding author*
E-mail address: guruvannavarakash@gmail.com

3. METHODOLOGY

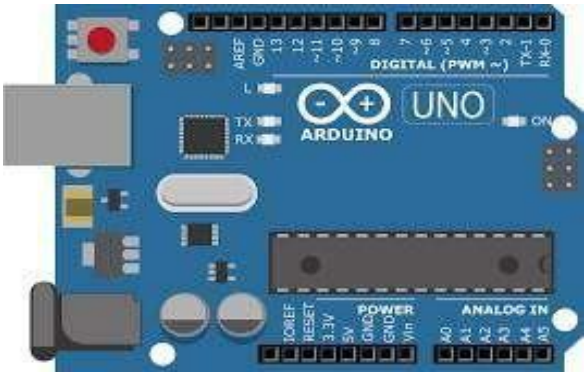
Arduino is an open-source microcontroller board. Having input and output digital and analog-pins, which enables it to get interfaced with different components. We have interfaced Ultrasonic sensor which is like the heart of the radar. Arduino is connected here is to control the servo motor in the angle between 0 to 180 degrees, therefore covering the radar range. On this servo motor, we are mounting the Ultrasonic sensor which is for the required operation we are looking forward in getting the desired results.

1. Arduino UNO:

The Arduino Uno is an open-source microcontroller board. The board is given sets of digital and analog input/output (I/O) pins which can be interfaced to other circuits. The board has got totally 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and also is programmable with the Arduino IDE (Integrated Development Environment), done via a sort B USB cable.

2. Arduino Software (IDE):

The Arduino Integrated Development Environment (IDE) may be a cross-platform application (for Windows, macOS, Linux) that's written in functions from C and C++. It is wont to write and upload programs to Arduino compatible boards, but also, with the assistance of third-party cores, other vendor development boards.



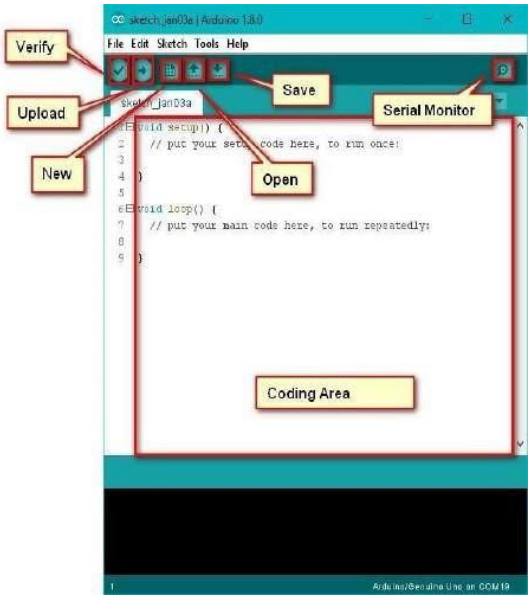


Fig. 1 - (a) Arduino Uno; **(b) Arduino software (IDE)**

System Overview:

