IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, March 2026
Impact Factor: 8.2

Arduino Based Radar System

Prof. Osmani. F. W [1], Matole Neha Uttam[2], Patil Vaibhavi Someshwar[3], Garad Tanuja Annasaheb[4]
[1,2,3,4]Students, Diploma in Information Technology Engineering
Vishweshwarayya Institute of Engineering and Technology, Almala, Maharashtra, India

Abstract: *An Arduino-based radar system is a cost- effective and efficient solution for object detection and distance measurement using ultrasonic sensing technology. This project utilizes an Arduino microcontroller, an ultrasonic sensor (HC- SR04), and a servo motor to simulate the working principle of a conventional radar system. The ultrasonic sensor emits high- frequency sound waves, which reflect off objects and return to the sensor, enabling distance calculation based on time delay. The servo motor rotates the sensor over a specified angular range, allowing detection across a wider field of view.*
The collected data is processed by the Arduino and visualized on a computer interface using serial communication and graphical software. This system is widely applicable in obstacle detection, surveillance, and automation systems due to its simplicity, low cost, and adaptability. The project demonstrates how embedded systems can replicate real-world radar functionality for educational and practical applications.

Keywords: *Arduino-based radar system*

I. INTRODUCTION

Radar systems are widely used in defense, aviation, navigation, and weather monitoring to detect the presence, distance, and speed of objects. Traditional radar systems use electromagnetic waves, which can be expensive and complex to implement. In contrast, this project presents a simplified radar system using
ultrasonic waves, making it more suitable for academic and low- cost applications.
The Arduino-based radar system mimics the basic functionality of conventional radar by detecting objects within a specific range and displaying their position. The system consists of an ultrasonic sensor mounted on a servo motor, which sweeps
across a predefined angle to scan the surroundings. The Arduino microcontroller processes the sensor data and sends it to a computer for visualization.
This project helps in understanding embedded systems, sensor integration, and real-time data processing. It also introduces students to practical applications of microcontrollers in automation and detection systems.

II. LITERATURE SURVEY

Several researchers and engineers have explored low-cost radar systems using microcontrollers and sensors. Previous studies highlight the importance of using ultrasonic sensors for short-range detection due to their affordability and ease of implementation.
Early works focused on basic distance measurement using ultrasonic sensors without angular scanning capabilities.
Later developments introduced servo motor integration, enabling 2D scanning similar to radar systems.
Some research incorporated graphical interfaces using software such as Processing IDE to display real-time object positions.
Advanced implementations utilized wireless communication modules and IoT platforms for remote monitoring and data logging.
Recent studies have also explored replacing ultrasonic sensors with LiDAR or infrared sensors to improve accuracy and range.

DOI: 10.48175/IJARSCT-31911

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 5, March 2026 Impact Factor: 8.2

These contributions demonstrate the evolution from simple detection systems to more advanced, real-time visualization-based radar prototypes. However, many systems still face
limitations in range, accuracy, and environmental interference.

III. SCOPE OF THE PROJECT

Functional Scope

Functional requirements describe the core operations and features of the Arduino-based radar system

1. Object Detection:

The system must detect the presence of objects within the sensing range using the HC-SR04 ultrasonic sensor by transmitting and receiving ultrasonic waves.

2. Distance Measurement:

The system should accurately calculate the distance of detected objects based on the time interval between transmitted and received signals using the speed of sound principle.

3. Angular Scanning:

The servo motor must rotate the ultrasonic sensor across a predefined angular range (typically 0° to 180°), enabling wide- area scanning similar to radar.

4. Continuous Monitoring:

The system should continuously scan the environment in a loop to provide real-time updates of object position and movement.

5. Data Processing:

The Arduino microcontroller must process raw sensor data and convert it into meaningful distance and angle information.

6. Data Transmission:

The processed data should be transmitted to a computer system via serial communication (USB interface).

Non-Functional Scope

Non-functional requirements define the quality attributes and constraints of the system.

1. Accuracy:

The system should provide reliable distance measurements within the operating range of the ultrasonic sensor (typically 2 cm to 400 cm), with minimal error under normal conditions.

2. Performance (Real-Time Operation):

The system must process and display data with minimal latency to ensure smooth and continuous radar scanning.
Reliability:

The system should function consistently over extended periods without failure, ensuring stable sensor readings and servo operation.

3. Scalability:

The design should allow future enhancements such as adding advanced sensors (LiDAR, IR), wireless modules, or extended scanning capabilities.

4. Cost Efficiency:

The overall system should remain affordable by using low- cost, widely available components.

5. Power Efficiency:

The system should consume minimal power, making it suitable for portable or battery-operated applications.

