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Detection of Drone Using CCTV Live Feed

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ABSTRACT

Drones are intended to create innovation and economic opportunities, but they also offer security risks. We provide technology that detects drones in real time using CCTV feeds, which is incredibly important in protecting our establishments and sensitive locations. Our solution is intelligent enough to recognize birds, and other flying objects from drones and detect them from afar. The YOLO algorithm will provide an optimal solution in real-time, our application alerts authorities when drones are spotted closer. A single convolutional neural network is used by the YOLO algorithm, a real-time object-detection system, to identify objects in a picture. The algorithm is evaluated on a set of test images after being trained on a collection of drone images to see how well it performs. Results show that the YOLO algorithm can accurately detect drones in images with a high detection rate and low false positive rate. This method can be used for various applications such as security surveillance and airspace management. Overall, this demonstrates the effectiveness of using the YOLO algorithm for drone detection in real-world scenarios.

Keywords — Drone detection; Image YOLO algorithm; real-time detection; CCTV; alert authorities;

I.INTRODUCTION

Drone detection technology has become increasingly important in recent times due to the growing popularity and usage of drones for both commercial and recreational purposes. As drones have become more affordable and accessible, they have also become an implicit security threat, as they can be used for illegal activities such as smuggling, espionage, and terrorist attacks. To combat these threats, various drone detection systems have been developed to detect and track drones in real time, providing security personnel with the necessary information to take action. These systems use a combination of technologies such as radar, cameras, and acoustic sensors to detect and locate drones, and can be integrated into existing security systems to provide an added layer of protection. With the increasing use of drones, drone detection has become a critical component of modern security systems and will continue to be an important area of research and development in the future. Drone detection using CCTV live feed with YOLO algorithm and RTSP link involves the use of deep learning and computer vision technology to identify and track drones in real time. The YOLO algorithm enables accurate detection and tracking of drones in the live feed, while the RTSP link ensures seamless streaming of the video feed. A subfield of machine learning called deep learning involves training artificial neural networks to make predictions from complex data. However, the human brain provides a model for how neural networks, which process information via layers of connected neurons, are organized and function. These layers in deep learning are made up of artificial neurons that process and alter the input in progressively more complicated ways, allowing the network to learn from and generalize to vast volumes of data at the cutting edge of technology.

It is an effective technique for resolving complicated issues in a variety of applications, such as computer vision, natural language processing, and speech recognition. Deep learning has revolutionized the field of computer vision, providing powerful tools for detecting and tracking objects in real time. In the context of drone detection, deep learning algorithms such as YOLO have emerged as a popular solution for identifying and tracking drones using CCTV live feed. A convolutional neural network is used by the YOLO method, a single-stage object detection technique, to forecast object classes and bounding boxes for those items in an image or video feed. This allows for real-time detection and tracking of objects, making it an ideal solution for drone detection applications.

To train the YOLO algorithm, large datasets of drone images are required. These datasets can be generated using various techniques, including manual annotation, automated annotation using machine learning algorithms, and synthetic data generation. The YOLO algorithm may be used to detect and track drones in real-time utilizing CCTV live stream and RTSP connections once it has been trained. The benefits of using deep learning in drone detection are numerous. Firstly, it provides highly accurate and reliable detection and tracking of drones, reducing the risk of security breaches and potential harm to people and property. Secondly, it enables automated detection and tracking, reducing the need for human intervention and increasing the efficiency of surveillance operations. Finally, it can be used in a variety of industries and applications, from security and surveillance to agriculture and environmental monitoring.

Deep learning algorithms such as YOLO have emerged as a powerful tool for detecting and tracking drones in real-time using CCTV live feed. With the increasing use of drones and their potential security threats, drone detection systems powered by deep learning are becoming essential tools for maintaining safety and security in public spaces and critical infrastructure.

