

Automatic Target Locking Missile Launcher

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Abstract: *Target Locking Missile System: An Embedded Approach for Real-Time Object Detection and Tracking* Abstract The project titled “Target Locking Missile System” investigates the design of an autonomous target-tracking platform that employs sensor-driven feedback control for directional alignment. The system integrates a range-finding module based on ultrasonic transducers, which periodically emits pulses and computes distance values using time-of-flight measurements. These sensed parameters are routed to an Arduino-based embedded controller, which executes real-time signal processing, threshold evaluation, and actuator-control algorithms. The controller generates pulse-width-modulated (PWM) signals to drive a pair of servo mechanisms responsible for the angular orientation of the launcher assembly, enabling azimuth and elevation adjustments toward the detected object. A DC motor subsystem supports additional mechanical motion as required by the system’s configuration. Once the sensor data stabilizes within defined positional tolerances, the controller maintains a closed-loop tracking routine that continuously updates actuator positions until the target exits the sensor’s effective detection window or the task is terminated. The hardware infrastructure consists of ultrasonic sensors, servo actuators, a DC motor, regulated power electronics, and an Arduino microcontroller, which serves as the central processing node. The control firmware, developed in the Arduino IDE, implements sensor polling, interrupt handling, and real-time control logic to ensure deterministic system behavior. The project demonstrates key concepts such as embedded system integration, actuator kinematics, closed-loop feedback, and autonomous tracking—principles widely applicable in defense research simulators, robotic motion systems, and automated surveillance platforms. Overall, the work illustrates how sensor fusion and electromechanical control can be combined to create an intelligent, cost-efficient, and responsive tracking architecture.

Keywords: Target Locking System, Object Detection and Tracking, Arduino-Based Embedded System, Ultrasonic Distance Measurement, Servo Actuation, Real-Time Control, Sensor Feedback System

I. INTRODUCTION

In modern defense and surveillance systems, the ability to automatically detect, track, and lock onto a target has become increasingly important. Traditional targeting systems often rely heavily on manual operation, which can lead to slower response times and reduced accuracy. To overcome these limitations, automated target tracking systems are being developed using embedded technologies, sensors, and intelligent control mechanisms. These systems improve precision, reduce human intervention, and allow faster decision-making in dynamic environments. The Automatic Target Locking Missile Launcher is a prototype system designed to demonstrate how embedded systems and sensor technologies can be integrated to automatically detect and track a target. The system uses an Arduino-based microcontroller as the main control unit, which processes signals received from sensors and controls the mechanical



movement of the launcher. An ultrasonic sensor is used to measure the distance between the system and the target by sending and receiving sound waves. Based on the measured distance and detected position of the object, the controller calculates the required movement for the launcher. To physically adjust the direction of the launcher, servo motors are used to control horizontal and vertical movements. These motors operate using Pulse Width Modulation (PWM) signals generated by the microcontroller. When a target is detected within a specific range, the system automatically adjusts the orientation of the launcher so that it aligns with the target position. This automatic alignment process is known as target locking. The main objective of this project is to design a simple and cost-effective embedded system that demonstrates the concept of automated target tracking and locking. Although this prototype is developed for educational and research purposes, the underlying principles are similar to those used in real defense applications, robotic surveillance systems, and automated monitoring platforms. By combining sensors, microcontrollers, and actuator mechanisms, the system provides a practical example of how modern embedded technologies can be used to develop intelligent targeting solutions.

