On Drone Technology

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Abstract: *Unmanned aerial vehicles (UAVs) or unmanned aircraft systems (UAS) are other names for drones, which are aircraft that do not have a pilot on board. A human operator can control it remotely, or it can fly itself using pre-programmed flight plans that use sensors and computers on board. Applications for drones are many and include everything from photography and recreational flying to military surveillance and package delivery. Numerous industries use drones because they can carry out tasks that are hazardous, challenging, or impossible for people to do directly. In order to detect obstacles, drones frequently use cutting-edge technology such as GPS, sensors, cameras, and occasionally LiDAR. A brief explanation of earlier drone technology works is provided in this paper.*

Key Words: *Drone, design, types, applications*

1. INTRODUCTION

A drone, also referred to as an unmanned aerial vehicle (UAV) or unmanned aircraft system (UAS), is an aircraft that is controlled remotely or is autonomous and does not have a human pilot, crew, or passengers on board [1]. Originally created during the 20th century for military tasks deemed too "dull, dirty, or dangerous" for humans, unmanned aerial vehicles (UAVs) were now vital tools for the majority of militaries by the 21st century.

The use of control technologies spread to numerous non-military applications as they became more advanced and more affordable.

These include precision farming, aerial photography, policing and surveillance, smuggling, product deliveries, entertainment, drone racing, policing and surveillance, weather monitoring, river and forest fire monitoring, precision agriculture, and aerial photography.

Autonomous drones have started to revolutionize a number of application areas in recent years because of their ability to fly beyond visual line of sight (BVLOS), maximize production, lower costs and risks, ensure site safety, security, and regulatory compliance, and safeguard human workers during pandemics. They can also be utilized for consumer-related tasks like vital medical supply deliveries and package delivery, as exemplified by Amazon Prime Air.

2. TYPES OF DRONES

2.1 Multi-rotor drones

These are the most common type, often featuring four or more propellers for lift and maneuverability.

2.2 Fixed-wing drones

These resemble airplanes and are typically used for longer-range flights and higher speeds.

2.3 Hybrid VTOL drones

These combine elements of multi-rotor and fixed-wing designs, offering vertical takeoff and landing capabilities with longer flight times.

3. DRONES DESIGN

Generally speaking, crewed and uncrewed aircraft of the same type share physical characteristics, as illustrated in Fig. 1 The cockpit and life support or environmental control systems are the primary exceptions.

A camera is one example of a payload that some UAVs can carry that weighs significantly less than an adult human, making them smaller.

Military UAVs equipped with weapons are lighter than their crewed counterparts with similar armaments, despite carrying large payloads.

Small civilian UAVs can be constructed with lighter, less robust materials and shapes and can use electronic control systems that have not been thoroughly tested because they do not have life-critical systems.

The quadcopter layout is rarely utilized for crewed aircraft, but it has gained popularity for small UAVs.

Miniaturization enables the use of less powerful propulsion technologies, like tiny electric motors and batteries, that are impractical for crewed aircraft.

Compared to crewed craft, UAV control systems are frequently different. The windows of the cockpit are nearly always replaced by a camera and video link for remote human control; digital commands sent over the radio take the place of actual cockpit controls. Different feature sets of autopilot software are utilized by crewed and uncrewed aircraft.

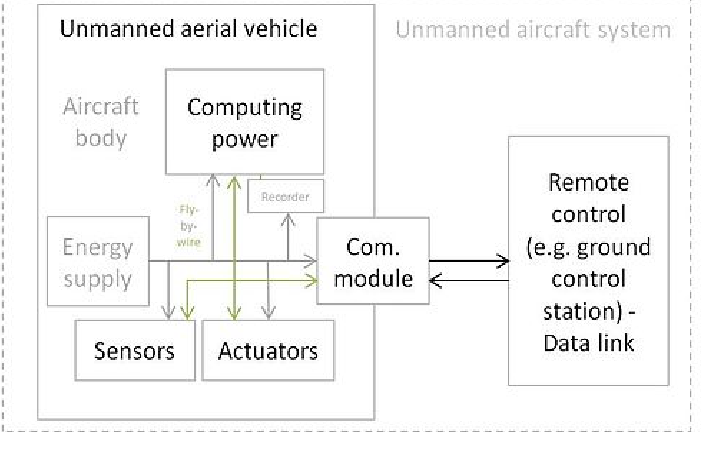

Fig. 1 General structure of drone

Sensors for position and movement in Fig. 1. describe the condition of the aircraft. For instance, proprioceptive sensors correlate internal and external states, whereas exteroceptive sensors deal with external information such as distance measurements.

