

AI based Drone Detection System

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ABSTRACT

This project presents an AI-based drone detection system designed to identify, classify, and track unauthorized drones in real time. With the growing use of drones in agriculture, surveillance, delivery, and disaster management, the risk of misuse in sensitive areas such as airports, military zones, and public events has increased significantly. To address this issue, the proposed system uses artificial intelligence and machine learning techniques to detect drones accurately and distinguish them from birds, aircraft, and other aerial objects. The model is trained using drone image datasets and deep learning, particularly convolutional neural networks, to improve detection reliability. The system processes images and video streams from camera inputs and provides instant alerts when a drone is detected. In addition, it can support monitoring through a web-based interface and hardware components such as ESP32-CAM, LCD, buzzer, and relay modules. The use of data augmentation and diverse training samples improves performance under varying lighting conditions and backgrounds. Overall, the proposed solution offers a low-cost, efficient, and intelligent approach to drone surveillance, enhancing security, reducing false alarms, and supporting safer monitoring of critical and public spaces.

Keywords: Drone Detection, Artificial Intelligence, Convolutional Neural Network

INTRODUCTION

In recent years, the rapid advancement of drone technology has led to widespread use in various fields such as agriculture, surveillance, delivery services, and disaster management. However, along with its benefits, the misuse of drones has also increased, posing serious threats to security, privacy, and public safety. Unauthorized drones can be used for illegal surveillance, smuggling, or even attacks in sensitive areas such as airports, military zones, and public gatherings.

To address these challenges, an AI-based Drone Detection System has emerged as an effective solution. This system utilizes advanced technologies such as Artificial Intelligence (AI) and Machine Learning (ML) to automatically detect, identify, and track drones in real-time. By using sensors, cameras, and signal processing techniques, the system can distinguish drones from other objects like birds or aircraft.

The integration of AI enables the system to learn from data patterns and improve detection accuracy over time. Techniques such as image recognition, deep learning, and pattern analysis help in identifying drone shapes, movements, and communication signals. The rapid expansion of Unmanned Aerial Vehicles (UAVs), commonly known as drones, has significantly impacted various industries, including agriculture, infrastructure monitoring, surveillance, and cinematography. Advances in drone technology have made these devices more accessible, cost-effective, and adaptable to diverse applications. However, their wide spread use also introduces challenges, particularly in security, privacy, and safety. Consequently, the development of reliable drone detection systems is essential to mitigate potential risks and ensure responsible drone operations.

This project aims to develop a robust drone detection system by leveraging deep learning techniques, specifically Convolutional Neural Networks (CNNs) trained using Google's Teachable Machine. CNNs are well-suited for image recognition and classification due to their capability to analyze spatial hierarchies of features.

Google's Teachable Machine simplifies the model training process, offering an intuitive interface for dataset annotation and training without requiring extensive programming expertise. To build an effective detection model, a diverse dataset of drone images is sourced from Robo flow, a platform that supports data annotation and preprocessing for machine learning applications. The dataset is annotated using the PASCAL VOC XML format to ensure precise object labeling. It is then divided into training, validation, and testing subsets to enhance model

generalization and performance evaluation. The training phase focuses on optimizing model parameters to reduce loss functions, ensuring accurate predictions and improving detection reliability.

An AI-based Drone Detection System is an advanced surveillance and security solution designed to identify, track, and classify unmanned aerial vehicles (UAVs) in real time. With the rapid growth of drone technology, unauthorized drone activities have become a significant concern for airports, military bases, industrial facilities, and public events. Traditional detection methods often face challenges in accurately distinguishing drones from birds, aircraft, or other objects.

Artificial Intelligence (AI) enhances drone detection by analyzing data collected from sensors such as cameras, radar, radio frequency (RF) receivers, and acoustic sensors. Machine learning and deep learning algorithms process this data to recognize drone-specific patterns, enabling accurate detection and classification. The system can provide real-time alerts, track drone movements, and support threat assessment and response actions.

AI-based drone detection systems offer improved accuracy, faster response times, and reduced false alarms compared to conventional methods. These systems play a crucial role in strengthening airspace security, protecting critical infrastructure, and ensuring public safety in environments where unauthorized drone operations may pose risks.

LITERATURE SURVEY

[1] Redmon et al. (2016) – YOLO: You Only Look Once

Joseph Redmon, Santosh Divvala, Ross Girshick, and Ali Farhadi introduced the YOLO (You Only Look Once) object detection framework. YOLO performs object detection in real time by processing the entire image through a single neural network. Due to its high speed and accuracy, YOLO has become one of the most widely used algorithms for drone detection in surveillance applications. The model is capable of identifying drones in complex environments while maintaining real-time performance.

[2] Ren et al. (2015) – Faster R-CNN

Shaoqing Ren, Kaiming He, Ross Girshick, and Jian Sun proposed Faster R-CNN, a deep learning-based object detection model. The framework introduced Region Proposal Networks (RPNs), which significantly improved object detection accuracy. Researchers later applied Faster R-CNN to drone detection tasks, achieving reliable identification of drones in aerial and ground-based surveillance systems.

[3] Saqib et al. (2017) – Drone Detection Using Deep Learning

Muhammad Saqib and colleagues developed a drone detection system using deep convolutional neural networks. Their work focused on detecting small drones in video sequences under varying environmental conditions. The study demonstrated that deep learning techniques could achieve high detection accuracy and outperform traditional image-processing methods.

[4] Rozantsev et al. (2017) – Detect and Track Small Flying Objects

Artem Rozantsev, Vincent Lepetit, and Pascal Fua proposed a framework for detecting and tracking small flying objects such as drones. Their approach combined appearance-based detection with motion information to improve tracking accuracy. The study showed promising results in identifying drones even when they occupied only a small portion of the image.

