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IMPLEMENTATION OF SURVEILLANCE BASED RADAR TURRET DEFENCE SYSTEM

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Abstract: With increasing security concerns in various fields, automation in surveillance and threat response has gained significant attention. This paper presents the development of an autonomous security vehicle equipped with a real-time face recognition system. The vehicle is trained with a predefined set of faces and is programmed to identify and respond to unauthorized individuals. When an unknown face is detected, the system activates an automated gun mechanism for defensive action. The implementation of artificial intelligence for face recognition, microcontroller-based hardware for control, and an actuation mechanism for response ensures a real-time and efficient security system. This research highlights the design, methodology, experimental setup, and results of this project, providing insights into its feasibility, limitations, and potential improvements for future developments.

I. INTRODUCTION

1.1 Background and Motivation

Security plays a crucial role in military, industrial, and residential sectors. Conventional surveillance systems rely on human monitoring, which can be prone to fatigue, errors, and delayed response times. The need for an automated security system that can identify threats and act upon them in real-time has led to the development of AI-powered surveillance models.

The proposed system introduces an car model that uses artificial intelligence for facial recognition and a robotic mechanism for response. Unlike traditional surveillance cameras that merely record and notify, this system actively engages with the environment by identifying potential threats and responding to them autonomously.

1.2 Objectives

- Develop an AI-based face recognition model for real-time threat detection.
- Implement an automated shooting mechanism for defensive actions.
- Integrate hardware and software components for autonomous operation.
- Optimize the system for accuracy, efficiency, and response time.

1.3 Scope of the Research

The research focuses on designing and implementing a prototype for real-time threat detection and response using embedded systems and artificial intelligence. The study covers:

- Hardware selection and integration
- Software and machine learning model development
- Experimental testing and accuracy evaluation
- Ethical considerations and future improvements

II. METHODOLOGY

2.1 Hardware Components

The system integrates multiple hardware components for seamless operation:

2.1.1 Camera Module

A high-resolution camera module is used for continuous facial detection. It provides real-time image processing input to the face recognition algorithm.

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Fig 1: ESP32 Cam module

2.1.2 Microcontroller

A ESP32 microcontroller is responsible for processing the image data, running the AI model, and executing commands for threat response.

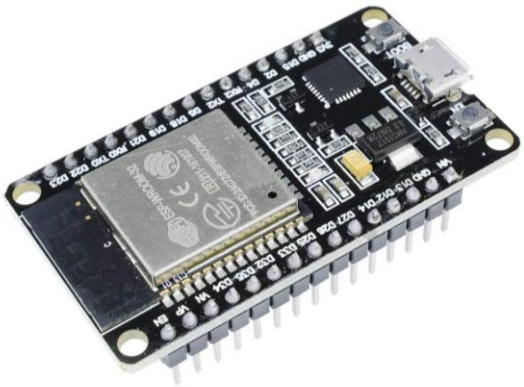

Fig 2: ESP32

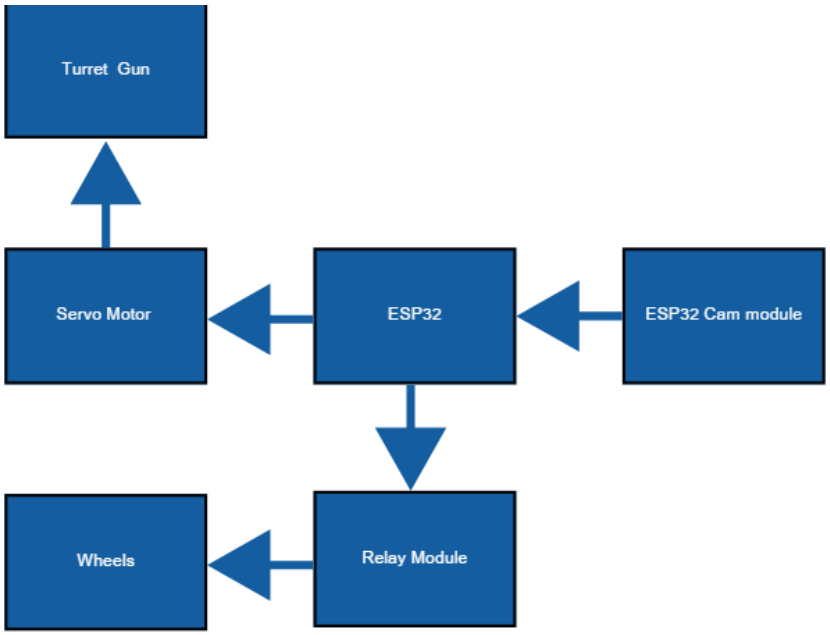

Fig 3: Block diagram of the proposed system

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2.1.3 Gun Mechanism

The gun module consists of:

- Servo Motors: Used to control the direction and movement of the gun.
- Trigger Mechanism: An automated trigger system actuated upon threat detection.
- Firing System: Can be designed using soft projectile launchers or non-lethal countermeasures based on application needs.

