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Classification of Genetics Based on Machine Learning Algorithms: A Review

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ABSTRACT

The multifaceted applications of drones in addressing humanitarian challenges, enhancing governance services, medical assistance, and security considerations. Drones are showcased as adaptable and swift responders in conflict or disaster-affected areas, mitigating risks for humanitarian workers and delivering crucial supplies to remote locations. The integration of digital technology in governance services is discussed, emphasizing transparency, efficacy, and reduced corruption. The study also introduces a taxonomy for GPS- guided drones in medical supply delivery, highlighting challenges in accuracy and cost reduction. Drones' wide- ranging potential uses, from police operations to advertising and shipment transportation, are outlined. A comprehensive evaluation of drone security, from consumer drones to military systems, is provided, along with preventive suggestions. Machine learning algorithms for drone detection and classification, showcasing the proposed DDI system's capability to accurately identify intruding drones and their operational modes. Machine learning in the context of used drones, focusing on detection and classification. The study assesses various machine learning algorithms, including image processing, sound analysis, and RF signal-based techniques, to identify and classify drones effectively. Data from diverse sensors are utilized for feature extraction, employing algorithms such as Deep Neural Networks, Support Vector Machines, and deep belief networks. The proposed DDI system adopts an RF-based approach and integrates a Deep Learning algorithm for precise detection and identification of used or intruding drones.

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1. INTRODUCTION

Utilizing drones for delivering supplies in places affected by conflict or natural disasters presents an innovative answer to the ongoing difficulties encountered by humanitarian initiatives. Drones prove to be adaptable and swift responders in hazardous areas where conventional methods are impeded by compromised infrastructure and security hazards. Unmanned aerial vehicles not only provide necessary supplies to remote and inaccessible areas but also reduce the risks faced by humanitarian workers in volatile combat zones [1]. Digital technology is enhancing the supply of governance services to impoverished individuals. It has enhanced efficacy, responsibility, and openness while diminishing corruption in the provision of services. Public hearings, social audits, management audits, and customer satisfaction surveys are the primary methods employed by organizations to obtain user input regarding the quality of their services. The utilization of digital technologies has facilitated the acquisition of consistent input from service users by governments, resulting in enhanced service quality. To improve the provision of services, it is necessary to develop a government that is both transparent and efficient, which will facilitate the successful implementation of policies and allocation of resources. Enable citizens by implementing strong accountability systems to ensure that government actions prioritize the broader public interest. Employ digital technologies to enhance governance procedures, promote transparency, facilitate regular feedback loops, enhance service quality, and mitigate corruption concerns [2][3].

A taxonomy is being developed to categorize GPS-guided drones that are used for delivering medical help in the aftermath of disasters, as well as for the advancement of drone systems specifically designed for delivering medical supplies. The study identified three key components that must be considered in the design of a drone system and the development of algorithms for routing drones: drone data, drone routing, and delivery of goods. However, these components did not succeed in enhancing accuracy or reducing cost and time. To enhance the precision of GPS-guided drones under various settings and maintain their optimal performance, it is advisable to include additional training data in the analysis [4][5][6]. Drones have a wide range of potential uses, such as assisting in police operations, monitoring borders, conducting military reconnaissance and surveillance, overseeing and managing operations in the energy and chemical industry, providing mapping and visualization services for geodesy companies, and serving as a platform for advertising. In addition, drones are being assessed as a method of transporting shipments [6][7].

Drones offer a comprehensive evaluation of the security aspects of drone systems, encompassing potential vulnerabilities, constraints, and suggested preventive methods. From miniature consumer drones to expansive unmanned aerial systems (UASs) employed for military applications, this study examines their susceptibility to cyber-attacks. In addition, they offer suggestions for enhancing drone security, such as implementing hybrid lightweight intrusion detection systems (IDSs) and employing multifactor authentication [8][9].

