# Princess Sumaya University for Technology

King Abdullah II Faculty of Engineering

Computer Engineering Department


**Embedded Systems 22442 - Fall 2023-2024**

**Automated Threat Recognition and Engagement System (ATRES)**

**Project Report**

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## Abstract

The Automated Threat Recognition and Engagement System (ATRES) is an autonomous defense mechanism engineered for swift and accurate threat identification and response. Its robust framework comprises a motorized rotating platform, ultrasonic and sharp sensors, precision calculations through advanced algorithms, temperature checking, and a spring-loaded shooters mechanism. Operating within a calibrated range, ATRES continuously scans its surroundings, detecting potential threats and initiating adaptive responses. Upon threat identification, the system processes sensor data, computes distances, and optimizes shooting angles for precise engagement. Motor drivers, H-Bridge PWM, and DC servo motors facilitate movement toward threats, ensuring accurate neutralization with a non-lethal spring-loaded shooters mechanism. The system transitions seamlessly between detection, engagement, and rotation, maintaining a continuous loop of surveillance for sustained security measures. ATRES demonstrates adaptability, responsiveness, and effectiveness in autonomously addressing potential risks within its designated operational radius.


# Table of Contents

# Background

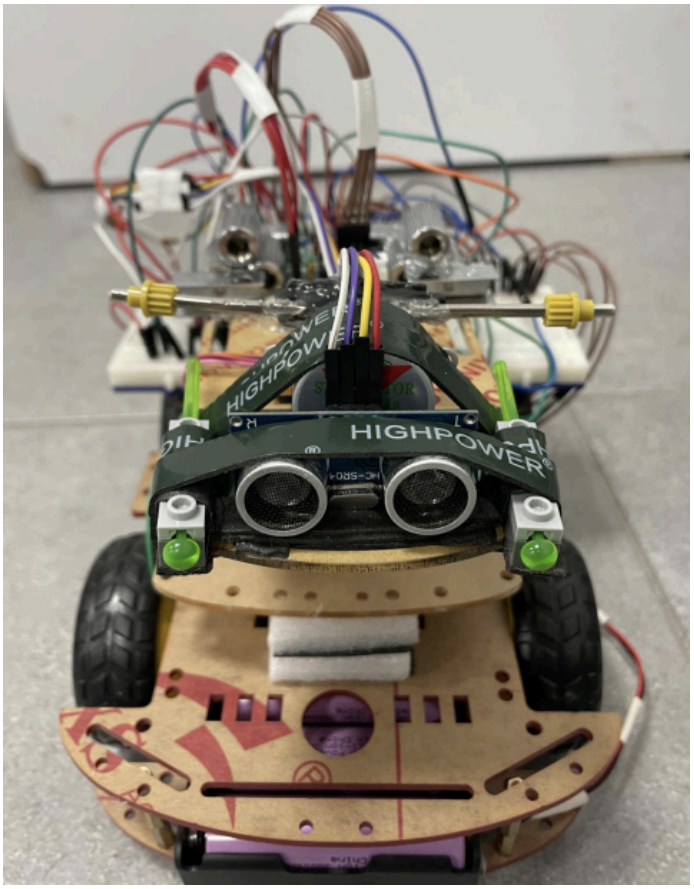
In response to the growing complexity of security threats and the limitations of traditional defense systems, the Automated Threat Recognition and Engagement System (ATRES) emerges as an innovative autonomous solution. Designed to swiftly and accurately detect and neutralize potential threats, ATRES combines a motorized rotating platform for comprehensive surveillance with ultrasonic and sharp sensors for real-time threat detection. Advanced algorithms enable precise calculations, optimizing shooting angles for engagement. Recognizing the dynamic nature of security challenges, ATRES integrates a temperature sensor to avoid hazardous zones and employs a non-lethal spring-loaded shooter mechanism for effective threat neutralization. In essence, ATRES represents a cutting-edge response to modern security demands, combining adaptability, precision, and ethical considerations in autonomous defense.

