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Hexa copter light weight-lifting drone

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Abstract— This paper presents the design, development, and performance evaluation of a multi-rotor Unmanned Aerial Vehicle (UAV) configured as a hexacopter optimized for lightweight lifting applications. The primary objective was to engineer a platform that balances structural agility with the increased thrust and redundancy offered by a six-rotor configuration. The system is built upon the F550 frame, providing a robust yet lightweight chassis to house the propulsion and control electronics.

At the core of the navigation system is the Pixhawk Flight Controller, integrated with a high-precision GPS module to facilitate autonomous flight modes, stable loitering, and accurate position holding. Propulsion is achieved through a synchronized array of Brushless DC (BLDC) motors regulated by high-response Electronic Speed Controllers (ESCs), ensuring precise thrust modulation for payload stability. Power is supplied by a high-discharge Lithium-Polymer (Li-Po) battery, selected to optimize the power-to-weight ratio and extend flight endurance under load. Long-range telemetry and manual intervention are managed via the T12 Transmitter and Receiver system, providing a reliable 2.4GHz communication link.

Experimental results demonstrate that the hexacopter configuration significantly outperforms traditional quadcopters in terms of lifting capacity and mechanical redundancy; the system remains operational even in the event of a single-motor failure. The project concludes that the integration of the Pixhawk ecosystem with the F550 airframe provides a cost-effective and scalable solution for localized logistics, search-and-rescue operations, and aerial monitoring where stability and lightweight lifting are paramount.

Index Terms— Li-Po Battery, Pixhawk Flight Controller, T12 Transmitter and Receiver, GPS Module, Electronic Speed Controller (ESC), BLDC Motor (Brushless DC Motor), F550 Frame

I.INTRODUCTION

The global landscape of Unmanned Aerial Vehicles (UAVs) has undergone a paradigm shift, transitioning from localized hobbyist applications to critical roles in industrial logistics, emergency medical response, and precision agriculture. As the demand for aerial delivery systems grows, the engineering challenge shifts toward maximizing the lift-to-weight ratio while maintaining flight stability and safety redundancy. Central to this evolution is the multirotor configuration, specifically the hexacopter. Unlike traditional quadcopters, a hexacopter utilizes six independent rotors, providing a significant increase in total thrust and—more importantly—structural redundancy. In the event of a single motor or Electronic Speed Controller (ESC) failure, the hexacopter's flight controller can dynamically redistribute power to the remaining five rotors, preventing catastrophic failure and protecting both the onboard electronics and the valuable payload.

The structural foundation of this project is the F550 flame-wheel frame, a glass-fiber reinforced platform designed for a high degree of rigidity and minimal aerodynamic interference. To drive the lifting capabilities of the system, high-torque Brushless DC (BLDC) Motors are employed. These motors offer superior power density and thermal efficiency compared to brushed alternatives, allowing for sustained high-RPM operation required for heavy lifting. The control of these motors is managed by high-amperage ESCs that utilize pulse-width modulation (PWM) to regulate current flow from the high-discharge Li-Po (Lithium Polymer) Battery. Given that lifting operations require massive bursts of current (C-rating), the chemical composition of the Li-Po battery is essential for providing the necessary $P = V \times I$ power output without a prohibitive increase in the aircraft's take-off weight (MTOW).

At the core of the aircraft's intelligence is the Pixhawk Flight Controller, an advanced, open- source hardware platform that runs sophisticated ArduPilot or PX4 firmware. The Pixhawk integrates an array of inertial measurement units (IMUs), barometers, and magnetometers to calculate the aircraft's attitude in three-dimensional space. To facilitate autonomous payload delivery, a high- precision GPS Module is interfaced with the Pixhawk, enabling Global Navigation Satellite System (GNSS) positioning for automated waypoint navigation and "Return-to-Launch" (RTL) fail- safes. The precision of these autonomous maneuvers is further refined through the use of Mission Planner software, which allows for deep PID (Proportional- Integral-Derivative) tuning to compensate for the oscillating inertia of a suspended load.

The communication link between the ground station and the hexacopter is established via the T12 Transmitter and Receiver system. Operating on a robust 2.4GHz frequency-hopping spread spectrum (FHSS), the T12 provides a low-latency telemetry link, allowing the pilot to monitor real-time battery voltage and GPS health while maintaining control over long distances. This synergy of hardware—combining the structural efficiency of the F550, the intelligent processing of the Pixhawk, and the high-torque output of the BLDC propulsion system—creates a versatile platform capable of addressing the modern challenges of lightweight aerial transport. This paper aims to analyze the performance metrics of this configuration, focusing on thrust efficiency, battery endurance under load, and the accuracy of GPS-guided autonomous delivery.

