Multi-copter Drone-based Aerial Network for Autonomous operation, Dynamic Target Detection & Analysis

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Abstract

This project presents the development of a real-time drone swarm consisting of one master octa-copter and two slave quadcopters. The master autonomously assigns tasks to the slaves using onboard sensor data, GPS, and object detection. The system enables coordinated missions like formation flight, orbiting, and image-based surveillance. Communication is managed over a local Wi-Fi LAN and collision avoidance is handled through GPS-based future position prediction. The platform has potential in agriculture, disaster response, and national security.

Objective

1. Real-time master-slave swarm coordination using onboard communication.
2. Autonomous task switching based on vision and GPS data.
3. Safe multi-UAV operation via distributed collision avoidance.

Methodology

The UAV swarm system consists of a master octa-copter and two slave quadcopters, each equipped with a Pixhawk flight controller and a Raspberry Pi. The master drone carries an onboard outdoor Wi-Fi router, which creates a dedicated LAN for real-time inter-drone communication. All Raspberry Pis connect to this network and communicate using MAVLink messages transmitted over UDP. Each drone runs a Python-based control script to interpret and act upon received commands.

The master drone gathers data from GPS, camera, and optional environmental sensors. It runs object detection models (e.g., YOLO) to identify targets or features of interest. Based on its assessment, the master sends behavior commands to the slaves, such as entering formation flight, orbiting around a point, or navigating to specific GPS coordinates. Slave drones execute these tasks using relative position control or waypoint navigation routines while maintaining awareness of other drones in the swarm.

To avoid mid-air collisions, each drone shares its GPS coordinates and velocity with others at regular intervals (1 Hz). A lightweight repulsion vector algorithm predicts potential conflicts and adjusts the velocity commands accordingly. Fail-safe behavior includes automatic loiter or return-to-home if communication is lost or spacing thresholds are exceeded. This is verified by building a python web-based simulation app.

Results

1. Formation and orbit missions executed successfully with 5 m spacing.
2. Task switching and data relay worked within shortest response time.
3. Object detection enabled target-based mission execution.

Conclusion

The developed system demonstrates a lightweight, intelligent UAV swarm capable of real-world missions. Future work includes vision-based positioning, AI-assisted decision logic, and improved multi-drone networking.