An assessment was conducted on several machine learning algorithms to detect and classify drones. This assessment involved employing different approaches, including image processing, sound analysis, and RF signal-based techniques. The data acquired from various sensors was classified and feature extraction was performed using machine learning algorithms such as Deep Neural Networks (DNN), Support Vector Machines (SVM), deep belief networks, and other algorithms to enhance performance. In this study, the proposed DDI system utilizes an RF-based approach. The system incorporates a Deep Learning algorithm as the classification technique to accurately detect and identify intruding drones. The algorithm proposed was capable of identifying the operational modes of the drones [10].

The rest of the paper is structured as follows. Section 2 Literature review and Section 3 is the Background: Smartest Drones Based on Machine Learning. The Result and Discussion in Section 4. Conclusion in Section 5, and References in Section 6.

2. LITERATURE REVIEW

[11] Suggested a viable method for identifying drones using image processing techniques. Employed Haar-like properties to detect drones from frames obtained using a solitary camera. The system identifies drones by analyzing the acquired images using Haar-like features that have been trained for this purpose. The drone image dataset is utilized in the Haar training procedure to produce a Haar- cascade model specifically designed for drones. It offers a convenient and cost-effective solution for the customer due to its superior average accuracy. It suggested a potential solution by gathering more extensive datasets. Employed the Haar-like feature selection optimization technique to identify objects, specifically drones, in frames obtained from a solitary camera. Attained a mean accuracy of 91.90%.

[12] Artificial neural networks (ANN), deep learning (DL), machine learning (ML), and the Internet of Things (IoT) have been implemented in drone-based agriculture to enhance the collecting, analysis, and processing of data, resulting in improved efficiency. Drones are utilized to achieve autonomous flight and collision avoidance, enhance soil and crop management, minimize human labor and stress, and analyze extensive amounts of nonlinear data. In agricultural drone applications, machine learning (ML) algorithms, specifically supervised and unsupervised learning techniques like Random Forest and Support Vector Machine (SVM), are employed. The Random Forest algorithm was trained using a dataset to classify corn and wheat crops, achieving an impressive overall accuracy of 98.89%. Additionally, the SVM algorithm was utilized to detect weeds with an accuracy of 84.6%. In general, the accuracy of machine learning algorithms varies based on the particular application and dataset. Furthermore, the accuracy levels of these algorithms are anticipated to enhance as the technology progresses and a greater amount of data is gathered for training.

[13] Utilized MEMS sensor technology with the MLA artificial neural network to pre-train the drone before real-world deployment, mitigating the potential for accidents. The drone was taught in both physical and virtual environments. The Visual Studio development environment was utilized as a simulator to train the intelligent module for controlling the drone. The objective was to reach the desired goal in a shorter

amount of time by processing the raw values obtained from the sensors. Virtual settings are superior to actual surroundings for drone training before deployment.

[14] Created unmanned aerial vehicles (UAVs) to conduct area surveillance, monitor road networks for traffic, deliver commodities, and observe environmental phenomena in smart cities. Employed machine learning classifiers to identify three distinct categories of unmanned aerial vehicle (UAV) assaults: GPS spoofing, command injection, and malicious waypoint change. The DJI Phantom 4 drone system utilizes flight logs to conduct exploratory analysis and machine-learning tasks. This allows for precise classification results, evaluation of various machine-learning algorithms, and the use of a random forest classifier. Performance metrics such as accuracy, recall, and precision are employed. The random forest classifier achieved a maximum accuracy of 0.9796, precision of 0.9818, and recall of 0.8666.

[15] Presented a novel method for detecting drones by analyzing the Radio Frequency (RF) signals generated during the real-time communication between the drone and its controller. This approach utilizes a sophisticated Deep Learning (DL) technology called Convolutional Neural Network (CNN). The study's findings have unequivocally demonstrated the efficacy of employing Convolutional Neural Networks (CNN) for accurately detecting drones. The proposed CNN architecture for drone identification has a precision rate of 99.8%.

[16] Worked in the evaluation of diverse object detection and classification models, as well as various mechanical models, to develop a video surveillance system that integrates three stages of data processing: extraction of moving objects, recognition and tracking of moving objects, and decision-making for automatic identification of significant events. The objective was to examine the efficacy of utilizing machine learning algorithms for object recognition and classification with the aid of a drone, and to analyze the potential impact of this concept on traditional approaches that have been in use for a long time.