Non-cooperative sensors are employed for collision avoidance and separation assurance because they can identify targets on their own.

The quantity and caliber of onboard sensors are referred to as degrees of freedom (DOF): 6 DOF suggests 3-axis gyroscopes and accelerometers (a common inertial measurement unit, or IMU); 9 DOF denotes an IMU plus a compass; 10 DOF adds a barometer; and 11 DOF typically adds a GPS receiver.

In Fig. 1 presents the UAV actuators. Among these are servomotors (primarily for aircraft and helicopters), weapons, payload actuators, LEDs, speakers, and digital electronic speed controllers that regulate the RPM of the motors connected to engines, propellers, and motors.

From high-level flight planning to low-level firmware that directly controls actuators, modern UAVs are powered by a software stack.

Firmware, at its most basic level, commands actuators like motors and directly regulates sensor readings, including an IMU. Calculating actuator speeds given the desired vehicle velocity is the responsibility of control software, also known as an autopilot.

This software may operate on microcontrollers and is particularly time-sensitive due to its direct hardware interaction. Radio communications may also be handled by this software for non-autonomous UAVs.

4. PREVIOUS WORKS

A conceptual model of how such an architecture can be set up is presented by the authors in [2], and we outline the features that an Internet of Drone (IoD) system built on our architecture should have. In order to achieve this, the authors take important ideas from three well-known large-scale networks - the Internet, cellular networks, and air traffic control networks - and investigate how they relate to our unique drone traffic management architecture.

The flexible control system for an autonomous unmanned aerial vehicle (UAV) is presented in the paper in [3]. This work presents a detailed description of the hardware and software solutions used to achieve autonomous flight. The primary goal of the study was to create software that makes drone systems with various pieces of equipment easy to modify and expand.

The system that is being presented can be used on a variety of hardware platforms and can accomplish a variety of tasks with little modification.

By introducing modular architecture, the concept described greatly streamlines the design of complex systems. By breaking up software components into modules with a single function, the suggested approach reduces the amount of work required to modify the system in the event that hardware changes.

A real-world working model that is intended for tracking and landing on moving targets supports the general system architecture concept that is being presented. The algorithms used are described in detail in this paper. An optical flow algorithm called Lucas-Kanade is used to track patterns that are detected.

Mission planning is accomplished by a state machine specifically designed for this purpose. Utilizing the subscriber-publisher model of data exchange between distinct software units, the system design is constructed using ROS (Robot Operating System). A specially made frame serves as a platform for hardware.

An exemplary system is implemented using a Pixhawk flight controller and a Raspberry Pi 3 as the onboard computer. The exemplary system and this concept are the outcome of the 2017 Mohamed Bin Zayed International Robotic Challenge preparations in Abu Dhabi. This paper presents the results of experiments conducted as competition trials and discusses potential future directions.

The authors present a comprehensive machine learning-based drone detection system in [4]. This system is made to work with drones that have cameras. The system uses machine classification to infer the drone's location and vendor model from the camera images.

The OpenCV library is actually used in the system's construction. For the purpose of learning, the authors gathered data and drone imagery. The accuracy of the system's output is approximately 89%.

The frequencies and modulation schemes utilized in low, slow, and small (LSS) unmanned aerial systems (UASs) are presented in the paper in [5].

Drones, also known as LSS UASs, are commercially available and simple enough for anyone to operate. Drones can pose a security or safety risk, regardless of whether they are operated by enthusiasts or malicious individuals.

Those who are researching or planning to create a counter-drone system will find this study useful.

The implementation of an autonomous unmanned aerial vehicle (UAV) controlled by a Pix Hawk flight controller is the main focus of the proposed research in [6]. The quadcopter is programmed to follow a predetermined path on its own and can navigate without any in-the-moment user input.

The algorithm makes it possible to use a control method that gives the quadcopter the ability to fly on its own, track its trajectory, move gracefully, and maintain an accurate altitude. The two main applications created for defense in the Line of Control and war zones are surveillance and machinery maintenance.

