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Assembly and Design of Thunderbird: Hexacopter Drone using Mission Planner Software

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ABSTRACT: The summary goal of the project is to gather and make a hexacopter drone to make a particularly challenging and remote areas designed for monitoring and military patrolling. This drone acts as a skilled air monitoring solution, significantly reduces the need for human appearance in high -risk areas. The hexacopter is manufactured using brushless engines, propellers, a cube orange + flight controller, electronic speed checks (ESC), a strong drone frame, GPS module and Herelink 1.0 HD Digital Transmission System for Control and Telemetry. A LIPO battery provides the necessary power supply, and the Open Source Mission Planner software is used for configuration and autonomous mission plan. A camera module is integrated to provide real-time video during flights, which can be monitors and stored on connected mobile devices. This layout improves surveillance operations, improves status awareness and adapts resource allocation by reducing direct human intervention in a potentially dangerous environment. In the following research we have done a comparison between our hexacopter drone with existing hexacopter drone where we found that the performance, payload capacity, stability, flight time is more enhanced than the existing hexacopters.

Keywords: Hexacopter Drone, Cube orange + Flight Controller, GPS module, Supervision.

INTRODUCTION

Drones, or Unmanned Aerial Vehicles (UAVs), are remote –operated flying systems controlled by trained pilots via transmitters .With rapid advancements in drone technology, their applications have expanded into critical areas such as surveillance, military operations, and security patrolling. In this project a hexacopter drone is assembled and programmed to perform surveillance and military patrolling, especially in high –risk or inaccessible areas. The hexacopter design includes six arms equipped with motors (one on each arm), allowing for stable flight and ability to carry payloads such as camera modules and sensors.

The drone uses a strong frame capable of carrying up to 1kg, making it suitable for mounting and surveillance equipment. A gimbal system is integrated for camera stability, enabling the capture of real–time, high quality aerial footage. Powered by a 22000mAh LiPo battery, the drone supports long-endurance flights necessary for extended monitoring missions.

The onboard GPS module allows precise location tracking, while the live feed from the camera helps in assessing ground situation from a safe distance.

The Cube Orange + flight controller and Mission Planner Software are used to program autonomous missions and manage flight stability. Compared to the traditional quadcopters, the hexacopter offers enhanced performance, reliability, and control. This drone reduces the need of human personnel in dangerous zones, improving safety while increasingl operational efficiency. Hexacopter drones, with their superior capabilities, play a vital role in military patrolling, border surveillance, and reconnaissance missions, making them a valuable asset in modern defense and security strategies.

This research presents the design and functionality of a Hexacopter drone, which is equipped to carry and launch payloads. The drone used a range of components to ensure the stable flight and precise control for various tasks, including surveillance and target engagement. The work involves the assembly of hexacopter drone with the essential components as well as software programming.

OBJECTIVE

The purpose of the project is to develop a hexacopter drone especially for monitoring and military patrol applications. The main purpose is put together a hexacopter with improved aircraft and increase the payload capacity to support extended operations in challenging areas. The drone has been programmed for an autonomous flight, which is equipped with self-insight and status awareness to navigate and perform tasks without direct human control. A high-resolution camera is installed on the drone to provide real-time air recording, making its suitable for monitoring sensitive areas. In addition, a GPS module is installed to enable the exact location and autonomous navigation. This setup reduces the need for human presence in a dangerous environment, increases safety, operational efficiency and general mission efficiency in military and surveillance operations. Operating efficiency, and general allocation efficiency in military and surveillance operations.

LITERATURE REVIEW

The civilian and defense industries have been aided by the development of hexacopters which have enhanced unmanned aerial vehicles (UAVs). Hexacopters are especially useful in high risk environments because they are more stable and have greater lift as well as redundancy (Mishra *et al.,* 2020; Pawar *et al.*, 2019). Unlike quadcopters, hexacopters have more resilience and higher payload capacity. This is important for critical missions such as disaster response or border patrol (Mishra *et al.*, 2020). Shelare *et al.* (2023) studied hexacopter designs focusing on payload-based units and achieving better efficiency with the flight dynamics. Stamate *et al.* (2020) studied how different hardware setups affect flight autonomy and energy consumption, paying particular attention to equipment selection in regard to optimized equipment configuration. The ease of accessing areas affected by natural disasters is greatly improved through drone based surveillance which was previously achieved through traditional ways. This was demonstrated by Mishra *et al.* (2020). Other than the design of the UAV, further development in materials and coatings technology also contributes to performance improvements. Kaliyannan *et al.*(2021); Velu Kaliyannan *et al.* (2019); Kaliyannan *et al.* (2019) investigated sol-gel coatings as well as gahnite nanosheets which can enhance the efficiency of solar cells and decrease the weight of drones, thus aiding solar-powered UAVs. Sathishkumar *et al.* (2013) studied fiber reinforced composites, which enhance the strength without increasing the weight of the drone frame. The method of manufacture also has an effect on the quality of the UAV.

