Development of Drone for Emergency Services

Mid-Review 1

GITAM
DEEMED TO BE UNIVERSITY

AY 2021-25

GITAM (Deemed-to-be) University

Major Project
Project ID: CS17

Project Team:
- Jagannath Sagar Karri
- Palakonda Visweswara Rao

Department of Electrical Electronics and Communication Engineering

Project Mentor:
- Sanhita Manna

Project In-charge:
- **Dr.Pankaj Kandhway**

Objective

Objective: The project addresses the need for advanced tools to enhance the efficiency of emergency response services, focusing on a drone designed for reconnaissance and support in disaster-affected areas. The drone will provide real-time situational awareness to emergency responders, reducing response times and improving decision-making

- **Develop a drone capable of providing real-time aerial reconnaissance** to emergency services.
- **Assist emergency response teams** in disaster-stricken areas by offering live video feeds, enhancing situational awareness.

Goals

Main Goals

- **Optimize the drone's flight efficiency, communication range, and operational capabilities** for seamless real-time data transmission.
- **Ensure ease of deployment and autonomous flight capabilities**, minimizing the need for manual intervention during critical operations.
- **Integrate the drone with existing emergency response systems** to improve coordination and effectiveness in rescue operations.

Project Plan

Literature Survey

Key Publications

- APPLICATIONS OF UNMANNED AERIAL VEHICLES: A REVIEW

http://dx.doi.org/10.17993/3ctecno.2019.specialissue3.85-105

- A review of UAV autonomous navigation in GPS-denied environments

https://doi.org/10.1016/j.robot.2023.104533

- Reliable Flying IoT Networks for UAV Disaster Rescue Operations

https://doi.org/10.1155/2018/2572460

- UAV- based Photogrammetry and Geo-computing for Hazards and Disaster Risk Monitoring – A Review

https://doi.org/10.1186/s40677-016-0060-y

Key Resources – Whitepaper| Application Notes | Datasheet | Others

- Component: Ublox NEO-M8N GPS Module Datasheet
- Component: Sharp GP2Y0A21YK0F Analog Distance Sensor Datasheet
- Component: HC-SR04 Ultrasonic Distance Sensor datasheet

