

Smart Drone-Based Disaster Management System

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Abstract: *Natural disasters such as earthquakes, floods, and landslides often lead to the collapse of conventional communication infrastructure, which will make rescue operations difficult and delay emergency response. This project will present the development of a Drone-Based No Internet Communication Network using ESP32 and GPS modules. The system will integrate a NEO-6M GPS module to obtain real-time location coordinates and an ESP32 microcontroller to create a Wi-Fi hotspot, enabling victims to connect and send SOS. Each SOS message will be automatically tagged with the sender's GPS location and will be transmitted to a base station through ESP-NOW or mesh networking. By deploying the system on a lightweight drone powered by a portable battery, communication coverage will be quickly established in disaster-affected areas. The proposed system will be cost-effective, portable, and scalable, providing a practical solution to ensure timely rescue operations, reduce response delays, and enhance disaster management efficiency.*

Keywords: Disaster Communication, Drone, ESP32, GPS, Wi-Fi Hotspot, Mesh Networking, Rescue System

I. INTRODUCTION

Natural disasters such as earthquakes, floods, and landslides often cause a complete collapse of communication infrastructure. In such scenarios, victims are unable to send their location or emergency messages, which delays rescue operations and increases fatalities. Traditional communication systems are expensive and dependent on cellular or satellite networks, which may not be available in rural or disaster-affected regions.

This project, "Drone-Based No-Internet Communication Network", will aim to design and develop a low-cost and portable communication system using ESP32 microcontroller and GPS module mounted on drones. The drone will act as a mobile communication relay by creating a Wi-Fi hotspot to enable victims to connect using their smartphones and send SOS messages without internet. Each message will be tagged with real-time GPS coordinates and transmitted to a base station laptop or smartphone using ESP-NOW or mesh networking. By deploying drones in affected areas, communication coverage will be quickly established, supporting faster rescue and relief operations. In situations where internet connectivity or cellular infrastructure is unavailable, drone-based communication networks serve as an alternative for enabling data exchange and coordination.

These networks are particularly useful in disaster management, defense communication, and remote monitoring applications. Unlike traditional systems that rely on fixed infrastructure, drones can form an adaptive ad-hoc network where each drone acts as a communication relay node. Technologies such as ESP32, LoRa, and GPS modules make it possible to create low power, long-range, and location-aware communication links between drones and ground users. The primary goal of such networks is to provide a temporary communication channel during emergencies or in areas lacking network coverage.

Research has focused on optimizing routing protocols, energy management, and mobility control to ensure seamless connectivity and efficient data transfer. With advancements in embedded systems and wireless protocols, drone-based no-internet communication systems are becoming more practical, scalable, and affordable.



II. LITERATURE REVIEW

In recent years, Unmanned Aerial Vehicles (UAVs), commonly known as drones, have gained significant attention as a promising solution for enhancing communication in emergency and remote environments. Various researchers have proposed innovative frameworks and algorithms to utilize drones for establishing reliable, adaptive, and efficient communication networks during disasters or low-infrastructure scenarios. (2025) proposed a drone-assisted mesh network framework designed to provide emergency connectivity in remote and low- infrastructure zones.

Their study demonstrated that drones could function as mobile network nodes, dynamically forming communication links to maintain connectivity during disaster situations. Extending this work, Sutradhar and Manipal Academy of Higher Education (2025) presented a drone- based mesh communication model that improved data transmission reliability in critical situations. Their research emphasized the adaptability and mobility of drones for emergency rescue operations and post-disaster recovery.

(2024) introduced a geo-drone-based Service-Oriented Architecture (SOA) routing algorithm, aimed at improving communication stability in emergency ad-hoc networks. Their approach significantly enhanced wireless link reliability, proving highly effective in challenging disaster environments where traditional infrastructure fails. (2024) developed a drone-based mobile full-duplex optical communication system, enabling simultaneous data transmission and reception. This advancement supports high-capacity and low-latency communication, which is vital for real-time data exchange during emergency response operations. (2024) focused on optimal handover strategies for Search and Rescue (SAR) drones using a digital twin-based approach. Their model ensured uninterrupted connectivity as drones transitioned between coverage zones, which is essential for maintaining continuous situational awareness in rescue missions. Furthermore, their work highlighted the synergy between deep learning, IoT, and real-time monitoring, enhancing operational efficiency and safety in critical conditions.

