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A Short-Range Radar System using Arduino

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Abstract: This research paper presents the design and development of a short-range radar system using Arduino UNO and an ultrasonic sensor. The system detects obstacles, measures their distance and angular position, and displays the information visually using the Processing IDE. The radar setup combines mechanical movement using a servo motor with digital control through Arduino, making it an affordable and educational prototype for object detection and mapping applications.

I. INTRODUCTION

Radio Detection **and** Ranging (RADAR) systems are essential in various domains for object detection and monitoring. The aim of this project is to design a compact radar system using an ultrasonic sensor to measure distances without physical contact. The radar system consists of a transceiver that sends and receives ultrasonic waves and uses Arduino as a controller. It operates efficiently for security surveillance, vehicle detection, and robotics applications.

II. BASIC CONCEPTS OF RADAR

A radar system operates by transmitting an electromagnetic or acoustic wave toward a target and analyzing the reflected signal. The time delay between transmission and reception helps determine the distance. The ultrasonic radar system replicates this behavior using sound waves at 40 kHz frequency. The reflected echo is captured by the sensor, processed by Arduino, and displayed graphically on a computer screen.

Block Diagram of Simplified Radar System:
Transmitter □ Propagation Medium □ Target □ Receiver □ Signal Processor □ Display

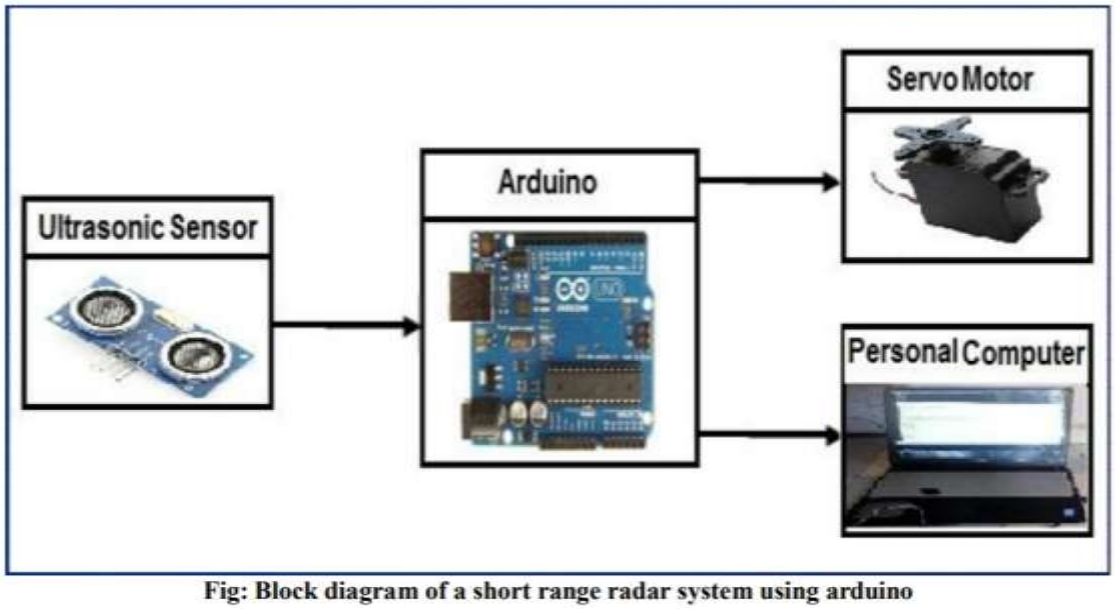
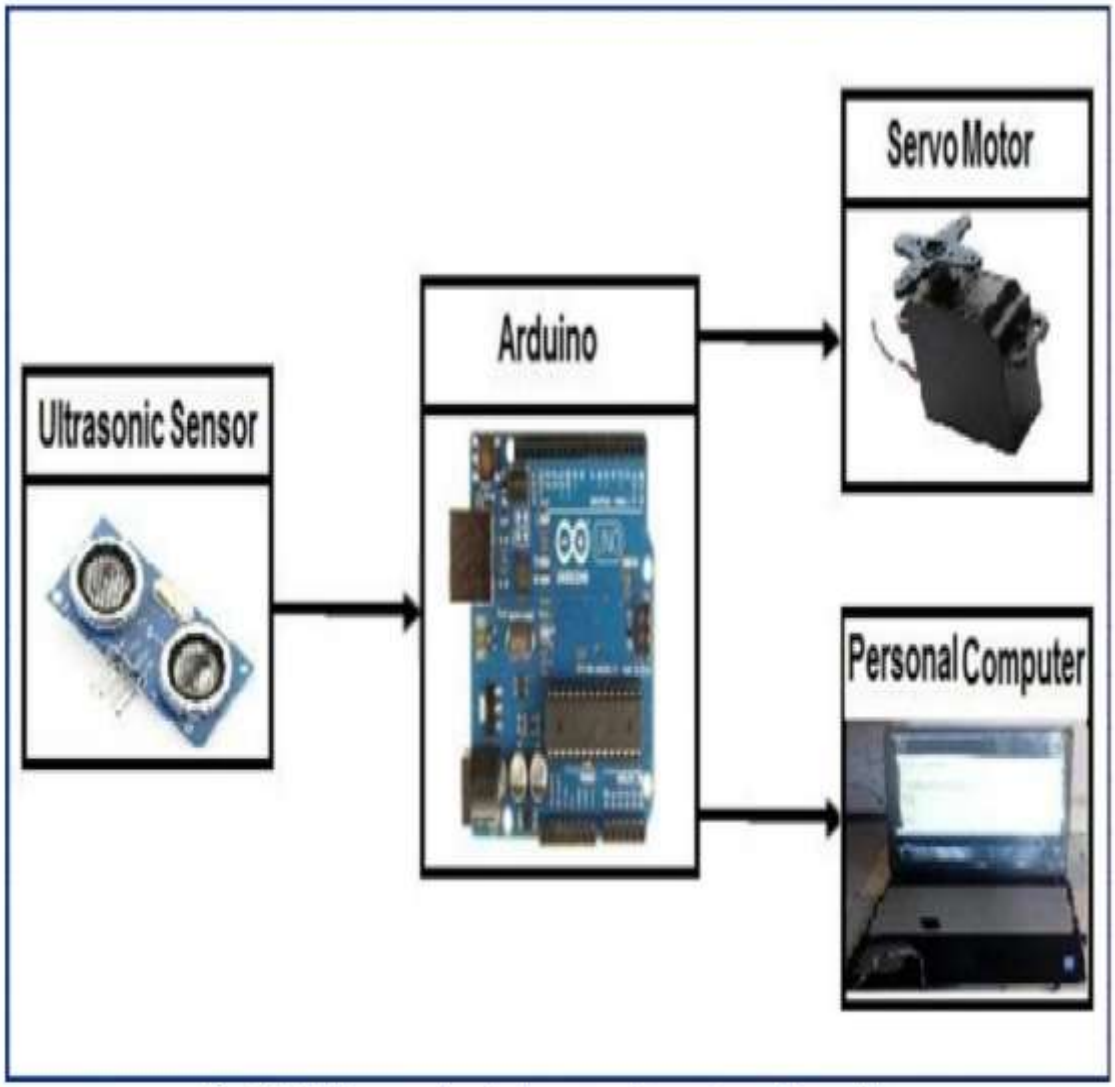