[5] Schumann et al. (2020) – Acoustic Drone Detection

Arne Schumann and his research team investigated drone detection using acoustic signatures. Machine learning algorithms were trained on drone sound data to classify different drone types. The study demonstrated that acoustic sensing could serve as a low-cost solution for drone detection, although performance was affected by environmental noise.

2.2 OBJECTIVE OF THE PROJECT

The objective of this project is to develop an AI-based drone detection system capable of detecting, identifying, classifying, and tracking drones in real time. The system aims to improve surveillance and security by accurately distinguishing drones from other aerial objects, reducing false alarms, and providing timely alerts for unauthorized drone activities. By utilizing artificial intelligence and deep learning techniques, the project seeks to enhance airspace safety, protect critical infrastructure, and support efficient monitoring in various environmental conditions. The main objective of this project is to design and develop an AI-based drone detection system that

can accurately detect, classify, and track drones in real time, thereby improving security, surveillance, and airspace safety.

IMPLEMENTATION AND METHODOLOGY

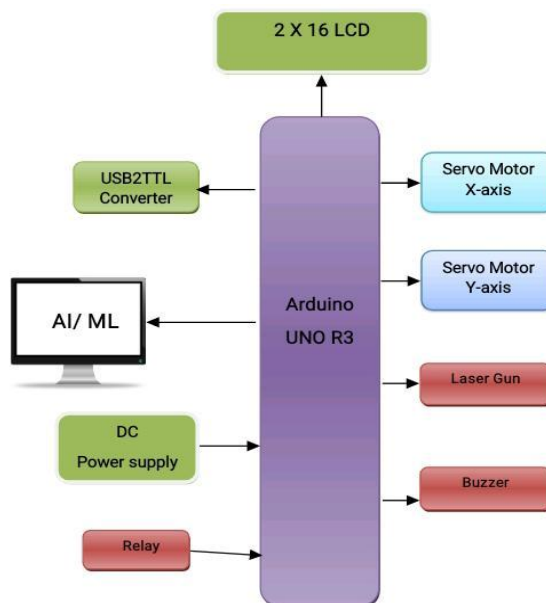


Fig : Block Diagram

COMPONENTS REQUERMENTS

1. ARDUINO UNO
2. POWER SUPPLY
3. LASER GUN
4. LCD
5. SERVO MOTOR
6. RELAY
7. USB2TTL CONVERTER

3.4 IMPLEMENTATION

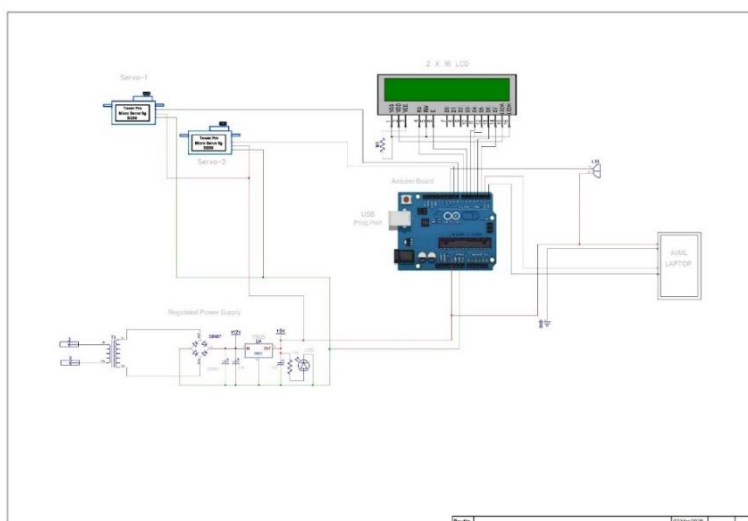


Fig 3.4 : Circuit Diagram

RESULT AND DISCUSSION

The proposed AI-based Drone Detection System was successfully implemented using a Convolutional Neural Network (CNN) model trained through Google's Teachable Machine and integrated with ESP32-CAM hardware. The system was tested using images, videos, and real-time camera feeds containing drone objects under different environmental conditions. The trained model effectively identified drones and distinguished them from non-drone objects with satisfactory accuracy.

The image detection tests demonstrated reliable classification of drone images, while video-based testing confirmed the model's ability to detect drones across multiple frames without significant performance degradation. Real-time hardware testing using the ESP32-CAM module showed that the system could continuously monitor the surroundings and provide instant detection results. Upon successful detection, the buzzer alert and LCD notification were activated, enabling immediate user awareness.

The use of data augmentation techniques and a diverse dataset improved the model's robustness against variations in lighting conditions, viewing angles, and background complexity. The integration of the Flask-based web application provided a user-friendly interface for monitoring and detection. Overall, the experimental results indicate that the proposed system is capable of providing an efficient, low-cost, and real-time drone surveillance solution suitable for security and monitoring applications.

CONCLUSION

AI-based drone detection systems have wide applications across defense, security, and civilian sectors. They enhance safety, prevent illegal activities, and protect sensitive areas by providing real-time monitoring and intelligent threat detection. The AI-based drone detection system represents a significant advancement in modern surveillance and security technologies. By integrating techniques from Artificial Intelligence and Machine Learning, the system is capable of accurately identifying, tracking, and classifying drones in real-time, even in complex and dynamic environments.

This technology enhances safety in critical areas such as airports, military zones, and public spaces by detecting unauthorized drone activities. Unlike traditional detection methods, AI-driven systems offer improved accuracy, faster response times, and adaptability through continuous learning. They can analyze multiple data sources such as radio frequency signals, audio patterns, and visual inputs to ensure reliable detection.

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