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REAL-TIME ULTRASONIC RADAR WITH TARGET LAUNCH INTEGRATION

[1]Shaikh Muskan Firoj, [2]Tawte Shravani Nilkanth, [3]Shaikh Jasmin Javed, [4]Waghmode Bhivra Dhula, [5]Utpat Nandan R

[1]Student, [2]Student, [3]Student, [4]Student, [5]Professor

[1]Department of Electronics & Tele-Communication,

[1]Karmayogi Institute of Technology, Shelve, Pandharpur, India

Abstract: This Project describe the design and implementation of real-time ultrasonic radar with target launcher integration using Arduino technology. The system employs an ultrasonic sensor to detect objects by transmitting ultrasonic waves and receiving their echos to calculate the distance of the target. A servo motor is used to rotate the ultrasonic sensor enabling scanning of a wider area and simulating radar-like operation. The detected distance and angle information is processed using the Arduino platform and programmed through Arduino the IDE. The system output is displayed on LCD providing real-time visual feedback of object position and distance. When an object is detected within a predefined range, a target launcher mechanism is automatically activated, demonstrating an effective combination of sensing and action. This project offers a low-cost and practical approach to understanding embedded systems, sensor interfacing, automation and real-time monitoring with potential applications in security systems, robotics and obstacle detection.

Index Terms - Real Time Ultrasonic Radar with Target Launch Integration System: Ultrasonic sensor scans the object in 180 degree, LCD display shows target detected, the Arduino uno activates the missile launcher at same direction, the missile is launched automatically on detected object.

INTRODUCTION

In today's world, real-time detection and automated response systems play a vital role in areas such as security, robotics, industrial automation and smart monitoring systems. Radar technology is widely used for detecting, tracking and identifying objects however, traditional radar systems are complex, costly and require advanced signal processing. For short-range and low-cost applications, ultrasonic sensing offers a practical and efficient alternative to conventional radar systems.

The Real-Time Ultrasonic Radar with Target Launcher Integration project is developed to demonstrate the fundamental working principles of radar systems using simple and affordable electronic components. This system uses an ultrasonic sensor to transmit high-frequency sound waves and receive the reflected echoes from nearby objects. By measuring the time taken for the echo to return, the system accurately calculates the distance of the object. To simulate radar scanning, the ultrasonic sensor is mounted on a servo motor, which rotates through a defined angular range allowing the system to scan a wide area in real time.

An Arduino microcontroller serves as the core control unit of the system. The entire system logic, sensor interfacing, servo motor control, LCD display handling and target launcher operation are programmed using the Arduino IDE. The microcontroller continuously processes sensor data, determines the position of detected objects, and updates the system output accordingly. A Liquid Crystal Display (LCD) is used to show real-time information such as object distance, scanning status and system operation making the system user-friendly and easy to understand.

A key feature of this project is the integration of a target launcher mechanism. When an object is detected within a predefined distance range, the Arduino automatically activates the launcher, demonstrating a real-time decision-making and action process. This integration highlights how sensing, processing and actuation can be combined in embedded systems to perform automated tasks without human intervention.

This project not only provides practical exposure to ultrasonic sensors, servo motors, LCD interfacing and Arduino-based programming, but also helps in understanding concepts such as real-time systems, automation and control logic. Due to its low cost, simplicity and educational value, the system can be extended or modified for applications like obstacle detection in robots, perimeter security systems, automated defence training models and smart surveillance systems.

I. LITERATURE SURVEY

In recent years, researchers and engineers have explored various methods for object detection and tracking using low-cost sensors and embedded systems. The literature survey for this project focuses on studies and implementations involving ultrasonic sensors, radar systems, microcontroller-based control, servo motor scanning mechanisms and automated response systems.

Ultrasonic sensing has been widely used in robotics, automation and distance measurement due to its affordability, reliability and relative immunity to environmental light conditions. Ultrasonic sensors work by emitting high-frequency sound waves and measuring the time interval between transmission and reception of the echo. Studies by *Rashid et al.* demonstrated that ultrasonic sensors could achieve reliable distance measurement in indoor environments with acceptable precision for robotic navigation and obstacle avoidance. Researchers also noted that the accuracy of ultrasonic measurements depends on surface reflectivity and sensor alignment but proper calibration can mitigate errors.

