IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 5, April 2025
Impact Factor: 7.67

Float Guard – Autonomous Drone for Flood Rescue and Emergency Aid Delivery

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Abstract: *Float Guard is a novel drone-based solution developed to address the critical challenges associated with water-based rescue operations. In situations involving floods, accidental drowning, or water-related disasters, victims are often stranded in inaccessible or hazardous environments where conventional rescue methods such as boats or helicopters are either delayed, limited by terrain, or pose high risk to human rescuers. Float Guard is designed to overcome these limitations by employing a cost-effective autonomous drone platform equipped with a wide array of features aimed at minimizing response time and maximizing rescue efficiency.*

The drone is capable of manually or autonomously navigating to victims and deploying a compact, non-inflated rescue tube that automatically inflates upon water contact. This mechanism allows the system to carry multiple flotation devices while maintaining a lightweight profile. The drone integrates real-time GPS tracking, live video transmission, a custom-designed lightweight frame constructed using ACP and carbon-nylon 3D-printed components, and mission planning capabilities for autonomous flight execution.

Float Guard is implemented in multiple stages, starting with manual operation, followed by pre-programmed mission execution, and advancing toward AI-powered victim detection and autonomous response. The inflation mechanism has been prototyped using both CO_2-based and chemical reaction-based approaches to ensure efficiency and reliability. This paper details the design and development process, system architecture, inflation strategies, field testing results, and outlines future enhancements including the integration of AI for intelligent real-time victim recognition and adaptive response.

Keywords: Flood Rescue Drone, Emergency Response, Payload Deployment, UAV for Disaster Management, Autonomous Drone, Real-time GPS Tracking, Rescue Tube Inflation, Water Accident Assistance, Mission Planning, AI-based Victim Detection

I. INTRODUCTION

Floods and water-related accidents continue to be among the most devastating natural and man-made calamities worldwide, often resulting in significant loss of life and property. In such emergencies, one of the greatest challenges lies in the **timely delivery of aid** to stranded or drowning individuals. Human rescuers frequently face delays due to poor visibility, impassable terrain, or turbulent water currents, and in many cases, risk their own lives to attempt rescues in highly dangerous conditions. Furthermore, conventional rescue methods such as boats and helicopters are often limited by factors such as cost, availability, weather constraints, and accessibility in narrow or debris-filled environments.

To address these limitations, **Float Guard** has been conceptualized and developed as a drone-based rescue platform specifically tailored for **flood-prone regions and water emergencies**. Float Guard is a custom-built **hexacopter UAV** equipped with capabilities for **autonomous mission planning**, **manual remote control**, and **real-time payload deployment**. The system is designed to reach victims in critical situations and deliver a **compact, non-inflated flotation tube** that **automatically inflates upon contact with water**, enabling rapid and efficient lifesaving intervention.

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The use of a non-inflated tube offers significant advantages—**reducing payload weight**, **minimizing storage space**, and allowing the drone to carry **multiple tubes in a single mission**. In addition to life-saving payloads, the drone is also capable of delivering **emergency supplies** such as food, water, and first-aid kits to unreachable locations during disasters.

II. OBJECTIVES

The primary objectives of the Float-gaurd project are:

- Design and develop a **robust hexacopter drone** capable of operating in flood-prone and water-affected regions with high stability and precision.
- Implement a compact, **non-inflated rescue tube deployment** system that inflates automatically upon water contact, allowing the drone to carry multiple tubes while minimizing weight and maximizing space efficiency.
- Develop a **lightweight and water-resistant frame**, combining ACP and 3D-printed carbon-nylon materials, ensuring mechanical stability and resistance to environmental conditions.
- **Incorporate safety and communication features** such as police strobes, emergency lights, onboard sound systems, and public announcement broadcasting capabilities.
- **Lay the foundation for future integration of AI-based vision systems**, enabling autonomous detection of drowning victims and intelligent response planning in real time..

III. SCOPE

The scope of the Float Guard project encompasses the design, development, and deployment of an autonomous drone system specifically engineered for water-based rescue operations. The project integrates diverse fields such as UAV technology, embedded systems, mechanical design, and wireless communication. It involves the creation of a lightweight hexacopter frame using ACP material and 3D-printed nylon-carbon arms, ensuring both durability and water resistance. The drone is equipped with a modular payload mechanism capable of deploying compact, non-inflated rescue tubes that automatically inflate upon water contact. The system supports both manual control and autonomous GPS-based mission planning, enabling flexible rescue strategies. Live video transmission and GPS tracking provide real-time situational awareness, enhancing coordination with rescue teams. Additionally, the project explores various inflation methods and integrates auxiliary features like sirens, police strobes, and emergency broadcasting tools. The scope also extends to future implementation of AI-based vision systems for autonomous victim detection, making the system highly scalable and adaptable to a wide range of disaster management scenarios.

IV. LITERATURE REVIEW

Unmanned Aerial Vehicles (UAVs), more commonly known as drones, have increasingly become a part of modern rescue and disaster management systems due to their flexibility, speed, and ability to operate in inaccessible areas. Several studies and real-world implementations have demonstrated their potential in applications such as aerial surveillance, search and rescue, and environmental monitoring.

