Military Surveillance Robot

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***Abstract*—The This project presents a comprehensive security solution for military storage rooms by combining dual authentication (RFID and facial recognition) with an autonomous surveillance robot. The system is designed to enhance security by using an ESP-32 to control an RFID reader, while a Python-based facial recognition program verifies the identity of authorised personnel. If both credentials match, the system opens the door using an L298 motor driver and a DVD loader mechanism. In case of a mismatch between the RFID and facial data, the system sends an alert through Telegram chatbot along with video footage. Simultaneously, an autonomous robot inside the storage room is activated, which tracks the intruder using a camera mounted on a pan-tilt mechanism controlled bya Raspberry Pi. The robot, equipped with a laser pointer, warns the intruder before escalating further actions. This project aims to provide real-time monitoring, automated threat detection, and response to secure high-value military assets.**

***Keywords*—Military Surveillance, RFID Authentication, Facial Recognition, Autonomous Robot, Real-time Monitoring, Laser Tracking.**

I. INTRODUCTION

In today's evolving security landscape, safeguarding sensitive military facilities has become increasingly complex. With rising threats from both external and internal sources, traditional security measures such as manual surveillance and single-factor authentication are no longer sufficient to protect high-value storage rooms containing critical military assets. In India, where security breaches in military facilities have been reported in recent years, there is an urgent need for advanced security systems that can autonomously monitor and respond to potential threats. The Indian Army's recent initiatives to induct robotic mules capable of surveillance in hazardous terrains highlight the growing importance of robotics in national defence. Drawing inspiration from such advancements, this project aims to develop a comprehensive security solution for secured storage rooms. The proposed system integrates dual authentication (RFID and facial recognition) with an autonomous surveillance robot that can detect and respond to unauthorised access attempts. The use of RFID technology for identity verification has gained popularity due to its reliability and ease of integration into existing systems. However, RFID alone may not be sufficient to prevent identity theft or unauthorised access. To address this limitation, we incorporate facial recognition technology as a second layer of authentication. This ensures that only authorised personnel can gain access to the secured storage room. In addition to dual authentication, the system includes an autonomous surveillance robot that can track intruders in real time. The robot is equipped with a camera mounted on a pan-tilt mechanism controlled by Raspberry Pi, allowing it to monitor the entire room. If an intruder is detected, the robot points a laser at them as a warning before taking further action. This project aligns with India's ongoing efforts to modernise its defence infrastructure by integrating cutting-edge technologies such as robotics and artificial intelligence (AI). By combining dual authentication with autonomous response capabilities, this system offers a robust solution for protecting sensitive military assets from unauthorised access.

II. LITERATURE SURVEY

1. This project suggests a home security robot that is driven by the Raspberry Pi 3 Model B. It was presented by Harshitha, R. and Hussain, M. H. S. in their paper "Surveillance Robot Using Raspberry Pi and IoT" (2018). The system has a webcam for surveillance, motion detection, and facial recognition for person identification. When an authorized individual is identified, they are contacted by the onboard voice assistant. Unauthorized personnel receive a notification from the system that includes pictures of the intruder and turns on live video feed streaming. Real-time monitoring is made possible by users being able to watch the live broadcast remotely over the internet.

When customers leave loved ones unattended or are gone, this solution improves home security and provides peace of mind.[1]

2. This project presents a surveillance robot that combines IoT with robotics, as described by Nayak, A. R., Ayyar, S. C., Aiswarya, O., Mahitha, C. H., and Mohankumar, N. in their work "Security Surveillance Bot for Remote Observation During Pandemics" (2020). The user controls the movement of the robot remotely while real-time video footage is transmitted. With the help of a Raspberry Pi microcontroller, the robot can patrol locations and provide video surveillance that can be seen on the user's screen. Developed as a low-cost, low-maintenance solution, the system finds use in residential complex security, healthcare, and defense. It provides an easy and effective way to observe and monitor remotely.[2]