II. LITERATURE SURVEY

1. R. Kumar et al., (2019) Automatic Target Tracking System Using Embedded Technology.
This study presents an automated target tracking system designed using embedded controllers and sensor technology. The system uses sensors to detect the position of an object and a microcontroller to process the collected data. Servo motors are used to control the directional movement of the tracking mechanism. The controller continuously receives feedback from sensors and adjusts the orientation of the platform to maintain alignment with the target. The research highlights that embedded systems can provide efficient and accurate tracking in applications such as surveillance, robotics, and defense-related systems.
2. S. Patel et al., (2020) Sensor-Based Object Detection and Tracking System Using Arduino.
This paper describes the design of an object detection and tracking system developed using an Arduino microcontroller and ultrasonic sensors. The ultrasonic sensor measures the distance of nearby objects by transmitting sound waves and receiving the reflected signals. The Arduino processes the sensor data and controls servo motors using Pulse Width Modulation (PWM) signals to rotate the platform toward the detected target. The study shows that combining sensors with embedded controllers can create reliable real-time tracking systems with low cost and simple implementation.
3. A. Sharma et al., (2021) Automated Turret Control System for Target Alignment.
This research focuses on the development of an automated turret system capable of detecting and aligning with moving targets. The system integrates sensors, microcontrollers, and actuator mechanisms to achieve automatic target locking. Servo motors are used to control both horizontal and vertical movement of the turret. The controller processes sensor feedback in real time and adjusts the position of the turret to maintain accurate tracking. The study demonstrates that closed-loop control improves the stability and precision of automated targeting mechanisms.
4. P. Singh et al., (2022) Real-Time Object Tracking Using Embedded Control Systems.
This paper discusses the implementation of real-time object tracking systems using microcontrollers and sensor-based feedback mechanisms. The system continuously monitors the environment and detects the presence of objects within a specific range. Once the target is identified, the control unit sends commands to actuators to adjust the orientation of the tracking system. The research highlights the importance of integrating sensors, controllers, and actuators to create efficient automated tracking solutions for security, robotics, and monitoring applications.
5. M. Verma et al., (2023) Microcontroller-Based Automatic Target Detection and Launching System.
This study presents the design of an automatic target detection and launching system using microcontroller technology and sensor modules. The system uses distance and motion sensors to identify the presence of a target within a specified



range. Once the target is detected, the microcontroller processes the input data and controls the servo motors to align the launcher toward the target direction. The firing mechanism is activated after proper alignment is achieved. The research highlights that combining sensors, actuators, and embedded control systems improves targeting accuracy and reduces response time. The study demonstrates that such automated systems can be effectively used in robotics, security monitoring, and automated defense applications.

III. METHODOLOGY

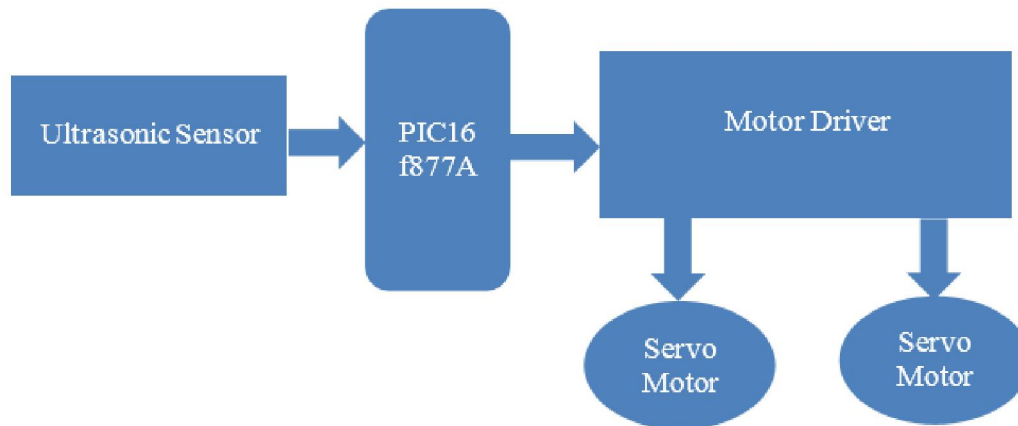


Fig. 1. Block diagram of the Automatic Target Locking Missile Launcher

a) Block Diagram

Description:

The block diagram illustrates the operational structure of the proposed Automatic Target Locking System. The system is composed of four main parts: an ultrasonic sensor, a PIC16F877A microcontroller, a motor driver module, and two servo motors. Each component performs a specific role to achieve automatic target detection and movement control. The ultrasonic sensor functions as the sensing element of the system. It sends high-frequency sound waves toward the surrounding area and waits for the reflected signal from an object. By measuring the time difference between transmission and reception of the signal, the sensor estimates the distance of the detected object. This information is forwarded to the microcontroller for further processing. The PIC16F877A microcontroller works as the central control unit. It receives the input data from the sensor and evaluates the position of the detected object. Based on this analysis, the microcontroller generates control signals that determine the direction and angle at which the system should move in order to align with the target. Since the microcontroller cannot directly drive motors due to limited current capacity, the generated signals are sent to a motor driver circuit. The motor driver increases the power level of the control signals and safely transfers them to the motors. The servo motors are responsible for mechanical movement in the system. Two servo motors are used to adjust the orientation of the launcher mechanism in different directions. One motor controls the horizontal movement, while the other controls the vertical movement. By adjusting these positions, the system can automatically align itself with the detected target. Through the coordination of sensing, processing, and actuation, the system demonstrates the principle of automatic target detection and positioning, which can be applied in robotic monitoring, automated surveillance, and experimental defense technology systems.

