International Journal of Research Publication and Reviews

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

Radar System Utilizing Arduino

Shivam Chowdhury[1], Soumya Mazumdar[1,2], Souravdeep Giri[1], Adrita Bhattacharya[1]

[1] Gargi Memorial Institute of Technology [JIS Group], West Bengal, India
[2] Indian Institute of Technology Madras, Tamil Nadu, India

ABSTRACT

This paper presents the design and implementation of a short-range radar system using an Arduino microcontroller. The system utilizes an ultrasonic distance sensor to measure the distance of objects, with the data processed and displayed on a personal computer. The sensor, mounted on a servo motor, provides polar distance measurements across a 180-degree rotation. Key components include the Arduino UNO, ultrasonic sensor HC-SR04, and servo motor, with the Arduino IDE and Processing software facilitating data processing and visualization. The system's applications span air traffic control, maritime navigation, and meteorological monitoring, showcasing its versatility and potential for various security and mapping tasks. By leveraging open-source hardware and software, the project underscores the accessibility and educational value of integrating radar technology into practical and experimental settings.

Keywords: Radar, Ultrasonic Sensor, Arduino Uno, Servo motor.

I. Introduction

RADAR is a method of object detection that employs radio frequencies to determine the height, size, direction, or movement of an object. Radar systems are available in a variety of capacities and performance requirements. Some radar systems are employed in early warning and long-range surveillance systems, while others are used for air traffic management at airports. The center of a missile guidance system is a radar system. There are many options for tiny, individually managed radar systems as well as large, multi-room systems. [1] Before and throughout the Second World War, a number of countries labored covertly to develop the radar. In 1940, the United States Navy invented the acronym RADAR, which stands for radio detection, along with many other innovations. Numerous air traffic control systems, such as radar, astronomy, air defense, anti-missile, marine maritime radars for site and vessel identification and repositioning, aircraft collision prevention systems, sea surveillance, space monitoring, and rendezvous systems are among the new uses for radar technology. Advanced radar systems are connected to digital signal processing. [1]

II. System Overview

The block design for the Arduino-powered short-range radar system is shown in (Figure 1). An ultrasonic distance sensor is used in this work to measure the object's distance, and the signal conditioning unit is linked to the sensor's output. Following that, the Arduino microcontroller processes it. The personal computer shows the measured findings. To determine the polar distance around the sensor up to 180 rotations, the sensor is fastened to the servo motor.

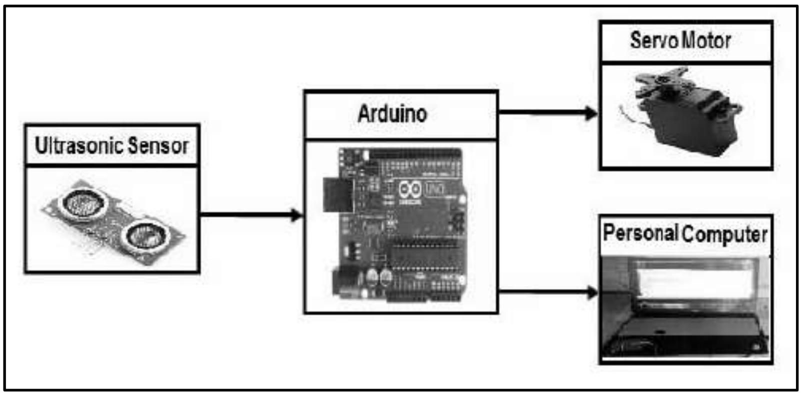


Fig. 1 System block diagram

III. Components Required

3.1 Arduino Board UNO Model

Arduino is an open-source software platform, computer hardware, and microcontroller-based device assembly kit that may be used to build interactive objects that can recognize and control physical objects. Arduino creates and produces software, software, and more software. The project's primary focus is the microcontroller design. The board has a combination of digital and analog input/output (I/O) pins that may be attached to shields, or expansion boards, as needed. Programs from personal computers may be loaded onto the plates using the Universal Serial Bus (USB) and other serial connection interfaces of the UNO model [3].

For microcontroller systems, the Arduino project provides an integrated development environment (IDE) that facilitates code creation and uploading to the board. It perfectly works with Windows, Linux, and Mac OS X. The code is written in Java, which is based on free source software and processing. Any Arduino board may run this program (Figure 3).