3. This project describes a spy robotic automobile intended for continuous surveillance in hazardous locations. It was detailed by Akilan, T., Chaudhary, S., Kumari, P., and Pandey, U. in their paper "Surveillance Robot in Hazardous Place Using IoT Technology" (2020). Using a wireless camera and Arduino UNO microcontroller, the robot can be controlled by a smartphone or PC and streams live video at any time of day or night. The robot's sensors, which include gas, ultrasonic, and PIR sensors, lessen the need for humans in hazardous situations. Through the use of Wi-Fi, an Android application controls navigation.[3]

III. OBJECTIVE

Primary Objectives:

- To design and implement a dual-authentication system using RFID technology and facial recognition.
- To develop an autonomous surveillance robot capable of tracking intruders in real time.
- To create a real-time alert system that sends notifications via Telegram chatbot along with
- video footage when unauthorised access is detected.

Technical Objectives:

- Integrate an ESP-32 with an RFID reader for identity verification.
- Develop a Python-based facial recognition program using OpenCV.
- Control door mechanisms using L298 motor driver and DVD loader.
- Implement Raspberry Pi-controlled pan-tilt camera system for real-time monitoring.
- Equip the robot with laser tracking capabilities for threat deterrence.

IV. EXISTING SYSTEM

Currently available security systems in high-security storage rooms primarily rely on single-factor authentication methods such as keycards or passwords. These systems are vulnerable to identity theft or unauthorised access due to their reliance on one form of identification. Additionally, traditional CCTV cameras used for monitoring often require constant human oversight, making them less effective in real-time threat detection. In some cases, manual guards are deployed alongside these systems; however, human error or delayed response times can compromise security. Furthermore, existing systems lack integrated robotic response mechanisms that can autonomously track intruders or provide immediate deterrence actions. This creates significant vulnerabilities when dealing with sophisticated breach attempts or insider threats.

V. PROPOSED SYSTEM

The proposed system addresses these vulnerabilities by introducing dual-factor authentication combined with autonomous robotic surveillance. The first part of the system involves verifying the identity of personnel using both RFID cards (for physical identification) and facial recognition (for biometric verification). If both credentials match perfectly, permission is granted to enter the secured area via automated door control mechanisms powered by L298 motor drivers and DVD loaders. If there is any mismatch between the RFID card data and facial recognition results (e.g., different identities), the system immediately sends an alert notification via Telegram chatbot along with video footage captured by the camera. Simultaneously, it activates an autonomous robot inside the storage room. The robot uses computer vision techniques powered by Raspberry Pi to track any human presence within its vicinity. It is equipped with DC motors for movement and servo motors for controlling its pan-tilt camera mount. The robot warns intruders by pointing a laser at them before escalating further actions if necessary.

VI. RESEARCH GAP

Despite advancements in security technologies such as biometrics or robotics individually being well-established in various sectors like financial institutions or defence facilities, there remains a significant gap in integrating these technologies into cohesive systems specifically designed for high-security environments like military storage rooms. Most existing systems still rely heavily on human intervention either through manual guards or remote monitoring stations which introduces delays during critical situations where immediate action is required.

VII. BRIDGING THE GAP

This project bridges these gaps by combining multiple layers of security (dual-factor authentication) along with automated responses through robotic surveillance systems capable of real-time threat detection/deterrence without requiring constant human oversight. By integrating both preventive measures (authentication) alongside reactive measures (robotic intervention), we create an all- encompassing solution capable of addressing modern-day challenges posed by sophisticated attackers attempting unauthorised entry into sensitive areas like military storage rooms.