II.EXISTING SYSTEM

Using a Visual Detection Algorithm, computer vision algorithms can be utilized to analyze the real-time video stream from CCTV cameras and find the presence of drones. To identify and track drones in real time, this algorithm typically uses object recognition, motion detection, and tracking techniques. Drone visual signatures can be recognized using optical sensors, such as cameras with specialized lenses or filters. These sensors can recognize the distinctive features of drones, such as their size, shape, or movement patterns, and inform users when one is found. Drone sound characteristics can be identified using acoustic sensors. These sensors are made to identify the distinct audio patterns that drones emit, such as the sound of rotors or engines, and to send out an alert when a drone is found. The use of radar technology can be used to find drones. To find objects in the airspace, radar devices emit radio waves and measure the reflected signals. Drones can be located and followed by examining the radar signals. RF sensors can locate drones by picking up their radio emissions. By identifying the signals drones use to communicate with their operators, radiofrequency (RF) sensors can detect the presence of drones. Identifying drones, it is possible to connect drone identification software with existing CCTV systems to analyze video data. To recognize and monitor drones in real time, these software solutions use a variety of technologies, including image processing, machine learning, or deep learning techniques.

1. III.LITERATURE SURVEY

In this section, we evaluate and analyze existing techniques for spotting and identifying intrusive drones, as well as how they could be applied in practical situations. Finally, we discuss the application of deep learning methods to drone systems. The development of the RF-based drone detection and identification system and the drone RF database both make use of experimental settings and preprocessing. Following that, samples from the created RF database are presented, along with an analysis of its spectrum data for several drones operating in various flight modes, and ultimately an RF-based drone recognition and identification system [1]. The alternative method gathers photographs from freely accessible public sources and uses databases of images of birds and drones. A YOLOv4 model was trained and assessed using the acquired pictures using our drone recordings. Since different object detection methods require datasets to be labeled in distinct formats, which takes time, this study was restricted to YOLO implementation [2]. Since YOLOv4 has minor disadvantages like time consumption and accuracy in prediction, it does support not environmental factors. Another methodology of detecting and tracking a moving target from a UAV. A vision-based approach for micro-UAV detection and distance estimation was proposed [3]. Vision-based systems typically have limited range capabilities. The effectiveness of the approach may decrease as the target moves farther away from the UAV. This often requires significant computational resources to process the visual data in real-time. In complex environments or crowded spaces, there may be occlusions or visual clutter that can obstruct the view of the target or confuse the vision-based system. These circumstances can result in erroneous distance estimates and detection. The research was conducted using the region-based detectors, Faster RCNN with the Resnet-101 and then Inception v2-based architectures and SSD with Inception v2. They began training with transfer learning from publicly accessible pre-trained COCO models to hasten convergence [4]. COCO models are trained on a specific dataset that contains a diverse range of object classes. However, the dataset might not cover objects or scenarios specific to drone applications.

The framework for drone identification suggested in the research is based on listening to ambient sound and identifying the drone's acoustic signature. Five modules make up the framework: audio capture, preprocessing, short-term analysis, mid-term analysis, frame modeling, imaging, and decision-making. Taking up sounds from the environment and digitizing them is the process of audio acquisition. Digital sound segments must be preprocessed by being divided into frames, normalized, and made ready for additional analysis. The system ranks the audio segment's content using SVM classifiers based on the proportion of structures with the "drone" tag, which denotes the presence of a flying drone in the surrounding area [5]. The quality of the acoustic signature database has a significant impact on the accuracy and dependability of sound-based drone detection systems. In this paper, a video-based drone monitoring system has been suggested. To improve the training data, they developed a model based on data augmentation approaches, and they used residual photographs as the drone tracking module's input [6].

The use of radar systems for drone detection with helicopters. Radar systems are preferred for micro-Doppler-based analysis when drones are detected. Additionally, it presents the claimed successes of passive forward scatter radar (PFSR), a new approach, for both ground- and aerial target detection [7] and Radar systems used for copter drone detection may have limited resolution. A dataset was created that uses a KCF tracker to classify data in a semi-automatic fashion rather than by hand. The structure of the YOLOv2 model was then modified using the input picture resolutions, and the dimensions of the anchor box for the drone's focus were adjusted [8]. The moving object detection is based on background subtraction, while classification is performed using a convolutional neural network (CNN) [9].

The recent development of a drone detector module utilizes a Haar Feature-based Cascade Classifier from OpenCV to accurately detect drones in video frames. Positive and negative examples were collected and used to train the classifier. The drone identifier module uses a CNN with two Conv layers and two fully connected layers to classify the drone's model based on the cropped image [10]. The research utilizes YOLOv5, a fast and high-performing object detection algorithm, for drone detection. YOLOv5's backbone, the CSPNet, reduces complexity and resolves gradient issues while extracting features. The PANet performs feature fusion, allowing high-level features to be known for final object detection [11].