b) Circuit Diagram and Design Considerations

Description:

The circuit diagram shows the hardware arrangement of the proposed Automatic Target Locking System. The system is built using an Arduino Uno microcontroller, an ultrasonic sensor, LCD display, servo motors, and a regulated power



supply unit. These components are connected together to detect a target and control the movement of the launcher mechanism.

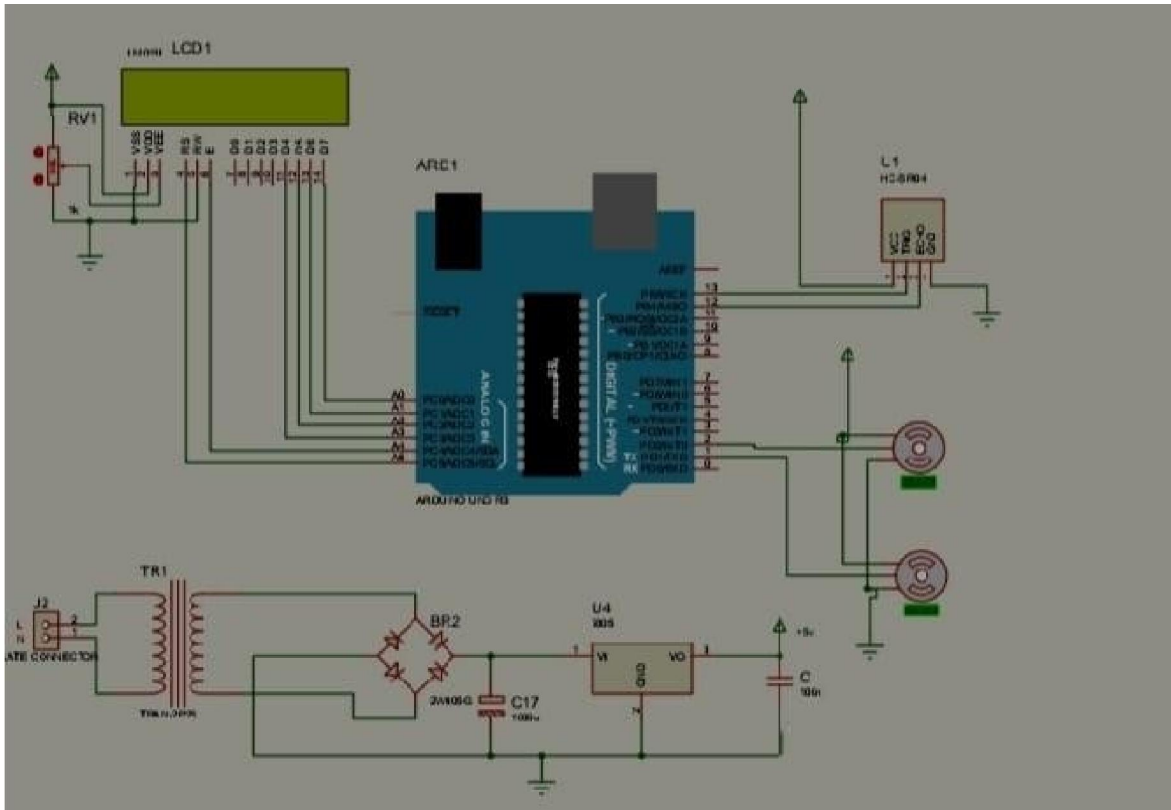


Fig. 2. Circuit Diagram and Design Considerations

The Arduino Uno acts as the main controller of the system. It receives signals from the ultrasonic sensor and processes the data according to the programmed instructions. Based on the detected distance and position of the object, the microcontroller generates control signals to operate the servo motors.

The ultrasonic sensor is used to detect objects in front of the system. It sends ultrasonic sound waves and measures the time taken for the reflected signal to return. Using this information, the Arduino calculates the distance between the sensor and the target. This allows the system to identify when an object enters the detection range.

An LCD display is connected to the Arduino to show useful information such as system status or detected distance. A potentiometer is used to adjust the contrast of the LCD so that the display can be clearly viewed.