METHODOLOGY

The research methodology adopted in this study encompasses the systematic design , component-level integration, and autonomous operation of a hexacopter drone intended for surveillance , precision payload delivery , and target engagement .

Components and Description

Frame and Motor:

Fig. 1.

Fig. 2.

Each of the six arms of the hexacopter is outfitted with an Electronic Speed Control (ESC), propeller, and brushless motor. These parts are in charge of giving the drone thrust and stability during flight. Every motor's speed and power output are determined by its 300kV rating.

Propellers: The drone generates lift with its six propellers. The 16-inch propellers are so well-optimized and capable that they can typically lift 4 to 8 kg by themselves (per motor/prop).

Fig. 3.

Battery: The drone is powered by a 6S Lithium Polymer (LiPo) battery with a capacity of 22,000 mAh. This large-capacity battery allows the drone to remain airborne for extended periods and power all systems, including the motors, flight control, and camera.

Fig. 4.

ESC (Electronic Speed Control): The 40A ESC helps regulate the speed of each brushless motor based on the PWM signals it receives from the flight control system. These signals adjust the speed of the motors for stable flight and precise control during tasks like launching the rocket.

Fig. 5.

Flight Control System (FCS): Controlling flight behaviour both manually (with a remote control) and automatically (with autopilot and waypoint programming) is the responsibility of the FCS, the drone's brain.

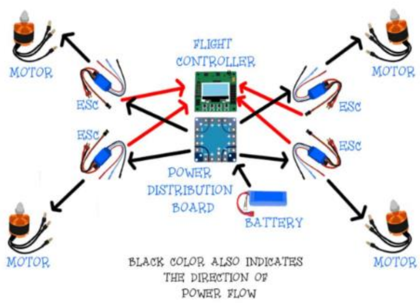

Fig. 6.

Fig. 7.

It interprets information from sensors such as the IMU (Inertial Measurement Unit) to maintain drone stability and adhere to predetermined paths.

Camera and Gimbal: Gimbal is used to mount the camera so that real-time footage can be obtained.A pivoting support that enables one-axis rotation of an item is called a gimbal. A camera installed on a standard three-axis gimbal can move independently of the person holding the gimbal. These three axes are known as roll, yaw, and pitch.

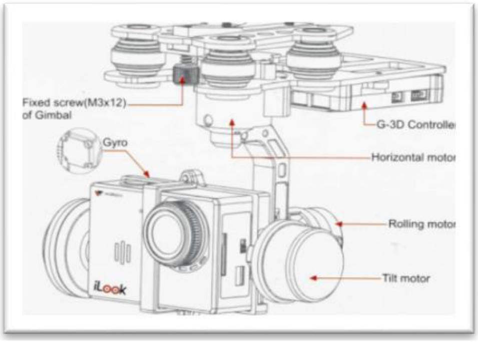

Fig. 8.

Transmitter and Receiver: An Air Unit (receiver) and a Ground Unit (transmitter) are components of the Herelink 1.0 system. Over 2.4GHz, it offers RC control, telemetry, and long-range HD video transmission.

In order to enable integrated control and real-time video streaming, the Air Unit links to the flying controller and camera, while the Ground Unit has a touchscreen controller.

Fig. 9.

METHODOLOGY

The development process was structured into four distinct phases: (A) System Architecture (B) Mechanical and Electrical Assembly, (C) Software Configuration and Navigation Logic, and (D) Experimental Validation**.**

(A) System Architecture. The hexacopter drone is built with a durable frame, six arms, and landing gear for structural stability. Motors are mounted alternately in clockwise and counter clockwise directions, each fitted with 16-inch propellers to ensure balanced and stable flight. Key electronic components such as the Electronic Speed Controllers (ESCs), Cube Orange+ flight controller, power module, and Herelink receiver are mounted on a power distribution board. The GPS module, safety switch, and buzzer alarm are connected to the flight controller to enhance navigation and safety. A servo motor is also linked for optional mechanical operations. For surveillance and military patrolling, a high-resolution camera is mounted on a gimbal to provide stable, real-time aerial footage. This configuration enables remote monitoring in sensitive areas, reducing the need for human presence.

(B) Mechanical and Electrical Assembly. Each motor-propeller-ESC assembly was mounted onto the arms of the hexacopter frame to ensure aerodynamic balance. The Cube Orange+ served as the central computational unit, interfacing with peripheral sensors and actuators through CAN and UART protocols. A three-axis gimbal system was installed to house the onboard camera, allowing real-time video stabilization across pitch, roll, and yaw axes.