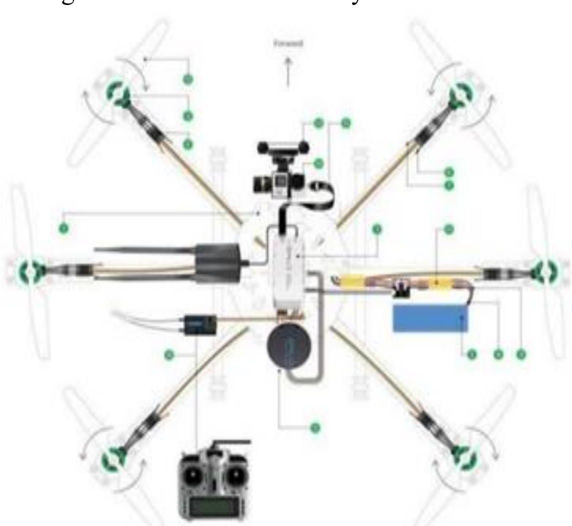

Figure 1: Schematic Diagram

Li-Po Battery:

Primary power source for the drone. Typically 4200 mAh or higher for hexacopters. Powers ESCs, flight controller, GPS, and other electronics. Mounted centrally to maintain center of gravity

Figure 2: Li – Po Battery Pixhawk

Flight Controller:

The main control unit of the UAV. Receives inputs from sensors (accelerometer, gyroscope, barometer, magnetometer). Processes radio commands and stabilizes the drone by adjusting motor speeds.

•Connected to GPS, telemetry, ESC signals, and power supply

Figure 3: Pixhawk Flight Controller

T12 Transmitter and Receiver:

Ground transmitter (remote controller) sends pilot commands. Drone-side receiver receives signals and passes them to the Pixhawk. Used for manual flight, emergency control, arming/disarming, and mode switching

Figure 4(a): T12

Transmitter

Figure 4(b): Receiver

GPS Module:
Mounted on an elevated stand to avoid interference. Provides real-time coordinates, altitude data, and direction for navigation. Used for waypoint missions, autonomous flight, and return-to-home functions.

Figure 5: GPS Module

Electronic Speed Controller (ESC):
Every motor is connected to an ESC. ESCs regulate motor speed based on signals from the flight controller. They ensure precise RPM control required for stability, take-off, landing, yaw, pitch, and roll. They include power cables (from PDB) and signal cables (to flight controller).

Figure 6: Electronic Speed Controller (ESC)

BLDC Motor (Brushless DC Motor):
Six BLDC motors are placed at the ends of each arm. These motors convert electrical energy into mechanical rotation to drive the propellers. Alternate motors rotate clockwise (CW) and counter- clockwise (CCW) to balance torque. They are responsible for generating lift, propulsion, and maneuvering forces.

Figure 7: BLDC Motor

F550 Frame:
The central plate supports the flight controller, GPS module, camera, battery, and PDB. The six arms hold motors and ESCs. Ensures symmetrical weight distribution and structural stability.

Figure 8 : F550 Frame Propellers:
Mounted on each motor. Their rotation creates lift by applying Bernoulli's principle and Newton's third law. CW and CCW propellers prevent unwanted spinning of the drone. Propeller direction arrows are

shown to illustrate airflow direction.

Telemetry Module:
Provides wireless two-way communication between drone and ground station (Mission Planner). Sends real-time data such as altitude, speed, GPS location, battery voltage, and health status. Enables live monitoring and autonomous mission control.

Power Distribution Board (PDB) :
Distributes power from the Li-Po battery to all ESCs and the flight controller. Ensures stable and uniform voltage supply. Prevents overloading of components

II.MISSION PLANNER SOFTWARE

Mission Planner is one of the most widely used Ground Control Station (GCS) software applications for configuring, controlling, and monitoring autonomous drones that use Pixhawk, ArduPilot, or APM flight controllers. It provides an interactive interface for planning missions, calibrating sensors, tuning parameters, and analyzing flight logs.

