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A REVIEW ON IMPROVEMENT OF DRONE DETECTION AND TRACKING SYSTEM USING ARTIFICIAL INTELLIGENCE

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ABSTRACT

The development of the drone industry has led to an increase injudicious, unauthorized, and illegal drone use, which has resulted in significant harm to society and the economy. They look at some major incidents involving drones around the world and identify essential characteristics for upcoming anti-drone systems. According to this study, the drone industry has made drones that can be used in everyday life available to the general public because of the widespread interest in them. However, as the use of drones became more widely available, the likelihood of accidents has increased, raising concerns regarding safety and security: slipping out of control, colliding with others, or breaking into secured properties. It is fundamental for the two eyewitnesses and the robot to know about an oncoming robot for wellbeing reasons. This paper presents a comprehensive drone detection system based on machine learning as a result of a literature review of various studies and the various issues encountered. All of these issues will be addressed by future research.

Keywords: - Drone safety, Drone security, artificial intelligence,UAV etc.

INTRODUCTION

The quantity of robots being utilized for military, business, and security designs is ascending pair with the progression of robot innovation [Lee 2018, Pham 2020]. Numerous drone types have received a lot of attention in recent years [Hama 2019] due to their effectiveness in airport security, facility protection, and integration into security and surveillance systems. However, drones may also be viewed as a serious threat in these security areas. As a consequence of this, it is of the utmost importance to develop a useful approach for identifying various kinds of drones for use in these applications [Pham 2020]. In order to keep drones safe and prevent their intrusion, these technologies can be incorporated into military systems and airport security. UAV detection, recognition, and identification are therefore essential when discussing public safety and the threats posed by UAVs. Detection is the process of observing the target, which may be suspicious and pose a security risk to the environment. Identification is the process of diagnosing the kind of target category, while recognition is the process of identifying the target category. This article distinguishes two distinct drone species from birds on the basis of their physical and behavioral similarities. Different sensors, similar to radar, can be utilized for this reason. LIDAR sensors [Lee 2018] and RF-based sensors [Hama 2019] Acoustic and warm sensors have likewise been used in the discovery and acknowledgment of robots. However, making use of these sensors necessitates a significant investment of money and energy [Hama 2019]. These sensors are difficult to integrate with drones due to their weight and size, and when it comes to thermal imagery, sensors typically have lower resolution. In contrast, thermal sensors have a lower resolution than visible imagery, and integrating sensors and drones does not pose problems. However, visible imagery also suffers from lighting issues, crowded backgrounds, and occluded areas. Therefore, the solution to this problem depends on how to locate and identify the drone. Over the past ten years, deep learning networks have emerged as the ideal model for visual processing tasks like object tracking and detection [Pham 2020]. they begin with a set of suggested areas and then break them down into distinct object categories for each area, area-based detection techniques fall into this first category. Deep learning methods like YOLO and SSD, which use classification and regression to find objects, fall into the second category. The advantages of visible imagery include its low cost, high resolution, and adaptability to a wide range of drones. This is due to the difficulties associated with various sensors as well as the significance of recognizing and detecting drones for a variety of purposes, including public safety. However, there are challenges, such as crowded backgrounds and images that, due to their small size, mistake drones for birds; Consequently, a suitable approach to addressing these issues is required. Because of its higher exactness, speed, and exact investigation of the information pictures, the Consequences be damned Profound Learning Organization is the best way to deal with conquering these impediments. This network's most recent version detects objects more quickly and precisely than previous versions [MARIN 2021]. UAV recognition and detection are investigated using visible imagery and YOLOv4 Deep Convolutional Neural Networks in this paper.

Unmanned Aerial Vehicles (UAV)

Deep learning network object detection has eceived a lot of attention [MARIN 2021] due to its superior accuracy and computational power. The best illustration of a deep neural network for object recognition is convolutional neural networks (CNNs) [A.K. 2021]. These networks have been considered and studied more extensively for object recognition due to their effectiveness in feature extraction. They are more appealing for object recognition because they extract more features than traditional methods. Based on how they look at input from the network, object recognition techniques can be divided into two groups.

A type of aircraft that does not have a human pilot on board are referred to as unmanned aerial vehicles, also known as drones or UAVs. There are a number of ways

that drones can be controlled remotely by a human operator or autonomously by onboard computers[Lee 2018]. At first, drones were mostly used by the military for dangerous or dirty missions that humans couldn't handle. Drones can be operated from any location and are easier to maneuver than manned aircraft. They provide pilots operating them with greater visibility because they are guided by satellites and have highly advanced cameras [Hama 2019, Pham 2020].

Police work, peacekeeping, surveillance, product delivery, aerial photography, agriculture, smuggling, and drone racing are just a few of the many commercial, scientific, recreational, agricultural, and other uses for drones [A.K. 2021, Trapal 2021]. Drones are used not only to replace humans on dangerous missions but also for evil purposes.