[17] Used multiple machine learning (ML) algorithms to facilitate decision-making in disease identification with drone technology. The CNN-based model is the most commonly utilized machine learning method, including several models including GoogleNet, VGG16, RetinaNet, YOLO, and VGG-Net. Additional machine learning algorithms utilized encompass support vector machines (SVM), radial basis function (RBF), random forest (RF), K-means clustering, AKAZE, Signet, multilayer perceptron (MLP), stacked denoising autoencoders (SDA), local spectral clustering (LSC), quantum support vector machines (QSVM), linear discriminant analysis (LDA), unsupervised clustering, kernelized multiclass support vector machines (KMSVM), kernelized multiclass segmentation (KMSEG), and k-nearest neighbors (KNN). These algorithms were employed for various tasks including classification, detection, mapping, categorization, monitoring, discrimination, quantification, identification, and prediction. The detection accuracy of drones varies depending on the specific use cases, datasets, machine learning algorithms, and evaluation metrics. Overall, the classification accuracies for detecting diseases such as Fusarium, Yellow rust, and potato late blight using hyperspectral-based drone data range from 80% to 98%. The utilization of RGB photos obtained from drones led to decreased accuracy rates, varying from 60% to 80%.

[18] Applied machine learning using several modalities. The technologies mentioned include radar, visual, acoustic, and radio-frequency sensing systems. Furthermore, it showcases the potential of machine learning-driven drone classification, as evidenced by numerous successful individual contributions. The utilization of machine learning algorithms to categorize drones using various methods has great potential and can be instrumental in detecting, categorizing, and identifying drones. This is especially important considering the projected expansion of the drone market and the subsequent rise in the number of drones in the airspace. Nevertheless, the pressing concerns concerning the quantity and quality of data necessitate immediate attention, and it is imperative to engage in collaborative endeavors to construct datasets that are accessible to the public. Furthermore, future studies must prioritize the examination of the classification accuracy of the distance of the drone, as well as the estimation of the range through the utilization of regression models. The following methods were employed to test drone identification and classification: Fully convolutional networks (FCNs), Recurrent neural networks (RNNs), and multilayer perceptron (MLP). The MLP classifier demonstrated a classification accuracy ranging from 70% to 85% for drones, depending on the Signal-to-Noise Ratio (SNR). On the other hand, the RNN and FNC classifiers achieved even better accuracy, nearing 100%, specifically when the SNR was set at 30dB.

[19] Compared the accuracy of three classification methods for drone detection: Convolutional Neural Network (CNN), Support Vector Machine (SVM), and k-Nearest Neighbor (KNN). CNN is an efficient and effective neural network architecture with multiple layers for image and signal processing. SVM is a popular supervised learning model that separates data points into different classes using a hyperplane and performs well with high-dimensional data. KNN is an instance-based learning algorithm that stores all available cases in a training dataset and classifies new cases based on similarity to existing cases. In the experiment, the CNN approach achieved the highest accuracy rate of 93%, followed by SVM with an accuracy rate of 91%. KNN achieved an accuracy rate of 94% but performed worse than the other two classifiers.

[20] Created an advanced anti-unmanned aerial system named DroneSwatter. The technology is specifically engineered to monitor, pursue, and eliminate a drone menace by employing a nimble, cost-effective drone interceptor. Applied machine learning methodologies to address counter-drone situations, employing deep learning detection algorithms and proportional-derivative (PD) as well as machine learning-based tracking control models. The evaluation of the DroneSwatter tracking system was conducted by assessing the Hunter drone's ability to pursue the Target Drone at various speeds during field testing. YOLO (You Only Look Once) is a compact object detector that, when provided with an image, identifies the existence of a drone object and precisely determines its location inside the image. YOLO is an object detection system based on convolutional neural networks (CNN).