Traditional radar systems use radio frequency waves for long-range object detection but these systems are often expensive and complex. Recent works have proposed the use of ultrasonic sensors mounted on rotational platforms to simulate short-range radar behavior. For example, *S. D. Lokhande et al.* developed an ultrasonic radar system using a microcontroller and servo motors to scan a predefined angular field. The research highlighted that the integration of servo mechanisms with ultrasonic sensors allows effective area scanning enabling real-time mapping of object positions relative to the sensor.

The Arduino family of microcontrollers has become popular for prototyping and implementing embedded systems due to its open architecture, ease of programming and extensive community support. *Mohan et al.* explored the use of Arduino boards for sensor interfacing and control applications concluding that Arduino IDE simplifies complex programming tasks and the platform supports multiple real-world interfaces including LCD displays, motor drivers and communication modules. Similar research has shown that integrating Arduino boards with ultrasonic sensors and display modules leads to user-friendly systems capable of real-time feedback.

Servo motors are commonly used in embedded projects where angular positioning is required. Their precise control via Pulse Width Modulation (PWM) makes them ideal for applications involving scanning and rotation. In the system developed by *Patil and Kulkarni*, servo motors were used to sweep sensors in a controlled motion enabling a scanning view of the surrounding environment. Results indicated that servo-based scanning improves detection coverage compared to fixed directional sensors.

While ultrasonic detection systems are well documented, fewer studies have explored the integration of detection with automated response mechanisms like firing or launching devices. Some research in automation and mechatronics discusses automated actuators triggered by sensor input. For instance, *Jain et al.* designed an automated object interaction system where specific sensor thresholds triggered a mechanical actuator. These works provide insight into how sensors and actuators can be combined to form responsive systems.

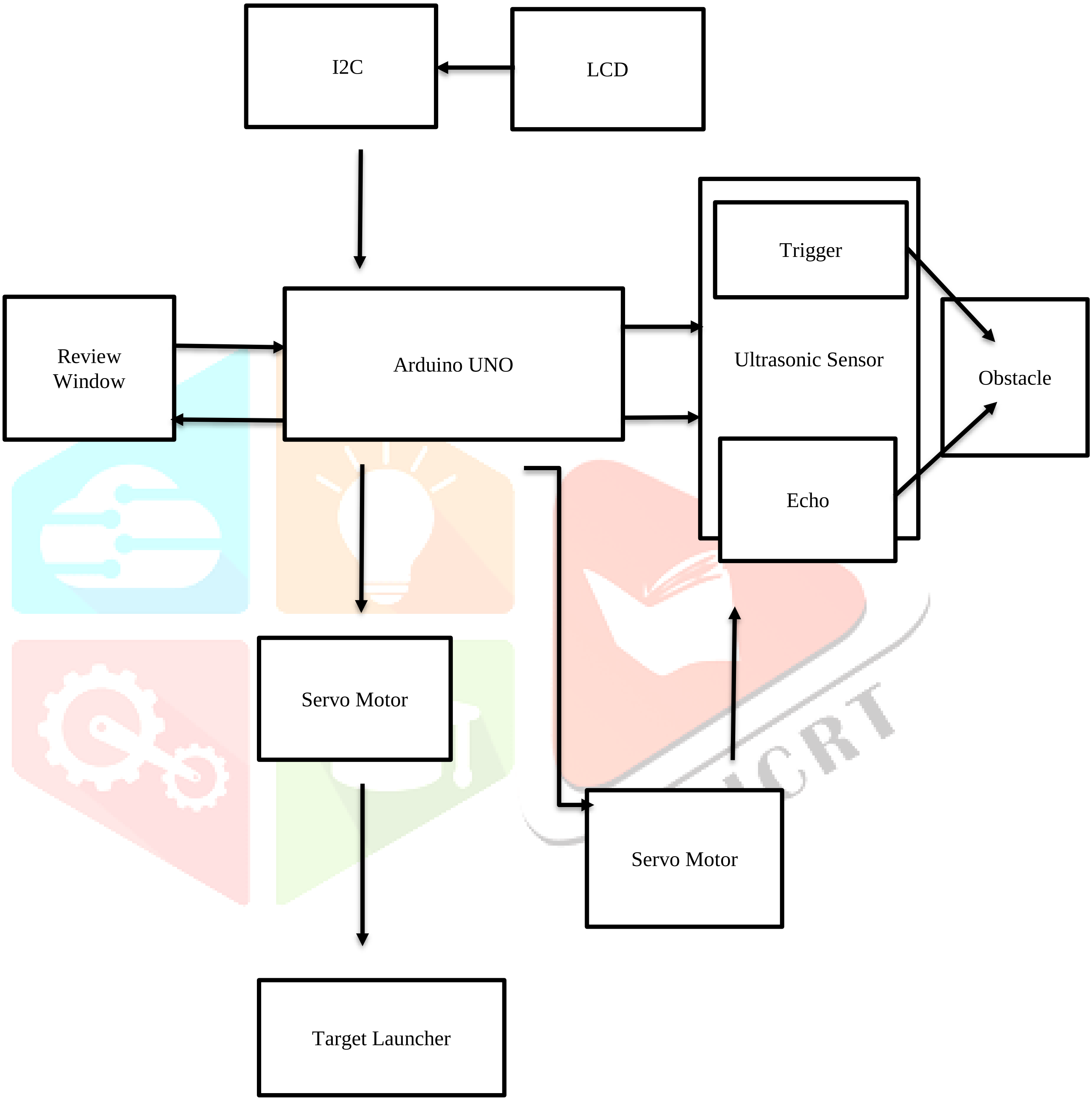
Based on the reviewed literature, many projects focus on ultrasonic detection or radar simulation independently and some explore servo scanning or Arduino control separately. However, the integration of real-time radar simulation using ultrasonic scanning with a target launcher mechanism is not extensively covered. Most literature emphasizes detection or automation individually but fewer works combine scanning, real-time display, distance measurement and an automatic launcher response in a single embedded system. This gap indicates the novelty of the current project in demonstrating how embedded sensing and actuation can be merged to perform coordinated tasks.

