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Automated Radar-based Defence Prototype

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ABSTRACT

This paper presents the design and implementation of a smart missile guidance and tracking system using Arduino technology. The proposed system demonstrates the fundamental principles of missile navigation and target tracking in a controlled and safe environment using low-cost and easily available hardware components. The system utilizes ultrasonic sensors to detect obstacles and targets within a predefined range, while servo motors are employed to adjust the directional movement of the missile prototype. An Arduino microcontroller serves as the core processing unit, collecting sensor data and executing control algorithms to guide the missile toward the detected target. The project aims to provide an educational platform for students to understand the working of embedded systems and real-time guidance mechanisms. A radar-like scanning mechanism is implemented to simulate target detection and tracking similar to real missile systems. The system architecture consists of sensing modules, control circuitry, and embedded software logic that enables dynamic path correction. Experimental results indicate that the prototype can effectively detect targets and respond with appropriate directional adjustments. The simplicity, modularity, and affordability of the proposed system make it suitable for academic demonstrations and further research. Future enhancements may include the integration of GPS modules, wireless communication, and image processing techniques to improve accuracy and functionality.

Keywords: - Missile Guidance, Arduino, Radar System, Target Tracking, Embedded Systems.

1. INTRODUCTION

Missile guidance and tracking systems are used to control the movement and direction of a missile so that it can reach a target accurately. These systems work by continuously monitoring the position of the missile and adjusting its path during motion. In real-world applications, missile guidance systems are highly complex and involve advanced technologies. However, for educational and experimental purposes, simplified models are developed to help understand the basic working principles of guidance and tracking mechanisms.

With the advancement of embedded systems, microcontroller-based platforms have become widely used in automation and control applications. Arduino is one such platform that is commonly used in academic projects because of its simple hardware design, low cost, and ease of programming. It allows efficient interfacing of sensors and actuators, making it suitable for real-time control systems. Sensors play a crucial role in guidance systems, as they provide necessary feedback about the surrounding environment or target position.

In this project, a smart missile guidance and tracking system is designed using Arduino to demonstrate the fundamental concept of target detection and directional control. An ultrasonic sensor is used to detect the distance of a target, and a servo motor is used to change the direction of the missile prototype based on sensor data. The proposed system provides a safe and practical approach to understanding missile guidance concepts and embedded system control logic through hands-on implementation.

2. SYSTEM ARCHITECTURE

The system architecture describes the overall structure of the smart missile guidance and tracking system. The proposed system is developed using simple hardware components to demonstrate basic guidance concepts. The main components include an Arduino microcontroller, an ultrasonic sensor, a servo motor, and a power supply.

The Arduino microcontroller acts as the central control unit of the system. It receives distance data from the ultrasonic sensor and processes this information to generate control signals. The ultrasonic sensor detects the presence of a target by measuring the distance between the sensor and the object.

Based on the sensor input, the Arduino controls the servo motor to adjust the direction of the missile prototype. This allows the system to continuously track the target. The block diagram shown fig.1 represents the interaction between all components used in the system.

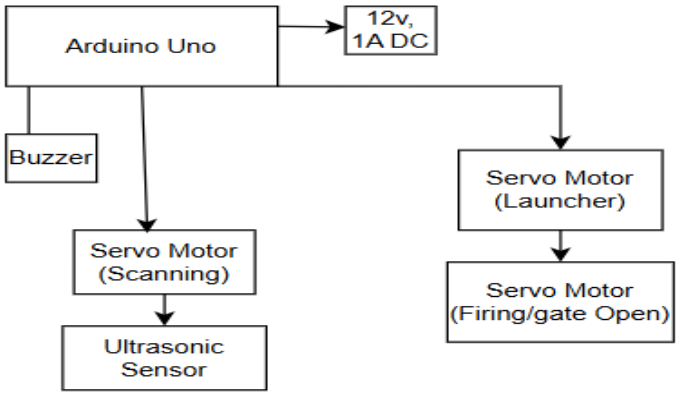

Fig. 1: Block Diagram

3. WORKING PRINCIPLE

The operation of the smart missile guidance and tracking system relies on real-time distance sensing and directional adjustment. An ultrasonic sensor Transmits sound pulse towards the target and analyse the reflected Echo to return to determine its Position. The obtained data is process By the Arduino the brain or microcontroller, which generates appropriate control signals.

Based on the signals the servo motor rotates the missile prototype in the required direction. The sequence of Sensing, processing and automation is repeated continuously Enabling the system to track the object and adjust its movement accordingly. The flowchart shown in fig. 2 explains the step-by-step working of the proposed system.