Fig: Block diagram of a short range radar system using arduino



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III. LITERATURE SURVEY

Previous research demonstrates the effectiveness of ultrasonic sensors in flood monitoring, driver safety systems, and automated navigation. Systems controlled via Arduino show high accuracy and reliability. The literature highlights that ultrasonic-based detection provides 95–96% accuracy under ideal conditions, making it suitable for low-cost radar systems.

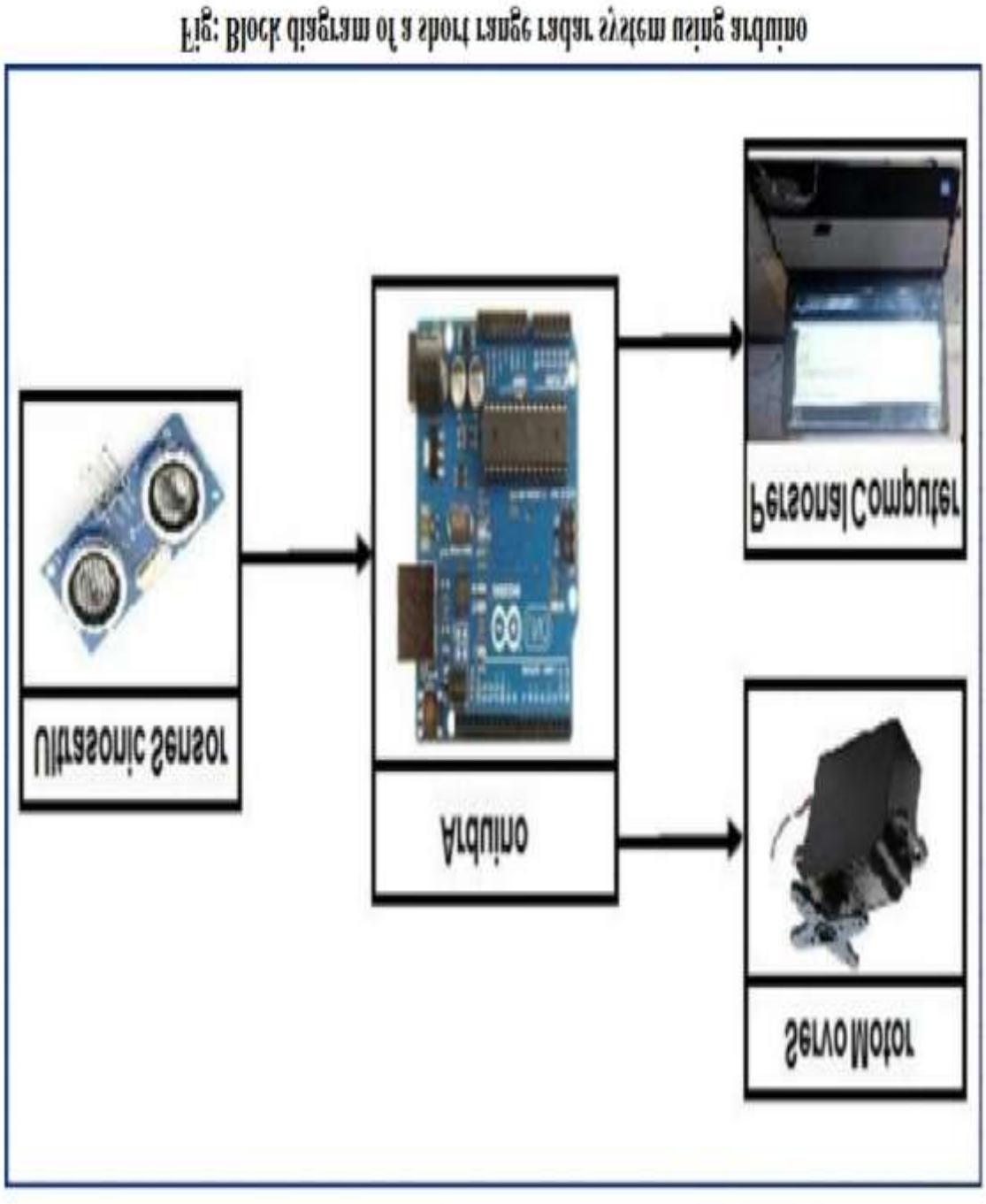
IV. AIM, OBJECTIVES AND SCOPE

The primary aim is to design a short-range radar using Arduino UNO and HC-SR04 ultrasonic sensor to detect obstacles and calculate their distance and angle. Objectives include achieving graphical output representation, improving detection accuracy, and ensuring cost efficiency. The scope includes applications in robotics, autonomous systems, and object tracking modules.

V. SYSTEM OVERVIEW

The radar system consists of Arduino UNO, ultrasonic sensor, servo motor, and Processing IDE. The sensor emits sound pulses that reflect from obstacles, while the servo rotates the sensor to cover 180°. Data is sent to Processing software that visualizes objects as arcs on a radar screen.

Block Diagram:
Ultrasonic Sensor □ Arduino UNO □ Servo Motor □ Buzzer □ LCD Display □ PC Interface



