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Disaster Response Drone for Remote Areas

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KEYWORDS

ABSTRACT

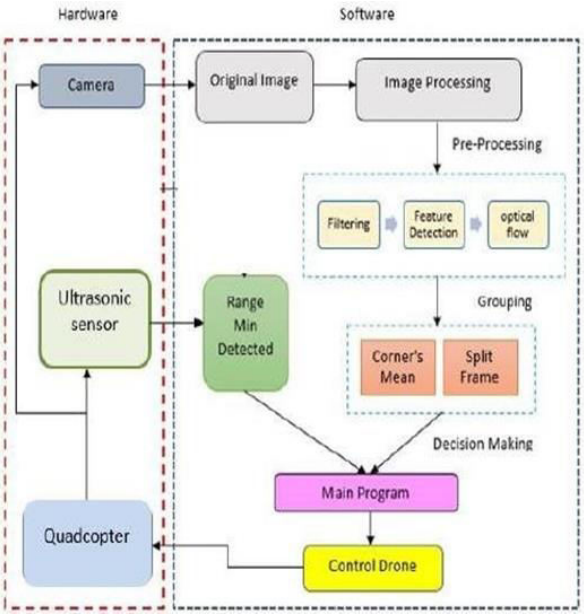
Natural disasters such as earthquakes, floods, and typhoons often damage transportation infrastructure and delay emergency response operations. Traditional search-and-rescue teams face significant challenges reaching affected areas within the critical "Golden Hour," which is essential for saving lives. Although drone technology has evolved rapidly, existing systems are limited because they rely on manual operation and cannot efficiently manage multiple drones simultaneously.

1. INTRODUCTION

1. Develop a centralized drone fleet management system capable of controlling multiple drones from a single dashboard.
2. Enable real-time monitoring and communication using WebSocket-based telemetry streaming.
3. Integrate AI-based decision support to assist operators in mission planning and safety evaluation.
4. Reduce response time in disaster operations by optimizing drone routing and resource allocation.
5. Provide a simulation environment to test missions without deploying physical drones.

2.Methodology

The development of Aero-Guard followed a Simulation-First methodology where the system was first tested using simulated drones before real hardware deployment.



Step 1: System Architecture Design – A modular architecture consisting of backend servers, communication layers, AI modules, and visualization dashboards was designed.

Step 2: Simulation Environment – A physics-based simulation engine was implemented to simulate drone motion, battery consumption, and environmental effects.

Step 3: Real-Time Communication – WebSocket technology was implemented for continuous communication between drones and the control server.

Step 4: AI Integration – AI-based analysis was integrated to evaluate mission safety and environmental conditions.

Step 5: Dashboard Development – A browser-based command dashboard was developed to visualize drone fleets and manage missions.

3.System Design

The Aero-Guard system consists of several key components:

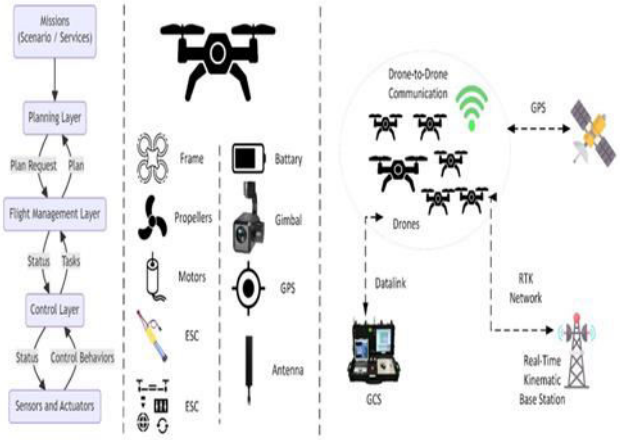
Drone Fleet Layer – Represents the drones that send telemetry data such as GPS coordinates, battery level, and operational status.

Communication Layer – Uses WebSocket protocol to transmit real-time data between drones and the control server.

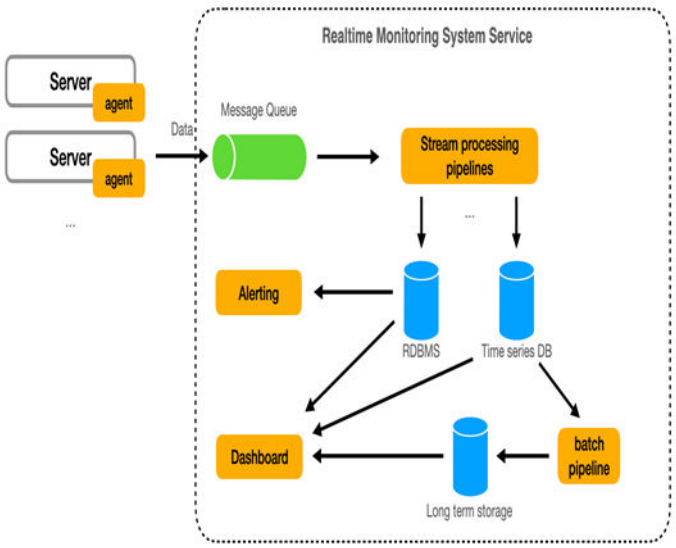
Backend Processing Layer – Processes telemetry data, performs safety checks, and manages mission commands.

AI Decision Layer – Analyzes operational conditions and provides recommendations for safe drone missions.

User Interface Layer – A web dashboard that displays real-time drone locations, telemetry, and mission information.



4.Key Features



1. Multi-Drone Fleet Management – A single operator can manage multiple drones simultaneously.
2. Real-Time Telemetry Monitoring – Live updates of drone location, battery level, and mission status.
3. AI Mission Advisor – AI-based analysis to provide safety recommendations.
4. Simulation Engine – Allows mission testing without deploying real drones.
5. Emergency Command System – Instant emergency commands such as return-to-base or mission abort.
6. Smart Payload Management – Calculates payload safety based on battery capacity and flight distance.

5.Results

The Aero-Guard prototype was evaluated using simulated disaster response scenarios.

Average telemetry latency: 85 milliseconds.

System supported up to 50 simulated drones simultaneously.

Real-time updates achieved less than 100 milliseconds rendering delay.

6.Conclusion

This research presented Aero-Guard, an AI-driven drone fleet management system designed to improve disaster response operations. The system integrates real-time telemetry, AI-based decision support, and a centralized command dashboard to enable efficient coordination of multiple drones.

Future work will focus on real drone integration, enhanced autonomous navigation, and large-scale swarm coordination.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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