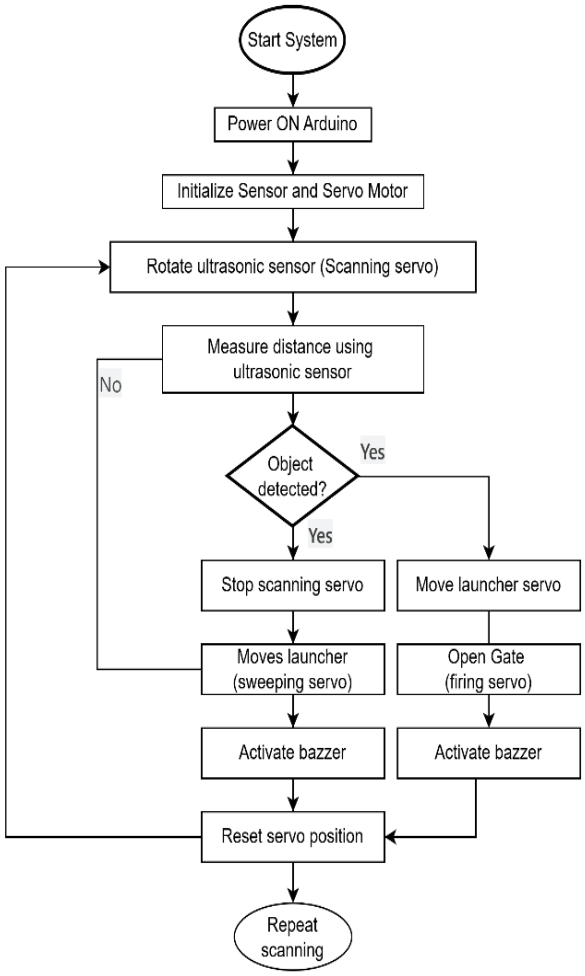

Fig. 2: Flow Chart

4. RESULT AND DISCUSSION

The developed prototype was tested to verify the working of the automated radar-based system. The system is able to detect the objects within the fixed range and respond automatically as expected from it. The ultrasonic sensor successfully measured the distance of the object during the process of scanning, and the servo motors performed the required movement correctly.

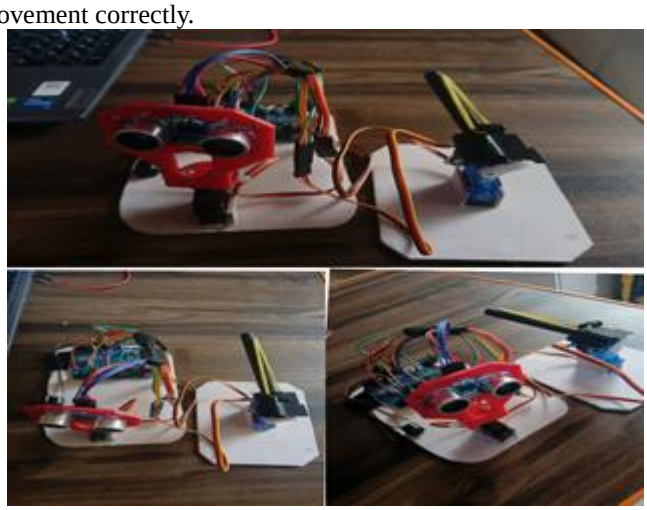

Fig. 3: Experimental setup of the developed prototype

The hardware prototype of the system is shown in fig. 3. The setup includes an adino microcontroller the brain of our system, Ultrasonic sensor for scanning, The servo motors used for scanning and directional control of missile and ultrasonic sensor. The scanning servo rotates the ultrasonic sensor to monitor Surrounding area continuously. When and target or object was detected the servo alignes the missile towards the object, And then a alert buzzer indicates successful detection.

The system performance was further analysed using real-time output data.

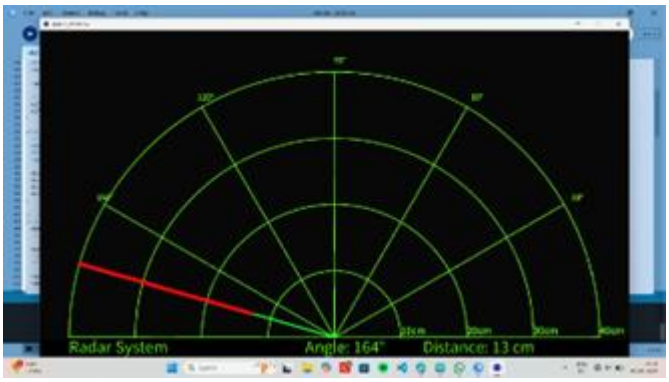

Fig.4: Serial monitor output showing real-time object detection

Fig. 5. Choose the radar visualisation output Obtained during testing. The display presents real time value of target angle in the distance, Confirming the accurate data acquisition and procession by the system. The verifiers that the system can track and detect object or target position dynamically.

All through the system operates effectively during testing, The detection range was limited due to the characteristics of ultrasonic sensor and of missile launching system. Environmental factors such as surface relations and surrounding obstacles also affect accuracy. Despite this limitation, the result demonstrate That the proposed system successfully implements the basic concept of automated target detection and response using embedded technology.

5. CONCLUSIONS

The smart missile guidance and tracking system successfully demonstrates the basic concept of target detection and directional control using embedded technology. The developed prototype was able to detect objects within a limited range and respond automatically based on sensor feedback. The integration of an ultrasonic sensor with an Arduino microcontroller enabled real-time distance measurement and effective control of servo motors.

The system provides a simple and low-cost platform for understanding missile guidance principles in an academic environment. Although the detection range and accuracy were limited due to sensor constraints and environmental factors, The overall performance was satisfactory for demonstration purposes. The project offers a strong foundation for further enhancements by incorporating advanced sensors and communication modules.

6. REFERENCES

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