Krishnakumar and Asokan (2023) proposed a geographic drone-based route optimization technique for emergency ad-hoc networks. Their findings indicated improvements in communication speed, energy efficiency, and reliability, which are crucial for time-sensitive disaster management.

(2022) designed an inspection network for UAVs based on 4G/5G communication technologies, demonstrating how next-generation wireless systems could enable long-range, low-latency, and high-throughput connectivity for remote monitoring and emergency response.

(2021) investigated drone-assisted multiple-antenna backscatter IoT sensor networks, illustrating how UAVs can enhance connectivity in resource-constrained environments. Their research revealed the potential of integrating drones with IoT infrastructure to extend communication coverage and improve data collection in large-scale systems such as disaster zones, agriculture, or environmental monitoring.

Overall, these studies collectively emphasize the growing importance of drones as intelligent communication agents capable of supporting resilient, adaptive, and high-performance networks in critical situations. The integration of technologies such as AI, IoT, 5G, and optical communication further strengthens the role of UAVs in establishing robust emergency communication frameworks for future smart and disaster-resilient societies



III. METHODOLOGY

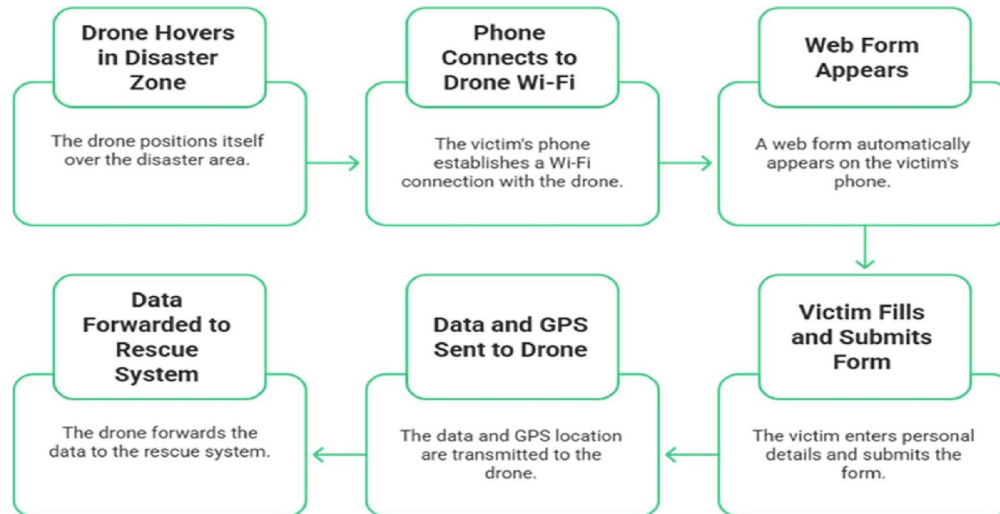


Fig1. Block Diagram of the System

ESP 8266 -2:



Fig2.ESP 8266 -2

The ESP8266 is a low-cost Wi-Fi-enabled microcontroller that connects devices wirelessly. Ground ESP8266: Acts as a Wi-Fi hotspot for victims' phones to send SOS and GPS data. Drone ESP8266: Mounted on the drone, it collects data from the ground unit using ESP- NOW and sends it to the admin server. It handles communication, data processing, and control signals efficiently using minimal power.

OLED Display (0.96" or 1.3"):

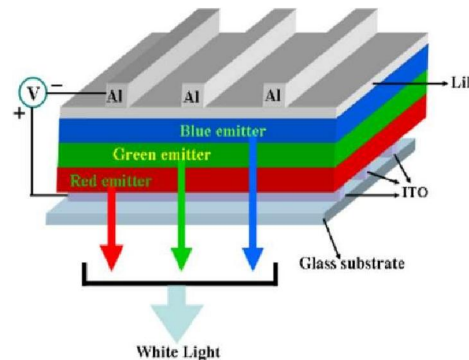


Fig3. OLED Display (0.96" or 1.3")

A small I2C OLED screen used to display important messages like: "Wi-Fi Active", "SOS Sent", "GPS Connected", or battery level. It helps in monitoring system status without needing a computer connection. Connected via SDA and SCL pins to the ESP8266. Low power consumption, lightweight, high contrast, and wide viewing angles. Used in mini displays for wearables, sensors, DIY electronics, and robotics projects.