Fig. 2 Arduino UNO

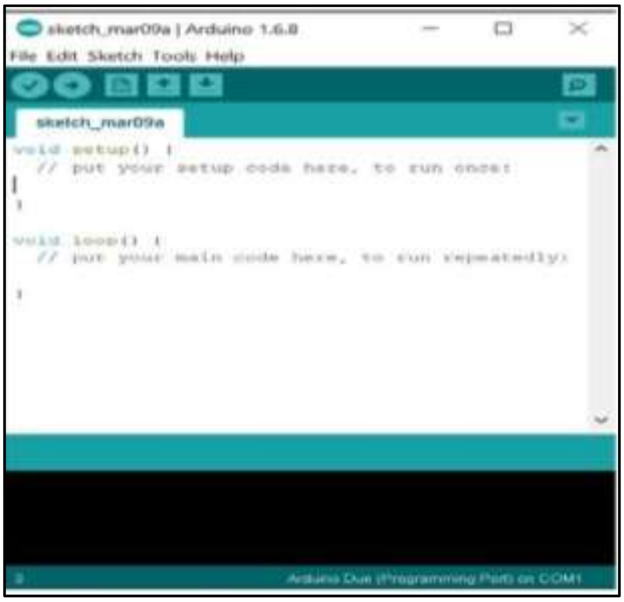


Fig. 3 IDE Software

3.2 Processing

The electronic arts, new media art, and visual design groups developed All Processing, an open-source computer programming language and integrated development environment (IDE) for teaching computer programming fundamentals in a visual context (Figure 4). The instructions for programming

- Downloadable for nothing and open source
- Interactive applications with output in 2D, 3D, or PDF
- Integrated OpenGL for accelerated 2D and 3D
- Regarding Windows, Mac OS X, and GNU/Linux

- Over a hundred libraries enhance the main program.
- Well documented, with many books available

Fig. 4 Software and processing.

3.3 Ultrasonic sensors HC- SR04

When an object or obstacle enters the path of the ultrasonic sensor's 40,000 Hz ultrasound beam, the sound waves bounce back to the sensor module. The sensor generates ultrasound at this frequency. By measuring the travel time of these sound waves and knowing the speed of sound, the distance to the object can be calculated. In air, sound travels at approximately 341 meters per second (1100 feet per second). The ultrasonic sensor uses this information along with the time interval between transmitting and receiving the sound pulse to determine the distance to the object. The calculation is performed using the following formula:

$$DISTANCE = \frac{TIME \times SPEED\ OF\ SOUND}{2}$$

where "Time" is the duration between when the ultrasonic wave is emitted and when it is received. The fact that the sound wave goes to and from the object is explained by the division by two.

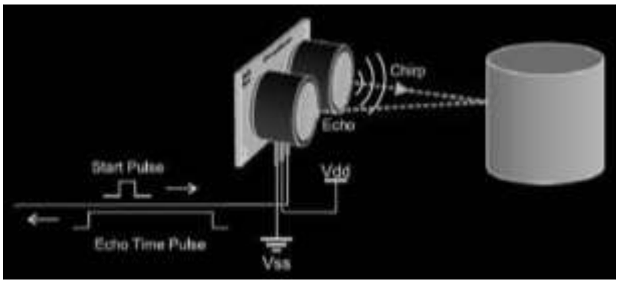


Fig. 5 Ultrasonic Sensor

3.4 Servo Motor

small, light, and powerfully outputted. The servo will function as tiny as the standard kinds and spin around 180 degrees (90 in each direction) (Figure 6). You may use any servo code, hardware, or library to monitor these services[4]. The servo motor's specifications:

- *Weight:* 10g
- *Dimension:* 22.2 x 11.8 x 31 mm approx.
- *Stall torque:* 1.8 kg fem
- *Operating speed:* 0.1 /60 degree

- *Operating voltage:* 4.8 V (~5V)
- *Temperature range:* 0 °C — 55 °C

Fig. 6 Servo motor.

The Arduino and PC are interfaced via RS232 USB. The Arduino receives and processes the data from the ultrasonic sensor. The Arduino application uses equation (1) to calculate the object distance. The Arduino program also determines and regulates the position angle of the radar. The two pieces of data that the Arduino sends to processing software in order for it to show them on the radar screen are the angle position and object distance. Figure 7 displays the hardware design that was produced in a scraping environment. It displays the connections between different electrical parts.