VIII. METHODOLOGY WITH BLOCK DIAGRAM

The project's methodology entails securing military storage facilities by combining autonomous monitoring and dual authentication. For credential verification, an ESP-32 microcontroller controls an RFID reader, and a Python-based facial recognition system verifies employees against a safe database. When dual authentication is successful, a DVD loading mechanism for door entry is operated by an L298 motor driver. The system uses a Telegram Chat bot to send breach notifications and video evidence when credentials don't match. At the same time, a Raspberry Pi-controlled autonomous security robot with a pan-tilt camera to monitor trespassers in real time is turned on inside the storage area. Additionally, the robot can boost security measures as necessary and warns intruders with a laser pointer. Modular components are used in the system to ensure flexibility.

Components used:

1. Bot Frame
2. DC Motor (4 nos)
3. 1080P USB Camer.
4. Pi Camera
5. L298N Motor Drive
6. RFID Tag
7. RFID Reader
8. Wifi Module
9. 20000mAhPower Bank
10. Rsp-5

Transmitter Block Diagram

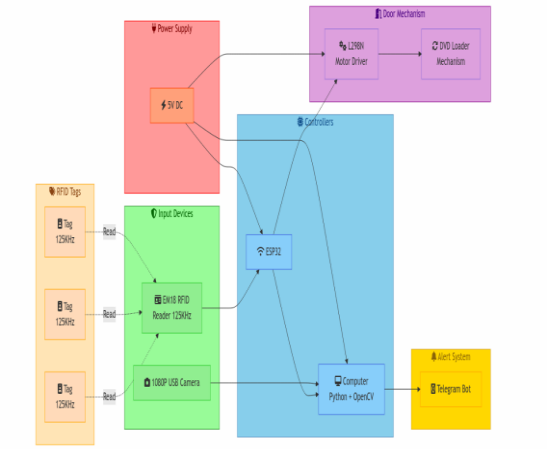

Figure 1.1

Receiver Block diagram:

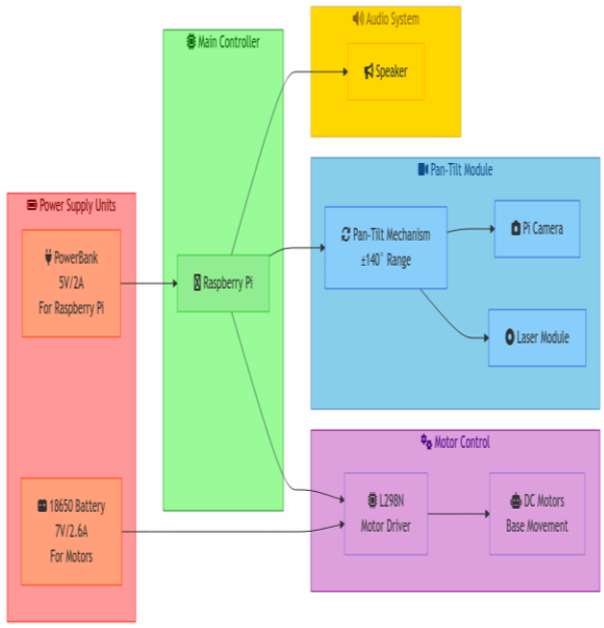

Figure 1.2

IX. FLOW CHART

Transmitter Part flow:

