Arduino Based Small and Shortrange Obstacles Tracking Radar System

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Abstract- *A Short range obstacles tracking radar system is a device that measures the distance from the target to the observer. It employes an ultrasonic sensor along with the Arduino microcontroller.Arduino receive an echo signal back as response of the transmitted signal by transmitter and the distance between the object and system is measured by calculating time interval taken by the signal to transmit and the echo reception. In this technical project, we make a simple radar using the ultrasonic sensor, this radar works by measuring a range from 3cm to 40 cm as non-contact distance, with angle range between 15˚ and 165˚.The movement of the sensor is controlled by using a small servo motor. Information received from the sensor will be used by "Processing Development Environment" software to illustrate the result on a PC screen.*

Keywords- Ultrasonic sensor, Arduino Uno, Arduino IDE, Processing 3.

I. INTRODUCTION

Radar technology is now pervasive in society and is crucial for tackling social and economic issues for the wellbeing of the population.

Radar is an object detection system that uses electromagnetic waves to recognize the range, altitude, path, or speed of both moving and fixed objects such as aircraft, ships, vehicles, weather formations, and terrain. When we use ultrasonic waves instead of electromagnetic waves, we call it ultrasonic radar. It is a type of ultrasonic system where ultrasonic wave signals are used to find the obstacles from the reflective surface.

This small and shortrange obstacles tracking radar system is capable to measuring the distance between transmitter and the receiver. The techniques to measuring the distance between using ultrasonic of an object include the pulse echo method. In that technique burst pulse is send the 40 kHz Signal through transmission medium and is reflected by an object kept at specific distance from the ultrasonic sensor, the time interval between echoes reflected from object to the module is proportional to the distance of object

The main components in any ultrasonic radar are the ultrasonic Sensors. Ultrasonic sensors work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively.

Radar's information will appear in different ways. Basic and old radar station used sound alarm or LED, modern radar uses LCD display to show detailed information of the targeted object. We use Computer screen to show the information (distance and angle).

II. TOOLS REQUIRED

Arduino Board UNO Model:

It is a microcontroller board based on ATmega328. It provides everything in need to support the microcontroller. Simply connect it to a computer with a USB cable or power it with AC-to-DC adapter or battery to get started. Arduino is a hardware and software company, project, and user community that designs and manufactures computer open-source hardware, open-source software, and microcontroller-based kits for building digital devices and interactive objects that can sense and control physical devices.

The project is based on microcontroller board designs. The board provides sets of digital and analog Input/output (I/O) pins that can interface to various expansion boards (termed shields) and other circuits Fig (1). The boards feature serial communication interfaces, including Universal Serial Bus (USB) on UNO model, for loading programs from personal computers.

For programming the microcontrollers, the Arduino project provides an integrated development environment (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board..

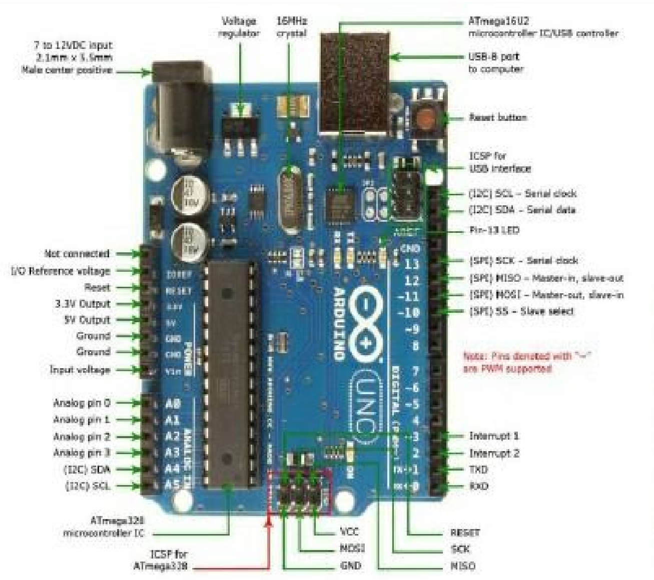


Fig (1).Arduino UNO

Processing:

Processing is an open source computer programming language and integrated development environment (IDE) built for the electronic arts, new media art, and visual design communities with the purpose of teaching the fundamentals of computer programming in a visual context Fig (2).