Existing Implementations – Products| Opensource| GitHub etc

- Aerial Drones for Fire Disaster Response

10.5772/intechopen.1002525

- DJI ENTERPRISE – Fire fighting

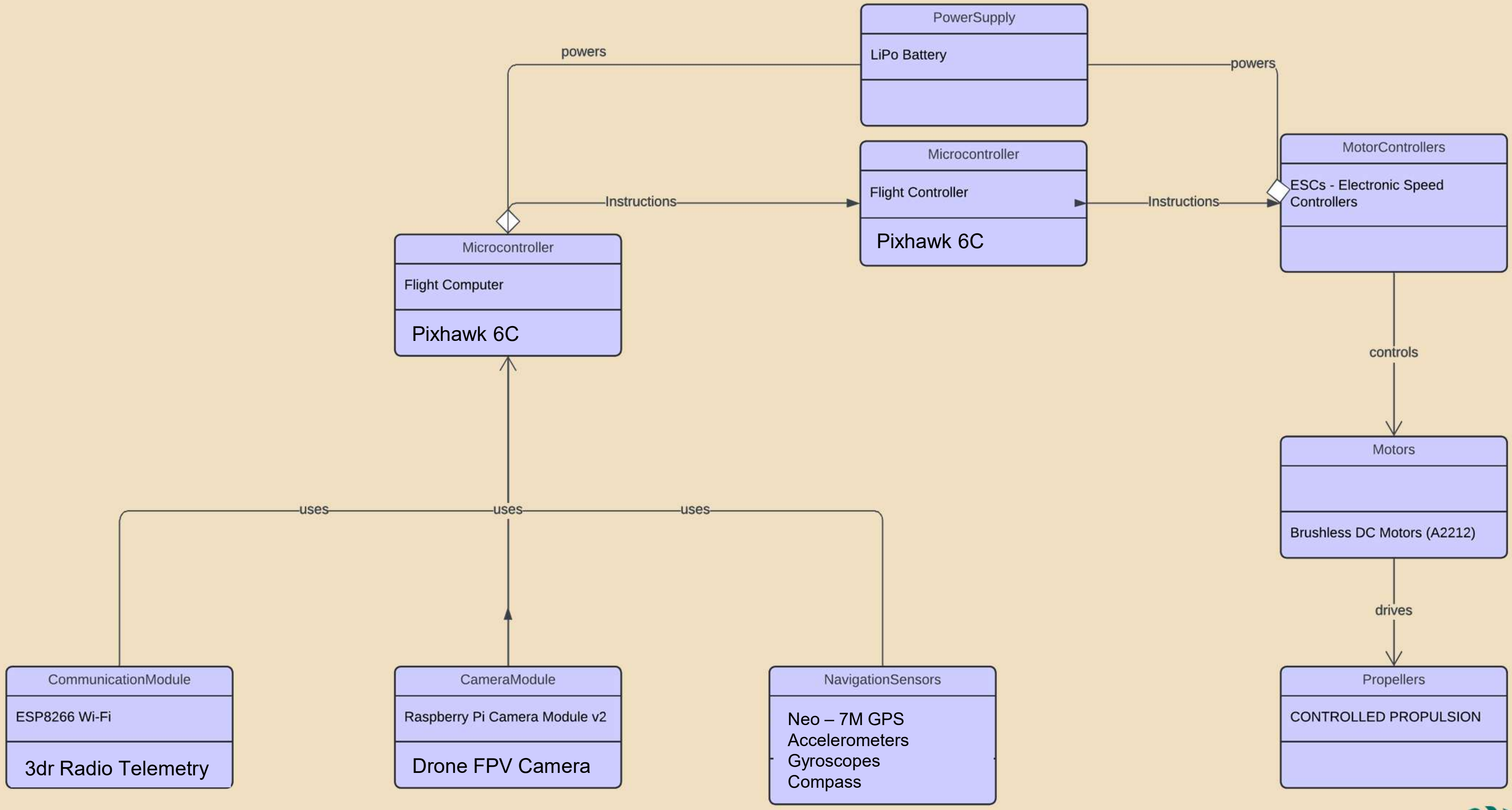
https://enterprise.dji.com/public-safety/firefightingFirefighting

https://docs.holybro.com/autopilot/pixhawk-6c

Flight Controller Complete Documentation

Architecture

Structural Diagram & Behaviour Diagram



LIST OF COMPONENTS AND THEIR PURPOSE

Component	Model	Specifications	Purpose
Flight Controller	Pixhawk 6C	32-bit ARM Cortex M7 MCU, 6-axis IMU, GPS support	Navigation and control
Motors	Brushless 2212 KV980	980KV, 3-4S compatible, max thrust 900g per motor	Propulsion
Electronic Speed Controllers (ESCs)	30A BLHeli_32	30A continuous current, supports DSHOT protocol	Motor control
Battery	LiPo 4S 5000mAh	14.8V, 5000mAh, high-discharge rate	Power source
GPS Module	Neo-6M	Positioning accuracy < 2.5m, UART interface	Position tracking
Camera	1080p FPV Camera	1920x1080 resolution, low-latency video transmission	Live video streaming
Communication Module	ESP8266 Wi-Fi Module	Supports 2.4GHz Wi-Fi, range up to 100m	Data transmission
Frame	Carbon Fiber Quadcopter Frame	Lightweight and durable, 450mm wheelbase	Structural support
Telemetry Module	915MHz Telemetry Radio	915MHz frequency, 1000m range, bidirectional communication	Remote monitoring

Use Cases & Testing

Use Cases

- **Scenario 1: Urban Disaster Site Monitoring:** The drone flies over a collapsed building, providing real-time images and thermal scans to locate trapped victims.
- **Scenario 2: Remote Area Surveillance:** In a wildfire scenario, the drone captures high-resolution footage to map fire spread and help direct firefighting efforts.
- **Scenario 3: Hazardous Environment Assessment:** The drone assesses a chemical spill site, providing situational awareness without exposing responders to toxic conditions.

