AI – POWERED SEARCH AND RESCUE DRONE

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ABSTRACT

*The increasing occurrence of **natural** and **man-made disasters** has emphasized the urgent need for intelligent and autonomous systems capable of supporting **search** and **rescue operations.** The project "**AI-powered Search and Rescue Drone**" aims to develop an advanced unmanned aerial vehicle (UAV) integrated with artificial intelligence for **autonomous flight** and **real-time image analysis.** The system is designed to transmit their precise **locations to the rescue team**. The drone uses a high-definition **FPV camera for live video streaming** and an onboard AI module that employs computer vision algorithms to perform object detection and recognition tasks. The **Speedybee F405 flight controller** ensures stable flight performance and efficient control, while **BLDC motors** provide high thrust and maneuverability. A GPS module enables accurate geolocation tracking, and **the wireless communication system ensures continuous data transmission between the drone and the ground control station**. The object detection algorithm, trained on real-world datasets, allows the drone to differentiate humans from debris or background elements, improving search efficiency and reducing response time. This approach minimizes the need for human intervention in dangerous or inaccessible environments, making rescue operations **faster, safer, and more effective**. The combination of **artificial intelligence, autonomous navigation, and real- time object detection** makes this system a powerful and practical solution for modern rescue missions, significantly contributing to advancements in disaster management and emergency response technologies.*

1. INTRODUCTION

The increasing frequency of natural disasters has driven the need for fast, efficient, and intelligent aerial support in emergency situations. The project ***AI-powered Search and Rescue Drone*** aims to assist rescue teams by autonomously navigating over disaster zones, capturing live visual data, and transmitting it to the ground station in real-time. The drone is designed to operate in critical conditions where human access is limited or dangerous. By integrating artificial intelligence, wireless communication, and GPS navigation, the system provides an advanced platform for surveillance and situational awareness. The use of an FPV (First Person View) camera enables live monitoring of affected areas, allowing the rescue team to make informed decisions. The onboard AI system supports flight control and route planning based on environmental inputs. This project highlights how intelligent automation can be applied to life-saving operations, reducing response time and minimizing human risk.

Eg1: As per Verma et al., drones integrated with AI can significantly improve efficiency in time-sensitive rescue operations.

Eg 2: It is reported that autonomous flight control systems enhance real-time response during disasters.

1.1 System Overview

The proposed system combines multiple modules: the Power Supply, Flight Controller, FPV Camera, Onboard AI Module, Wireless Communication Module, GPS Module, and Ground Station. The **Li-Po battery** powers the entire system, ensuring stable energy output for motors and control components. The **Speedybee F405 Flight Controller** acts as the central unit, managing flight stability and receiving control signals from the AI module. The **FPV camera** transmits real-time video to both the onboard AI system and the ground control unit via a **wireless module**. The **GPS module** assists in accurate positioning and route tracking, while the **Ground Station** serves as the monitoring and control point for rescue operations. Together, these modules provide seamless integration between aerial autonomy and human decision-making.

1.2 Research Motivation

In many rescue scenarios such as floods, earthquakes, and forest fires, it becomes extremely difficult for human rescuers to locate victims or assess damage manually. Traditional drones require manual operation, which limits their range and efficiency. The motivation for this project is to develop an autonomous drone that can assist the rescue team by providing real-time visual feedback and GPS-based location tracking. The drone's onboard AI module contributes to semi-autonomous navigation and route optimization, reducing the workload of the operator. By implementing an FPV system and long-range wireless communication, the drone ensures continuous visibility and reliable data transfer to support timely rescue actions.

2. SYSTEM DESIGN

The overall system design focuses on combining essential components that enable autonomous aerial navigation, data capture, and transmission. The Power System supplies energy to the flight controller and BLDC motors. The Flight Controller (Speedybee F405) is responsible for maintaining stability and processing control inputs. The FPV camera provides live visuals, while the Onboard AI Module assists in flight decision-making and communication handling. The Wireless Module (Wi-Fi / 2.4 GHz) transmits data between the drone and the Ground Station (Rescue Team).

