# Drone Detection in Long-Range Surveillance Videos

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**Abstract – The use of drones is increasingly apparent.in contemporary society is evident the In recent years, significant progress in drone technology has enabled drones to execute increasingly complex tasks. The escalating proliferation of drones within the national airspace,encompassing both recreational and commercial applications, has spurred concerns regarding potential misuse. Instances such as smuggling and violations of privacy underscore the necessityfor effective drone detection systems. Detecting drones presents challenges due to the presence of Identifying drones amidst similar objects in the sky, like airplanes and birds, presents a significant challenge. Furthermore, automated detection systems require substantial training data to ensure high accuracy. Real-time detection further necessitates sophisticated hardware configurations like graphical processing units (GPUs). In addressing these challenges, the studypresents a remedy Introduce the text by means of a one-shot detector named You Only Look Once version 5 (YOLOv5). This model effectively utilizes pre-trained weights and integrates dataaugmentation techniques to optimize the training process. Evaluation of The trained model hasachieved conducted using metrics such as "Mean Average Precision (MAP)" denotes the average precision value computed across various classes or categories within a classification context and recall.[1]**

**Keywords- Machine Learning Algorithm, object recognition, deep learning, YOLO v5.**

## I. INTRODUCTION

The Drones are increasingly favored for their affordability, versatility, and lightweight construction, finding wide-ranging applications across various industries. As of October 3, 2022, the registration count for drones stood at 865,505, with a notable portion intendedfor recreational purposes. Nonetheless, the widespread presence of drones prompts substantial apprehensions concerningpublic safety. Their potential to transportexplosiveshas sparked fears of targeted attacks on public spaces, leading to exploitation by smugglers and terrorists. Recent advancements in object detection, particularly with YOLOv5, aim to refinetinyobject detection. This study concentrates on optimizing drone detection using YOLOv5, conducting experiments oncomplex datasetsto accurately discern drones within short videos.[1]

## II. AIMS AND OBJECTIVE

### a) Aim

Testing some popular YoloV5, version 5 Model Architecture to see the drone detectionproject is to develop an effective and reliable system for detecting and identifying unauthorized drones Within a specified airspace.

### b) Objective

- The Aim Objective is to Enhance security by detecting and mitigating threats posed by rogues drone. Protect sensitive areas such as airports, government facilities, and public events from unauthorized drone incursions.
- Monitor airspace for compliance with regulations and enforce no-fly zones. Provide real-time alerts to authorities about unauthorized drone activity. Utilize a combination of sensors, cameras, and radar to accurately identify and locate drones

## III. LITERATURE SURVEY

**Paper 1: Drone detection using YOLOv3with transfer learning on NVIDIA JetsonTX2**

The proliferation drones in contemporary society is evident. In recent years, this growthhas been largely attributed to advancements in drone technology, which empower drones


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to undertake increasingly complex tasks. autonomously with the incorporation of technologies like computer vision, object avoidance and artificial intelligence. instances of dronemisuse, exemplified by theGatwick Airport incident, led to significant disruptions impacting roughly 140,000 passengers.Implementing drone surveillance becomes imperative to avert comparable incidents in the future. This entails initial detection followed by Drones tracking.This research introduces and investigates the utilization of YOLOv3, a object detector, incorporating Pre-trained transfer learning and weight are utilized in the process. methodologies to specifically train the model for drone detection. This study Finally, integratedYOLOv3, which demonstrated an overall accuracy post-machine learning with aninput taken image size of 416 x 416, into NVIDIA.[5]

**Paper 2: Drone Detection and Identification System using Artificial Intelligence**

In this paper, As drones gain significant attention, the drone industry has expanded its market to include everyday consumers, allowing drones to be integrated into daily life. As drones become more accessible to a wider range of users, concerns regarding safety and security have escalated due to increased risks of accidents, such as collisions with individuals, loss of control, or trespassing on secured properties. The system is specifically tailored for utilization on drones equipped risks of accidents, such as collisions with individuals The system is actualOpencv library.[8]