Most video and audio sensors and a thermal infrared camera are two examples of recently created techniques. The system also includes a fish-eye lens camera with a broad road field of view that is used to identify objects that are moving and is utilized for directing these cameras in particular directions of interest [12]. This fish-eye lens has limited resolution and potential distortion, higher cost due to the integration of multiple cameras, complex calibration requirements, increased processing demands, higher power consumption, and potential privacy concerns. The system implementation contains four components: situation awareness module, PTZ (pan-tilt-zoom) platform, multi-class drone classifier using deep learning, and alert command center [13].

Some of the methods use the combination of MobileNet and the Single Shot Detector (SSD) framework for the fast and efficient deep learning-based method to object detection of drones [14]. Another approach includes the K-nearest neighbor method is then used to match the image descriptors and all the algorithms are run on the Qualcomm platform in real-time [15]. By synthesizing and critically evaluating the available literature, this survey has laid the groundwork for the subsequent sections of this paper, allowing us to present a novel and valuable contribution to the field.

2. IV. PROPOSED SYSTEM

A novel technique for real-time drone identification and tracking uses CCTV live feed with the YOLOv5 software. The goal of this suggested system is to improve security and monitoring in a variety of locations, such as critical installations, commercial sites, and huge events. By leveraging the power of deep learning and computer vision, the system can accurately identify and alert the presence of drones, mitigating potential threats. The software implementation of the proposed system involves several steps. Firstly, a CCTV camera is used to capture the live video feed of the monitored area. The YOLOv5 algorithm, which has been trained on a large dataset of drone images, is integrated into the software. This algorithm is capable of recognizing and classifying drones accurately. Each frame from the CCTV live feed is then passed through the YOLOv5 algorithm for drone detection. The algorithm analyzes the frame and identifies the presence of drones based on their specific features such as shape, size, and movement patterns. Upon detecting a drone, the system triggers an alarm or alert system to notify security personnel. This can include visual notifications on a screen, text alerts to security personnel, or even sound alerts to grab immediate attention. Real-time tracking of the detected drones is also implemented, enabling security personnel to monitor their movements and take necessary actions promptly.

The technical procedure involved in the implementation of this software includes setting up the software environment, integrating the YOLOv5 algorithm, processing the video frames, implementing a sound alert system, and developing a graphical user interface (GUI) for user interaction. Training YOLOv5 to detect drones using Google Colab involves a step-by-step process. First, you need to collect a dataset of images or videos that contain drones. It's crucial to have a diverse range of drone images with different angles, lighting conditions, and backgrounds. Once you have the dataset, you need to annotate it by drawing bounding boxes around the drones and assigning labels to these regions. Next, you need to convert the annotated data into the YOLO format. This involves creating text files where each line represents an image and its corresponding object annotations. Afterward, you customize the YOLOv5 configuration file to suit the drone detection task. This includes adjusting parameters like network architecture, input image size, number of classes (in this case, the drone class), and training hyperparameters. To start training, you upload the annotated data and YOLOv5 code to a Google Colab notebook, leveraging the computational power of Google's GPUs. You install the necessary dependencies and libraries required for YOLOv5, such as PyTorch, NumPy, and OpenCV. Then, you run the training script in the Google Colab notebook, which loads the YOLOv5 model, initializes the weights, and begins the training process using the annotated data. During training, you monitor the progress and evaluate the model's performance on a validation set. If needed, you can fine-tune the training process by adjusting parameters like the learning rate and batch size to improve detection accuracy. Once training is complete, you save the trained YOLOv5 model, including its weights and configuration files. Finally, you can use the trained model for inference on new images or video frames. You may analyze the output predictions, including bounding box coordinates and confidence ratings, bypass the input data through the model, and use the results to instantly identify and locate drones. Using YOLOv5 and Google Colab, this procedure enables the creation of an effective drone detection system. To set up the software environment, the required libraries such as OpenVC, Numpy, Winsound, frameworks, and dependencies are installed. Python, known for its ease of use and extensive support for deep learning libraries, is commonly used as the programming language. The YOLOv5 algorithm, with pre-trained weights and configuration files, is integrated into the software. By using a convolutional neural network to analyze each frame of the CCTV live stream, video analysis, and drone identification are carried out. The YOLOv5 algorithm analyzes the frame, identifies drones, and extracts their location information. A sound alert system is implemented to enhance the effectiveness of drone detection. The program makes a characteristic sound, like a warning beep or siren, when a drone has been detected to inform security staff. A graphical user interface (GUI) is created to

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offer a user-friendly interface. The GUI allows users to start and stop the detection process, enter the RTSP link for the CCTV live feed, and display the video feed with real-time drone tracking.