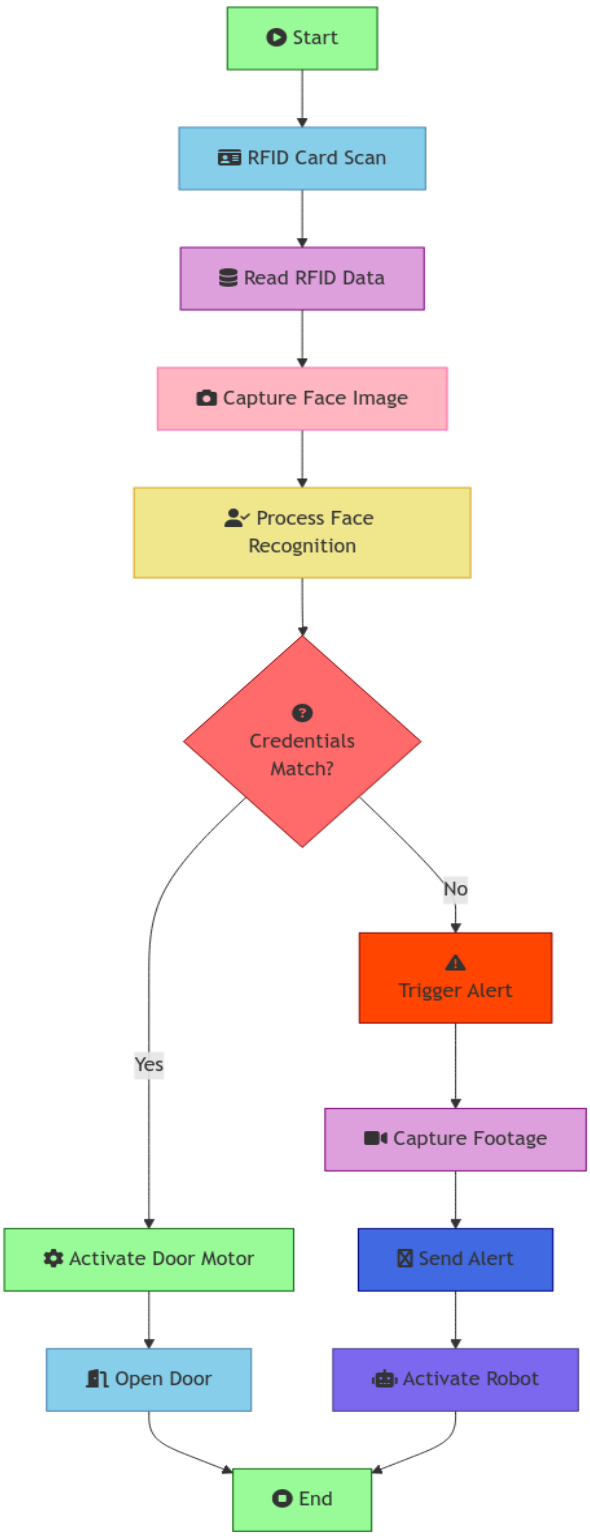

Figure 1.3

Receiver Part Flow:

