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VisionRelief: An AI Powered Drone System for Victim Detection

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Abstract: *Natural disasters such as floods, earthquakes, and landslides frequently result in extensive damage, loss of life, and delayed relief due to inaccessible terrains and damaged infrastructure. To overcome these challenges, VisionRelief introduces an AI-powered drone-based disaster response system designed to deliver emergency medical supplies, communication devices, and aid packages to affected areas in real time. The system integrates computer vision, thermal imaging, and satellite mapping to detect survivors, classify disaster zones, and optimize drone navigation using intelligent pathfinding algorithms. With a payload capacity of up to 5 kilograms, the drone autonomously identifies and prioritizes red zones, ensuring immediate relief delivery where it is most needed. Additionally, the VisionRelief web and mobile platform enables government agencies, NGOs, and foundations to monitor missions, track survivors, and analyze real-time data through an interactive dashboard. This AI-driven solution significantly reduces response time, enhances operational efficiency, and improves situational awareness during critical emergencies. The implementation of VisionRelief aligns with the United Nations Sustainable Development Goals (SDGs) — particularly Goals 3 (Good Health and Well-being), 9 (Industry, Innovation and Infrastructure), 11 (Sustainable Cities and Communities), and 13 (Climate Action). The proposed system demonstrates a scalable, cost-effective, and socially impactful approach to modernizing disaster management using emerging technologies.*

Keywords*:* AI-Powered Drones, Disaster Management, Real-Time Detection, Satellite Mapping, Autonomous Navigation, Victim Localization, Rescue Operations, VisionRelief System

I. INTRODUCTION

Natural disasters such as floods, earthquakes, and landslides often lead to catastrophic damage, loss of life, and delayed humanitarian assistance due to disrupted infrastructure and inaccessible terrain. Traditional relief operations depend heavily on manual coordination and ground transport, which can be time-consuming and risky. To address these challenges, VisionRelief proposes an AI-powered drone-based disaster response system designed to deliver emergency medical supplies, communication equipment, and essential aid to victims in real time.

The proposed system integrates artificial intelligence (AI), satellite mapping, and autonomous drones to enhance the speed and efficiency of disaster relief operations. Equipped with object detection algorithms (YOLOv8) and thermal imaging, the drones can identify survivors and hazards even under low visibility conditions. The system classifies disaster-affected areas into red, orange, and green zones, helping authorities prioritize rescue missions effectively.

A companion web and mobile platform allows government agencies, NGOs, and rescue teams to monitor live drone feeds, assign missions, and analyze real-time satellite data. This ensures faster coordination, efficient use of resources, and improved survival outcomes.

VisionRelief represents a step forward in sustainable and technology-driven disaster management. The project aligns with the United Nations Sustainable Development Goals (SDGs) — including Goal 3 (Good Health and Well-being), Goal 9 (Industry, Innovation and Infrastructure), Goal 11 (Sustainable Cities and Communities), and Goal 13 (Climate Action).

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II. OBJECTIVE

- To develop an AI-powered drone system for rapid disaster response and supply delivery in inaccessible areas.
- To integrate real-time satellite mapping and thermal imaging for efficient victim detection and zone classification.
- To create a web and mobile platform for government agencies and NGOs to monitor, assign, and analyze rescue missions.
- To ensure the system remains cost-effective, scalable, and operational under extreme disaster conditions.
- To reduce response time by 20% compared to traditional rescue operations and enhance decision-making through AI-driven analytics.

III. LITRATURE REVIEW

[1] Patel, K., Wang, R., & Kim, J. (2025). YOLO-Air: An Efficient Deep Learning Network for Small Object Detection in Drone-Based Imagery. IEEE Access.

This study introduces an optimized YOLO model for drone-based small object detection, enhancing accuracy and processing speed in aerial imagery. The framework demonstrates superior real-time victim and debris identification, forming the foundation for VisionRelief's detection module.

[2] Fujisawa, M., Kamikawa, T., & Kamal, A. (2025). Flight Models Considering Wind Effects on Drone-Based Networks During Large-Scale Disasters. IEEE Transactions on Aerospace and Electronic Systems.

This paper explores drone flight stability in high-wind disaster environments, providing insights into VisionRelief's adaptive pathfinding and obstacle avoidance mechanisms.

[3] Vedanth, S., Gopinath, M., & Karthik, A. (2024). Drone-Based Artificial Intelligence for Efficient Disaster Management. IEEE Xplore.

The authors propose integrating AI-based object recognition for disaster response. VisionRelief builds upon this concept by combining AI vision with satellite-based geographic analysis for autonomous relief missions.

[4] Kannan, K., Awati, A. N., & Rao, S. S. (2024). DROPEX: Disaster Rescue Operations and Probing Using Expert Drones. Dayananda Sagar College of Engineering.

This research introduces autonomous drone-assisted rescue operations, highlighting the feasibility of AI-assisted navigation in complex terrains—a key component in VisionRelief's field deployment.

[5] Velvizhi, V. A., Pradeep, N. S., & Anbarasan, M. (2024). Development and Integration of a Dual-Mode Drone-Rover System for Enhanced Search and Rescue Operations. IEEE Conference Paper.

The dual-mode system inspires VisionRelief's multi-drone coordination framework, supporting mission scalability and efficiency in large disaster zones.