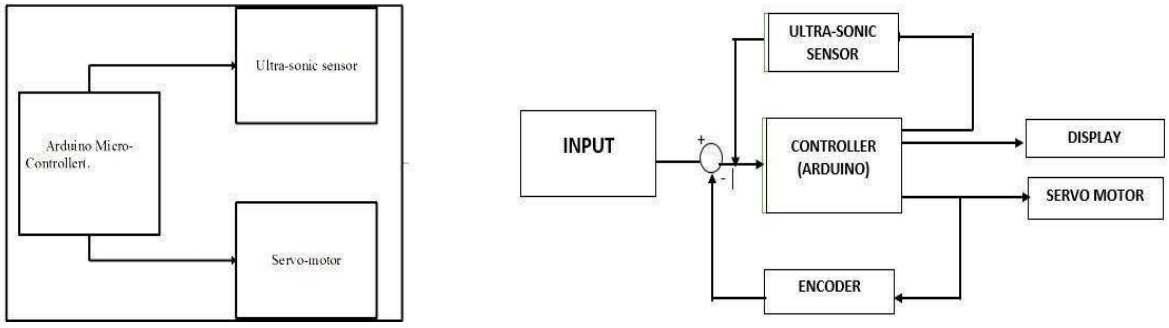


Fig. 2 - (a) System Overview; (b) Block Diagram of Radar System

The above figure 2 - (a) represents a quick overview of this radar system. Here, due to the controlling operation required, we are using is Arduino along with the input of Ultrasonic sensor and therefore the output is that the servo motor that rotates 180 degrees. The Arduino(microcontroller) controls all the operations of this technique, from rotation of the motors to the obstacle detection of the ultrasonic and representation of the result on the screen.
Figure 2 - (b) represents the system's block diagram. Here, it is often seen how the work flow during this radar system. The sensor goes to sense the obstacle and determine the angle of incident and its distance from the radar. The servo motor is constantly rotating to and from, hence making the sensor move. The data obtained is encoded and fed to the processing IDE which then is made to represent it on the screen. The results are displayed further during this paper. All these operations are done by Arduino microcontroller from the rotation of the servo, data collection from the sensor, feeding the info to encoder to transferring it to the display.

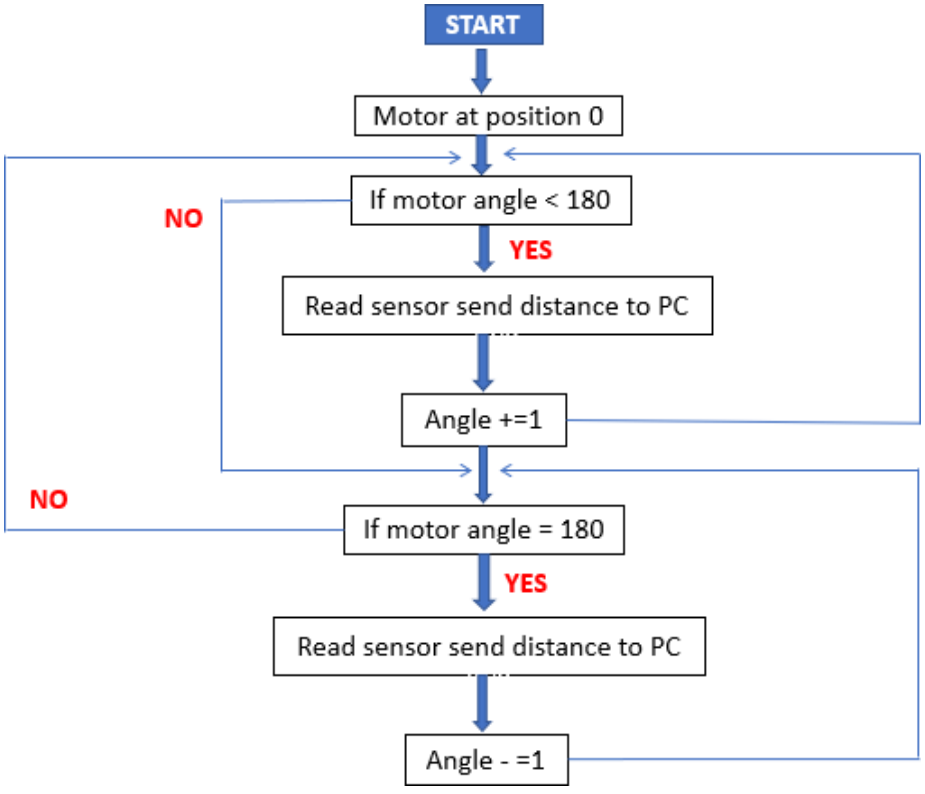


Figure. 3 - Flow Chart

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 detect any object, at any condition the encoder in it feeds the information in the controller while the servo keeps constantly rotating. As soon as any obstacle/an 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.

2. WORKING

Initially, the step is to upload the code to Arduino after making the connections. You can observe the servo sweeping from 0 to 180 and again back to 00. Since the Ultrasonic Sensor is mounted over the Servo, it'll also participate within the sweeping action. Then, should open the processing application and paste the above given sketch. In the Processing Sketch, making necessary changes is important to look after that's within the COM Port selection and replace it with the COM Port number to which your Arduino is connected to. Now, run the sketch within the Processing and if everything goes well, a replacement Processing window exposes just like the one shown below**.**

