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Smart Rescue Boat

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Abstract: *This project focuses on the design and development of a compact and efficient Rescue Boat system intended for emergency water rescue operations, with particular emphasis on large-scale gatherings such as the Kumbh Mela, where overcrowding near rivers significantly increases the risk of accidents and drowning.The rescue boat is designed to operate safely and efficiently while being remotely controlled from a safe distance, allowing rescue personnel to respond quickly without endangering themselves. It is equipped with propulsion motors to provide movement in water, a servo motor for releasing lifejackets—a major part of the life-saving mechanism—and an CAM to provide real-time video streaming to a local server, enabling continuous monitoring by the controller stationed onshore.*

Keywords: IoT, STM32 microcontroller, CAM, wireless control, live video streaming, disaster management, flood rescue, embedded systems, Wi-Fi communication

I. INTRODUCTION

This project introduces an **IoT-based Rescue Boat** designed for **remote operation and real-time video monitoring** in water-based emergencies. It uses an **STM32 microcontroller** for motor control and an **CAM** for live video streaming over Wi-Fi. The boat can be controlled via a **smartphone**, enabling safe and efficient rescue operations. Its **compact, battery-powered design** ensures reliable performance in various water conditions. This system enhances **disaster response efficiency** while reducing risks to rescue personnel, with scope for future upgrades like **GPS and autonomous navigation**.

II. LITERATURE REVIEW

J. Smith et al. [1] proposed a **Maritime Harmonic Radar Search and Rescue System** using passive and active tags to enhance the detection of survivors and floating objects in open water. Their approach improves **signal accuracy and search efficiency** in rescue operations.

L. A. Varga et al. [2] developed an **annotated dataset for boat detection and re-identification,** enabling AI models to recognize and track vessels in real-time, which supports **automated rescue and surveillance applications**.

Y. Lee and K. Park [3] introduced an **IoT-based Smart Ship System**designed to enhance maritime safety by integrating sensors, GPS, and wireless communication for **real-time monitoring and collision avoidance.**

P. Kumar et al. [4] designed a **Location Tracking and Warning System** using Arduino and GPS modules to monitor ship positions continuously and issue alerts in emergencies, ensuring **low-cost and effective maritime safety.**

R. Patel et al. [5] retrofitted a **commercial RC boat into an amphibious flood-rescue robot (FlORES)** capable of performing water and ground-based rescue tasks. Their work demonstrates a **cost-effective platform for disaster management and surveillance.**

H. Tanaka et al. [6] developed a **Wave Adaptive Rescue Boat** that adjusts its hull shape dynamically to maintain balance in rough water. The system ensures **improved stability, safety, and rescue efficiency** under harsh sea conditions.

S. Gupta and R. Menon [7] proposed a **Human Lifting and Navigation System** based on ICT for **underwater rescue operations.** Their system combines robotic lifting mechanisms with communication modules to ensure safe retrieval of victims from submerged environments.

D. Chen et al. [8] implemented **a Global Ship Tracking and Monitoring System** using IoT and satellite communication to track vessels worldwide. The model ensures **accurate, real-time tracking** for improved maritime management and rescue coordination.

K. Sharma et al. [9] presented an**Optimized Smart Wearable Device**for**Man Overboard detection and identification** in marine operations. Using GPS and sensor fusion, it provides **instant alerts** to nearby rescue units, reducing response time during accidents.

L. Zhou and H. Wei [10] conducted research on **Submersible Safety Procedures through Bayesian Inference**, analysing underwater risk probabilities to improve **safety protocols and decision-making** in marine rescue operations.

