American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-9, Issue-12, pp-01-08
www.ajer.org
Research Paper Open Access

Arduino Uno Controlled Robotic Radar System Object Detector Using Ultrasonic Sensor

Ikechi Risi.* Arobo Raymond C.Amakiri, and Nicholas Nkasiovu Tasie
Department of Physics
Rivers State University, Port Harcourt, Nigeria
Corresponding author email: ikechi.risi@ust.edu.ng*

ABSTRACT *Radar in a broader perspective entailed an electronic system that uses electromagnetic signals to detect positions of either dynamic or static objects. However, here, the radar system with the help of an ultrasonic sensor utilizes an ultrasonic signal in place of electromagnetic signals. In this work, an ultrasonic radar system that can detect and measure the position of an object in a short-range is implemented using Arduino Uno, ultrasonic sensor, servo motor, and software. Object recognition range of the ultrasonic radar is within a distance of 40cm and the robotic angular rotation of the ultrasonic radar is from 5 to 175 and 175 to 5 degrees. Arduino Uno controls the radar system with a written code in the Arduino IDE environment and serially communicates with the display panel (computer) through the processing software.*
KEYWORDS*: Arduino; Radar; Ultrasonic Sensor; Object Detector.*

Date of Submission: 24-11-2020 Date of acceptance: 07-12-2020

I. INTRODUCTION

The radar system is an electronic framework that can detect objects within its range of transmission and reception. There are different diversity and classifications of the radar system with distinct achievement requirements. Some radar systems are used in military applications for the purpose of our defense, basically in target detection [1]. Other mediums where radar systems can be used are air traffic control used in channeling aircraft through safe landing during bad weather condition, ground traffic control use by police officers for the purpose of detecting speed limit of vehicles, remote sensing which can be used for monitoring weather condition and finally can also be applied through space for a secure landing of space car on the moon. A short-range radar system that can measure object range within 3cm to 40cm with a focusing angle of rotation from 15^{o} to 165^{o} can be implemented using an ultrasonic sensor [2].

The development of the radar system has passed different stages of improvement. It was first experimentally verified in the 1880s by a Physicist Heinrich Hertz. Since then, the development has improved from the 1930s. Most countries pick interest in its development and modernization before and during World War II [3,4].

However, the ultrasonic radar system which is basically made with an ultrasonic sensor is designed to detect object position such as indicating the distance and angular position of the object location [5]. Arduino Uno controls the servo motor with the help of the uploaded code and a processing code is also written in the processing IDE environment which enables the Arduino Uno to communicate with the serial port for visual output of the input.

II. MATERIALS AND METHOD

2.1 **Arduino UNO**

Arduino Uno otherwise called microcontroller is the hardware brain box in the implementation with the basic function of controlling other components for the total output of the commands. The command is of course imputed into the Arduino board in the form of code written in the Arduino IDE (integrated development environment) through the computer connection. Arduino Uno controls the rotation of the servo motor [6]. Figure 1 represents the pictorial diagram of Arduino Uno.

Figure 1: Arduino Uno board.

2.2 Servo Motor

A servo motor is a rotary device that can swing from left to right, right to left, or propel in an angular direction. It is basically used as a base or pivot for the movement of other components or modules attached to it. It is what rotates the ultrasonic sensor searching for obstacle objects within the range from 5^{o} to 175^{o} frontward and 175^{o} to 5^{o} backward.

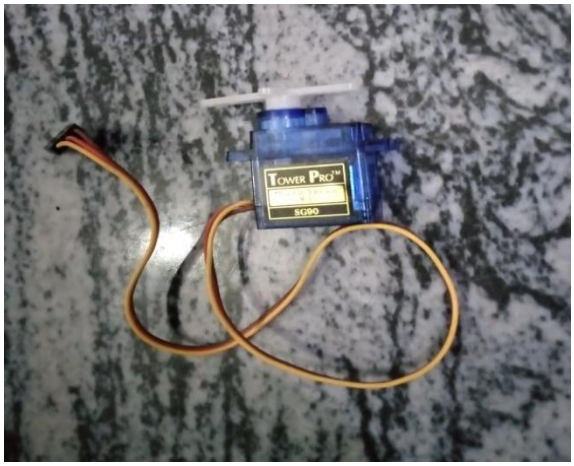

Figure 2: Servo Motor.