Research in [1] highlighted the limitations of traditional flood rescue methods, such as boats and helicopters, which often face delays due to debris, high water currents, and logistical constraints. Drones, when equipped with proper payload and sensing capabilities, offer a scalable alternative by reducing response time and human risk. Similarly, [2] proposed the use of UAVs for delivering life-saving kits in earthquake and flood-hit areas, showing improved efficiency in reaching victims faster.

In [3], autonomous navigation using GPS waypoints was shown to significantly increase the coverage area and reliability of drone missions. Studies like [4] explored the integration of AI for detecting human bodies in disaster zones through image processing, although real-time onboard processing remains a challenge due to hardware constraints.

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V. NEED OF WORK

- Traditional flood rescue methods such as boats and helicopters are often delayed, expensive, and limited by environmental conditions, putting victims and rescuers at risk.
- Many affected areas during floods are inaccessible due to debris, strong currents, or narrow passageways where conventional vehicles cannot reach.
- Human rescuers face significant danger in flood zones, especially when operating under time pressure or during adverse weather conditions.
- There is a critical need for an autonomous, low-cost, and reliable aerial system that can respond rapidly and carry out life-saving tasks.
- Current drone applications focus on either surveillance or basic delivery, lacking integrated functionality for real-time rescue-specific tasks such as flotation device deployment.
- Victims stranded in floods often require not only flotation support but also delivery of essential items like food, water, and medicines, which manual systems fail to address efficiently.
- Float Guard is developed to bridge these gaps by offering a multifunctional drone platform capable of autonomous rescue missions, live monitoring, GPS tracking, and scalable AI integration for future victim detection.

VI. PROBLEM STATEMENT

- Traditional flood rescue operations using boats and helicopters are often slow, costly, and unsafe in high-risk or inaccessible regions.
- Delays in reaching victims trapped in waterlogged areas significantly increase the risk of drowning and injury.
- Human rescuers face life-threatening situations during floods, especially when navigating strong currents, debris, or unstable terrain.
- Current drone systems lack integrated capabilities for automated flotation device deployment, limiting their effectiveness in water-specific rescue missions.
- Inflated rescue equipment adds bulk and weight, reducing the number of flotation devices a drone can carry in a single flight.

VII. PROPOSED SYSTEM

The **Float Guard** system proposes an intelligent, modular, and drone-based solution to address the challenges of water-based rescue operations during floods and similar disasters. The system is designed to operate both manually and autonomously, offering rapid response, precision in payload deployment, and optional AI-powered victim detection in later stages. It integrates mechanical design, embedded electronics, real-time communication, and flexible power systems to ensure reliable operation in demanding environments.
Key modules in the proposed system include:

Flight Control & Navigation Module:
Utilizes the RadiolinkCrossflight flight controller and GPS module for precise manual and autonomous flight. This module supports waypoint-based mission planning and real-time telemetry tracking.

Rescue Payload Deployment Module:
A servo-controlled release mechanism allows the drone to drop a non-inflated rescue tube which inflates upon water contact. Multiple inflation mechanisms such as CO_2 cartridge activation or chemical reaction-based inflators have been prototyped for this.

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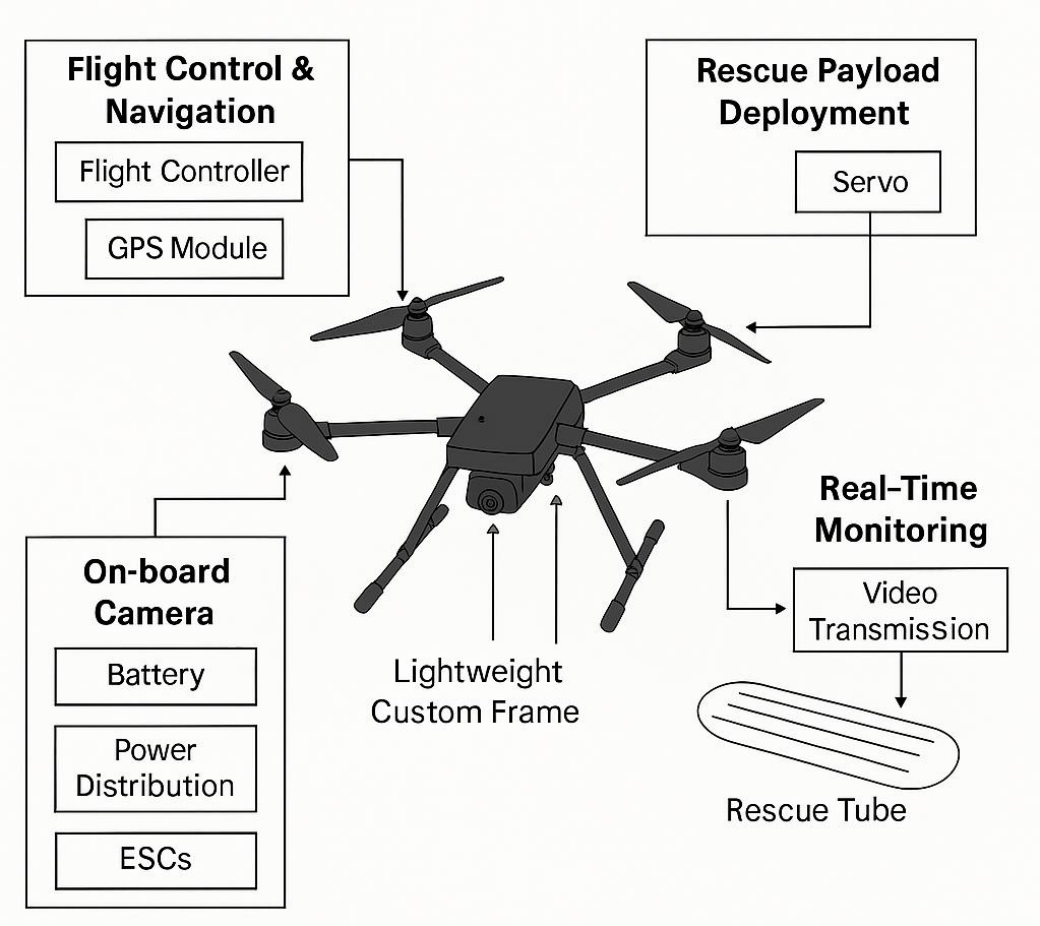
Real-Time Monitoring Module:
An onboard camera system with video transmission relays live footage to a ground control station, helping operators assess the situation in real time and make informed decisions.