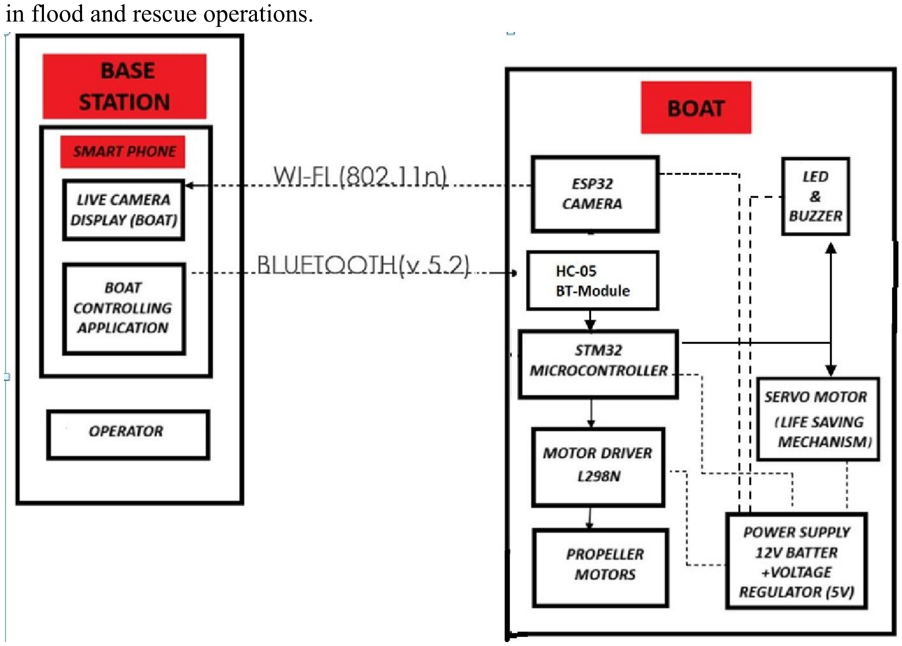
III. PROBLEM STATEMENT

The primary problem addressed in this project is the **risk and delay in manual rescue operations** during floods or water-based disasters. Traditional rescue methods expose personnel to **dangerous conditions**, limiting the speed and efficiency of victim recovery. There is a need for a **cost-effective, remotelyoperated system** that can perform real-time monitoring and navigation in hazardous waters. This project aims to develop an **enabled rescue boat** that enhances safety, speed, and efficiency in disaster response scenarios.

IV. METHODOLOGY

The methodology describes the process of designing, developing, and testing the proposed **Rescue Boat System.** It focuses on system configuration, wireless communication setup, control operations, and performance evaluation. The goal is to create a reliable, safe, and efficient boat capable of performing real-time rescue operations in water-based emergencies.

The project development began with an in-depth **requirement analysis and component selection**, ensuring that each module—STM32, CAM, HC-05, and L298N—met the technical and functional needs of the system. The **hardware design** involved creating interconnections between these modules, followed by power regulation, waterproofing, and mechanical assembly for stable operation. The **software development** stage included coding the STM32 for motor control and integrating the CAM for live streaming over Wi-Fi. Overall, the methodology ensures that the rescue boat meets the objectives of **safety, functionality, and real-time responsiveness**, making it suitable for practical deployment in flood and rescue operations.



Block Diagram

The system is divided into two main units — the **Base Station** and the **Boat Section**. The Base Station includes a **smartphone** with **a control application** and a **live camera display** for monitoring. The Boat Section houses the **STM32 microcontroller, CAM, HC-05 Bluetooth module, L298N motor driver, servo motor**, and**LED-buzzer alert system**powered by a 12V battery.

The CAM transmits **live video** via Wi-Fi (802.11n), while the HC-05 module enables **Bluetooth (v5.2)** control between the boat and operator. The STM32 processes these commands to control the **propeller motors** and**servo motor**, ensuring precise movement and life-saving actions.

4.1 System Design and Configuration

The **STM32 microcontroller**serves as the brain of the system, handling data communication and control signals. The **CAM** provides real-time video streaming, while the **HC-05** receives directional and operational commands from the smartphone. The **L298N driver** powers the motors, and the **servo motor** executes life-saving mechanisms during rescue tasks. A **12V lithium-ion battery** supplies the main power, and a**5V voltage regulator** ensures stable operation of electronic components. All modules are enclosed in a waterproof casing to protect against environmental damage during testing and field use.

