MULTI-OPERATIONAL UAV FRAMEWORK FOR DELIVERY SERVICES AND NIGHT AERIAL MONITORING

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Keywords:

UAV, Autonomous Drone, Delivery Services, Night Surveillance, GPS Navigation, Live Monitoring, Disaster Response, Smart Cities.

Introduction:

A Multi-Operational UAV Framework uses drones for both delivery and night monitoring tasks. It enables the safe, automated transportation of packages with minimal human intervention. The system uses a mission planner to handle navigation efficiently. It can monitor areas at night using specialized cameras, such as front-person view cameras or low-light sensors. The framework is designed to operate in different environments, including urban and remote areas. It helps in reducing delivery time and improving operational efficiency. It also enhances safety and security through continuous aerial monitoring. Overall, this system supports modern smart applications and reduces human effort.

Figure 1: Assembled Multi-Operational UAV

Objectives:

1. To design a UAV that can perform both delivery and night monitoring using one platform.
2. To develop a stable flight control system for safe operation in different conditions.
3. To build a lightweight and accurate delivery mechanism for secure payload release.
4. To integrate night-vision or low-light cameras for effective night surveillance.
5. To ensure long flight time using efficient power and communication systems.

Methodology:

The UAV system utilises an F450 quadcopter frame with a centrally mounted Crossflight flight controller to minimise vibration interference, powered by a 3S 5500mAh Li-Po battery that supplies power to BLDC 1000kV motors via ESCs for precise PWM thrust control, while maintaining a modular design for future sensor and payload upgrades. Component selection is guided by critical equations including Peak Thrust = MTOW × 2 / 4 motors, ESC Amps = Motor Current × 1.5, and Flight time = (Capacity × 0.8 × Voltage) / (1000 × Power), integrating Radiolink TS100 Mini M8N GPS, IMU, FPV camera for night surveillance, and payload drop system through a reliable power distribution board. Mission planning via Mission Planner uploads waypoints and calibrates sensors, with Crossflight running ArduPilot firmware for autonomous navigation, real-time mode switching, and MAVLink-enabled live video streaming, and SD card data logging. Energy management features continuous battery monitoring to activate power-saving modes and trigger Return-to-Launch (RTL) at critical thresholds, complemented by geofencing, failsafe protocols for signal/GPS loss, and pre-flight diagnostics to ensure regulatory compliance and safety. Experimental validation follows progressive testing: motor/ESC calibration for balanced thrust, GPS/IMU accuracy through ground trials, payload drop precision, FPV video quality under night conditions, and battery endurance tests, with mission logs analyzing waypoint adherence, hover stability, and optimization needs for reliable autonomous operation.

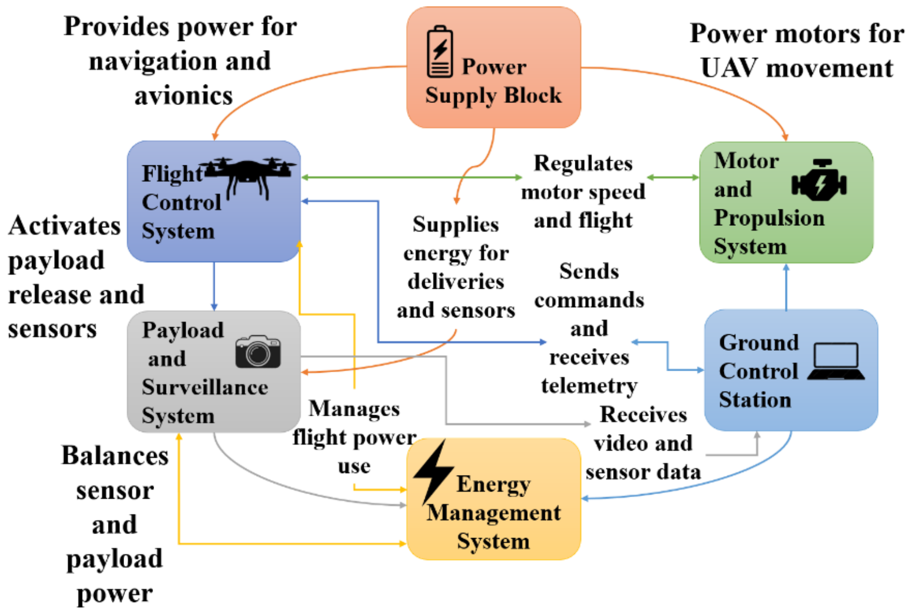

Figure 2: Functional Flow Diagram of UAV Subsystems and Interconnections

Result and Conclusion:

All components were verified, Mission Planner was configured with firmware, and sensors, ESCs, and motors were calibrated for proper operation. A stable low hover was successfully achieved with real-time power monitoring active. Autonomous flight was executed by setting waypoints at 5–10 m altitude with loiter and RTL functions. The UAV completed the mission accurately without manual intervention while monitoring GPS, battery, and performance data.

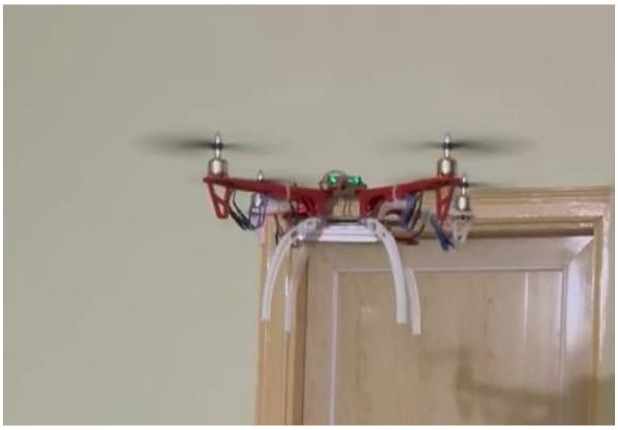

Figure 3: Hover-Level Integration Test for UAV

Expected Performance - The UAV is expected to achieve stable flight, a ~12–14 minutes duration, a 4–5 m/s speed, a ~420 m range, and reliable safety features.

In conclusion, the project demonstrates a reliable UAV system capable of stable flight, accurate navigation, and efficient payload delivery with minimal human intervention. The integration of real-time monitoring and safety mechanisms ensures dependable operation during missions. In the future, enhancements such as AI-based object detection, improved communication range, and solar-assisted power can further increase performance and application scope. This system provides a scalable foundation for advanced surveillance, emergency response, and delivery solutions.

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Future Scope:

The future scope of this project includes:

1. Integration of Artificial Intelligence (AI) for real-time object detection such as human identification, intrusion detection, and fire detection during surveillance.
2. Implementation of multi-UAV (drone swarm) systems to improve area coverage, coordination, and efficiency in large-scale disaster management operations.
3. Enhancement of flight endurance using solar-assisted power systems and advanced battery technologies for longer mission durations.