For telemetry and control, the Herelink 1.0 system—comprising Ground and Air Units—was implemented to provide integrated RC control, HD video transmission, and telemetry feedback over a 2.4 GHz frequency band. All components were assembled with attention to electromagnetic compatibility and power management optimization .

Fig. 10.

Fig. 11.

(C) Software Configuration and Navigation Logic. Select frame Type for this project is a hexacopter frame in mission planner software. The selected frame is a hexa X.

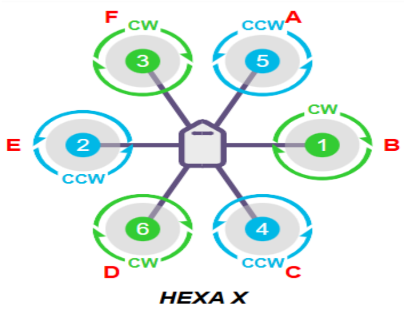

Fig. 12.

The calibration process of the hexacopter drone involves several essential steps to ensure stable and accurate flight. Accelerometer calibration is done by placing the drone on a level surface and sequentially positioning it to the right, left, nose up, and nose down, which helps set proper orientation for stability. Compass calibration is performed by rotating the drone 360 degrees in all directions, allowing it to detect magnetic fields from every angle for accurate heading control. GPS calibration is done through the Mission Planner software by selecting and enabling two compasses simultaneously for improved positioning. Radio calibration involves turning on the transmitter, connecting it to the receiver, and moving all sticks and switches to calibrate all channels.

Fig. 13.

Fig. 14.

Fig. 15. Compass Calibration.

To plan an advanced mission, waypoints should be accurately plotted on the Mission Planner software along with appropriate servo commands. The drone's flight altitude should be set to 100 to 150 meters, and key commands such as takeoff, waypoint navigation, delay, servo open, and servo close must be configured. After entering and reviewing all necessary instructions, the mission should be saved and uploaded to the drone. Once the upload is complete, the mission can be initiated by executing the start command, enabling the drone to follow the programmed path and actions autonomously.

Fig. 16.

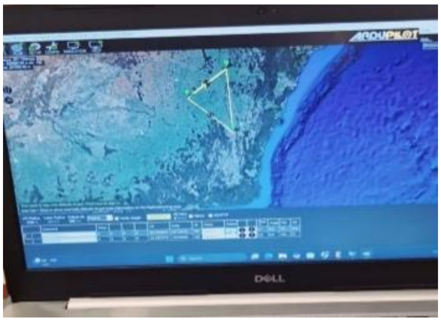

Fig. 17.

APPLICATIONS. Forest Surveillance: The drone may be used for reconnaissance and surveillance operations thanks to its high stability and camera-equipped systems, which give the operator real-time footage to make decisions.

Agricultural Use: Because of its steadiness and payload capacity, this drone has been utilized for more traditional duties like taking pictures and watering plants, even if its primary purpose is more tactical.

Comparison Table

Feature	Hexacopter	Typical Hexacopter
Flight Time	45 Minute	20-30 Minute
Top Speed	20 m/s	10-15 m/s
Payload Capacity	2 Kg	0.5-1.5 Kg
Camera	4K HD	1080p or 4K
Landing Gear	Retractable	Fixed
Response Time	1 Second	2-3 Second
Max Altitude	150 Meter	120-150 Meter

FINAL HEXACOPTER DRONE

Fig. 18.

RESULTS

Hexacopter drone performed successfully in all main parameters during test flights. It maintained the maximum flight time up to 45 minutes below a 2 kg carrier load and confirmed its suitability for extended surveillance missions. The GPS performance was accurate within ± 1.2 meters, and 92% of autonomous waypoint missions were completed without manual intervention. The 3-axis Gimbal secured the camera weight, with the video deviation below 1.5°, even under rapid movements and light air conditions. Return-to-Lunch (RTL) function works fixed, with a 100% success rate during a simultaneous signal loss test. The modular and folding design allowed rapid mounting and dismantling in less than 3 minutes, which caused it to become field red and portable. These results validate the effectiveness of the drone of monitoring, with the possibility of future improvement as AI integration and autonomous mission adaptability.

Fig. 19.

CONCLUSIONS

A multipurpose hexacopter drone weighing 8 kg overall and carrying a 2 kg payload was successfully designed and constructed in this study. Important characteristics including retractable landing gear, carbon fibre folding propellers, and folding arms increase its portability and simplicity of deployment in a variety of environments. While the modular architecture facilitates quick upgrades and maintenance, the Return-to-Launch (RTL) capability guarantees safety and operational effectiveness. This system's design aims to minimize the need for human resources, lower operating expenses, and improve security and monitoring operations response times. Future developments might involve integrating AI and machine learning algorithms to facilitate autonomous decision-making, particularly in situations such as dynamic mission adaption or communication loss.

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