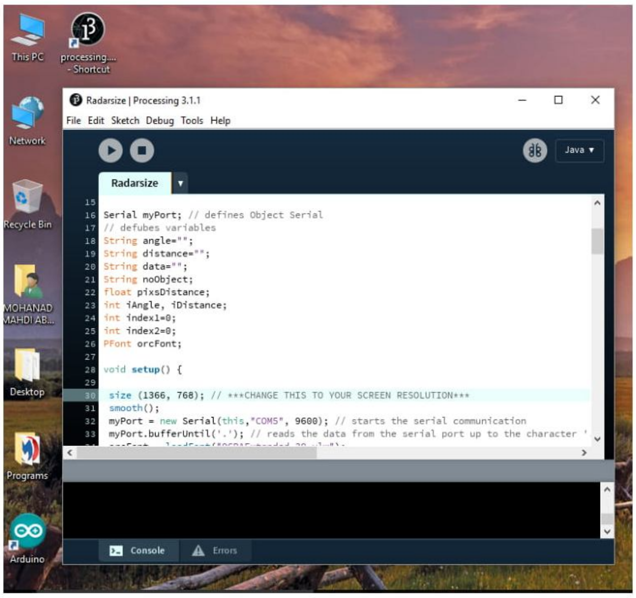


Fig (2) Software and processing

Ultrasonic sensors HC- SR04:

Ultrasonic sensors are bassed on the measurement of the properties of acoustic waves with frequencies above the human audible range often at 40kHz. Ultrasonic ranging module HC - SR04 provides 2cm - 400cm non-contact measurement function, the ranging accuracy can reach to 3mm. The modules include ultrasonic transmitters, receiver, and control circuit, within measuring angle 15 degrees. Ultrasonic sensors work on a principle similar to radar or sonar which estimates qualities of a target by taking the echoes from radio or sound waves respectively.

Ultrasonic sensors generate high frequency sound waves and estimate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. This technology can be used for measuring: object, speed and direction (anemometer), fullness of a tank and speed through air or water. Further applications include: humidifiers, sonar, medical ultra pornography, burglar alarms and non-destructive testing. Systems typically use a transducer which generates sound waves in the ultrasonic range, above 20,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed. The Fig (3) is shown ultrasonic sensor used in the project.

Fig (3). Ultrasonic. HC- SR04

Servo Motor tower pro micro servo 9g:

A servo motor is an electrical device which can push or rotate an object with good precision. Servo motor is a rotary actuator or linear actuator that allows for precise control of angle, velocity and acceleration.

Tiny and lightweight with high output power. The servo can rotate approximately 180 degrees (90 in each direction), and works just like the standard kinds but smaller Fig (4). You can use any servo code, hardware or library to control these servos.

The stepper motor used in the system has a step angle of about 1.8 degrees. The sequences of the motor are controlled by the Arduino. To supply quantity of current to the motor a motor driver IC is used. The Stepper motor takes a 14.4degree step angle and then assessment is done at that point.

Fig (4) Servo Motor Tower Pro Micro Servo 9g

III. CIRCUIT DIAGRAM

We connected the Ultrasonic Sensor HC-SR04 to the pins number 10 and 11 on the Arduino Board.

TrigPin = 10.
EchoPin = 11.

And the servo motor to the pin number 12 on the Arduino Board. Fig (5) shows circuit structure for the project.

MyServo = 1

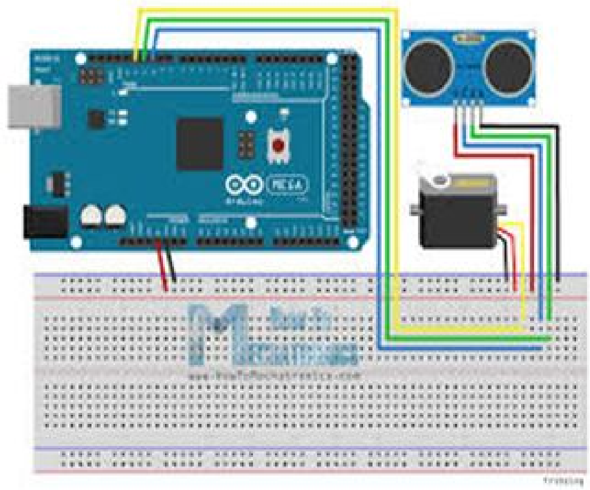


Fig (5). Circuit Diagram

We made a base form plastic box for servo motor and ultrasonic that allows servo motor to move within 180˚.The final Hardware look is shown in Fig (6).