3. BACKGROUND

3.1. Drone Technology

The term "drone" commonly denotes any aircraft that operates without a human pilot on board, often known as "unmanned aerial vehicles" (UAVs). A drone is an autonomous aerial vehicle. Drones may be operated from a distance by utilizing built-in sensors and GPS technology. Historically, unmanned aerial vehicles (UAVs) were primarily linked to military operations, intelligence collection, and, to a more contentious extent, as platforms for weaponry. Drones are currently employed for a wide range of activities, including search and rescue operations, surveillance, traffic monitoring, weather monitoring, firefighting, and even personal errands. Drones are now extensively employed in the film business and have emerged as a crucial component. Furthermore, news reporters are utilizing drones to transmit information from distant areas. A drone can be operated using a remote control or a mobile application. Drones are capable of operating in environments that are arid, monotonous, or hazardous for human aviators. Utilizing drones enables us to perform tasks with great ease. That is the reason why the majority of countries worldwide are embracing the use of drones [21].

3.2. How Do Drones Work

Drones, also known as unmanned aerial vehicles (UAVs), are aircraft that can operate without a human pilot on board. Drones possess two fundamental functionalities: flying mode and navigation. To achieve flight, drones require a power source, such as batteries or fuel. In addition, the aircraft will include rotors, propellers, and a frame. The drone's structure is constructed using lightweight, composite materials to save weight and enhance mobility. Drones necessitate a remote controller to initiate, maneuver, and safely land the aircraft. The controller establishes communication with the drone by the utilization of radio waves, specifically Wi-Fi. Drones can reach elevated heights. The crucial components of a drone encompass the operating system and the flying controller [22].

3.3. Parts of the Drones

Drones have many parts; a drone consists of 10 parts. Below are the parts of the drone [7].

- Quad-copter frame
- Motor
- Electronic Speed Controller (ESC)
- Flight Control
- Propeller
- Radio transmitter
- Battery, electronics, and power distribution cables
- Camera
- Landing gear
- First-person video

3.4. Application of Drone Technology

Drones, or unmanned aerial vehicles (UAVs), are aircraft capable of autonomous operation without human pilots on board. Drones have two primary capabilities: flight and navigation. Drones necessitate a power source, such as batteries or fuel, to attain flight. Furthermore, the aircraft will incorporate rotors, propellers, and a frame. The drone's framework is fabricated using lightweight, composite materials to minimize weight and improve maneuverability. Drones require a remote controller to initiate, maneuver, and safely land the aircraft. The controller establishes a connection with the drone by the exploitation of radio waves, specifically Wi-Fi. Drones possess the capacity to attain elevated altitudes. The essential elements of a drone consist of the operating system and the flight controller [7].

Let's discuss the importance of drone technology and the best use of drones.

- Aerial Photography

- Agriculture
- Shipping and Delivery
- Science and Research
- Drones And Engineering Applications
- Military Drone Technology
- Weather forecast
- Entertainment

3.5. Drone Attack Models

Drones, despite their widespread use, pose security challenges due to inherent vulnerabilities that compromise their reliability and effectiveness in minimizing design and manufacturing costs. Common issues include susceptibility to firmware modifications and the absence of encryption for static data transmitted to ground controllers. Some drone manufacturers address these concerns through over-the-air (OTA) firmware updates, akin to mobile phone software fixes, allowing for the prompt resolution of vulnerabilities post-purchase. Exploiting software or firmware weaknesses can lead to disruptive consequences, such as altering flight trajectories and compromising the encryption of flight logs. The critical operational data collected by drones becomes a potential target for adversaries if transmitted without encryption, posing risks of unauthorized access and exploitation. Traditional communication protocols lacked automatic encryption, and the absence of secure firmware could disable encryption functions, further accentuating security vulnerabilities in drone operations [14] [23].