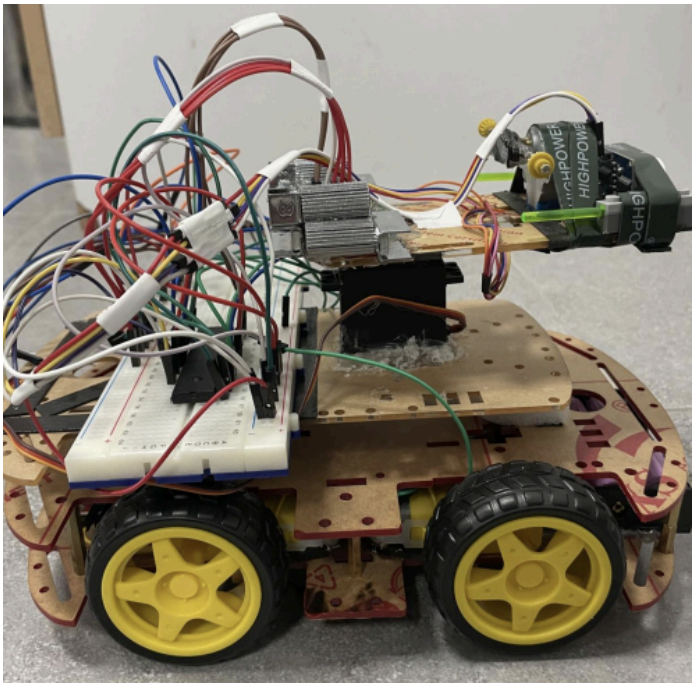
This report will explore the straightforward yet innovative design of ATRES, providing insights into its components, functionality, and adaptive capabilities. By understanding the driving forces behind ATRES, we uncover a new approach to autonomous defense systems, showcasing the future potential of responsive and efficient security measures.

# Components

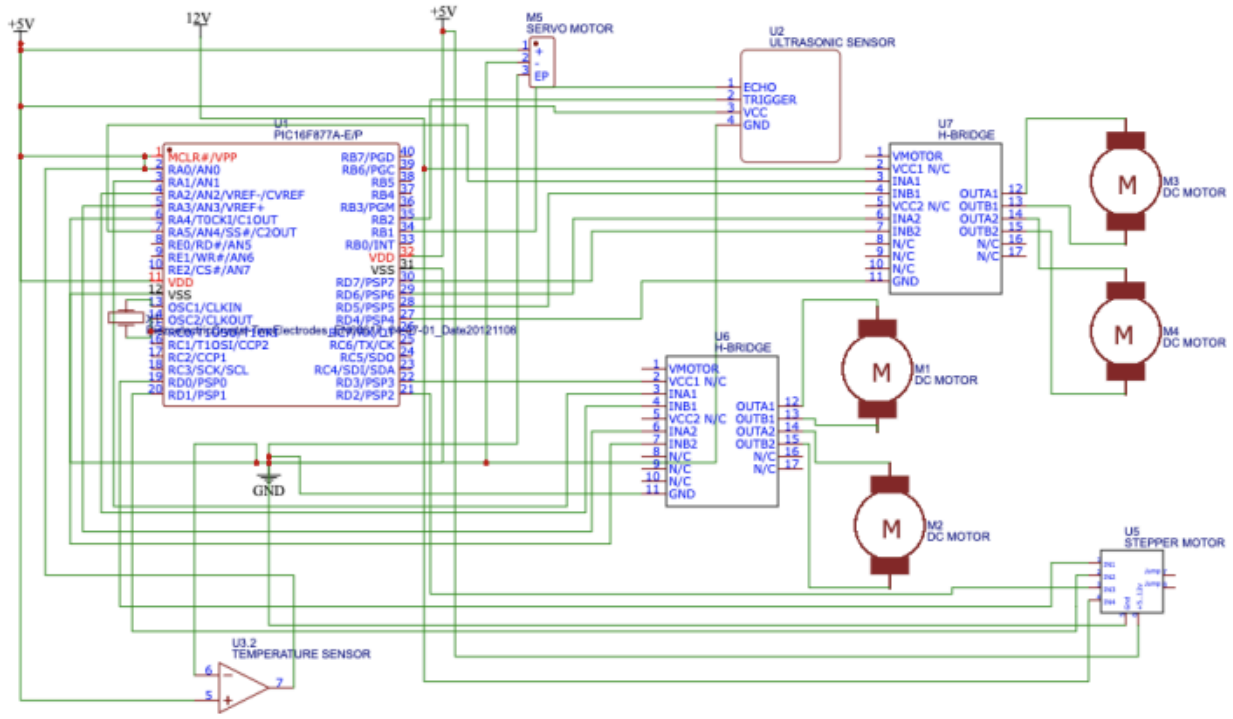
- PIC16F877A
- Breadboard x2
- Stepper Motor
- MG995 Servo Motor 180 degrees
- Wires
- 8 MHz piezoelectric material crystal oscillator.
- Ultrasonic Distance Sensor
- Stepper Motor and Driver ULN2003
- DC Motors x4
- H-Bridges x2
- Voltage sources 11.8V, 5V
- Housing system