6. Usability:

The system should be simple to install, operate, and understand, making it accessible for students and beginners.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 5, March 2026 Impact Factor: 8.2

IV. METHODOLOGY / APPROACH METHODOLOGY / APPROACH

The proposed system is designed using a combination of hardware and software components that work together to simulate radar functionality.

1. System Components Arduino

Uno microcontroller Ultrasonic sensor (HC-SR04) Servo motor (SG90 or similar) Jumper wires and breadboard Computer with Arduino IDE and Processing software

2. Working Principle

The ultrasonic sensor emits sound waves at a frequency of approximately 40 kHz. When these waves encounter an object, they are reflected back to the sensor. The time taken for the echo to return is measured and used to calculate the distance using the formula:

The servo motor rotates the ultrasonic sensor from 0° to 180°, scanning the surrounding area.

3. Data Acquisition

The Arduino triggers the ultrasonic sensor to send pulses. The echo signal is received and timing is measured.

Distance is calculated and associated with the servo angle.

4. Data Processing and Visualization

The Arduino sends angle and distance data via serial communication.

A computer application (e.g., Processing IDE) receives the data.

A radar-like graphical interface is generated, showing detected objects in real time.

5. Flow of Operation

Initialize system components

Rotate servo motor incrementally Trigger ultrasonic sensor

Measure echo time Calculate distance Send data to computer

Display results on radar interface Repeat scanning process

6. Limitations

Limited detection range (typically up to 400 cm) Sensitivity to environmental noise and obstacles Lower accuracy compared to real radar systems ADVANTAGES

Low-cost and affordable system Simple design and easy to build Provides real-time object detection Low power consumption

Easy to modify and upgrade

Useful for multiple applications (security, automation, etc.)

V. APPLICATIONS

Obstacle detection in robots Security and surveillance systems Parking assistance in vehicles Military and defense applications Weather monitoring systems

Smart home automation systems

VI. CONCLUSION

The Arduino-based radar system is an innovative and practical project that demonstrates the fundamental concept of radar technology using simple and cost-effective components. It mainly consists of an Arduino microcontroller, an ultrasonic sensor, a servo motor, and a buzzer or display system. The ultrasonic sensor continuously emits sound waves and receives the reflected signals from nearby objects. Based on this, the system calculates the distance and detects the presence of objects. The servo motor rotates the sensor over a range of angles, allowing the system to scan a wide area, similar to a real radar system.

This project is highly beneficial for students as it provides hands-on experience in embedded systems, programming, and sensor integration. It helps in understanding how real-time object detection and distance measurement systems

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 5, March 2026 Impact Factor: 8.2

work. The system is widely applicable in various fields such as robotics for obstacle detection, security systems for intrusion detection, and automation systems for smart control.

However, the system also has some limitations. The detection range is limited compared to real radar systems, and the accuracy may be affected by environmental conditions such as temperature, humidity, and object surface. Despite these limitations, the project serves as a strong foundation for further development.

In the future, this system can be enhanced by integrating advanced technologies such as Internet of Things (IoT) for remote monitoring, wireless communication modules for data transmission, and artificial intelligence for smart object recognition. More advanced sensors like LiDAR or infrared sensors can also be used to improve accuracy and range. Therefore, the Arduino-based radar system is not only an educational project but also a stepping stone toward developing more advanced and intelligent detection systems used in real-world applications like smart vehicles, defense systems, and surveillance.

VII. ACKNOWLEDGEMENT

We express our sincere gratitude to the Vishweshwarayya Institute of Engineering and Technology, Almala for giving us the opportunity to work on the Major Project during my final year of Diploma in Information Technology Engineering is an important aspect in the field of engineering. We would like to thank Prof. Lokare. A.P., Head of the Department of Information Technology Engineering at Vishweshwarayya Institute of Engineering and Technology, Almala for their kind support. We also owe our sincerest gratitude towards Mr.Osmani F.W for her valuable advice and healthy criticism throughout my project which helped me immensely to complete my work successfully. I would also like to thank everyone who has knowingly and unknowingly helped me throughout my work. Last but not least, a word of thanks for the authors of all those books and papers which I have consulted during my project work as well as for preparing the report.