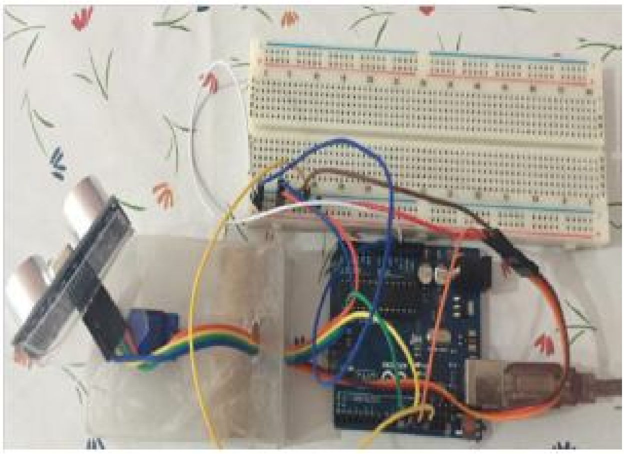


Fig (6) Final Hardware look

IV. DISTANCE MEASUREMENT

The Ultrasonic wave propagation velocity in the air is approximately 340 m/s at 15°C of air or atmospheric temperature, the same as sonic velocity. To be precise, the ultrasound velocity is governed by the medium and its temperature hence the velocity in the air is calculated using the formula below (1).

$V=340+0.6(T-15)m/s$ …………. (1)

T: temperature, °C.

The measured distance is calculated on the basis of rotation time .which is finding transmitting and receiving signal of the ultrasonic signal as measuring distance display.

The formula is to calculate the distance is shown below
Distance(cm) = (travel time *10^6* 34300)/2 ………………. (2)
(OR)

The time delay between the corresponding edges of the transmitted and received pulses is measured by microcontroller; this gives the time of flight. Substituting the time delay and the velocity of ultrasound in air (330 meters/second) in the following formula we can determine the distance between the transmitter and the target. Fig.2 shows the transmitted and received pulses.

Distance = Velocity X Elapsed time ………… (3)

V. ARDUINO CODE UPLOADING

We wrote a sketch in IDE, for this project we need to include some libraries. We use (Serial.h) built-in library for transfer data through the serial port with processing software. Therefore, we add the last library for servo motor (Servo.h) and added NewPing library which includes the last update functions and features for the ultrasonic sensor.

Then, we make a code and upload it to the Arduino board to enable the interaction between the Arduino and the Processing IDE Fig (7).

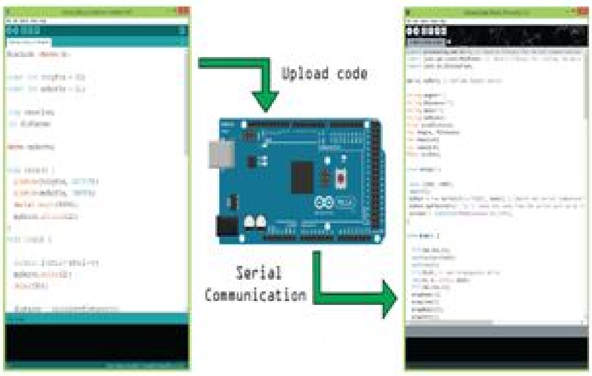


Fig (7) Project Code

VI. PROCESSING CODE UPLOADING

The values for the angle and the distance measured by the sensor will be read from the Arduino board by the Processing IDE using the SerialEvent() function which reads the data from the Serial Port. These values will be used for drawing the lines, the detected objects and some texts.

For drawing the radar display we make this function drawRadar() which consist of arc() and line() functions Fig(8).