Drones can first and foremost scout targets and collect data from specific locations, or they can track moving objects like cars and people to spy on them without being noticed [S. Karl 2021]. Second as shown in Figure, Unintentionally bringing weapons or bombs into public areas can be done by a drone. Thus, addressing the robot discovery issue is basic to keeping up with security in confined or unique zones.

Figure: 1: Drone brings weapons to attack targets [Lee 2018]

It would like to propose a drone detection technique based on image processing as a solution to the aforementioned issue. The central idea of the proposed solution is to train an AI model for drones using a dataset of both drone and non-drone images. An AI classifier is then utilized in an image processing procedure to ascertain whether drones are present in a frame using the trained AI model of drones [H.A. 2020].

Problems with Drone Detection and Recognition Since drones have the ability to enter sensitive areas and pose potential threats, it is essential to recognize and detect various drone types. However, distinguishing drones from birds and identifying various drone types is always challenging. Some of these difficulties are listed below.

The Similarity Between Drones and Birds Because of their behavior and appearance, drones can be mistaken for birds, especially from a great distance. A few illustrations of the similarities between drones and birds can be found in Figure 2.

Figure 2: Some samples of challenges related to the resemblance of drones and birds [Lee 2018]

ANTI-DRONE BACKGROUNDS

This considers the motivations and requirements of anti-drone system. Drone industry expansion has increased injudicious, unauthorized, and illegal drone use, causing considerable social and economic damage. We review some major drone incidents worldwide, and derive essential features for emerging anti-drone systems.

DRONE INCIDENTS

Terrorism and illegal drone use have recently occurred in a variety of ways. To determine appropriate anti-drone system objectives, we list and examine a number of significant incidents.

1) Illegal flights at airports In December 2018, an illegal drone breached the runway airspace at Gatwick Airport, the UK's second-largest airport [Pham 2020], causing it to be shut down for a day. Over the past 15 hours, more than 50 unregistered drones have been spotted in the vicinity of the airport. Since these are industrial drones that are significantly larger than commercial models, it appeared that this was done with the intention of causing confusion for airport operations. In May 2019, illegal drones also showed up close to the aircraft landing area for about an hour [MARIN 2021] near Frankfurt Airport, Germany. The drones reached crucial areas like the runway or airspace in both instances without being detected by airport security systems. Due to a lack of response procedures and inadequate detection distance and accura**cy,** these incidents resulted in significant financial losses.

2) Attacks on public institutions In September 2011, an unmanned aircraft armed with a C-4 bomb attempted to attack Capitol Hill and the U.S. Department of Defense [A.K. 2021]. This was the first known act of terrorism involving drones and an illustration of the FBI's terrorist prevention strategies of proactive blocking and tracking. The case demonstrates that collaborating with national organizations like the military and police is necessary to construct an effective anti-drone system. In January of 2018, the first attack by a drone fleet was defended by the Russian military [Mahdavi 2020].

Thirteen unmanned, armed fixed-winged aircraft attempted to attack the Tartus naval installation and Khmeimim Air Force base, but Russian military radio electronic warfare technology stopped them. Ten drones were shot down by missiles, and Russian hijacking technology prevented the other three. High-level anti-drone systems were present at several military bases; however, missile-type anti-aircraft systems cannot be utilized at non-military locations. Therefore, non-weaponized neutralization techniques like hijacking and capture should be prepared by anti-drone systems. In September 2019, a drone attack destroyed the largest oil refining facilities at Aramco, Saudi Arabia's national oil company [Trapal 2021].

The facility was targeted by ten drones carrying 3 kilograms of explosives per unit. The incident had a significant impact on Saudi Arabia's crude oil production as well as the international peak price of crude oil. Due to a lack of simultaneous defense and detection systems for multiple drones, this attack was successful. However, it is nearly impossible to install equipment that neutralizes drones to completely cover such a large number of businesses and facilities. Anti-drone systems must therefore be prioritized and concentrated in key facilities.

III. RELATED WORK

Drone identification and detection system based on image processing and machine learning is our main interest area. For the purpose of object detection, Haar feature-based cascade classification [MARIN 2021] is utilized. There are three main characteristics of this method. One is that the detector's features can be computed quickly using Integral Image, complexity will be reduced in this research work [Lee 2018]. Two is constructing the classifier using a learning calculation to select a small but significant component, resulting in a highly effective classifier. Three is a technique that dramatically accelerates the cascading combination of increasingly more complex classifiers. In recent times, numerous studies in the field of image processing have utilized deep learning in CNN, one of the structures of deep neural networks, has attracted a lot of attention due to the fact that it automatically identifies crucial features during its learning phase. It has already demonstrated

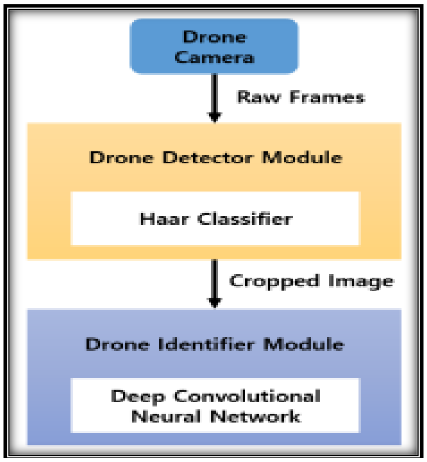

Figure 3: Process of Drone Detection and Identification System [Lee 2018]