II. IMPORTANCE OF PROJECT

The real-time Ultrasonic Radar with Target Launcher Integration project is important because it demonstrates a low-cost and practical approach to real-time object detection and automated response using embedded systems. It helps in understanding the basic working principle of radar systems by using an ultrasonic sensor for short-range distance measurement and area scanning with servo motor.

The project provides hands-on experience with Arduino-based programming, sensor interfacing, motor control and LCD display, thereby strengthening knowledge of embedded system design. The integration of a target launcher highlights the concept of automation showing how sensor data can be used for decision-making and actuation. Overall, the project bridges the gap between theory and practice and is valuable for learning, demonstration and basic automation applications.

III. BLOCK DIAGRAM



IV. RESULT AND APPLICATIONS

Results:

The Real-Time Ultrasonic Radar with Target Launch Integration was designed, implemented and tested successfully meeting all the defined project objectives. The ultrasonic sensor accurately detected objects within the specified short-range distance and continuously provided real-time distance measurements. When mounted on a servo motor, the sensor performed smooth angular rotation allowing the system to scan the surrounding area and simulate the working of a radar. The Arduino Uno efficiently processed the echo signals, calculated object distance with good accuracy and coordinated the operation of all connected components.The LCD displayed real-time distance values and system status clearly making monitoring easy and user-friendly. The buzzer responded immediately when an object entered the predefined threshold range providing an audible alert. Based on the programmed decision logic, the Arduino automatically activated the target launcher through a servo motor whenever an object was detected within the set distance demonstrating reliable automation and actuation. The overall system showed stable performance, quick response time and effective coordination between sensing, processing, display and mechanical action, proving the practical feasibility of a low-cost real-time ultrasonic radar and automated response system.

