CANARA ENGINEERING COLLEGE - PROJECT EXPO 2025 - 2026

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SYRACUSE: AUTONOMOUS TURRET SYSTEM FOR DRONE DETECTION & TRACKING AND REAL-TIME SMART SURVEILLANCE - GROUP 08

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Introduction

- Unmanned Aerial Vehicles (UAVs) have become widely accessible, creating security risks in restricted areas such as campuses, industries, defense zones, and public events. This project presents a low-cost, AI-powered autonomous turret system that detects, classifies, and tracks drones in real time using computer vision. The system combines deep-learning-based detection with a servo-controlled pan–tilt mechanism to maintain continuous focus on a moving aerial target.

Literature Review

- Recent research on UAV security highlights the need for automated drone detection in restricted areas. Studies on YOLO-based vision models show strong real-time accuracy for identifying small aerial targets. Work on pan–tilt tracking systems also demonstrates effective servo-based alignment. Together, these findings support combining deep learning with mechanical tracking for reliable, low-cost surveillance solutions.

Objectives

- Integration of Artificial Intelligence for real-time detection and tracking of UAVs such as Drones.
- Implement a pan–tilt servo-based tracking mechanism to automatically follow the detected drone.
- Build a modular, low-cost prototype suitable for academic research, automated surveillance, and experimentation in AI-based monitoring systems.

Product Design and Development/ Experimental Setup & details

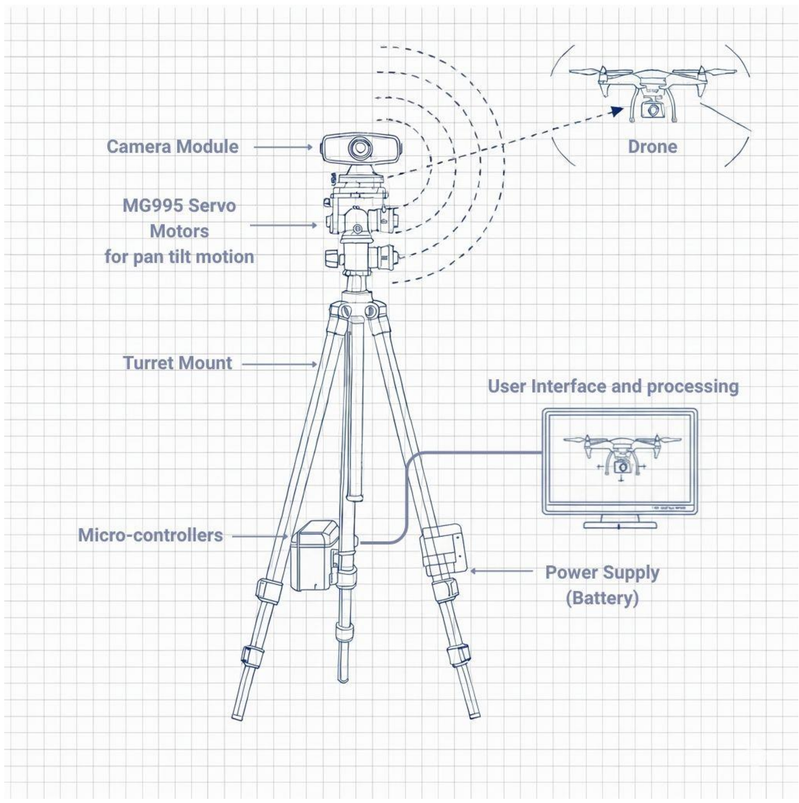

Fig : Drone Detection Turret Diagram

Methodology

1. The system uses computer vision and a YOLOv11 deep-learning model to detect drones in real time.
2. A camera captures live video, which is processed to find the drone's position.
3. Tracking algorithms follow the drone's movement across frames.
4. An Arduino UNO controls two MG995 servo motors to move the camera (pan and tilt).
5. The camera automatically adjusts to keep the drone centered in view.
6. A visual indicator turns on when the drone is successfully locked onto.
7. If no drone is detected, the system switches to an automatic scanning mode.
8. Tests are performed to check detection accuracy, servo response, and system stability.

Results & Discussion

The YOLOv11 model delivered strong real-time detection performance, achieving **91.51% precision**, **91.06% recall**, and an **F1-score of 91.28%**, indicating balanced accuracy and consistency. The system also reached **94.26% mAP@0.5** and **62.72% mAP@0.5:0.95**, showing reliable detection even under varying distances and angles. During testing, the turret maintained smooth pan–tilt tracking and held target lock during most drone movements. When the drone moved out of view, the automatic scanning mode quickly reacquired it. Overall, the combined AI + mechanical design proved stable, responsive, and effective for real-time drone surveillance.

Conclusions and Scope for Future Work

The system reliably detects and tracks drones in real time using YOLOv11 and a servo-based turret, providing stable locking and smooth automated scanning.

Future Scope:
Add long-range sensors, improve tracking control, enable edge deployment, and integrate alert-based surveillance features.

Visible research outputs