3.6. Machine Learning for Intrusion Detection

Machine learning is a subset of Artificial Intelligence that involves using mathematical models to train a classifier. The classifier is next evaluated using test data, where it applies the skills, it acquired during the training phase to classify the data. Machine learning classifiers can be broadly classified into four categories. Machine learning techniques used in drone applications. Supervised learning involves providing labeled data for classification, such as identifying attack vectors in drone attacks. Unsupervised learning deals with unlabeled data, clustering similar samples into clusters without predefined classes. Reinforcement learning utilizes rewarding functions to optimize classification without labels, often integrating with supervised learning to enhance overall accuracy. Common classifiers like Naive Bayes, support vector machines (SVMs), and random forests are employed in drone applications. Random forest classifiers, known for resilience in image categorization, use a bootstrap technique and out-of-bag data for model evaluation. SVMs create hyperplanes for optimal class separation, while Naive Bayes relies on the Bayes theorem, assuming attribute independence. The Naive Bayes classifier is particularly effective in classifying string data due to its independence assumption [14] [24].

3.7. Drone Management System

Enables users to specify specific objectives and view the calculated flight mission plan. The system establishes a connection with a cloud server, which receives position data from the users and calculates the most efficient flight mission plan. Subsequently, the drone is instructed to adhere to the pre-calculated flight mission plan. To achieve dynamic tracking, the drone continuously retrieves data from its onboard sensors, including as GPS, video feed, and SoC. This data is used to monitor the real-time flying state of the drone. Suppose significantly abnormal sensor readings are observed compared to the values predicted in the pre-determined mission plan. In that case, real-time calibration can be conducted to determine the smallest necessary modification to the previous plan [25].

3.8. Drone Routing Algorithms

We analyze algorithms for routing drones in delivery systems that rely on drones. We focus on three key aspects: trajectory planning, charging strategy, and security. These aspects are essential for creating efficient and dependable delivery systems using drones. Additionally, we examine and discuss each algorithm in terms of its main objective, operational characteristics, advantages, limitations, and performance. To begin, we categorize the existing algorithms for routing drones in delivery systems. We introduce a new classification system that highlights three primary aspects of drone routing in delivery systems: trajectory planning, charging, and security. This classification system is visually represented [4].

3.9. Drones' security, safety, and privacy concerns

The utilization of drones presents numerous benefits across various domains, encompassing both commercial and personal applications. Nevertheless, drone systems are plagued by several security, safety, and privacy concerns. The security and privacy infringements caused by drones must be dealt with at the highest level of national governance. Furthermore, it is imperative to implement a stringent measure to restrict the drones' capacity to capture photographs and film videos of individuals and properties without sufficient authorization. Drone-assisted public safety networks differ from typical wireless networks like Wireless Sensor Networks (WSNs) and Mobile Ad-hoc Networks (MANETs) in terms of security and threat analysis. This can be attributable to the fact that it carries a smaller amount of information and requires less power when compared to a public safety network that is helped by drones. Furthermore, the drone has a larger and more extensive coverage area compared to Wireless Sensor Networks (WSNs) and Mobile Ad hoc Networks (MANETs). Thus, the main security challenges are essentially associated with the limited availability of resources and the time limitations of UAVs. Furthermore, it is crucial to guarantee that communication channels meet the requirements of secrecy, integrity, availability, authentication, and non-repudiation [22].

3.10. Security concerns

The drone's attributes, including its compact size, affordable price, and effortless mobility and maintenance, rendered it a favored option among thieves. In addition, terrorists have begun to shift their focus towards utilizing unmanned aerial vehicles (drones) to execute terrorist acts, mostly due to the inherent characteristics of drones that render them less susceptible to being detected. Drones can be equipped with weaponry and altered to transport lethal substances or be outfitted with explosive devices to target vital infrastructure. Furthermore, drones equipped with explosive devices have the potential to be detonated in remote locations where people are congregating. This facilitates the accomplishment of the work for a terrorist, particularly because drones combine the inconspicuousness of a suicide bomber with the extensive reach of an airplane. Concerns among military analysts have arisen regarding the utilization of drones for espionage activities against the United States. This phenomenon occurs because ISIS can retrofit commercially accessible drones, rendering them suitable for military operations in Iraq and Syria [8] [26].