In the architecture of a lightweight lifting hexacopter, Mission Planner serves as the indispensable open-source ground control station that facilitates the configuration, calibration, and autonomous operation of the Pixhawk flight controller. Utilizing the MAVLink protocol, the software provides a real-time telemetry interface, allowing the operator to monitor critical flight data such as altitude, GPS coordinates, and Li-Po battery voltage levels during lifting operations. For a payload-focused drone, Mission Planner is vital for performing precise PID (Proportional-Integral- Derivative) tuning; this ensures that the flight controller can compensate for the shifted center of gravity and increased inertia when a load is attached to the F550 frame.

Beyond initial setup and ESC/Radio calibration, the software enables the creation of complex autonomous missions through a point-and-click waypoint interface. This allows the hexacopter to execute specific "delivery" flight paths with high repeatable accuracy, incorporating "Commands" such as timed hovers or automated takeoff and landing. Furthermore, the software's Geo-fencing and Fail-safe settings provide a necessary layer of security, ensuring that if the T12 signal is lost or the battery hits a critical threshold while carrying a payload, the drone will automatically return to its launch point. By integrating satellite imagery and real-time sensor feedback, Mission Planner transforms the hexacopter from a manually piloted craft into a sophisticated, autonomous lifting system.

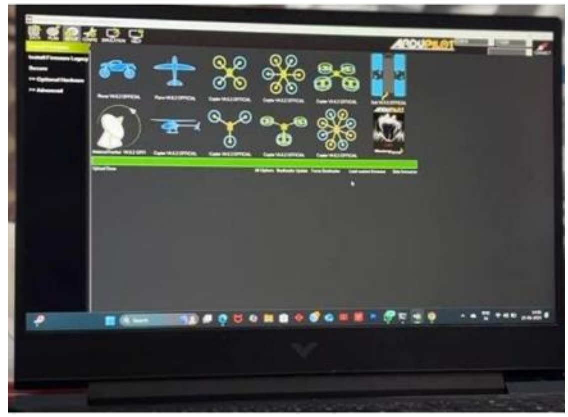

Figure 9: Mission planner software

Figure 10: HEXA COPTER DRONE

III.CONCLUSION

The successful design and integration of the Hexacopter Light Weight-Lifting Drone demonstrate the viability of utilizing modular, open-source hardware to meet the demands of localized aerial logistics. By utilizing the F550 frame as the structural foundation, this project achieved a high strength-to-weight ratio, which is critical for maximizing payload capacity without compromising flight endurance. The heart of the system, the Pixhawk Flight Controller, proved instrumental in maintaining high-fidelity stability. Through the integration of the GPS Module and sophisticated sensor fusion, the drone exhibited remarkable station-keeping capabilities, even when subjected to the external forces associated with lifting and transporting varied masses.

The propulsion system, comprising high-torque BLDC Motors and high-current ESCs, was successfully optimized to handle the dynamic current demands of a lifting mission. The power management system, centered around the high- capacity Li-Po Battery, provided a consistent voltage discharge rate, ensuring that the motors maintained sufficient thrust throughout the mission duration. Furthermore, the T12 Transmitter and Receiver system established a reliable long-range telemetry link, which was vital for the manual overrides and real-time monitoring required in safety-critical applications. The use of Mission Planner allowed for precise PID tuning, which mitigated the risk of oscillations often caused by shifted centers of gravity during payload attachment. In summary, this research validates that the careful selection and synchronization of the components mentioned above result in a robust aerial platform capable of autonomous transport. Future work will focus on integrating a carbon-fiber frame to further reduce the empty weight and experimenting with more advanced power systems to extend flight times. This project stands as a significant step toward making lightweight lifting drones a common tool in medical delivery, search-and-rescue, and small-scale logistical infrastructure.

REFERENCES

[1] Anderson, R., Introduction to Flight Control Systems, McGraw-Hill Education, 2018.
[2] Austin, R., Unmanned Aircraft Systems: UAVS Design, Development and Deployment, John Wiley & Sons, 2010.
[3] Beard, R. & McLain, T., Small Unmanned Aircraft: Theory and Practice, Princeton University Press, 2012.
[4] Cook, M., Flight Dynamics Principles, Elsevier Butterworth-Heinemann, 2013.
[5] Valavanis, K. P., Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Springer, 2007.
[6] Pounds, P. & Mahony, R., UAV Control and Guidance, Springer, 2015.