Paper 3: Drone Detection based on An Audio-assisted Camera Array

In recent times, the significant advancements of small, low-cost UAVs, often referred to as drones, have introduced notable concernsregarding privacy and security. Detection of drones stands out as a critical approach toaddressing these issues. Primary obstacles in drone detection include:

1) Difficulty in distinguishing drones from other airborne entities like birds, 3) Limited coverage provided by existing surveillance systems. The deployment of a camera array system presents a viable solution for extensive airspace monitoring.[9]

**Paper 4: A Video Streaming Vehicle Detect- ion Algorithm Based on YOLOv4**

The Series YOLO and SSD, Retina Net method are two one-stage target identification algorithms that excel in both accuracy andspeed. Vehicle detection is still some distance from real-time, but the newest algorithm in theYOLO series, YOLOv4, has improved the rapidity and precision of vehicle target recognition compared to prior Version Themost used methods for measuring the speed ofmoving vehicles are technologies used in aircraft or video frames, radar, photo detectionand ranging, drones' radar.[10]

## IV. EXISTING SYSTEM

Various methods are employed in drone detection systems, including radar technology, which provides data on a drone's location, speed, altitude, and direction, with Doppler radar aiding in distinguishing drones from other objects. Radio Frequency (RF) detection utilizes sensors and spectrum analyzers to identify radio signals emitted by drones, potentially revealing details about the drone's manufacturer and model. Acoustic sensors detect unique drone sounds, complementing other detection methods for improved accuracy. Additionally, optical and infrared cameras offer visual confirmation ofdrones.[3]

## V. COMPARATIVE STUDY

| Sr. No. | Author | ProjectTitle | Publication | Technology | Purpose |
|---|---|---|---|---|---|
| 1. | Burchan Aydin, Subroto Singha. | Drone Detection Using YOLOv5 | MDPI, 2022 | YOLOv5 | An drone technology thatfurnishes droneswith the capability to Detect drone In Long Range. |
| 2. | qi Dongkyu 'Roy' Lee, Sir Woong Gyu La, Hwangnam KimExplanation | Drone Detection and Identification System using Artificial Intelligence | IEEE, 2020 | OpenCV | magery and information for learning processwith OpenCVlibrary |
| 3. | Zhou Hao Liu1, Zhiqiang Wei1 Yitong Chen2, Jie Pan1 Le | Drone Detectionbased in a Audio- assisted CameraArray | IEEE, 2019 | UAV | his paper proposesUAV– also known as drone which brings privacywith security issues. |
| 4. | Ruchita ValabojuChitiprolu Harshitha Alekhya Reddy Kallam | Drone Detection and Classification using Computer Vision | IEEE2020 | CNN | Drones that are usedforespionage can retrieve valuable information regarding the differentstrategiesof the military. |

Table 1: Comparative Study

## VI. PROBLEM STATEMENT

This project utilizes transfer learning with YOLOv5 to develop a detection system addressing concerns over unauthorized role activities Its goal is to precisely identify and track drones in real- time across a range of contexts.

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This is because tracking drones in sensitive regions, protecting public events,and improving security in vital infrastructuresall depend on it. In modern world when dronesarecommon, the project aims to provide an effective way to reduce the risk of drone threats by utilizing cutting-edge machine learning techniques. This will enhance overallsafety and securityprotocols.[2]

## VII. PROPOSED SYSTEM

**Training Images:** This block refers to a collection of images that the system is trained on to identify drones. In the training phase,the system learns to recognize the features ofadrone in an image.[7]

**Fine-tuned YOLOv5:** This block refers to a pre-trained YOLOv5 model that is further customized to improve its ability to detect drones in long-range surveillance videos. Thiscustomization process is called fine-tuning.[1]

**Object Detection**: In this block, the fine- tuned YOLOv5 model is used to detect drones in unseen surveillance videos. When a video frame is given, the system searches the frame for features that resemble those of a dronebased on what it learned from the trainingimages.[6]

**Testing Videos:** This block refers to a set of videos the system is tested on to measure its accuracy in drone detection in real-world scenarios.[4]

### 1. YOLO-5 Model Files

# Install Required Libraries

-You start by installing the necessary Python libraries: `numpy`, `opencv- python`, and

`torch`.Theselibraries are essential for working with the YOLO-5 model and images.