Applications:

1. Security and Surveillance Models
2. Robotics Applications
3. Automation Demonstrations
4. Obstacle Detection Systems
5. Educational and Training Projects
6. Research and Prototyping

V. CONCLUSION AND FUTURE SCOPE

Conclusion:

The Real-Time Ultrasonic Radar with Target Launch Integration project was successfully designed, developed, and tested using an ultrasonic sensor, Arduino Uno, servo motors, LCD and buzzer. The system effectively detects nearby objects by continuously transmitting and receiving ultrasonic waves and calculating the distance in real time. By mounting the ultrasonic sensor on a servo motor, radar-like scanning of the surrounding area was achieved allowing detection of objects from different angles. The Arduino Uno acted as the central controller, efficiently processing sensor data, controlling servo movements, updating the LCD display, activating the buzzer for alerts and triggering the target launcher when an object entered the predefined distance range. The system demonstrated reliable performance with acceptable accuracy and response time for short-range applications. The integration of sensing, real-time monitoring, decision-making and mechanical actuation clearly illustrates the concept of automation in embedded systems. The project also provided hands-on experience in sensor interfacing, motor control using PWM, embedded programming and system integration. Overall, the project achieved all its objectives and proved to be a low-cost, effective and educational model for understanding radar principles and automated response systems.

Future Scope:

The Real-Time Ultrasonic Radar with Target Launch Integration project offers wide possibilities for future enhancement and real-world application. While the current system effectively demonstrates short-range object detection, radar-like scanning and automated actuation, several improvements can be implemented to increase its performance, intelligence and usability.

One major future enhancement is the integration of wireless and IoT technologies. By adding Bluetooth, Wi-Fi, or IoT modules, the system can transmit real-time data to mobile devices, computers, or cloud platforms. This will allow remote monitoring, control and data logging, making the system suitable for smart surveillance and industrial automation applications.

The project can be further improved by implementing a graphical radar visualization system. Instead of displaying only numerical values on an LCD, a PC or mobile-based graphical interface can be developed to show real-time radar scanning with object position, distance and angle. This enhancement would improve data interpretation and provide a more realistic radar experience.

Another important scope for development is the use of advanced sensing technologies. Ultrasonic sensors can be combined with or replaced by infrared sensors, LiDAR or radar modules to increase detection range and accuracy. Sensor fusion techniques can be used to overcome the limitations of individual sensors and improve reliability under different environmental conditions.

The system can also be enhanced by incorporating artificial intelligence and machine learning algorithms. These techniques can enable object classification, motion prediction, and intelligent decision-making. Instead of simple distance-based triggering, the system could respond differently based on object type, speed or movement pattern.

Mechanical and hardware improvements can be made to enhance the target launcher mechanism. More precise actuators such as stepper motors, better motor drivers, and improved mechanical design can increase accuracy, durability and safety. Additional safety features and controlled actuation mechanisms can also be implemented.

Finally, the project can be adapted for real-world applications such as robotic navigation, autonomous vehicle obstacle detection, industrial safety systems, border security models and smart monitoring systems. With further development, testing and refinement, this project has the potential to evolve from an educational model into a practical intelligent sensing and automation system.

Another possible future improvement is the integration of a camera or vision-based system along with the ultrasonic radar. By combining visual data with ultrasonic sensing, the system can achieve better object identification and situational awareness. This hybrid approach would improve detection accuracy, reduce false triggering, and allow the system to distinguish between different types of objects making it more intelligent and suitable for advanced automation and security applications.

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VIII. AUTHOR DETAILS

Ms. Shaikh Muskan Firoj is currently studying in Final Year Diploma of Electronics & Tele-Communication Engineering at Karmayogi Institute of Technology, Shelve-Pandharpur. Her area of interest is Embedded Systems an Python Full Stack Development.

Ms. Tawate Shravani Nilkanth is currently studying in Final Year Diploma of Electronics & Tele-Communication Engineering at Karmayogi Institute of Technology, Shelve-Pandharpur. Her area of interest is Embedded Systems and Circuit Testing.

Ms. Shaikh Jasmin Javed is currently studying in Final Year Diploma of Electronics & Tele-Communication Engineering at Karmayogi Institute of Technology, Shelve-Pandharpur. Her area of interest is Embedded Systems and Circuit Testing.

Ms. Waghmode Bhivra Dhula is currently studying in Final Year Diploma of Electronics & Tele-Communication Engineering at Karmayogi Institute of Technology, Shelve-Pandharpur. Her area of interest is Embedded Systems and Circuit Testing.

Mr. Nandan Ragnath Utpat is currently working as Lecturer in Karmayogi Institute of Technology Shelve-Pandharpur. He purchased his Post Graduate Degree MBA (Marketing) Savitribai Phule Pune University, Pune, Maharashtra, India-411028. His area of interest is Marketing Management.