Neo 6M GPS Module:



Fig4. Neo 6M GPS Module

The Neo-6M is a GPS receiver that provides real-time location data. This module ensures victims' exact locations are captured and transmitted during emergencies. It's commonly used in hobbyist, robotics, UAV, and navigation projects since it offers a good balance of performance and cost.

Li Po Battery:



Fig5. Li Po Battery

A Li-Po (Lithium Polymer) battery is a type of rechargeable battery that uses lithium-ion chemistry combined with a polymer electrolyte instead of a liquid one. This design makes the battery lightweight, compact, and flexible in shape, which is ideal for modern portable devices. Each cell typically provides a nominal voltage of 3.7V, reaching 4.2V when fully charged and about 3.0V when discharged. Li-Po batteries are widely used in drones, smartphones, laptops, RC vehicles, and robotics due to their high energy density and low self-discharge rate. However, they must be handled carefully since they are sensitive to overcharging, over-discharging, and physical damage, which can lead to swelling or even fire. Despite these precautions, their light weight and efficiency make them one of the most popular battery types in today's electronic applications.

IV. DISCUSSIONS

The Smart Drone-Based Disaster Management System offers an innovative and efficient solution for handling emergencies and natural disasters. In traditional disaster management systems, rescue operations often face significant delays due to inaccessible terrains, communication failures, and a lack of real-time information. The integration of smart drones addresses these issues by providing rapid situational awareness, real-time data collection, and quick deployment capabilities in affected areas.

In this system, drones are equipped with GPS modules (Neo-6M), microcontrollers (ESP32), and communication interfaces such as Wi-Fi or LoRa. These components enable the drone to operate autonomously, capture aerial images, and transmit location data even in the absence of conventional communication networks.

This ensures that rescue teams receive timely and accurate information, which helps them to plan and execute operations effectively. The incorporation of smart features, such as AI-based image analysis and machine learning algorithms, enhances the decision-making process by detecting survivors, identifying hazards, and assessing the extent of damage. The system's OLED display provides real-time operational feedback, while Li-Po batteries ensure reliable and extended flight performance. These features collectively make the drone system efficient, portable, and suitable for diverse disaster conditions such as floods, earthquakes, and wildfires. Despite its numerous advantages, the system faces certain challenges. Battery limitations, signal interference, and adverse weather conditions may affect its continuous operation and data accuracy.

Additionally, issues related to data security and regulatory restrictions must be addressed before large-scale deployment.



Nevertheless, with further development and optimization, the Smart Drone-Based Disaster Management System can significantly reduce response time, enhance coordination, and minimize human risk during critical disaster scenarios. In conclusion, this system demonstrates how the fusion of drone technology, IoT, and intelligent communication systems can transform disaster management into a proactive, data-driven, and highly responsive process, ultimately contributing

V. CONCLUSION

The Smart Drone-Based Disaster Management System proves to be a powerful and reliable technological innovation for modern emergency response. By integrating drone technology, IoT devices, and wireless communication systems, it enables authorities and rescue teams to efficiently monitor disaster zones, collect real-time information, and make informed decisions. The system's ability to function even in areas without network connectivity makes it highly suitable for critical situations where conventional systems fail. Through the use of components such as the ESP32 microcontroller, Neo-6M GPS module, Li-Po battery, and OLED display, the drone becomes capable of performing autonomous navigation, live location tracking, and data transmission. These features collectively enhance the accuracy, speed, and safety of disaster relief operations. Furthermore, the system's adaptability allows it to be applied in various disaster scenarios such as floods, landslides, earthquakes, and forest fires. Although challenges such as limited battery life, environmental interference, and data security persist, continuous advancements in drone hardware, artificial intelligence, and communication networks are expected to overcome these issues. The implementation of this system can significantly reduce human risk, improve coordination among rescue teams, and ensure timely response in emergencies. In essence, the Smart Drone-Based Disaster Management System represents a major step toward creating a technology-driven, efficient, and proactive disaster management framework that aligns with the growing need for intelligent It demonstrates how innovation, when combined with humanitarian goals, can contribute meaningfully to saving lives and rebuilding communities.

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