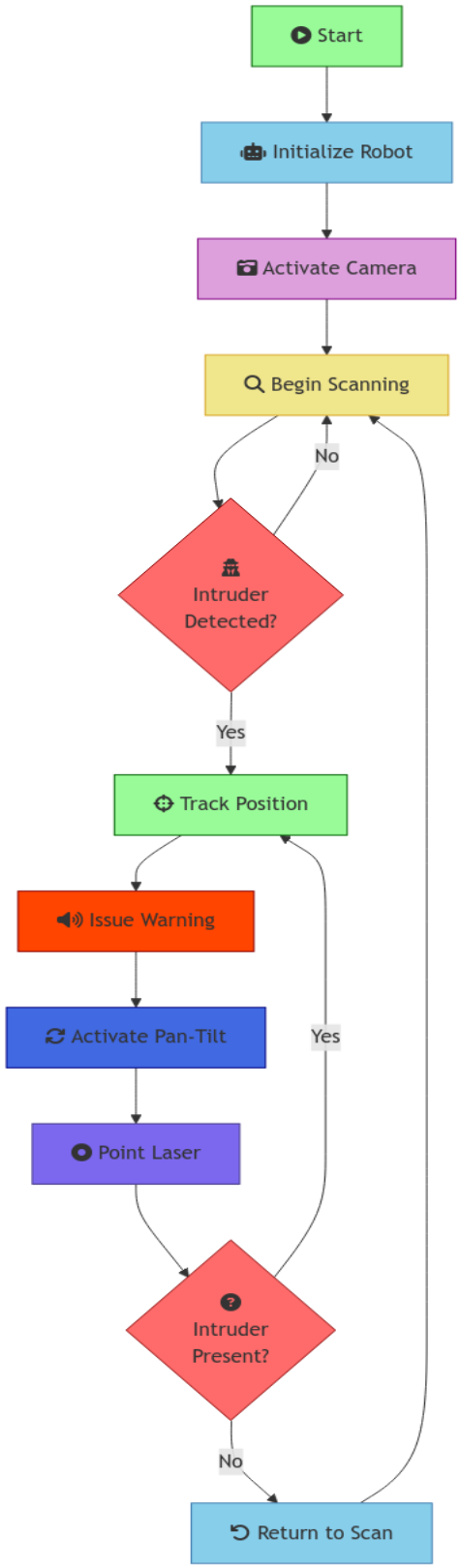

Figure 1.4

I. HARDWARE REQUIREMENTS

1. ESP-32: Used for controlling the RFID reader and managing door operations.
2. Raspberry Pi: Powers the camera system and handles real-time video processing for tracking intruders.
3. L298 Motor Driver: Controls the motors responsible for opening/closing doors using DVD loader mechanisms.
4. RFID Reader Module: Used for reading RFID cards presented by personnel attempting entry.

II. SOFTWARE REQUIREMENTS

1. Python 3.x: Used for developing facial recognition software using OpenCV libraries.
2. OpenCV Library: Provides image processing capabilities required for facial detection/recognition.
3. Arduino IDE: Used for programming ESP-32 to control RFID reader operations.
4. Telegram Bot API: Enables real-time notifications via Telegram when unauthorised access is detected.
5. Raspberry Pi OS: Operating system used on Raspberry Pi for handling camera feeds and controlling motors.

III. NOVELTY OF THE PROJECT

The novelty lies not only in combining two distinct forms of authentication but also integrating them seamlessly into an autonomous response framework where robots play active roles beyond mere passive observation—actively engaging potential threats through laser tracking/warning mechanisms while simultaneously alerting authorities via instant messaging platforms like Telegram. This holistic approach sets it apart from traditional siloed approaches where different components operate independently rather than cohesively working together towards achieving comprehensive protection against varied threats ranging from external attackers attempting physical breaches through forceful means down towards internal actors exploiting weaknesses within existing infrastructures reliant solely upon outdated technologies lacking adaptive capabilities required within today’s dynamic threat landscapes.

IV. RESULT

The project successfully developed an advanced military surveillance system for secured storage rooms, combining dual authentication with autonomous robotic response capabilities. The system utilizes RFID technology and facial recognition for identity verification, enhancing security measures beyond traditional single-factor authentication methods. An ESP-32 controls the RFID reader, while a Python-based facial recognition program verifies the identity of authorized personnel. When both credentials match, the system grants access by opening the door using an L298 motor driver and a DVD loader mechanism. In cases of credential mismatch, the system activates an alert mechanism, sending notifications through a Telegram chatbot along with video footage. Simultaneously, an autonomous surveillance robot inside the storage room is activated. This robot, equipped with a camera mounted on a pan-tilt mechanism controlled by a Raspberry Pi, tracks intruders in real-time.The robot's laser pointer serves as a warning system before further actions are taken.

V. CONCLUSION

In summary, a major advancement in incorporating state-of the-art technology for high-security applications can be seen in the creation of the "Advanced Military Surveillance Robot for Secured Storage Rooms." The idea successfully overcomes the drawbacks of conventional security techniques by fusing independent robotic monitoring with dual authentication (RFID and biometric identification). Utilizing cutting-edge materials and modular parts guarantees scalability and environmental adaptability. One example of the system's strong design is its real-time detection, prevention, and response to unwanted access. In addition to improving security measures, this all-encompassing strategy establishes a standard for intelligent access control and monitoring systems in the future, guaranteeing that vital military assets are protected from changing threats.

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