2.3 Ultrasonic Sensor (HC_ SR04)

The ultrasonic sensor can also be called a transceiver because it works in the principle of transmission and reception, meaning that it converts electrical energy into sound or radio wave as such a triggered signal which is sent from the microcontroller (Arduino Uno) to the Ultrasonic Sensor in the capacity of 10µS [7]. Ultrasonic Sensor uses the signal, it generates an acoustic wave which is then propagated along the air medium to strike object within the range and within a short period of time, the Ultrasonic Sensor will receive the echo and turns the wave back into electrical energy where the information from the object it is processed, calculated and visualized.

Frontside Backside

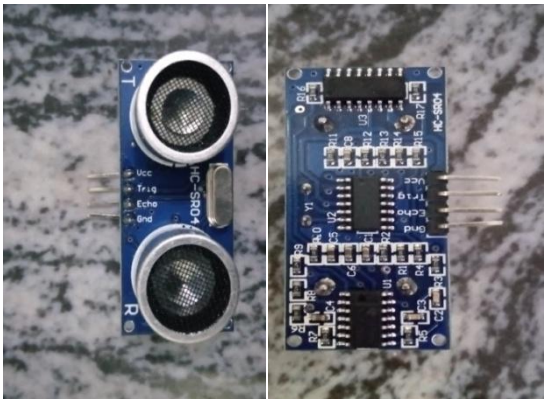

Figure 3: Ultrasonic Sensor.

2.4 Bread Board

For the pragmatic purpose, the prototype breadboard is used as the base for which the connections are made and all the modules such as Arduino Uno, Servo Motor, for which Ultrasonic Sensor are mounted on.

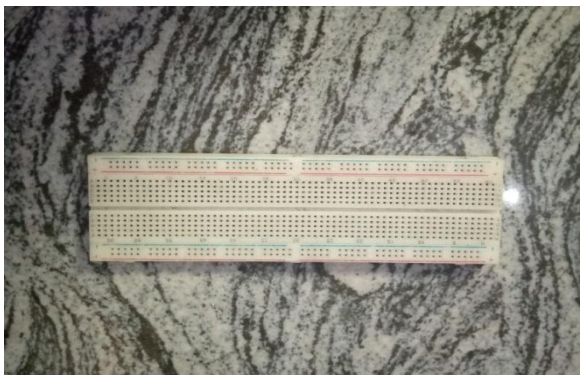

Figure 4: Bread Board

Components Connection

STEP 1: The Arduino Uno is connected with the Servo Motor.

Arduino Uno	Servo Motor
GND	GND
5V	VCC
Pin12	Signal/pulse Pin

STEP 2: The Arduino Uno is connected with Ultrasonic Sensor.

Arduino Uno	Ultrasonic sensor
GND	GND
5V	VCC
Pin11	EchoPin
Pin10	TrigPin

STEP 3: Write and upload Arduino IDE programmed code.

A code was written in the Arduino IDE software environment and uploaded to the Arduino Uno which controls other components. Libraries such as “Servo.h” and “NewPing” were added for the sake of servo motor and ultrasonic sensors respectively.

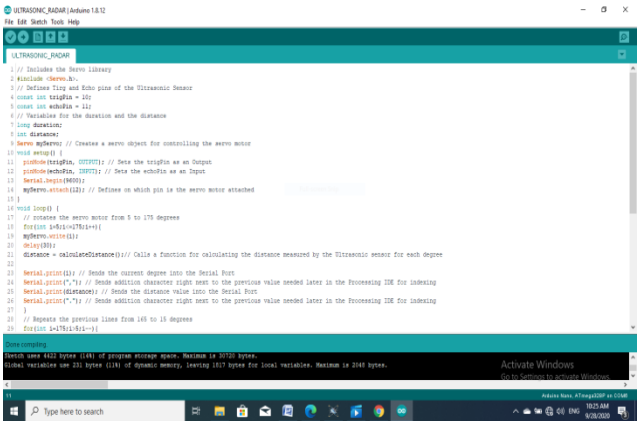

Figure 5: Arduino code

STEP 4: Write and run processing IDE programmed code.
Processing software is an integrated development environment (IDE) and a programming environment that enables input detected objects to be visualized on the computer.