3.11. Safety concerns

Security and safety are not always synonymous. Civilian drones or UAVs, outside of military use, can also malfunction and collide with neighboring houses or groups of people, resulting in damage to property and materials, as well as injuries or fatalities to humans. These injuries can range from trauma or blunt force trauma to deep cuts made by the blades of the drone, leading to lacerations. On August 9th, 2016, a fatal vehicle crash occurred due to a drone being flown near Wandsworth Prison in London, marking the first non-military connected drone incident resulting in a loss of life. In November 2016, a drone that was not being controlled properly caused an 18-month-old child from Stourport-on-Severn, Worcester UK, to have his eyeball cut in half by its propeller. In April 2016 [8][27].

4. RESULT AND DISCUSSION

Table 1. Summarizes Related Work About Smartest Drones Based On Machine Learning

Author Name	**Year**	**Algorithm Used**	**Accuracy**
Giao N. Pham	2020	Haar-like features	91.90%
Rejeb et al	2022	Random Forest, SVM	98.89%
Florin Covaciu	2022	MLA Artificial Neural Network	N/A
Baig et al	2022	Random Forest Classifier	97.96%
Sara Al-Emadi	2022	CNN	99.8%

Dembla et al	2021	Various ML models	N/A
Chin1 et al	2023	CNN, GoogleNet, VGG16, RetinaNet, YOLO, etc.	80%-98%
Bilal Taha	2019	FCNs, RNNs, MLP	70%-100%
Fatemeh Mahdavi	2020	CNN, SVM, KNN	93%-94%
David Cheng	2023	YOLO (You Only Look Once)	N/A

The various drone detection methodologies discussed in this paper are the diverse range of approaches and technologies employed in this evolving field. Image processing with Haar-like features, integration of artificial neural networks and machine learning for agriculture, the use of radio frequency and CNN, and comparative analyses of classification methods all contribute valuable insights. Each method exhibits strengths in specific aspects, such as efficiency, precision, and innovation. Determining the best approach is subjective and depends on the specific requirements of the drone detection system. Factors such as accuracy, cost-effectiveness, ease of implementation, and adaptability to different environments play crucial roles in this determination. While some methods, like radio frequency and CNN, boast impressive accuracies, the choice ultimately depends on the unique needs and priorities of the application at hand. The continuous evolution of machine learning and sensor technologies suggests that the ideal drone detection method may vary based on the specific use case and technological advancements in the future.

5. CONCLUSION

In this paper, the exploration of drone technology presented in this text underscores its multifaceted applications across diverse sectors. From delivering crucial supplies in conflict zones and disaster-stricken areas to enhancing governance services through digital technology, drones have emerged as innovative solutions to complex challenges. The taxonomy and design considerations for GPS-guided drones emphasize the importance of additional training data to optimize their precision.

The versatility of drones is further highlighted as they find applications in policing, border monitoring, military reconnaissance, industry operations, mapping, and even advertising. The examination of security aspects reveals potential vulnerabilities, prompting recommendations for improved drone security, including the implementation of intrusion detection systems and multifactor authentication.

Machine learning plays a pivotal role in the realm of drone technology, particularly in the detection and classification of drones. Various studies showcase the effectiveness of machine learning algorithms, such as Convolutional Neural Networks (CNN), Support Vector Machines (SVM), and k-nearest Neighbor, in accurately identifying drones. Also delves into counter-drone technology, exemplified by advanced systems like DroneSwatter, which leverage machine learning methodologies for monitoring and eliminating drone threats.

As technology continues to advance, collaborative efforts are stressed to construct accessible datasets for machine learning algorithms, addressing concerns related to data quantity and quality. To evaluate drone classification accuracy concerning factors like distance and signal-to-noise ratio.

The transformative potential of drone technology underscores its role in addressing critical issues across humanitarian, governance, security, and technological landscapes. The integration of digital technology and machine learning not only enhances the efficiency and transparency of drone operations but also propels the development of counter-drone measures, contributing to a nuanced understanding and utilization of this evolving technology.

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