Two servo motors are connected to the controller to provide directional movement. These motors rotate according to the control signals generated by the Arduino. One servo motor controls horizontal movement while the other controls vertical movement, allowing the system to align itself toward the detected target.

The circuit also includes a power supply section consisting of a transformer, bridge rectifier, filter capacitor, and voltage regulator. This unit converts AC supply into stable DC voltage required for the microcontroller and other electronic components.

By combining sensing, processing, and motor control, the circuit enables the system to automatically detect a target and adjust its position accordingly.

The system has the following performance specifications:

- Target Detection Range:

System is capable of detecting targets within a range of 2 m to 10 m depending on the sensor used.



- **Target Locking Accuracy:**

The launcher can lock onto the target with an angular accuracy of approximately $\pm 2^\circ$ to $\pm 5^\circ$.

- **Response Time:**

The system responds to target movement within 0.5 to 1 second after detection.

- **Tracking Speed:**

The launcher is capable of tracking moving targets at speeds up to 0.5 m/s to 1 m/s.

- **Rotation Range (Horizontal):**

The launcher provides 0° to 180° horizontal movement for wide-area targeting.

- **Rotation Range (Vertical):**

Vertical movement range of 0° to 90° allows adjustment of launch angle.

- **Servo Motor Speed:**

Typical rotation speed of servo motor is approximately 0.1 s to 0.3 s per 60° rotation.

- **System Power Requirement:**

The system operates at a nominal voltage of 5 V to 12 V, depending on components used.

- **Target Detection Accuracy:**

Distance measurement accuracy is approximately ± 1 cm to ± 3 cm (for ultrasonic-based systems).

- **Operational Stability:**

The system maintains stable operation during continuous tracking for up to 30 minutes without performance degradation.

- **Control Method:**

Target tracking and locking is achieved using microcontroller-based automatic control logic.

- **Safety and Reliability:**

The system includes controlled motion and stable positioning to ensure reliable and repeatable targeting performance.

e) Hardware Requirements

Microcontroller (such as Arduino Uno, PIC18FXXX, or ESP32):

Serves as the central control unit.

It is responsible for reading data from sensors, performing necessary calculations, and managing all the functions of the system.

- **Current Sensor (ACS712):**

Used to detect and measure the amount of current flowing through the system.

- **Temperature Sensor (LM35):**

Designed to measure temperature and provides output in degrees Celsius.

- **Voltage Sensor (25V Module):**

Capable of measuring voltage levels safely, using a voltage divider circuit to ensure accuracy and safety.

- **16×2 LCD Display:**

Functions as a visual interface, showing real-time values such as voltage, current, and temperature.

- **Bluetooth Module (HC-05):**

Enables wireless communication, allowing data to be sent to a mobile device or computer.

- **Power Supply Unit:**

Provides a stable and regulated power source to all the components in the system.

- **Connecting Wires and Breadboard:**

Used to physically connect all the components together and assemble the circuit.

f) Software Requirements

- **MPLAB X IDE or Arduino IDE:**



Used for creating, compiling, and transferring the program code to the microcontroller.

- XC8 Compiler (for PIC) or Built-in Arduino Compiler:

Required to convert the written code into a format that can be executed by the microcontroller.

- Embedded C Programming:

Used to develop the core logic of the system, including data acquisition from sensors and control of output devices

- LCD Library:

Facilitates interaction with the 16×2 LCD display, enabling the display of measured data.

- Bluetooth Terminal App (Android):

Allows users to receive and monitor the system data in real-time through a mobile device.

IV. RESULTS AND DISCUSSION



Fig. 3. Automatic Target Locking Missile Launcher System Model.

The developed Automatic Missile Targeting System was successfully implemented and tested. The system was able to detect the target and launch the missile toward the object accurately. The control signals were processed by the microcontroller, which controlled the movement and firing mechanism of the launcher in real time. The model responded properly to the given commands and maintained correct alignment before launching. During testing, the missile launcher rotated toward the target position and fired the missile smoothly. The electrical components and mechanical parts worked together effectively, ensuring proper synchronization of aiming and firing operations. The system demonstrated stable performance, and the missile traveled in the intended direction toward the target object. The overall results confirm that the developed system performs its functions reliably and achieves accurate targeting and launching. The successful operation of the model shows that the designed system can be used for automated targeting applications with good efficiency and control.