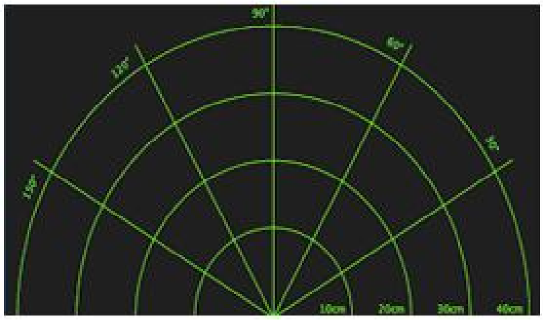


Fig (8). The radar workspace

For drawing the moving lines we make this function *drawLine()*. Its center of rotation is set with the *translate()* function and using the *line()* function in which the iAngle variable is used to redraw the line for each degree Fig(9).

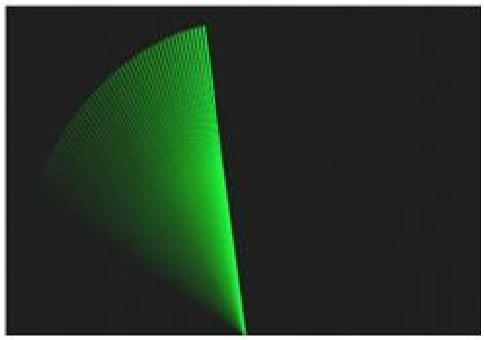
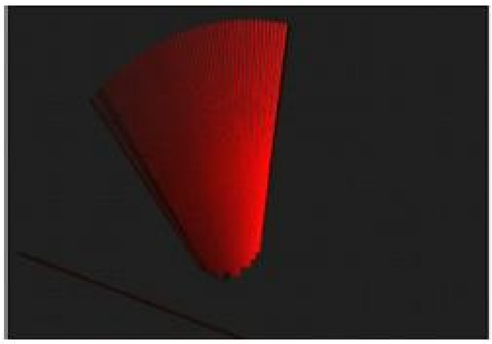


Fig (9) Radar line



Fig(10).Radar detected lines

For drawing the detected objects we made the *drawObject()* function. It receives the distance from the ultrasonic sensor, transforms it into pixels. Then, using the angle detected by the sensor it draws the object on the radar screen Fig (10).

To illustrate the text on the screen, we make the *drawText()* function that draws texts on some particular locations. All of these functions are called in the main *draw()* function which is repeated in each iteration to draw the screen details.

We are using the *fill()* function with 2 parameters for simulating motion blur and slow fade of the moving line. Fig (11) shows the final appearance of the radar screen

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Desktop display has been used to display the output. The output is like the one we see in radar systems. The scan is shown by a line and it moves from 0 to 180 as stepper moves. Whenever a object is detected LCD glows at that point. This display is used for show the detected object in the form of latitude and longitude

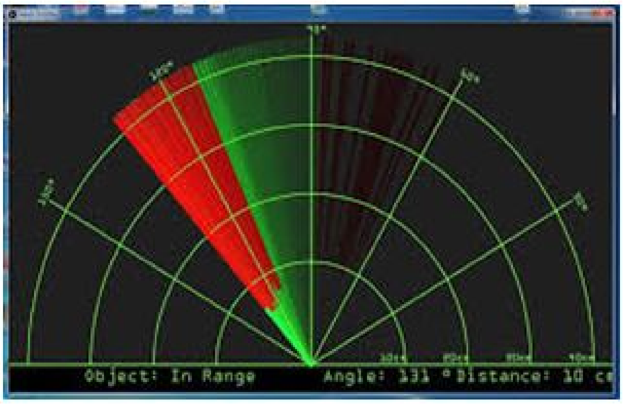

Fig (11). Radar Screen

VII. APPLICATONS

- Urban surveillance and imaging in buildings.
- House security surveillance.
- Tracking position of a human head.
- Used in automotive, petrochemical, steel mills etc.

VIII. ACKNOWLEDGEMENT

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IX. CONCLUSION

Radar is normally used to determine velocity, range, and position of an object. In this technical project has been successfully implemented and the aim of obstacle tracking is achieved without any deviation and we read the distance and angles of detected objects in order to convert these data into visual information. It works smoothly to detect objects within the designed range. The screen shows the information clearly with enough delay for the user to read it. This project could be helpful for object avoidance/ detection applications. This project can also be extended or modified according to the rising need it.

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