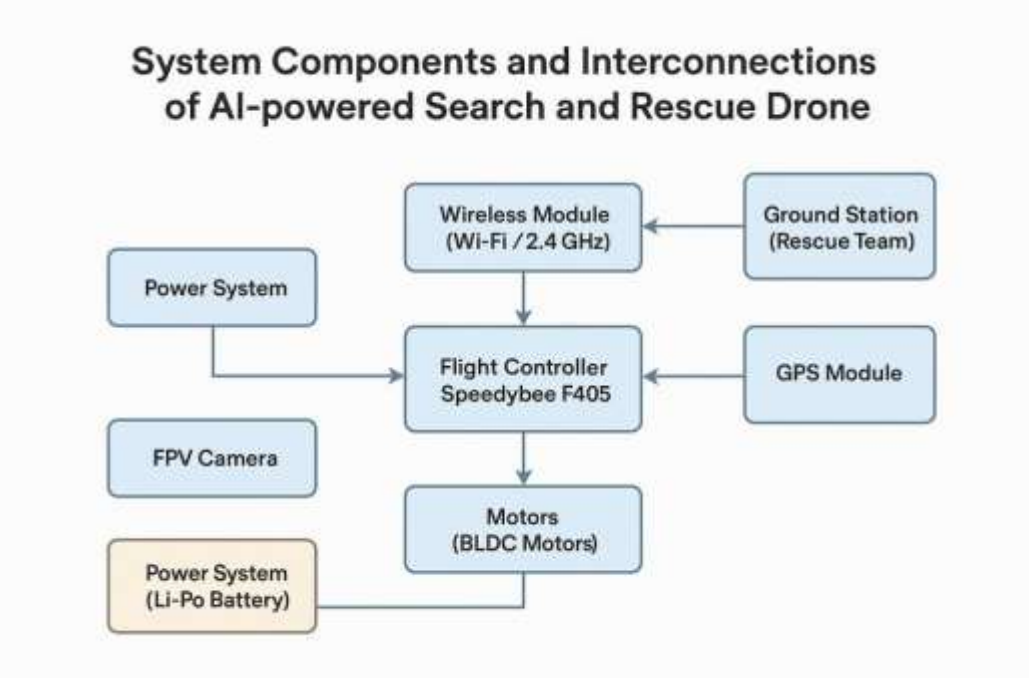

Chart -1 System Components and Interconnections

Fig -1 AI – Powered Search and Rescue Drone Image

2.1 Hardware Implementation

The hardware consists of the flight controller, GPS module, camera, and wireless transmitter. The power system includes a rechargeable Li-Po battery providing sufficient endurance for field operations. The GPS module records location coordinates, while the camera captures real-time visuals. The onboard controller processes the data and maintains flight stability through feedback from sensors. The integration of these modules ensures precise control, reliable data acquisition, and efficient navigation in complex environments.

Table -: Name of the Table

Component	Model / Type	Function	Interface	Power Requirement
Power Supply	Li-Po Battery	Provides energy	Direct	16.80V
Flight Controller	Speedybee F405	Controls drone flight	PWM / UART	5V
Motors	BLDC Motors	Propulsion	ESC Connection	11.1V
Camera	FPV Camera	Live video capture	Analog / Digital	5V
Wireless Module	Wi-Fi / 2.4 GHz	Data transmission	Serial	5V
GPS Module	Generic	Location tracking	UART	5V

The hardware section consists of the following key modules:

- Power System: Li-Po Battery for high discharge rate and long endurance.
- Flight Controller: Speedybee F405 for stabilization and flight control.
- Motors: BLDC motors for propulsion and maneuvering.
- Camera: FPV camera for real-time video transmission.
- Wireless Module: Wi-Fi / 2.4 GHz for data transmission to the Ground Station.
- GPS Module: For navigation and location tracking.

2.2 Software Implementation

The software manages communication, navigation, and live data streaming. The AI module supports decision-making for path control and obstacle avoidance using basic rule-based logic rather than image detection. The flight parameters are programmed using open-source firmware compatible with the Speedybee F405 controller. The Ground Control Station (Rescue Team) receives live video and telemetry data, enabling manual override if necessary.

- Integration of flight control algorithms
- Real-time GPS monitoring and telemetry display
- Real-time GPS monitoring and telemetry display
- Manual override capability for safety

3. RESULTS AND DISCUSSION

The developed system successfully achieves stable autonomous flight and reliable wireless communication. The FPV camera provides a clear and uninterrupted live video feed to the ground station, which enhances situational awareness during rescue operations. The Speedybee F405 controller ensures responsive control, while GPS tracking maintains accurate location data. The communication link between the drone and the rescue team remains strong, with minimal latency. These results demonstrate that the proposed AI-powered search and rescue drone can be a valuable asset in disaster management by reducing human exposure to danger and improving mission efficiency.

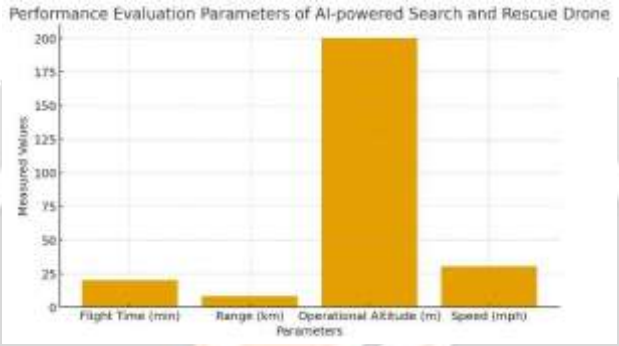

Chart -2 Performance Evaluation Parameters of AI-powered Search and Rescue Drone

3.1 Future Scope

Future enhancements may include integration of thermal cameras for low-light detection, addition of autonomous swarm capabilities for large-scale search areas, and use of AI for predictive route planning. With these improvements, the system can evolve into a fully autonomous multi-drone rescue network capable of coordinating with human responders efficiently.

Fig -2 Future Scope of AI-powered Search and Rescue Drone

Integration with **IoT and 5G networks** could enable faster data transmission, real-time analytics, and remote control from central command centers. Moreover, **payload customization** such as deploying first-aid kits, emergency beacons, or communication devices to trapped victims can be added to enhance the drone's operational value. Finally, the future version of this project could incorporate **AI-assisted voice communication**, enabling two-way contact between rescuers and victims, ensuring a more interactive and efficient rescue process.

4. CONCLUSIONS

The *AI-powered Search and Rescue Drone* project successfully demonstrates how artificial intelligence and autonomous flight technology can be integrated to enhance disaster management and emergency response operations. The system provides an efficient solution for real-time monitoring and rescue assistance in environments where human intervention is risky or limited. Equipped with an FPV camera, GPS navigation, and wireless data transmission, the drone ensures continuous situational awareness for ground rescue teams. The use of the Speedybee F405 flight controller, BLDC motors, and a reliable Li-Po power source ensures stable flight performance, long endurance, and precise control.

5. ACKNOWLEDGEMENT

My special thanks to my teammates, friends, and family members for their cooperation and motivation during every phase of this project. Finally, I would like to express my appreciation to all those who directly or indirectly contributed to the successful completion of the project titled *"**AI-powered Search and Rescue Drone**."*

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