1. Core Arduino Books (Highly Recommended)

o 1. Programming Arduino: Getting Started with Sketches
— Simon Monk
• Covers Arduino basics, coding (C/C++), sensors, and interfacing
• Very useful for beginners building radar projects
• Frequently cited in Arduino radar research papers

o 2. Arduino Cookbook — Michael Margolis
• Advanced reference with ready-made code examples
• Helps in working with ultrasonic sensors, servos, and serial communication
• Widely referenced in Arduino-based system designs

o 3. Arduino Workshop — John Boxall
• Hands-on project book (great for mini-projects like radar)
• Covers practical interfacing of sensors and displays

o 4. Arduino: Tools and Techniques for Engineering Wizardry — Jeremy Blum
• Good for understanding electronics + Arduino integration
• Often referenced in engineering-level Arduino projects

2. Radar & Sensing Theory Books

These help you write the theory section of your project report:

o 5. Introduction to Radar Systems — Merrill Skolnik
• Standard textbook for radar fundamentals

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 5, March 2026 Impact Factor: 8.2

• Covers:
o Radar principles
o Signal propagation
o Detection techniques
• Commonly cited in radar-related Arduino research

o 6. Radar and Non-Contact Sensing (Elsevier – Encyclopedia chapter)
• Explains sensing methods including radar & proximity detection
• Useful for comparing ultrasonic vs real radar systems

1. Additional Arduino & Embedded Systems Books
o Getting Started with Arduino — Massimo Banzi
• Written by the co-founder of Arduino
• Great for explaining:

o Microcontroller basics
o Digital/analog I/O
• Good for introduction section

o Exploring Arduino — Jeremy Blum
• Covers:
o Sensors, actuators, serial communication
o Real-world interfacing projects
• Useful for hardware + software integration explanation

o Beginning Arduino — Michael McRoberts
• Step-by-step beginner guide
• Helps explain:
o Servo motor control
o Ultrasonic sensor working

o Make: Electronics — Charles Platt
• Not Arduino-specific, but excellent for:
o Understanding circuits
o Breadboard design
• Useful for circuit diagram explanation

2. Sensors & Measurement Books (Very Useful)
o Measurement Systems: Application and Design — Ernest O. Doebelin
• Explains:
o Measurement principles
o Sensor accuracy and errors
• Helps justify ultrasonic sensing methodology
o Sensors and Actuators: Engineering System Instrumentation — Clarence W. de Silva
• Covers:

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 6, Issue 5, March 2026 Impact Factor: 8.2

o Sensor classifications
o Real-world applications
• Strong theoretical backing for your project

o Handbook of Modern Sensors — Jacob Fraden
• Industry-level reference
• Includes:
o Ultrasonic sensing principles
o Signal processing basics

D 3. Signal Processing & Communication (Advanced Section)
These are useful if your teacher expects deep technical explanation:
o Signals and Systems — Alan V. Oppenheim & Alan S. Willsky
• Helps explain:
o Signal behavior
o Echo and time delay concepts

o Digital Signal Processing — John G. Proakis
• Advanced reference for:
o Filtering
o Noise reduction

4. Robotics & Automation (Optional but Impressive)
o Robotics, Vision and Control — Peter Corke
• Helps relate radar system to:
o Obstacle detection
o Autonomous systems

o Introduction to Autonomous Mobile Robots — Roland Siegwart
• Explains:
o Mapping
o Environment sensing

5. Communication & Electronics Basics
o Electronic Devices and Circuit Theory — Robert Boylestad
• Useful for:
o Circuit explanation
o Component behavior

o The Art of Electronics — Paul Horowitz & Winfield Hill
• Highly respected reference
• Adds strong credibility to your report

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 5, March 2026
Impact Factor: 8.2

REFERENCES

Websites & Technical Documentation:
Arduino Official Documentation
://www.arduino.cc
Provides https complete information about Arduino boards, programming, libraries, and hardware interfacing.
Arduino Reference Guide https://www.arduino.cc/reference/en/
Contains detailed explanations of functions, syntax, and built-in libraries used in Arduino programming.
HC-SR04 Ultrasonic Sensor Datasheet https://components101.com/sensors/ultrasonic-sensor-working- pinout-datasheet
Includes technical specifications, working principle, and pin configuration of the ultrasonic sensor.
SG90 Servo Motor Datasheet
https://components101.com/motors/servo-motor-basics-pinout- datasheet
Provides details about servo motor operation, PWM control, and specifications.
Processing IDE Official Website https://processing.org
Used for creating the radar visualization interface and handling serial communication.
Electronics Tutorials – Ultrasonic Sensor Working https://www.electronics-tutorials.ws/io/io_7.html
Explains the working principle of ultrasonic sensors and distance measurement.
Circuit Digest – Arduino Radar Project
https://circuitdigest.com/microcontroller-projects/arduino-radar- system
Step-by-step implementation of a radar system using Arduino and ultrasonic sensor.
Instructables – Arduino Radar System https://www.instructables.com/Arduino-Radar-System/
Practical guide with circuit diagrams and code examples.
IEEE Xplore Digital Library https://ieeexplore.ieee.org
Source for research papers related to radar systems and embedded applications.