Test Cases

- Verify the effectiveness of autonomous navigation in different terrains

.

- Test the range and reliability of real-time data transmission under various network conditions.
- Evaluate the drone's durability and performance in harsh environmental conditions (e.g, wind)

Implementation and Results – Iteration 1

1. Hardware Integration Challenges

One of the primary challenges faced during the project was the integration of multiple hardware components, such as the flight controller, GPS module, motors, and communication module. Ensuring seamless communication between these components while maintaining stability was a complex task.

Solution: To address this, we carefully followed manufacturer guidelines for wiring and connectivity. Thorough calibration procedures were conducted, and multiple test flights were performed to fine-tune the system. Additionally, software debugging was carried out to resolve communication protocol mismatches.

2. Real-Time Video Transmission Issues

The drone was designed to provide live aerial footage, but achieving a stable and low-latency video transmission proved difficult due to bandwidth limitations and environmental interference.

Solution: We optimized the transmission protocol by selecting an appropriate frequency band and using error-correction techniques to minimize data loss. A high-gain antenna was also used to enhance the range and signal strength.

3. Flight Stability and Navigation Accuracy

Initial test flights showed instability, especially in high-wind conditions. The drone's navigation system also experienced occasional drift due to GPS inaccuracies.

Solution: We implemented sensor fusion techniques by integrating data from the IMU (Inertial Measurement Unit) and GPS module to improve stability and navigation accuracy. Fine-tuning the PID (Proportional-Integral-Derivative) controller in the flight control algorithm further enhanced maneuverability.

Implementation and Results – Iteration 1

4. Battery Life and Power Management

The drone's operational time was limited due to high power consumption, which posed a challenge for long-duration reconnaissance missions.

Solution: A power-efficient flight path was designed to minimize unnecessary energy expenditure. Additionally, a high-capacity LiPo battery was chosen, and a dynamic power management system was implemented to distribute power efficiently among various subsystems.

These solutions collectively ensured that the emergency support drone met the required performance standards and provided reliable reconnaissance during disaster scenarios

Implementation and Results – Iteration 2

1. Flight Performance and Stability

The drone exhibited stable flight performance during test trials, successfully maneuvering in both open and obstacle-rich environments. The implementation of sensor fusion techniques and PID tuning enhanced flight stability, ensuring smooth navigation and minimal drift.

2. Video Transmission and Data Processing

Real-time video transmission was achieved with minimal latency, allowing emergency teams to receive live footage without significant delays. The implementation of a high-gain antenna and optimized transmission protocols ensured reliable communication over long distances.

3. Autonomous Navigation and Obstacle Avoidance

The drone was able to follow predefined flight paths autonomously and demonstrated effective obstacle avoidance capabilities using onboard sensors. Path-planning algorithms helped optimize flight routes for efficient coverage of disaster zones.

4. Battery Performance and Flight Duration

Power management optimizations resulted in extended flight time, allowing the drone to operate for longer durations without frequent battery replacements. This ensured that the drone could cover larger areas without interruption.

Overall, the project demonstrated the feasibility of deploying an emergency support drone for disaster response, highlighting its potential to significantly enhance emergency management and rescue operations.

Contribution

Team Progress and Movement

- Jagannath Sagar – Team Lead
- Palakonda Visweswara Rao - Hardware

Individual Contribution

Key contributions: Jagannath Sagar

- Drone Assembly
- Flight Control Systems
- Camera Integration
- Telemetry Configuration
- Autopilot integration

Key contributions: Palakonda Visweswara Rao

- Radio systems calibration
- Power system setup

Conclusion & Future Work

Summary and Conclusion

The development of the emergency support drone has demonstrated the potential of UAV technology in disaster response and emergency services. The project successfully addressed key challenges in reconnaissance, real-time video transmission, and autonomous navigation, making it a viable tool for enhancing situational awareness during natural disasters and accidents.