Fig 4: Gun model

2.1.4 Chassis and Movement System

The security vehicle is built on a robotic chassis with motors for mobility. It navigates autonomously within predefined patrol areas.

2.1.5 Power Supply

A rechargeable battery system is used to power the microcontroller, motors, and camera module.

2.2 Software and AI Implementation

The face recognition and threat response system are designed using the following technologies:

2.2.1 Face Recognition Algorithm

- Implemented using Deep Learning-based models
- The model is trained with known faces and tested with a dataset of unauthorized faces.

2.2.2 Embedded System Programming

C/C++ is used for low-level control of motors and sensors.

2.2.3 Communication Protocols

- Wi-Fi/Bluetooth for remote monitoring and control.
- Real-time logging of events for later analysis.

2.3 Working Mechanism

1. Face Detection and Recognition:

- The camera continuously captures images and processes them in real-time.
- The AI model checks if the detected face belongs to the trained dataset.

2. Decision Making:

- If the face is recognized, no action is taken.
- If the face is unknown, the system classifies it as a threat.

3. Threat Response Mechanism:

- The gun is aimed toward the detected threat.
- The trigger is activated to neutralize the intruder.

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4. Logging and Alerts:

- The event is recorded with images and timestamps.
- Alerts are sent to security personnel if required.

III. EXPERIMENTAL SETUP

3.1 Training and Testing Dataset

- The face recognition model was trained with 10+ images of authorized personnel.
- Unknown faces were introduced for testing in different lighting conditions and angles.

3.2 Testing Parameters

- Recognition Accuracy: How accurately the system detects known and unknown faces.
- Response Time: The time taken to identify and act upon a threat.

3.3 Deployment and Evaluation

- The system was tested indoors and outdoors.
- Different lighting conditions and occlusions were considered.
- Performance was evaluated based on speed, accuracy, and effectiveness.

IV. RESULTS AND DISCUSSION

4.1 Observations

- The system performed well in controlled environments but struggled in extreme lighting.
- Recognition was slower when multiple faces appeared in a frame.
- The shooting mechanism required further calibration for precision.

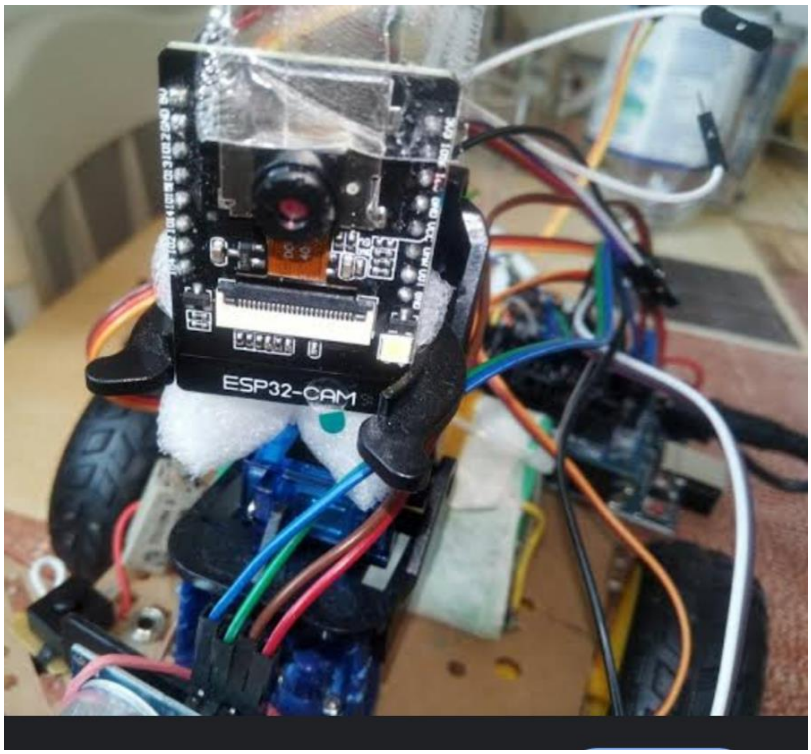

Fig 5: Proposed system

4.2 Challenges and Limitations

- Lighting Variations: Recognition accuracy dropped in dim or overexposed conditions.
- Occlusion Issues: Partial face coverage affected detection performance.
- Legal and Ethical Concerns: Deploying an autonomous weapon system requires compliance with security laws.

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V. CONCLUSION AND FUTURE SCOPE

5.1 Summary

This research demonstrates a working prototype of an Surveillance based radar turret defence system capable of real-time facial recognition and automated threat response. The integration of AI, embedded systems, and mechanical actuation provides an efficient security solution.

5.2 Future Improvements

- Enhanced AI Algorithms: Using 3D face recognition and thermal imaging to improve accuracy.
- Better Mobility: Implementing autonomous navigation using LiDAR or GPS.
- Legal and Ethical Considerations: Ensuring non-lethal defensive measures.

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