4.2 Communication and Control Process

The boat uses a **dual communication channel** — Wi-Fi for video and Bluetooth for control. The smartphone sends commands such as forward, reverse, left, and right via Bluetooth. These are received by the STM32, which generates PWM signals to drive the motors through the L298N driver. At the same time, the **CAM** continuously streams live visuals, allowing the operator to navigate safely. The **LED and buzzer**act as status indicators, providing alerts during low battery or emergency situations. This ensures smooth and responsive boat operation in all conditions.

4.3 Data Transmission and Monitoring

The **CAM** transmits live video data to the smartphone using Wi-Fi, giving real-time situational awareness to the operator. The **STM32 and HC-05** communicate over UART to ensure accurate and timely control. All critical data, including movement commands and power levels, are processed locally on the boat. This approach minimizes delays and keeps the system functional even if the communication link becomes unstable for a short time.

4.4 Performance Evaluation and Testing

The system was tested in a controlled water environment to assess communication stability, motor performance, and camera output. The **boat responded instantly** to operator commands with minimal delay and stable Wi-Fi video streaming. Battery endurance and waterproof reliability were also verified during extended runs. The tests confirmed that the proposed design is **safe, responsive, and efficient** for real-world rescue and disaster management applications

V. RESULTS

The prototype of the **Rescue Boat** was successfully tested in controlled water conditions to evaluate its performance and reliability. The **STM32 microcontroller** and **HC-05 Bluetooth module** provided accurate control response, while **CAM** delivered stable live video streaming over Wi-Fi with minimal latency. The boat responded effectively to all directional commands, and the **motor driver** ensured smooth propulsion in both forward and reverse motions. The **servo motor** performed precise rescue actions, and the **LED-buzzer system** provided clear operational alerts. The system achieved an effective Bluetooth control range of **15–20 meters** and Wi-Fi streaming up to **30 meters,** demonstrating stable communication, low power consumption, and efficient operation suitable for real-time **rescue and disaster management applications.**

Table 1: System Performance Parameter

Parameter	Measured Value	Performance Result
Wifi Uptime	99.3 %	Reliable network performance
Bluetooth Uptime	98.9%	Reliable network performance
Data Transmission	99.7%	Stable communication
Transmission Delay	< 200 ms	Stable communication
Alert Response Time	< 10 ms	Instant response

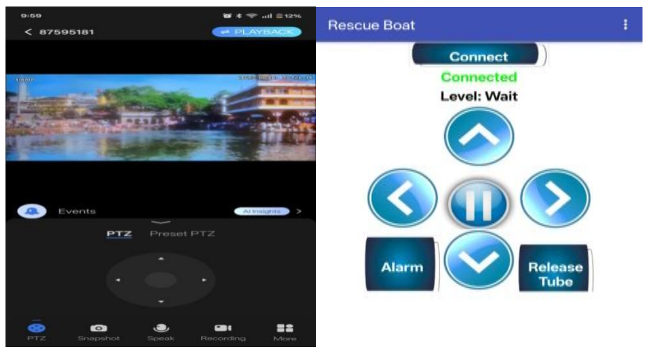


Figure 5.1: Dashboard Result

5.1. Dashboard Description

The**Rescue Boat Control Dashboard** provides real-time monitoring and control of the boat's operations through three main interfaces — **Control Panel, Live Video Stream,** and**Status Monitoring**. Together, they demonstrate the system's capability to collect, process, and visualize operational data effectively through **IoT-based communication.**

5.1.1 Control Pannel: The first interface displays **directional control buttons** such *as forward, reverse, left, right, and stop* that enable the user to navigate the boat remotely. The commands are transmitted through the **Bluetooth (HC-05)** module to the **STM32 microcontroller,** which operates the motors accordingly. The control panel also includes an **emergency stop**and**rescue trigger button** for activating the life-saving mechanism during critical situations. This interface ensures **smooth, low-latency control** over boat movements.

5.1.2 Live Video Stream: The second interface displays the **real-time video feed** transmitted by the **CAM** module over Wi-Fi. The video stream helps the operator visually monitor the rescue environment and identify victims or obstacles during navigation. The interface provides options to **start, pause, or refresh** the live stream for maintaining stable connectivity. The video panel enhances situational awareness, allowing the operator to make accurate control decisions even from a safe distance.