The goal of this project is to create a quadcopter that can fly through designated waypoints in response to a command. From data collected by cameras and ultrasonic sensors to the cloud, the deep learning algorithm recognizes human movements. A Sjcam 5000x Elite Camera is used to detect deviations from the standard protocol. Additionally, in the event of an unanticipated disaster or an attack that impairs the primary drone's ability to fly, a backup auxiliary mini drone is programmed to eject along with the data stored on the primary drone's memory.

A new blockchain-based Internet-of-Drones (IoD) architecture is proposed by the authors in [7]. A Hyperledger blockchain network, edge servers, and various drones are used by the authors to implement the suggested architecture.

According to the proof-of-concept design, the suggested architecture can provide high-level services like extending a drone's operational duration, enhancing the precision of human detection, and providing a high degree of security, traceability, and transparency.

The system presented by the authors in [8] allows delivery drones to navigate and deliver packages at different locations throughout a house on their own, based on the recipient's preferences, without the need for external markers, which are currently in use. Recent developments in deep learning have spurred this development, which may eventually replace the specialized markers currently employed by delivery drones to locate potential package delivery locations.

Since the suggested system uses instructions on where to deliver the package as input, just like human couriers do, it is more natural. Initially, authors suggest a descending location estimator based on semantic image segmentation, which allows the drone to locate a secure location within the house where it can descend from higher altitudes. The authors then suggest a visual routing method for the drone to use from the point of descent to a designated delivery location, like the front door. The authors thoroughly assess this method in a simulated setting and show that a delivery drone can use our system to deliver a package to the front door as well as other designated spots within a home.

Drones employing the suggested system located and arrived at the front doors of the 20 test homes 161% quicker than those in a strategy based on frontier exploration.

In [9], the study examines how different types of businesses are currently using drone technology and examines market trends. Business insights into the UAV market are provided by consumer and industry surveys.

The views of consumers regarding consumer drones are examined. It examines how UAVs affect business operations, consumer and industry viewpoints, and data on new business decision-making opportunities.

The technical aspects, possible uses, and difficulties of integrating drone networks into a 5G environment are covered in [10], where authors give an overview of the process. Additionally, the authors look at the advantages of using 5G networks for drone operations, including improved safety, accuracy, and range.

The authors conclude by pointing out the need for more study in areas like drone security, energy efficiency, and spectrum management in order to integrate drone networks into a 5G environment.

A new quadcopter drone that uses modular design to support search and rescue efforts is presented in [11]. Three modules make up the drone. A wireless portable patient monitoring system is the first module. Vital signs like body temperature, heart rate, electrocardiogram, and oxygen saturation are recorded by the module. The module can be worn around the user's finger and is wireless.

The second module reads environmental data, including GPS coordinates, humidity, and ambient temperature. A tiny thermal camera that records a signature of body temperature makes up the third module. In order to find individuals who are lost in the wilderness or trapped beneath debris, this feature is essential to search and rescue operations. Medical professionals and patients can communicate remotely via a two-way video and audio-conferencing module.

The drone transmits the data in real-time to a cloud server. All of the drone's data can be accessed on any computer, a custom handheld Raspberry Pi, or through a phone application. The outcomes demonstrated the drone's ability to record video-audio communications, thermal imaging, vital signs, and weather and environmental measurements in real time.

A user-friendly application renders all data that is sent. Advanced image processing and pattern recognition techniques will be introduced in future work to automatically detect and identify objects.

The purpose of the paper in [12] is to act as a guide for selecting the hardware, electronic, and layout components. It makes the difficult process of choosing parts simple and methodical by going over all the calculations and technicalities involved.

It is beginner-friendly and starts with an explanation of the different kinds of drones and their limitations.

Strict computations are described to meet the demands of the particular application. For students, researchers, and entrepreneurs looking to build their own drones, the paper is a one-stop resource.

By performing a tertiary literature review (TLR) that evaluates the caliber of SLRs, compiles information from various research domains, and offers recommendations for scholars and practitioners in the UAV community, the study seeks to fill these gaps in [13]. It is clear from an analysis of 73 SLRs that the quality of SLRs pertaining to UAVs is generally poor, with insufficient reporting of primary study details and no quality assessment.

To improve the openness and comparability of upcoming UAV-related research, this study provides reporting items and sample quality assessment ratings. It also draws attention to common constraints that UAV applications face, including technical, social, regulatory, and research-related issues that must be addressed for the field to advance.