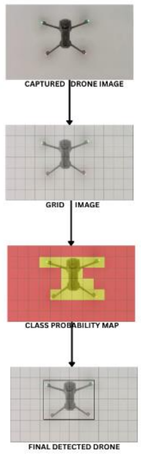

Figure 2. Working of YOLO

The proposed system offers several advantages and finds applications in various domains. Firstly, it enhances security by detecting and tracking drones in real-time, allowing security personnel to respond promptly to potential threats. It provides efficient surveillance of sensitive areas, industrial sites, and large events, offering an additional layer of protection. Real-time detection and tracking capabilities ensure continuous monitoring and situational awareness. The system can be customized to fit specific requirements and can scale to monitor multiple CCTV feeds simultaneously. With its versatility, the proposed system finds applications in diverse fields, including defense, law enforcement, critical infrastructure protection, and event management.

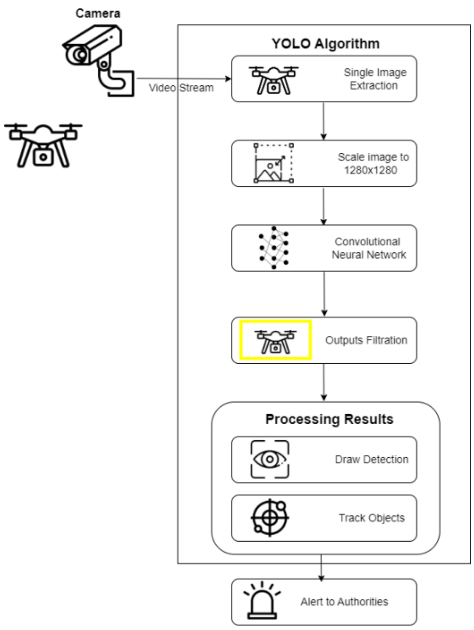

Figure 1. The Architecture of Drone Detection

3. V. RESULTS AND DISCUSSION

The accuracy of the YOLO method, the richness and variety of the training dataset, and the available computer resources are some of the variables that affect how well a drone detection system performs. To efficiently train the algorithm, a well-annotated and varied dataset is essential. Additionally, fine-tuning the

YOLO model specifically for drone detection can enhance its accuracy. It's important to note that the effectiveness of a drone detection system using YOLO may vary in different environments and conditions. Factors like lighting conditions, drone sizes, and backgrounds can impact the algorithm's performance. Continuous monitoring and updates to the algorithm and training dataset can help improve its accuracy over time.

Overall, the YOLO algorithm provides a promising approach for real-time drone detection. However, the specific results and discussions about a particular drone detection system using YOLO would require access to relevant research papers, reports, or implementations.

4. VI.CONCLUSION

Drone detection technology is a rapidly evolving field that is becoming increasingly important in addressing security and safety concerns related to the growing use of drones. The technology uses a combination of technologies such as radar, cameras, acoustic sensors to detect and locate drones in real time, providing security personnel with the necessary information to take action. The YOLO algorithm is a deep learning-based object detection algorithm that is designed to be fast and efficient, and it's one of the most commonly used for drone detection. The need for drone detection technology is clear and the scope is vast, it is essential to ensure the safety and security of the general public and the critical infrastructures. The development of drone detection systems using CCTV live feed offers an innovative and effective solution for detecting and monitoring drone activity. The system offers numerous benefits, including the ability to detect potential drone threats and prevent security breaches. The integration of multiple modules, including object detection, tracking, data analytics, and user interface, allows for a comprehensive and efficient security solution.

In the future, Drone detection systems that use CCTV live feed are anticipated to advance in sophistication and be integrated with other security systems in years to come. Artificial intelligence (AI) and machine learning algorithms can substantially enhance drone identification and tracking while reducing false alarms. Additionally, improvements in camera technology and the development of specialized cameras for drone detection can enhance the accuracy and range of the system. With the continuing advancement of technology and the growing need for effective security solutions, the future of drone detection using CCTV live feed is bright, and the potential for further innovation is significant.

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