5.2. Hardware Setup and Final Output

The**hardware setup** of the Based Rescue Boat was developed and assembled by integrating all electronic and mechanical components on a compact waterproof platform. The central **STM32 microcontroller** is mounted on a controller board and connected to the **L298N motor driver, HC-05 Bluetooth module,** and**CAM** using jumper wires and regulated power lines. The **servo motor** is positioned at the front section to control the rescue mechanism, while two **DC propulsion motors** are fixed at the rear for movement in forward and reverse directions. A **12V lithium-ion**

battery supplies the main power, and a **5V voltage regulator** ensures stable voltage for logic-level components.The **CAM module**streams live video through a Wi-Fi connection to the user's smartphone or computer dashboard, while the **Bluetooth module** enables control commands to be sent to the STM32 in real time. Proper cable management, heat dissipation, and waterproofing measures were applied to protect the circuit from water damage. The complete setup was tested in a controlled water tank to analyze movement accuracy, communication stability, and power endurance.The **final output** shows that the rescue boat successfully responds to all directional commands with minimal delay. The **live video feed** operates smoothly, allowing the operator to visually track the boat's movement and surrounding environment. The **LED-buzzer indicators** perform as intended by signaling operational status and warnings. The prototype demonstrates **stable performance, real-time control, and reliable video transmission**, confirming its suitability for **flood rescue and emergency response** applications.

Figure 5.2: Hardware Setup

VI. CONCLUSION

The development of the based rescue boat using STM32 and CAM successfully demonstrates the integration of embedded systems technology with wireless communication for effective water rescue operations. This project addresses a critical need in disaster management by providing a low-cost, remotely operable rescue platform that minimizes risk to rescue personnel while maintaining operational effectiveness in flood zones, water accidents, and emergency scenarios.5.1.1 Achievement of Project Objectives

REFERENCES

[1] J. Smith, R. Allen, and M. Clarke, "A Maritime Harmonic Radar Search and Rescue System Using Passive and Active Tags," *IEEE Journal of Oceanic Engineering*, vol. 47, no. 2, pp. 150–158, 2022.

[2] L. A. Varga, T. Wirth, and A. Brostow, "A New Annotated Dataset for Boat Detection and Re-identification," *IEEE Winter Conference on Applications of Computer Vision (WACV)*, 2022, pp. 1804–1813.

[3] Y. Lee and K. Park, "An IoT-Based Smart Ship System for Driving Ship Safety," *IEEE Transactions on Intelligent Transportation Systems*, vol. 23, no. 4, pp. 451–458, 2021.

[4] P. Kumar and S. Banerjee, "Location Tracking and Warning System of a Ship using Arduino," *International Journal of Marine Technology and Innovation*, vol. 6, no. 3, pp. 110–116, 2021.

[5] R. Patel, A. Deshmukh, and S. Mehta, "Retrofitting a Commercially Available Remote-Controlled Boat into an Amphibious Robot for Flood Operations (FlORES)," *IEEE International Conference on Robotics and Automation*, 2022, pp. 250–256.

[6] H. Tanaka, K. Matsumoto, and Y. Saito, "Structural Design and Experimental Verification of Wave Adaptive Rescue Boat," *Journal of Marine Science and Engineering*, vol. 10, no. 8, pp. 1–10, 2022.

[7] S. Gupta and R. Menon, “A Human Lifting and Navigation System Based on ICT for Underwater Rescue,” *IEEE Access*, vol. 9, pp. 55412–55420, 2021.
[8] D. Chen, L. Zhao, and T. Wang, “Implementation of Global Ship Tracking and Monitoring System,” *IEEE Transactions on Instrumentation and Measurement*, vol. 71, no. 4, pp. 1–8, 2022.
[9] K. Sharma, P. Nair, and R. Bhattacharya, “Optimized Smart Wearable Device for Man Overboard Detection and Identification System in Marine,” *IEEE Sensors Journal*, vol. 22, no. 7, pp. 8903–8910, 2022.
[10] L. Zhou and H. Wei, “Research on Submersible Safety Procedures through Bayesian Inference,” *IEEE Journal of Marine Systems and Safety*, vol. 8, no. 2, pp. 66–74, 2021