By offering insights into the current state of UAV-related SLRs and practical advice for researchers and practitioners in the form of data-extraction templates and quality control questions for upcoming UAV-related reviews and primary research, this study seeks to improve the overall quality and knowledge sharing within the UAV research community.

An algorithm for image processing-based drone detection is presented and investigated in [14]. A multi-channel algorithm is used for the detection, enabling the detection of objects that are separated at various distances from the camera.

The YOLO (You Only Look Once) program, which is used for object recognition, has trouble identifying very small objects. Both thermal and standard video images were used in the experiments. Thermal or infrared imaging has the benefit of being able to be used during the evening hours.

In [15], drones can automatically detect and identify people who need assistance from above by integrating AI-based automatic object recognition capabilities. After being located, the drones can sound an alarm and drop supplies like food, clothing, and rescue equipment right next to the victims.

By limiting the amount of time that rescue teams are exposed to dangerous terrain, this technology not only increases the effectiveness and speed of rescue operations but also lowers their risk.

Additionally, a number of technologies, such as processor boards, cameras, drones, and artificial neural networks, are needed for the development of this system.

By integrating these technologies, the system is able to precisely identify and locate people at a slanted angle from a height of approximately 50 to 100 meters above the ground. The AI-controlled automated payload dropping mechanism makes sure that victims receive vital supplies in a timely and accurate manner.

Our disaster management system integrates the sophisticated YOLO model of version 8 to precisely identify and detect people in need of assistance.

This advanced YOLO variant is made especially to quickly recognize and locate individuals in aerial footage taken by the drone's infrared camera. This system can efficiently analyze the video feed in real-time by utilizing YOLO version 8's object detection and recognition features. This enables us to promptly locate and follow people, even in difficult situations or during rainy seasons.

The dynamic nature of drone technology is examined in [16], along with its many uses, societal effects, and changing deployment challenges. The transformative potential of the integration of Unmanned Aerial Vehicles (UAVs) in a variety of industries is examined, with a focus on precision agriculture, cinematography, and geospatial mapping.

The study emphasizes how drones are revolutionizing solutions for problems like managing natural disasters, conducting search and rescue missions, and offering virtual travel experiences.

The integration of autonomous drone capabilities and Geographic Information System (GIS) technology is particularly discussed in relation to indoor inspections and cinematography, highlighting the necessity of striking a balance between ethical considerations and technological innovation.

The thorough analysis highlights the significance of carrying out in-depth threat analyses to guarantee the safe operation of remotely piloted aircraft systems and offers insights into the security threat landscape related to Augmented Reality (AR) drones. By classifying different facets of the UAV threat landscape and creating classification methods based on connections and nodes within flying ad-hoc networks (FANETs) and the Internet of Drones (IoD) infrastructure, researchers have addressed issues pertaining to cyber threats.

A thorough examination of drone forensics is provided in [17], which also includes a review of the literature on models and techniques for analyzing attacks and malfunctions. The survey covers evidence collection methods and incorporates neural network architectures like Transformers in forensic investigations, among other important challenges, from machine learning applications to autopilot systems.

The intricate process of drone analysis, especially in conflict areas, is clarified by discussing real-world situations and forensic examination tools used by law enforcement. In addition to highlighting recent developments in drone detection, the paper explores the role of machine learning in intrusion detection and attack classification. In addition to highlighting the significance of standardized methodologies in drone forensics, it outlines future research opportunities for the field.

These lines of inquiry seek to address existing challenges and advance more potent methods for identifying evasive malware. This study offers a roadmap for future research at the nexus of technology and law and provides insightful information about the complex field of drone forensics.

A thorough analysis of UAV technologies, with an emphasis on their classifications, structural elements, communication systems, and operating platforms, is provided in [18]. Size, range, and altitude capabilities are used to classify UAVs. Important structural components like frames, sensors, propulsion systems, and control mechanisms are looked at. Communication requirements, architectures, protocols, and related difficulties are also covered in the paper.

It also discusses the real-time operating systems that UAVs use, emphasizing design factors. Finding new trends and potential avenues for future research in UAV development, the survey's conclusion offers insightful information for both novice and experienced researchers.

5. CONCLUSIONS

Drones are a quickly developing technology that has the potential to completely transform many industries. Even though there are still obstacles to overcome, developments in artificial intelligence, sensor technology, and regulation are opening the door for increasingly complex drone applications in the years to come. We can fully utilize drones for the benefit of society if we embrace responsible development and respond to public concerns.

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