Performance improvements in object detection and image classification [Pham 2020] CNN's ability to extract abstract features accounts for its excellent feature extraction performance. As a result, it can process more quickly and accurately [Trapal 2021]. In [A.K. 2021] and [S. Karl 2021] supervised learning, a systematically more adjusted CNN, was used. Because of its superior performance to unsupervised learning [H.A. 2020], it is gaining recognition. We chose CNN to improve speed and effectiveness based on the aforementioned studies. The two modules in this system necessitate image-based learning. The system can perform better with careful calibration and sufficient learning because it heavily relies on machine learning.

Table 1:Summary of dataset used in the literature.

Paper	**Dataset**	**Technique Used**	**Performance**	**Future Scope**
[Lee 2018]	For training the classifier, They used 2088 positive examples and 3019 negative examples. They collectedthe positive examples from Google, and manual cropped thedrone from every images. Negative examples were collectedfrom http://face.urtho.net/. By applying image distortion on thepositive examples, we expanded our positive example pool to7000.	Machine learning-based	The system's output shows about 89 % accuracy	A machine learning-based, comprehensive drone detection system is presented in this paper.
[Hamatapa . R. 2019]	Set the Camera Evaluation Kit See3 CAM-CU135	Machine Learning	The results of the experiment concluded that	The experiment came to the conclusion that only the speed of

			there was only a speed that had an effect at 22.65%.	22.65% had an effect.
[Pham, G.N. 2020]	2000 images of drones, ranging in size and color, from a variety of drone types; also, 2000 non-drone pictures in genuine circumstances as birds, kites, planes, helicopters for the Haar preparing process.	Haar-cascade model	In the environments that were tested, the solution's average accuracy was 91.9 percent, and it offered a user-friendly and cost-effective solution.	Thesolution is simple and cost-effective, with an average accuracy of 91.9 % in the tested environments.
[MARIN,F.B. 2021]	The image data sets for training. We have used 200 different images taken in different sky weather.	Computer vision-based methods for drone detection	In this techniques resolution pictures with a good rate of detection.	These methods produce high-resolution images with a high rate of detection.
[A.K. 2021]	MSCOCO dataset	Artificial intelligence	In this technique resolution pictures with a good rate of detection.	However, the task is made more difficult by factors such as motion blur, occlusion, altitude, and camera angle.
[Mahdavi, F. 2020]	712 images of drone and birds are collected with cameras.	Convolutional neural network (CNN)	The outcomes show that CNN, SVM, and nearest neighbor have total accuracy of 95%, 88%, and 80%, respectively.	The results indicate that CNN, SVM, and nearest neighbor have respective total accuracy rates of 93 %, 88%, and 80%.
[Trapal, D.D.C. 2021]	Images of drone and birds are collected with cameras.	DCF-based comparative tracking	Total accuracy of 95%, 88%, and 80%, respectively.	This enabled only the appropriate drone targets to be identified and tracked. As long as they were visible in the camera scene, the drones could be detected and followed

				throughout.
[S. Karlsson 2021]	MAV in a laboratory environment	Convolution Neural Network (CNN)	The efficiency of this scheme has been extensively evaluated in the Gazebo simulation environment, as well as in experimental evaluations with a MAV equipped with a monocular camera.	This scheme has been thoroughly tested in the Gazebo simulation environment.
[H.A. 2020]	The image data sets for training. We have used 200 different images taken in different sky weather.	Kalman filter	In this techniques resolution pictures with a good rate of detection.	During the 140 seconds of a GNSS outage, simulation results revealed significant performance enhancements as the number of satellites in view decreased.

RESEARCH ISSUES

From the above literature different issues related with detection & tracking are found:

- It discovered that shortening the architecture is not as reliable as narrowing it. To put it another way, for the very specific case of the drone detection problem, it has been discovered that keeping the number of layers the same while reducing the number of filters is more effective.
- The second issue is the absence of reference datasets and a general, based on needs, specification for the detection and classification of drones issue, both of which would be helpful for evaluating various solutions.
- A binary classification problem, in which two labels, such as "Drone" and "No Drone," are used, is another issue when applying machine learning to the detection of drones. A binary classification problem with corresponding data labels is also needed to distinguish drones from other aircraft or birds.

CONCLUSION

In drone detection and identification system making decision is based on video frames. This system has shown that even with simple artificial intelligence, the performance is very promising. All systems were actually implemented in literature and training data is available online. The system demonstrated excellent accuracy even with a small quantity of quickly gathered training data, which increases its appeal. For future work, we would like to develop a distance estimation module to complement the existing system based on video frames. Estimating the distance between the surveillance drone and the unknown drone can be valuable information, and can be used for tracking.

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