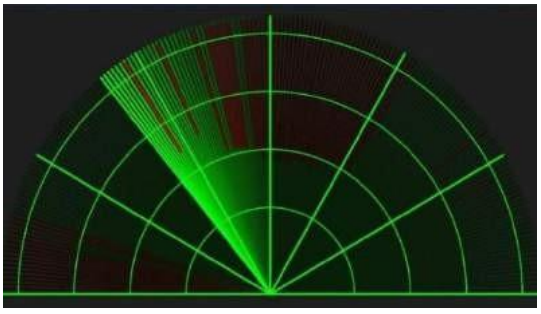


Figure. 4 - Radar Screen

Graphical representation of the info from the Ultrasonic Sensor is represented during a Radar type display. If the Ultrasonic Sensor detects any object within its range, an equivalent is going to be displayed graphically on the screen.

3. RESULTS

Our system is designed consisting of the following components such as, a servo- motor, an ultra-sonic sensor and a microcontroller board (Arduino). The objective is to track the distance and angle of the object and to represent this information graphically, means its output should be in graphical form which will be represented through processing software. Here, we can just have the idea of this radar's efficiency that's made by testing objects at different levels and observe how faster or smoothly it detects an object that it finds in a way and gives an expected range of the obstacle. The following figure shows the results of monitor screen of our design when the sensor rotates through the area and detects an obstacle in the way of its radiation range. The red area shown like a beam indicates the presence of obstacle and below the angle of incident and distance is being displayed.

Testing of the system:

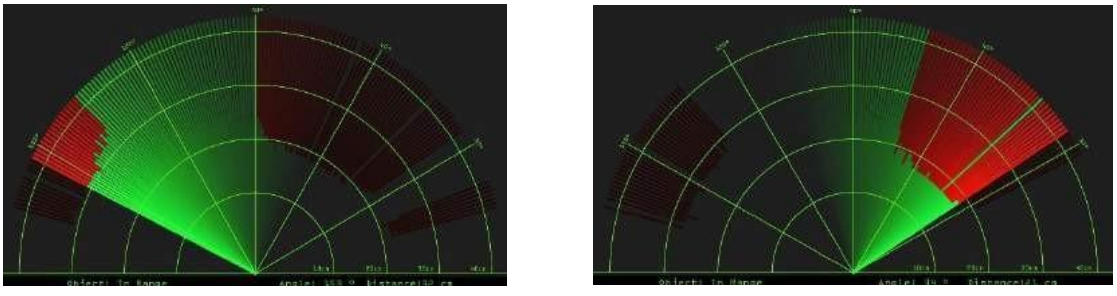


Figure. 5 (a) and (b) - Processing IDE Screen displaying an output of system which we have tested by placing objects.

a) Object 1 is placed 30.5 far from the radar, radar gives the distance 32 cm, so:
   - error = (32-30.5) / 30.5) * 100 = 4.918%
   - efficiency 1 = 100 - error = 95.08%

b) Object 2 placed at a distance of 20.3 cm from the radar, radar gives the distance 21 cm so:
- error = ((21-20.3) / 20.3) * 100 = 3.44%
- efficiency 2 = 100 - error = 96.55%

After the observations and calculations, we can conclude that this system is 95.815% efficient.

4. APPLICATION

This Radar System has various applications like, for security purposes and it is mainly used for mapping.

APPLCATION IN AIR FORCE: It is used in airplanes or aircraft machines which have implemented the radar system in it to detect the objects that come in a way. It is also used to calculate height readings at ATC.

APPLICATION IN MARINE: This radar system is also used in ships or marine. It is implemented on the big ships to calculate the distance of other boats or ships, with the help of this sea, accidents can also be reduced by not letting them get collided. It can also be implemented on ports to measure the distance of other ships and also to monitor or to control the ship movements.

APPLICATON IN METEROLOGY: Meteorologists also use radar systems to track or to monitor the wind. It has been become an important equipment for climate testing day today manner. For example, to detect tornados, storms.

5. CONCLUSION

This work aims on the use of Ultrasonic Sensor by connecting to the Arduino UNO R3 board and the signal from the sensor is further provided to the screen formed on the screen which measures the presence of any obstacle in front of the sensor as well as determine the range and angle at which the obstacle is detected by the sensor. For this screen, we use Processing 2 software by Benjamin Fry and Casey Reas, Massachusetts Institute of Technology, Cambridge.

6. REFERENCE

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