# Mechanical Design



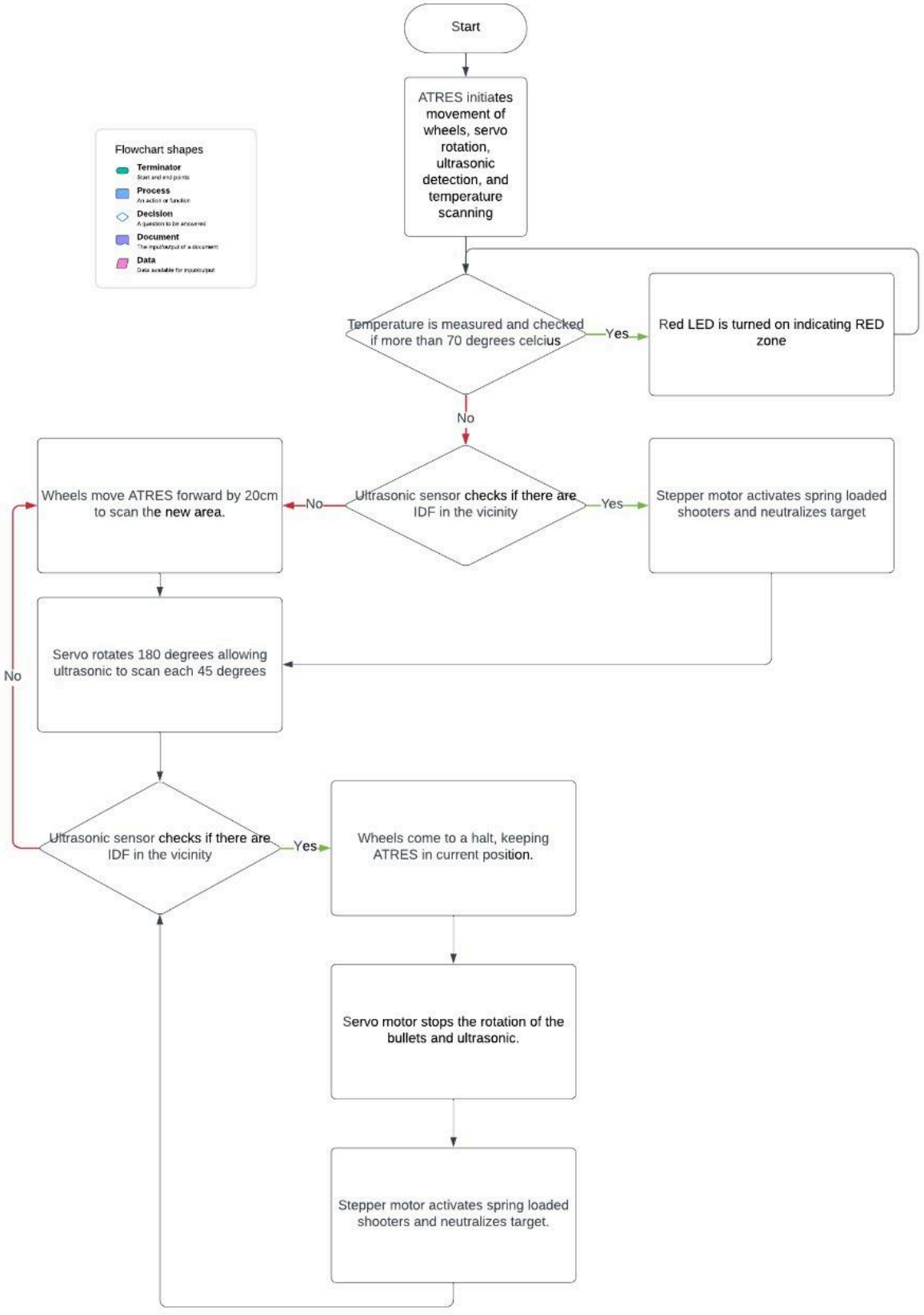



# Electric Design




Please see attached standalone image for a clearer schematic.

# Flowchart


Start
ATRES initiates movement of wheels, servo rotation, ultrasonic detection, and temperature scanning
Flowchart shapes
Terminator
Process
Decision
Document
Data
Temperature is measured and checked if more than 70 degrees celcius
Yes
Red LED is turned on indicating RED zone
No
Ultrasonic sensor checks if there are IDF in the vicinity
No
Wheels move ATRES forward by 20cm to scan the new area.
Yes
Stepper motor activates spring loaded shooters and neutralizes target
Servo rotates 180 degrees allowing ultrasonic to scan each 45 degrees
No
Ultrasonic sensor checks if there are IDF in the vicinity
Yes
Wheels come to a halt, keeping ATRES in current position.
Servo motor stops the rotation of the bullets and ultrasonic.
Stepper motor activates spring loaded shooters and neutralizes target.

# Working Mechanism

**Continuous 180-Degree Scanning:**

- ATRES operates on a sturdy rotating base, utilizing a 180 degree servo motor to facilitate a continuous 180-degree scanning capability.
- The ultrasonic sensor, mounted on top of the rotating base, serves as the system's eyes, actively scanning the surroundings for potential threats that breach the safety perimeter.

**Threat Detection and Data Processing:**

- Upon detecting a potential threat, the sensors trigger a seamless sequence of actions.
- ATRES swiftly processes incoming sensor data, employing advanced algorithms to compute the precise distance between itself and the identified target.