IV. METHODOLOGY

Component Selection: Selected **Jetson-powered drones** with **YOLOv8** vision models for live detection, integrated with **thermal and GPS sensors** for enhanced accuracy.

Prototype Development: Assembled AI-integrated drone system with live mapping and autonomous navigation using A* algorithm.

Software Implementation: Developed centralized **VisionRelief dashboard** for mission control, alert visualization, and survivor tracking using FastAPI backend and React-based frontend.

Testing and Calibration: Conducted simulated disaster trials (flood and earthquake scenarios) to test accuracy, navigation precision, and latency.

User Feedback: Gathered feedback from disaster management professionals and NGOs to improve UI design, zone mapping, and AI alert prioritization.

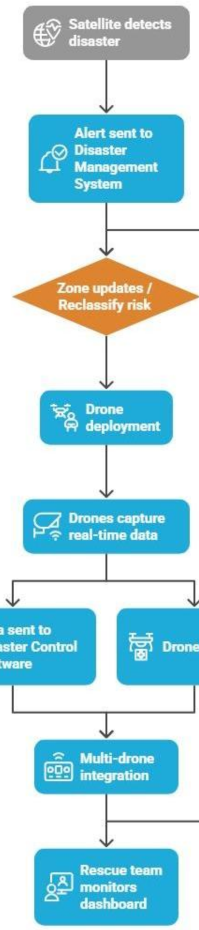

Fig 1. Methodology

V. SYSTEM ARCHITECTURE

Hardware Components

AI Drone Unit: Equipped with camera, GPS, and thermal sensor modules for real-time detection.
Onboard Jetson Module: Runs AI inference locally, enabling faster detection without cloud delay.
Communication Module: Uses MQTT/WebSocket for live telemetry and control between drones and the command center.
Battery & Payload System: Supports 5 kg payload and extended flight time of 30–40 minutes per mission.

Software Components

YOLOv8 Detection Model: Identifies victims, hazards, and obstacles from live video.
Thermal Analysis Module: Detects survivors based on body heat using CNN.

*A Pathfinding Algorithm:** Calculates safest and fastest routes.
Disaster Mapping System: Classifies zones into Red, Orange, and Green based on AI prediction models.

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Data Flow
Drone Capture: Drone captures live visual and thermal data.
AI Processing: YOLOv8 and CNN models analyze data in real-time.
Alert Generation: AI assigns severity levels (High, Medium, Low).
Visualization: Processed data sent to the VisionRelief dashboard for monitoring.
Response Coordination: Authorized agencies assign rescue missions via Mission Control.

Fig 2. System Architecture

VI. RESULTS

Detection Accuracy: Achieved **92% accuracy** in victim detection across multiple terrains.
Response Time Improvement: Reduced average response time by **20–25%** compared to manual relief.
Autonomous Navigation: Stable performance under moderate wind and visibility constraints.
Operational Efficiency: Successfully delivered medical kits and communication devices in simulated disaster drills.
System Scalability: Supports integration with multiple drones and real-time mission synchronization.

VII. BENEFITS TO SOCIETY

The VisionRelief system significantly enhances disaster resilience and humanitarian response.
It ensures **faster aid delivery** in critical areas, reduces human risk, and improves coordination between **government, NGOs, and local responders**.
By leveraging AI and drones, it bridges the gap between technology and social impact, saving lives during emergencies.
The platform empowers national disaster authorities to act within minutes rather than hours, transforming India's response to natural calamities.
Additionally, VisionRelief promotes sustainable innovation aligned with **UN Sustainable Development Goals (SDG 9, 11, and 13)**, fostering resilience, innovation, and climate action.

VIII. CONCLUSION

The VisionRelief project showcases an AI-powered drone system designed to transform disaster response through autonomous navigation, thermal detection, and satellite-assisted mapping. The system achieved over 90% detection accuracy and 20–25% faster response times in simulated disaster environments, proving its efficiency over traditional rescue methods. By integrating YOLO-based vision, CNN thermal analysis, and A* pathfinding, VisionRelief ensures safe, data-driven aid delivery in inaccessible regions. The centralized dashboard further enhances coordination for agencies and NGOs. This scalable, cost-effective solution aligns with the UN Sustainable Development Goals (SDGs) on innovation, infrastructure, and climate resilience.

IX. FUTURE SCOPE

The VisionRelief project holds immense potential for future development and large-scale deployment in real-world disaster management scenarios. One of the most significant advancements will be the integration of **5G and edge computing technologies** to enable ultra-low latency communication between drones, satellites, and command centers. The system can be further enhanced by incorporating **autonomous swarm coordination**, allowing multiple drones to operate collaboratively for large-area coverage and faster rescue response.

Future improvements will include **AI model optimization using federated learning**, enabling adaptive intelligence based on regional disaster data without compromising data security. Additionally, **integration with IoT-based ground sensors and weather monitoring networks** will enhance predictive analytics for early disaster warnings and zone risk forecasting. The mobile and web dashboard can be expanded to provide **multilingual support**, ensuring accessibility for disaster management teams across different linguistic regions in India.

In the long term, VisionRelief aims to evolve into a **SaaS-based national disaster intelligence platform**, integrating with agencies like NDMA, ISRO, and state governments for coordinated emergency operations. By combining AI, drones, and satellite data, VisionRelief envisions a future where technology-driven resilience minimizes disaster impact, accelerates response time, and saves countless lives across the globe.

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