# Example: pip install numpy opencv-pythontorchimport cv2

import torch

frommodels.experimental import attempt_load

### 2. Load the YOLO-5 Model

# Load the YOLO-5 Model

-The codeloads the YOLO-5 model using the

`attempt_load`function. It delineates the route towards theYOLO-5 model weights (e.g., 'yolov5s.pt')and setsthe target device to 'cpu'for inference.

Model=attempt_load('yolov5s.pt',map_location='cpu')

Load an Image for Detection

-Load the image you want to analyze for detection using OpenCV. Replace 'your_image.jpg'with the path to your image.image = cv2.imread('your_image.jpg')

### 3. Visualize Detected Objects Visualize Detected Objects

- If objects are detected, this step iterates throughthe objects and draws bounding boxes of the labels on the image. Ithighlights the locationandclass of each detected object.

if results:

for det in results[0]: image.shape[:2]).round() plot_one_box(det,image, color=(0, 25, 0),label=f'Object

{int(det[5])}')

## IX. MATHEMATICAL MODEL

### 1. YOLO, v5

Logistic YOLOv5 represents a cutting-edge live object detection algorithm at the forefrontof the field. Is The fifth Varient of the YOLO series of the object detection models, which areknown for and accuracy rate in detecting objects in images and video frames. YOLOv5 capitalizes on the strengths of its predecessors while also introducing several improvements. YOLOv5 for a drone detection project involvesseveral key steps. YOLOv5 is a Fastest Object detection in real-time is the ability to identify and locate objects within a scene instantaneously that can be adapted for dentifying drones within images or video sources

- Input: Let's denote the input image as J, where I is a3D tensor representing Theimage'sheight (), width (W), and channels (C). So, J €RExWxc a specialized deep learning architecture designed to effectivelyprocess and analyze visual data by employing convolutional layers to features hierarchically The YOLOV5 architecture typically consists of a deep CNN that extracts features of an the input image. Let f(L) represent the output featured an map from the CNN. f (J) is a 3D tensor with spatial dimensions & x us where Sis the stride.

Anchor Boxes : Anchor boxes are used to predict bounding boxes of objects in the image.Let B be the anchor boxes and its number, andA be the number of attributes associated with each anchor box (e.g., width, height, class scores). The anchor box be represented as A;

€ REX where 2 corresponds to a particularspatial location in the feature map. Bounding Box Predictions: The YOLOv5 model predictsbounding boxes for the image. Let P be the setof predicted bounding boxes. Each bounding box R®x4 can be represented as iB e, where 7 corresponds to a specific object class.

Output:

$$\sum \alpha_i +_2 w \;\; w{-}w \;\sum \alpha_i \, d_i \, x_i{-}b \sum \alpha_i d_i$$

The final output of the The YOLOv5 model structure can be denoted as **Y € Rs* 5% (4B+C)** encompassing bounding box coordinates, objectness scores, and class probabilities.

Loss Function: The loss function L used to train the

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YOLOv5 model is A fusion of localization loss, evaluating the precision of bounding box forecasts,and classification loss, assessing the accuracy of class forecasts. Itcan be represented as: L= Aeoord Yo Yop Obj; [MSE(Bbox;;, Bbox!*) + AciassMSE Here:Acoord and Aciass are hyperparameters. 0 ge represents the number of spatial positions within in the feature map. Obj;is an indicator variableindicatingwhether an object present at location 2. " Bbox;; and Bbox!; represent the anticipated andactual truth bounding box coordinates. Class;; and Class'; represent the anticipated and actual ground truthclass probabilities. This mathematical model captures the fundamental components and operations of YOLO, v5 of detection in a drone detection project. It involves extracting features from an input image, predicting bounding boxes on class probabilities, and optimizing the modelusing aloss function during training. If the square of an parameter diminishes and falls below the data dimensions, 'h' will eventually become independentof dimension.