**Dynamic Threat Approach:**

- If the detected target is beyond a 1-meter range, the stepper motor driver initiates movement to trigger the bullet of the Spring loaded Shooters towards the target, ensuring accuracy in neutralization.

**Adaptive and Responsive Operation:**

- ATRES operates within a calibrated range, providing coverage without compromising accuracy.
- Once a target is identified and ATRES is within the optimal range, the Spring loaded Shooters mechanism is activated using a servo to neutralize the threat with the correct precision.

**Post-Neutralization Transition:**

- Following a successful neutralization, ATRES seamlessly transitions back into continuous rotational scanning mode.
- The system remains vigilant and ready to respond to any emerging threats within its designated operational radius.

**Additional Features - Adaptive Surveillance and Temperature Checking:**

- ATRES maintains a continuous loop of detection, engagement, and rotation to ensure sustained security measures.
- An added feature includes temperature checking, with a red LED light indicator signaling when ATRES enters high-temperature or radioactive zones, enhancing its adaptability to diverse threat environments.

The comprehensive architecture and integrated features of ATRES showcase its prowess as an autonomous defense mechanism, offering a sophisticated and effective solution for threat detection and neutralization.

# Problems

**Voltage Supply Complexity:**

- The project requires multiple voltage supplies for different components, leading to increased complexity in the overall system. Managing and regulating diverse voltage requirements can pose challenges in terms of power efficiency and system reliability.

**Component Overload:**

- The inclusion of various sensors, motors, and mechanisms may result in an overloaded system. This can lead to increased power consumption, heat generation, and potential strain on the power supply components.

**Integration Challenges:**

- Integrating and synchronizing the operation of motors, sensors, and the Spring loaded Shooters mechanism may present challenges in terms of software and hardware integration. Ensuring seamless communication and coordination among components is crucial for the system's effectiveness.

**Temperature and Radiation Sensitivity:**

- The temperature checking feature introduces additional complexity, and false positives or negatives in detecting high-temperature or radioactive zones may compromise the system's reliability. Calibration and accurate threshold setting are critical.

# Recommendations

**Unified Power Supply:**

- Using a single, unified power supply with multiple voltage outputs or implementing voltage regulators to simplify the power requirements. This can enhance efficiency and reduce the complexity of managing multiple power sources.

**Optimization of Components:**

- Evaluating the necessity of each component and exploring options for component optimization. This may involve selecting components with similar voltage requirements or combining functionalities to reduce the overall component count.

**Modular Design:**

- Implementing a modular design approach, separating different functionalities into distinct modules. This can simplify troubleshooting, maintenance, and future upgrades. Additionally, it allows for better isolation of components with different voltage needs.

**Software and Hardware Optimization:**

- Conducting thorough testing and optimization of both software and hardware to ensure seamless integration. Employing feedback mechanisms and error-handling protocols to address potential issues arising from the diverse components.

**Enhanced Temperature Sensing:**

- Investing in more sophisticated temperature sensing mechanisms or redundant sensors to improve the accuracy and reliability of temperature checking. Implement adaptive algorithms to filter out false readings and enhance the system's resilience.

**Documentation and Training:**

- Creating comprehensive documentation for the system, detailing the voltage requirements, component specifications, and integration processes. Provide training to operators and maintenance personnel to ensure effective troubleshooting and system management.

By addressing these issues and implementing the recommended solutions, the Automated Threat Recognition and Engagement System (ATRES) can achieve improved reliability, efficiency, and ease of operation. This will contribute to the overall success and practicality of the autonomous defense mechanism.

# Conclusion

In conclusion, the project's core focus on swift and accurate threat identification, coupled with an adaptive engagement strategy, underscores its potential for enhancing security measures in diverse environments.

Throughout the project, we have successfully demonstrated the capabilities of ATRES, showcasing a robust framework that incorporates a variety of sensors, motors, and responsive mechanisms. The continuous 180-degree scanning capability, dynamic threat approach, and adaptive surveillance loop illustrate the system's versatility and effectiveness in addressing potential threats within a designated operational radius.

However, as with any ambitious project, challenges have been identified, such as the complexity of managing multiple voltage supplies and the potential overload of components. The recommendations provided aim to streamline the system's operation, improve power efficiency, and enhance overall reliability.

ATRES, with its innovative features like the Spring loaded shooting mechanism and temperature checking, stands as a promising solution in autonomous defense technology. The project not only contributes to the current landscape of security systems but also serves as a foundation for further research and development in autonomous threat recognition and engagement.

As we move forward, continuous refinement of the system based on the recommendations outlined will be essential to ensure optimal performance and practicality in real-world applications. ATRES represents not just a project but a proactive step toward bolstering security measures through advanced autonomous technologies, paving the way for a safer and more secure future.