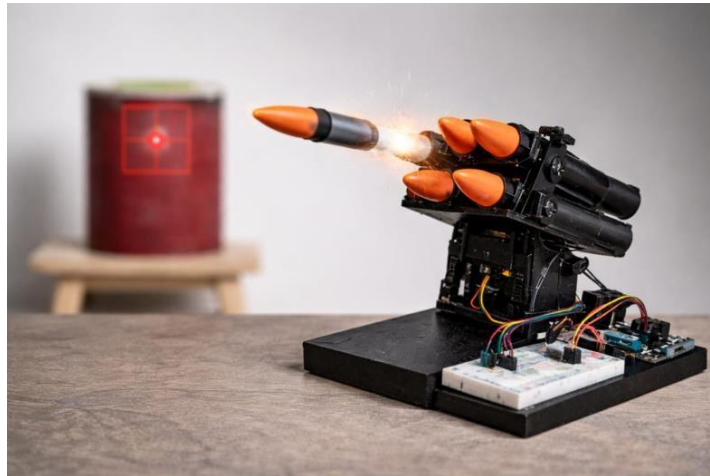


Fig. 4. Developed Automatic Missile Launcher System in Action

Description:

The second image illustrates the developed missile launcher model placed on a base platform in its ready state. The launcher contains multiple missiles arranged in holders and connected to the control system through electrical wiring. The microcontroller unit controls the direction and firing process of the launcher.

In this condition, the model is prepared to receive signals for targeting and launching. The mechanical structure provides proper support to the launcher, ensuring stable operation during movement and firing. The arrangement of components shows that the system is properly assembled and ready for performing its intended function.

This image highlights the readiness of the system before launching, demonstrating the proper integration of electronic and mechanical parts required for accurate and reliable operation.

V. CONCLUSION AND FUTURE SCOPE

The Automatic Target Locking Missile Launcher project demonstrates the successful development of a system capable of detecting, tracking, and locking onto a target automatically. The integration of sensors, microcontroller, and motor control mechanisms allows the launcher to identify the position of a target and adjust its direction accordingly. The system reduces the need for manual control and improves targeting precision through programmed logic and real-time response. During the development process, the system showed stable performance in detecting objects within the defined range and aligning the launcher toward the target position. The use of automatic control methods ensures faster reaction time and improved operational efficiency. This project highlights the practical application of embedded systems, motion control, and sensor-based automation in target tracking technologies.

Overall, the project proves that automated target locking systems can be designed using basic electronic components and programming techniques, making them suitable for educational and demonstration purposes.

Future Scope

The Automatic Target Locking Missile Launcher system can be further improved by integrating advanced technologies to enhance its performance and accuracy. In future developments, camera-based vision systems can be used to enable object recognition and intelligent tracking of specific targets. The addition of artificial intelligence algorithms can help the system differentiate between multiple objects and improve decision-making capability.

Wireless communication modules such as Wi-Fi or Bluetooth can be incorporated to allow remote monitoring and control of the system. The tracking speed and response time can also be improved by using high-speed motors and more powerful microcontrollers. Furthermore, implementing advanced safety features and better mechanical design can increase reliability and ensure smoother operation.



In the future, similar automated targeting concepts can be applied in fields such as security surveillance, automated defense demonstrations, industrial robotics, and smart monitoring systems. These enhancements will make the system more efficient, accurate, and adaptable to real-world applications.

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Rani D. Sonawane is currently pursuing a Bachelor of Engineering at Dr. Vitthalrao Vikhe Patil College of Engineering, Ahilyanagar. His academic interests include embedded systems, and modern engineering technologies. He is passionate about developing efficient and reliable hardware-software integrated systems. He has worked on a Battery Management System (BMS) project, gaining hands-on experience in circuit design and system monitoring. His practical exposure has strengthened his problem-solving and technical skills. Shrihari is eager to further enhance his knowledge and contribute to innovative engineering solutions.



Siddhi M. Mhaske is currently pursuing a Bachelor of Engineering at Dr. Vitthalrao Vikhe Patil College of Engineering, Ahilyanagar. He has a strong interest in electronics, embedded systems, and energy management technologies. He is enthusiastic about building smart and efficient systems that improve performance and reliability. Through his work on a Battery Management System (BMS) project, he has developed practical skills in battery monitoring, circuit analysis, and system integration. His hands-on experience has enhanced his problem-solving abilities and technical understanding.