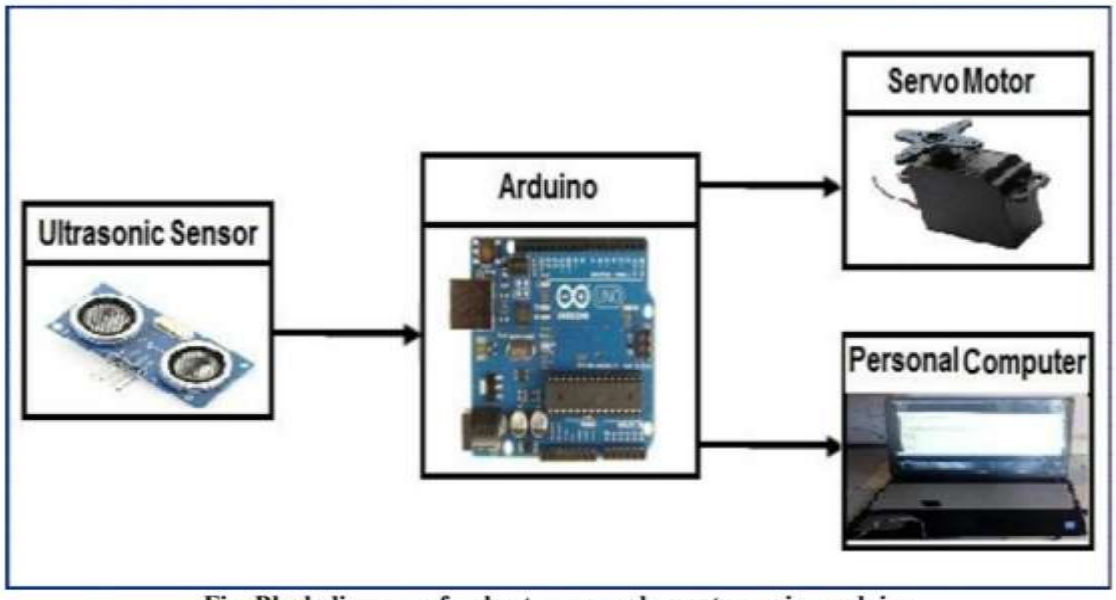


Fig: Block diagram of a short range radar system using arduino

VI. COMPONENT DETAILS

Arduino UNO: A microcontroller board based on ATmega328P with digital I/O pins and PWM capability. It controls sensors and motors, and processes signals.
Ultrasonic Sensor (HC-SR04): Uses ultrasonic waves to measure distances between 2 cm and 400 cm. It operates using trigger and echo pins and provides non-contact distance measurement. **Servo Motor:** Provides angular motion (0°–180°) for the sensor sweep. Controlled via PWM from Arduino.
16x2 LCD Display: Displays distance and angle of detected objects in real-time.
Buzzer: Acts as an alert system when an object is within a predefined range.
Power Supply (12V 1A SMPS): Converts AC to regulated DC for powering Arduino and peripherals.

VII. HARDWARE DESIGN AND PCB FABRICATION

The hardware circuit was designed in PROTEL99SE software. The PCB fabrication includes schematic design, layout preparation, photoresist coating, UV exposure, etching, drilling, and soldering. Proper component placement and minimal path routing ensure compact design and noise reduction.

PCB Design Steps:

1. Schematic Creation
2. Layout Design
3. Printing and Etching
4. Drilling
5. Mounting Components
6. Soldering and Testing

VIII. SOFTWARE DESIGN

The software part includes Arduino IDE for coding and Processing 4 for radar visualization. Arduino code controls sensor triggering, servo rotation, and serial data transmission. The Processing script receives this data and draws real-time radar arcs.

Arduino IDE Code Overview:

1. Initialize pins for trigger, echo, and servo.
2. Send pulse, measure echo time.
3. Calculate distance using sound velocity.
4. Rotate servo from 15° to 165°.
5. Transmit data to PC for visualization.

IX. WORKING PRINCIPLE

The ultrasonic sensor emits sound waves which bounce back upon hitting an object. Arduino calculates the time delay to determine distance. The servo motor continuously rotates the sensor, covering 180°. The Processing IDE visualizes the detection area dynamically, showing obstacles within range as red arcs.

Equation: Distance = (Time × Speed of Sound) / 2

X. ADVANTAGES AND APPLICATIONS

Advantages:

- Simple and low-cost design
- Accurate short-range detection
- Portable and scalable
- Useful for learning embedded systems
- Weather-independent performance
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Applications:

- Airborne obstacle detection
- Marine navigation
- Robotics mapping
- Smart parking systems
- Autonomous vehicles and drones

XI. FUTURE SCOPE

Future improvements can include full 360° scanning using continuous rotation servos, integration of wireless modules for remote monitoring, and AI-based object classification. High-range sensors can extend detection up to several meters for industrial use.

XII. CONCLUSION

The radar system using Arduino and ultrasonic sensors successfully demonstrates object detection and visualization in real time. It provides an educational and practical approach to understanding radar principles at low cost. The project can be further developed for autonomous navigation and IoT-based applications.

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