Power & Propulsion System:
Comprising FlycatiRotor 5010 750KV motors, 1447 carbon nylon propellers, 40A ESCs, and a 2500mAh 4S LiPo battery, the system ensures sufficient thrust, balance, and endurance for extended operation times.



VIII. SYSTEM REQUIREMENTS

Hardware Requirements:

- **Flight Controller:** Radiolink Crossflight – responsible for flight stabilization, telemetry, and waypoint navigation.
- **Motors:** Flycati Rotor 5010 750KV brushless motors – selected for optimal thrust-to-weight ratio.
- **Electronic Speed Controllers (ESC):**Readytosky 40A 2–4S – for stable motor control and current handling.
- **Propellers:** Orange HD 1447 (14x4.7) carbon nylon – lightweight and high-lift performance.
- **Battery:** 2500mAh 4S LiPo (14.8V, 25C) – supplies power to the flight system.
- **GPS Module:** uBlox NEO-M8N – provides real-time location and altitude data for mission planning.
- **Payload Release Mechanism:** MG996R servo motor with custom mount – for tube deployment.

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- **Camera & Transmission:** HD camera with video TX module (Raspberry Pi-based) – real-time footage to ground station.
- **Custom Frame:** ACP (Aluminum Composite Panel) with 3D-printed carbon-nylon arms – lightweight and waterproof.
- **PDB (Power Distribution Board):** XT60 with built-in 5V/12V BEC – distributes regulated power to all modules.
- **Secondary Battery:**Custom 12V battery – powers lights, speakers, and additional electronics.

IX. CONCLUSION

The **Float Guard** drone system represents a practical, scalable, and innovative solution to the critical challenges posed by flood and water-related rescue operations. By leveraging autonomous drone technology, real-time GPS tracking, live video streaming, and modular payload deployment, Float Guard delivers life-saving support to victims in areas that are otherwise unreachable or too dangerous for human rescuers.

The integration of a compact, water-activated inflatable tube system ensures that multiple rescue devices can be deployed efficiently without overburdening the drone. In addition, the inclusion of mission planning capabilities allows for both manual and fully autonomous operation, enabling flexible deployment in a variety of disaster scenarios.

Supplementary features such as police strobes, emergency lights, and onboard broadcasting enhance the drone's utility beyond rescue—making it suitable for public announcements, supply delivery, and area surveillance. The project's phased development approach ensures a strong foundation for future upgrades, particularly the planned integration of AI-based victim detection for intelligent response automation.

Float Guard not only addresses a critical real-world need but also demonstrates how low-cost, high-impact UAV systems can contribute meaningfully to public safety, emergency response, and disaster management infrastructures.

X. FUTURE SCOPE

- **AI-Based Victim Detection:** Integration of onboard AI algorithms using Raspberry Pi or Jetson Nano to enable real-time detection and tracking of drowning individuals using computer vision techniques.
- **Advanced Inflation Control Mechanisms:** Development of a smart inflation module that can switch between CO_2, chemical, or mechanical inflation based on available payload and environmental conditions.
- **Environmental Sensor Integration:** Adding modules such as temperature, water depth, and gas sensors to collect and transmit environmental data during rescue operations.
- **Deployment via Ground Vehicle or Boat:** Integrating the drone into emergency vehicles or boats for auto-launching based on flood detection or rescue command signals.
- **Custom Rescue Payloads:** Designing interchangeable payload modules for different scenarios—such as medicine kits, thermal blankets, or communication devices in addition to flotation tubes.

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