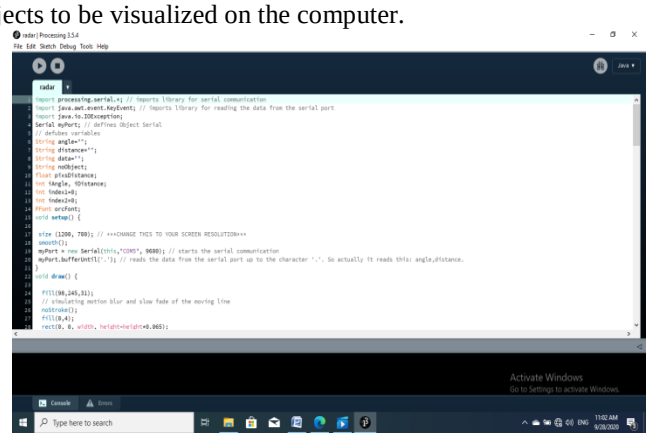

Figure 6: Processing code

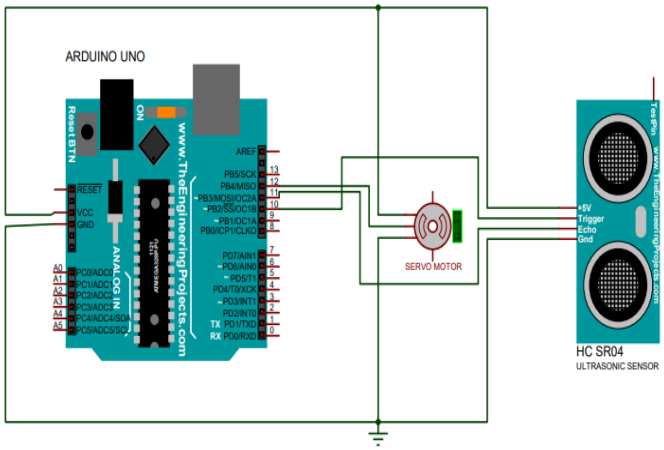

Figure 7: Ultrasonic Radar Circuit Design.

III. RESULTS AND DISCUSSION

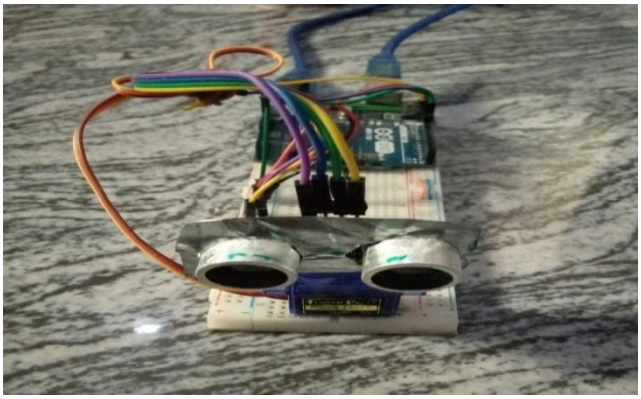

Figure 8: Constructed prototyped ultrasonic radar device

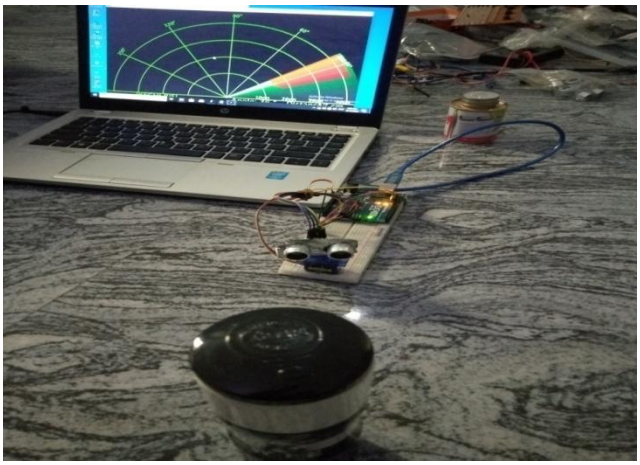

Figure 9: Radar device communicating serially with processing environment detecting object