The key conclusions drawn from this project include:

- **Rapid Deployment Capability:** The drone can be deployed quickly in emergency situations, providing crucial reconnaissance in the early stages of disaster response.
- **Enhanced Situational Awareness:** Real-time video streaming enables emergency teams to assess damage, locate victims, and coordinate rescue efforts efficiently.
- **Autonomous and Reliable Operation:** The integration of GPS-based navigation, sensor fusion, and obstacle avoidance ensures stable and autonomous flight, reducing the need for manual intervention.
- **Optimized Power Management:** Energy-efficient flight paths and battery optimizations allow for extended operation, increasing the effectiveness of reconnaissance missions.

Despite the challenges faced, the project successfully achieved its goals, proving that drones can serve as valuable assets in emergency management. Future advancements can further refine the system to make it even more effective for real-world deployment.

Conclusion & Future Work

FUTURE WORK

While the emergency support drone demonstrated strong performance in its current state, there are several areas for further improvement and expansion to enhance its capabilities.

1. AI-Powered Disaster Assessment

Incorporating artificial intelligence (AI) for automated hazard detection and victim identification would improve the drone's effectiveness. Machine learning algorithms could analyze video footage to detect collapsed buildings, fires, or stranded individuals, enabling faster response.

2. Improved Power Management and Flight Duration

Future versions of the drone could utilize advanced battery technologies, such as hydrogen fuel cells or solar-powered charging, to further extend flight time. Additionally, energy-efficient flight planning algorithms could optimize battery consumption.

3. Integration with 5G Networks

The implementation of 5G technology would significantly enhance data transmission speeds, reducing latency and improving the reliability of live video streaming. This would allow emergency teams to receive high-quality footage in real-time, even in remote areas.

4. Enhanced Environmental Adaptability

Future iterations of the drone could incorporate weather-resistant materials and adaptive flight control systems to improve performance in harsh conditions such as heavy rain, strong winds, or extreme temperatures.

5. Multi-Drone Coordination

A swarm of coordinated drones could be deployed simultaneously for large-scale disaster monitoring. Swarm intelligence algorithms would allow multiple UAVs to cover vast areas, share data in real-time, and improve overall efficiency in reconnaissance operations.

By addressing these future advancements, the emergency support drone can evolve into a more powerful tool for disaster response, further aiding emergency services in life-saving operations.

REFERENCES:

- **"Applications of Drone in Disaster Management: A Scoping Review"**
- DOI: 10.1016/j.ijdrr.2021.102133
- Link: https://www.sciencedirect.com/science/article/pii/S1355030621001477
- **"The Role of Drones in Disaster Response: A Literature Review of Drone Deployments and Future Research Directions"**
- DOI: 10.1111/itor.13484
- Link: https://onlinelibrary.wiley.com/doi/10.1111/itor.13484
- **"Drone Applications for Emergency and Urgent Care: A Systematic Review"**
- DOI: 10.3390/ijerph191610031
- Link: https://www.mdpi.com/1660-4601/19/16/10031
- **"Integrating Drones in Response to Public Health Emergencies"**
- DOI: 10.1016/j.jnma.2022.09.246
- Link: https://www.sciencedirect.com/science/article/pii/S2590607622002855
- **"Using Drones in Planning Practice"**
- DOI: Not available
- Link: https://www.planning.org/publications/report/9207028/
- **"Drone as First Responder: Revolutionizing Emergency Response"**
- DOI: Not available
- Link: https://www.thedroneu.com/blog/drone-as-first-responder/

THANK YOU

JAGANNATH SAGAR

PALAKONDA VISWESWARA RAO