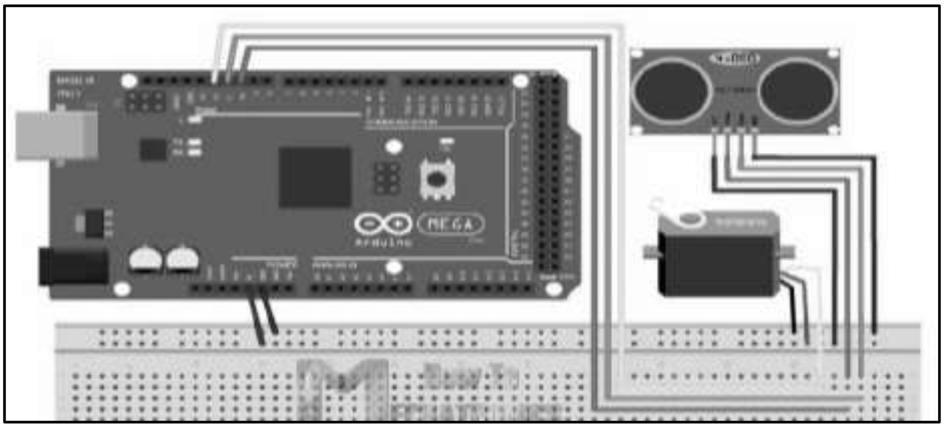
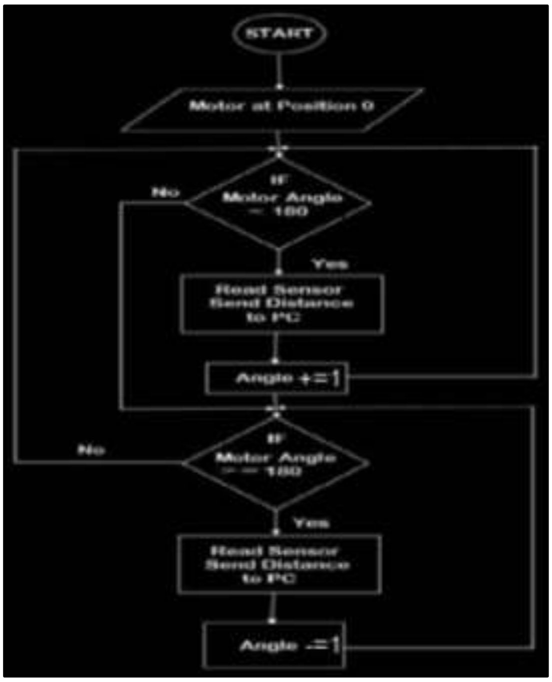


Fig. 7 Hardware system design.

IV. Flowchart

The system's general functioning using software to operate the servo motor is shown in the flowchart.



V. Results

The radar workspace is shown in Figure 8.

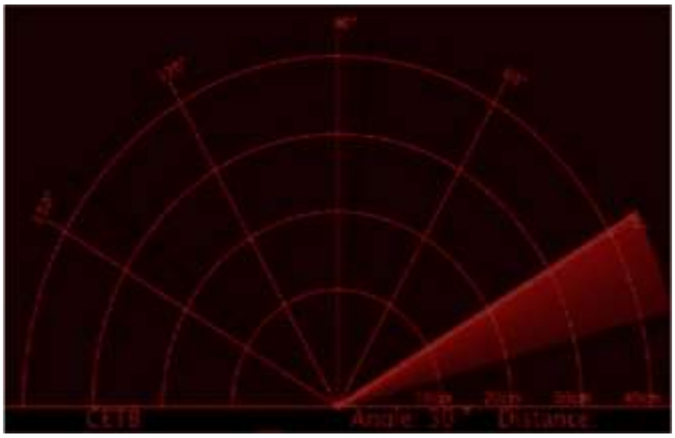


Fig. 8 Radar workspace

Figure 9 shows object radar information on radar workspace where the distance between object and radar is 11cm, and angle is 160.