Figure 10: No object detected at 53^{o} anticlockwise direction

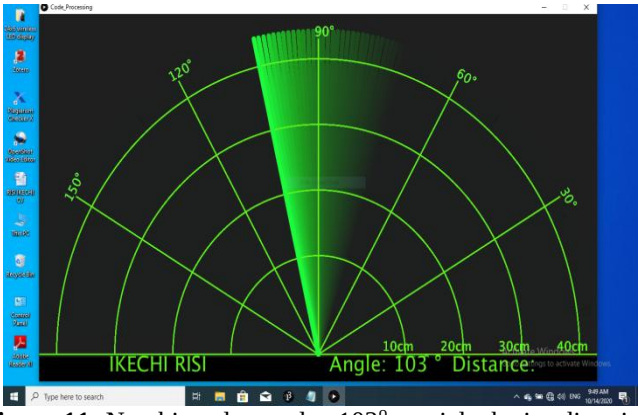

Figure 11: No object detected at 103° anticlockwise direction

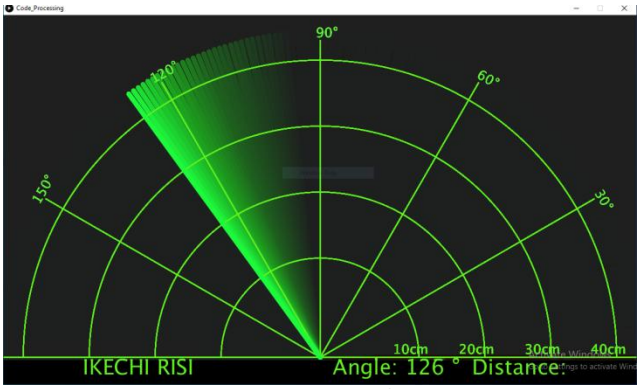

Figure 12: No object detected at 126° anticlockwise direction

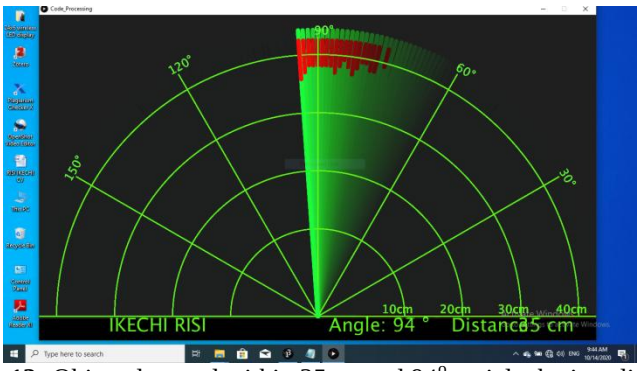

Figure 13: Object detected within 35cm and 94° anticlockwise direction

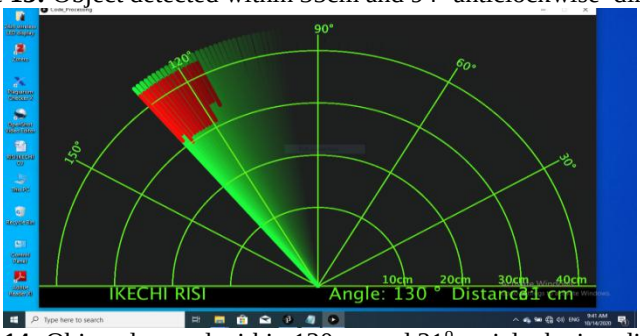

Figure 14: Object detected within 130cm and 31° anticlockwise direction

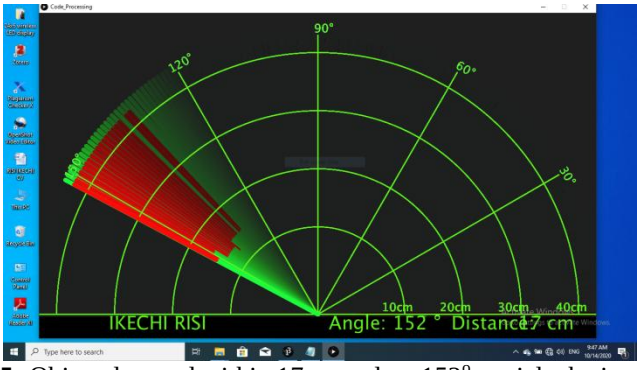

Figure 15: Object detected within 17cm and 152° anticlockwise direction

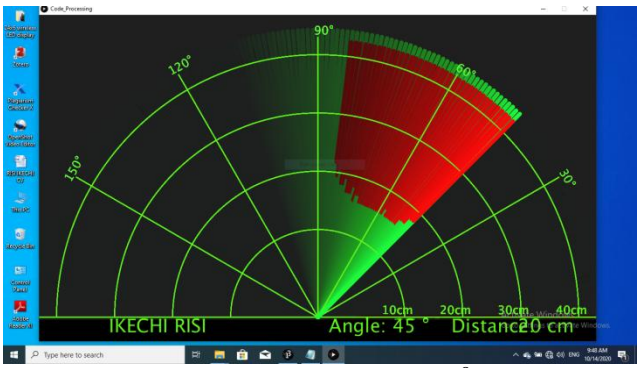

Figure 16: Object detected within 20cm and 45° clockwise direction

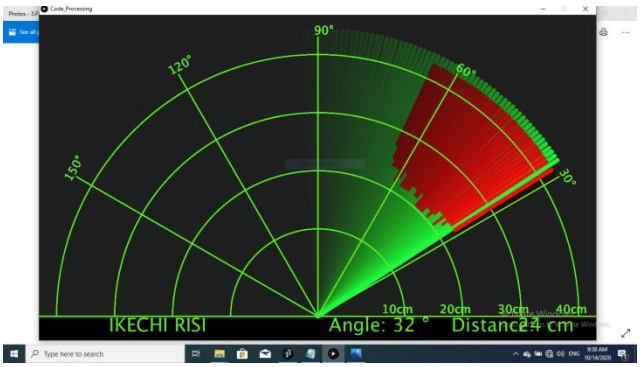

Figure 17: Object detected within 24cm and 32° clockwise direction

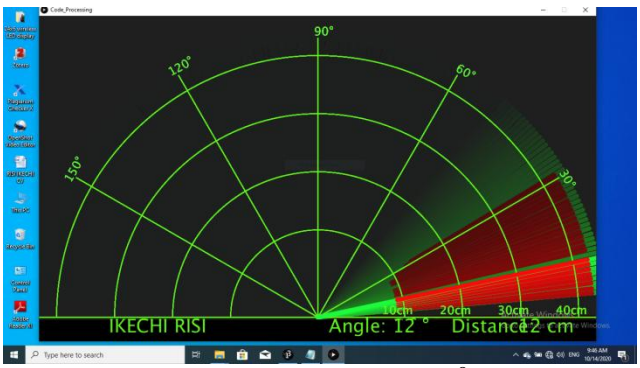

Figure 18: Object detected within 12cm and 12° clockwise direction

Figure 8 is the final prototype ultrasonic radar system. It can rotate both clockwise and anticlockwise directions. In figure 8, the ultrasonic radar device is connected and communicated serially with processing software which showcases the object detected.

Figures 10, 11, and 12 showing a green background which simply means that no objects were detected when the radar rotated at angle 53°, 103°, and 126° through the anticlockwise direction.

Figures 13, 14, and 15 showed an object detected in different positions when the angle is rotated at 94^o, 130^o, and 152^o anticlockwise direction. The red background indicates object detection, whereas, the green area shows a non−obstacle zone. When the radar moved through 94^o, 130^o, and 152^o, it captured obstacles at a distance of 35cm, 130cm, and 17cm respectively.
Figures 16, 17, and 18 demonstrate object detected at distance 20cm, 24cm, and 12cm at 45^o, 32^o, and 12^o North East (NE).

IV. CONCLUSION

In this project, a radar system made with an ultrasonic sensor was created and executed pragmatically for the purposes of object detection that can be applied in different areas of security and otherwise. Some of the materials or components that were used for the achievement are Arduino Uno microcontroller which controls other components, an ultrasonic sensor that transmits and receive signals for obstacle detection, and a servo motor that helps to tilt the radar system attached with it in different positions from 5^o to 175^o anticlockwise and 175^o to 5^o clockwise directions in a robotic manner.

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Ikechi Risi, et. al. "Arduino Uno Controlled Robotic Radar System Object Detector Using Ultrasonic Sensor." *American Journal of Engineering Research (AJER)*, vol. 9(12), 2020, pp. 01-08.