$g(x) = W^T x + b$

Maximizek such that :

$w^T x + b \geq k$ for $d_i == 1$ $w^T x + b \leq k$ for $d_i == -1$

Value of g(x) depends upon || w ||: 1)Keep

|| w ||=1 and maximize g(x) or ,

$\Rightarrow \alpha_i[d_i \; x_i + b0) - 1] = 0$

$\Rightarrow either \alpha_i = 0$ o0r$d_i(\omega^T x_i + b0) = 0$

## X. SYSTEM ARCHITECTURE

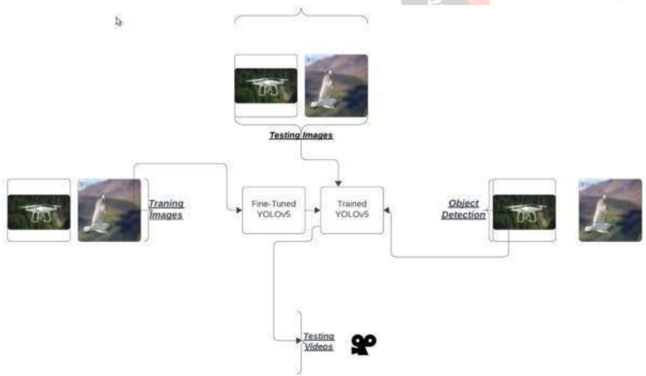


Fig 1:system architecture

**Training Images:** Images used to teach the system to recognize drones.

**Fine-tuned YOLOv5:** Pre-trained model customized for better drone detection.

**Object Detection:** System uses fine-tunedmodel to spot drones in videos.

**Testing Videos:** Assess system's Accuracy.

## XI. ADVANTAGES

- Help identify unauthorized drone activity and increases potential security threats.
- They can safeguard individuals' privacy by preventing drones from capturing unauthorized images or videos.
- It helps in managing airspace,preventingdisruption to manned aircraft and ensuring safety.
- Drone detection systems can help authorities combat smuggling activities, as drones are sometimes used to transport contraband across borders

## XII. DESIGN DETAILS

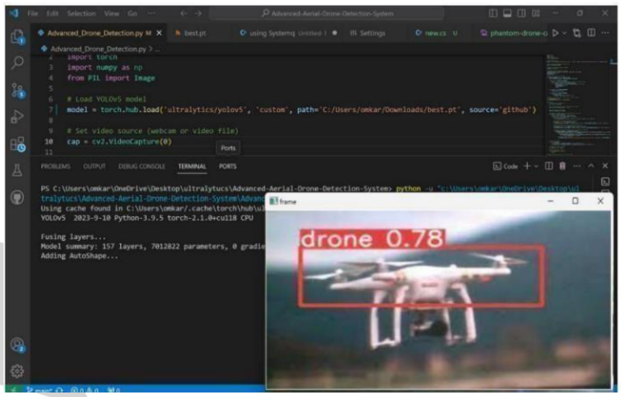


Fig 2:Result

## XIII. CONCLUSION

Thus, We have tried to implement the paper "Aydin, Burchan, Subroto Singha", "Drone Detection Using YOLOv5", MDPI 2023 the implementation of drone detection in long- rangesurveillance videos using YOLOv5 technology presents a robust solution to enhance security and monitoring capabilities in various environments. Through meticulous data collection, model training, and testing, our project demonstrates the effectiveness of YOLOv5 in accurately detecting drones amidst complex backgrounds and varying conditions. By deploying the trained model, we can efficiently identify and track drones in real- time, empowering surveillance systems with the capability to respond promptly to potential threats. This project not only showcases the potential of YOLOv5 in aerial surveillance but also lays the groundwork for further advancements in drone detection technology, contributing to the ongoing efforts in ensuring safety and security in our skies

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