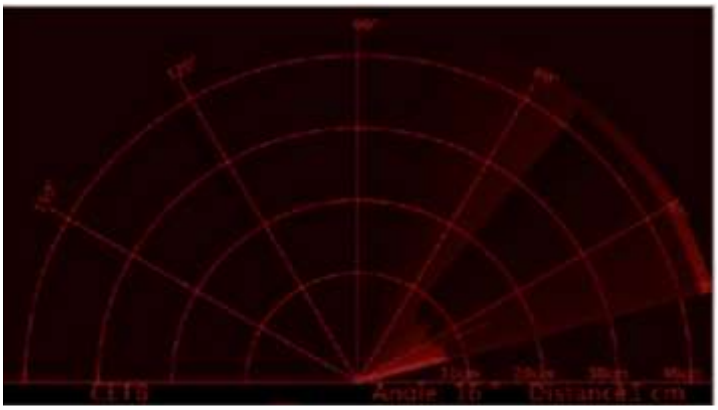


Fig. 9 Radar information

VI. Applications

The Arduino-powered short-range radar system has several practical applications across various fields, particularly in security and mapping. Some notable applications include:

- **Air Force**

Object Identification

Radar systems are crucial for identifying incoming aircraft and objects within planes equipped with radar technology. They play a vital role in monitoring airspace and ensuring the security of airborne assets.

Height Measurement

Radar technology is often employed to measure the altitude of objects, providing essential data for flight operations and air traffic control.

- **Marine**

Collision Avoidance

Maritime radar systems are used to calculate the distance to other vessels, helping to prevent collisions at sea. This application is critical for the safety of large ships navigating busy waters.

Vessel Monitoring

In ports and harbors, radar systems monitor the movements of vessels, tracking their positions and ensuring safe docking and maneuvering. This helps in maintaining organized and efficient port operations.

- **Meteorology**

Wind Tracking

Radar systems are used to monitor and track wind patterns, providing valuable data for weather forecasting and climate studies. This application is essential for predicting and understanding weather phenomena.

Tornado Detection

Meteorological radar systems play a significant role in detecting tornadoes and severe storms, offering early warnings that can save lives and minimize property damage. The ability to track and analyze storm movements is a critical aspect of modern weather monitoring.

These applications highlight the radar system's versatility and importance in various domains. By integrating radar technology into air force operations, maritime navigation, and meteorological monitoring, the system enhances safety, security, and efficiency in these fields.

VII. Conclusion

The short-range radar system driven by Arduino provides an example of how to effectively integrate different technologies for object recognition and distance measuring in real-world applications. This project demonstrates a small and effective solution for radar-based applications by using an Arduino microcontroller for data processing and control, a servo motor for sensor rotation, and an ultrasonic sensor for distance measurement.

The system's versatility is shown by its capacity to measure distances precisely and provide real-time data on a personal computer. Radar technology is very versatile; its uses range from improving security and navigation in the maritime and aviation industries to supplying vital information for meteorological observations.

Moreover, the system's versatility and accessibility for educational and experimental objectives are emphasized by the use of open-source hardware and software platforms like Processing and Arduino. The project is a useful tool for learning and creativity because of its full functionality and simple design.

To sum up, the radar system driven by Arduino provides a fundamental framework for more research and advancements in the field of radar technology. Its use in a variety of fields highlights how crucial it is to keep up research and development in order to improve the performance and capabilities of radar systems.

References

[1] Anuj Dutt, Arduino Based RADAR System. United States: GRIN Verlag, Jun 25, 2014.

[2] Ultrasonic RADAR/Electronic Design Lab (EE-318) Submitted by: Praveen Tamhankar (06d07007), Piyush Mittal (06d07035), Ashutosh Singh (06d07034) Guide: Prof. Jayanta Mukhergee.

[3] *Arduino - home*. (n.d.). https://www.arduino.cc

[4] Servo motor datasheet.

[5] Dejan. (2022, February 17). *Arduino Radar Project*. How to Mechatronics. http://howtomechatronics.com/projects/arduino-radar-project

[6] M. Ishihara, M. Shiina, S. Suzuki, "Evaluation of Method of Measuring Distance Between Object and Walls Using Ultrasonic Sensors", Journal of Asian Electric Vehicles, Volume 7, Number 1, June 2009.

[7] Y. B. Gandole, "Simulation and data processing in ultrasonic measurements", Anadolu University Journal of Science and Technology, Vol.:12, No: 2, pp. 119-127, 2011

[8] G. Benet, J. Albaladejo, A. Rodas, P.J. Gil, An intelligent ultrasonic sensor for ranging in an industrial distributed control system, in: Proceedings of the IFAC Symposium on Intelligent Components and Instruments for Control Applications, Malaga, Spain, May 1992, pp. 299-303.

[9] G. Benet, F. Blanes, J.E. Simó, P. Pérez, Using infrared sensors for distance measurement in mobile robots, Else viewer, Robotics and Autonomous Systems 1006 (2002) 1-12.