DESIGN AND DEVELOPMENT OF SMART ROPE DELIVERY SEA RESCUE ROBOT FOR PREVENTING DROWNING ACCIDENTS

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Introduction:

Drowning accidents are one of the leading causes of accidental deaths, especially in coastal areas, rivers, and beaches. Many of these incidents occur due to the lack of immediate rescue facilities and delayed response time. Traditional rescue operations mainly depend on human lifeguards, which can be risky and sometimes ineffective in critical situations. Environmental conditions such as strong currents and waves further increase the danger for both victims and rescuers. To overcome these challenges, the project focuses on the design and development of a smart rope delivery sea rescue robot. This system is developed to provide a fast and efficient rescue solution without putting human lives at risk. The robot is capable of reaching a drowning person quickly and delivering a rope or flotation support. This helps the victim stay afloat until further rescue assistance arrives. The project combines mechanical design with modern technologies like embedded systems and wireless communication. It ensures smooth operation even in harsh water environments. The robot can be remotely controlled or operate in a semi-autonomous mode for quick response. This innovation significantly reduces rescue time and improves survival chances. It also minimizes the risk faced by human rescuers during emergency situations. The system is cost-effective and can be deployed in public water areas for safety enhancement.

Overall, this project highlights the importance of applying engineering solutions to real-world safety problems. It contributes to drowning prevention and promotes smarter, safer rescue operations.

Objectives:

1. To design and develop a lightweight floating robot capable of stable and high-speed movement on water.

2. To implement a dual-propeller propulsion system for maneuverability and directional control.
3. To develop a Wi-Fi–based remote-control system using the ESP8266 (Node MCU) module.
4. To design a rope-delivery mechanism for deploying a floating rope or buoy to the victim.

Methodology:

The development of the rescue robot was carried out in a structured sequence of steps to ensure proper execution and validation. The major stages include:

1. Problem identification and requirement analysis
2. Conceptual design and system architecture
3. Selection of components
4. Mechanical design and buoyancy calculation
5. Electronic circuit design and control implementation
6. Fabrication and assembly
7. Waterproofing and safety measures
8. Testing and performance evaluation

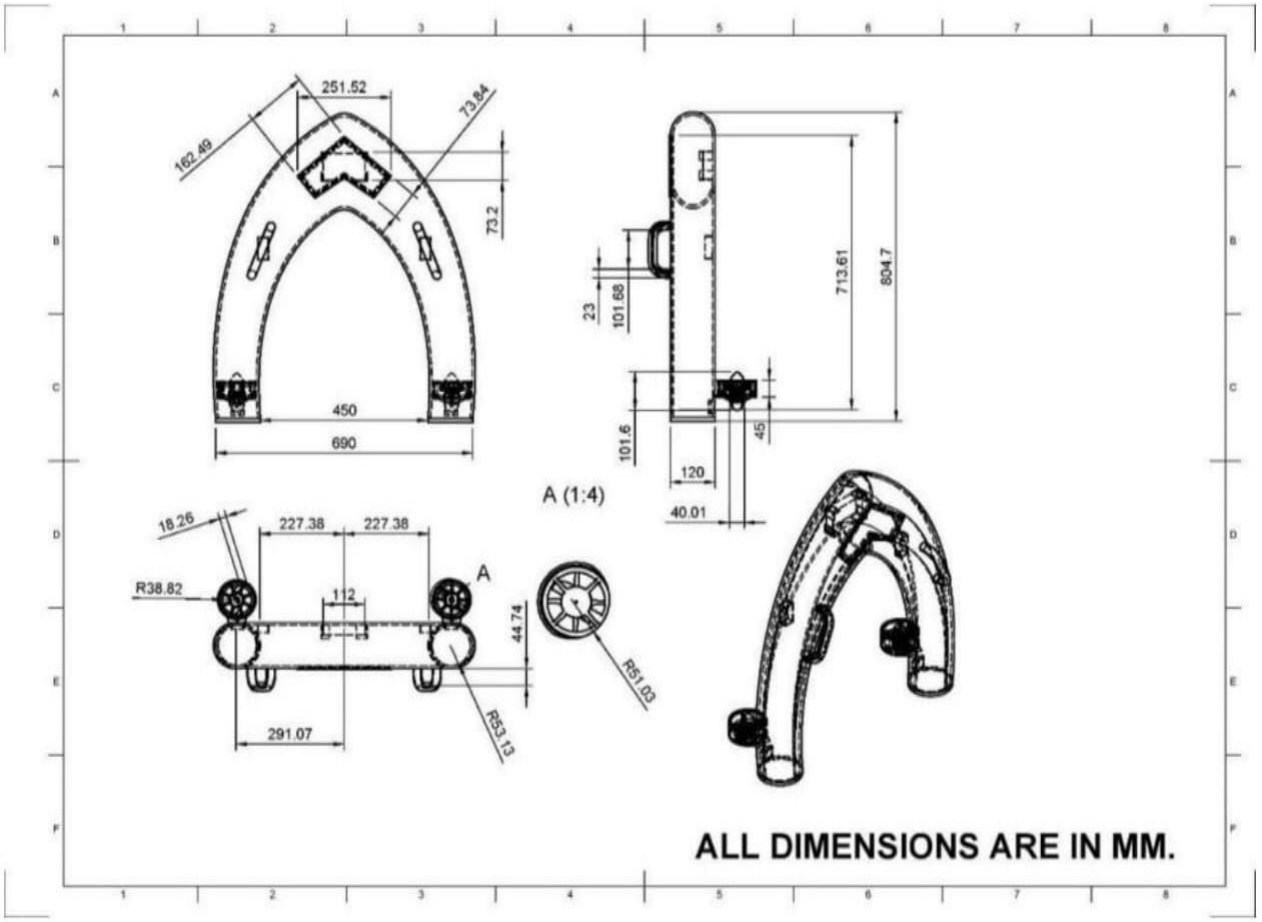


Fig 1: CAD Model

Fig 2: Fabricated Sea Rescue Rob

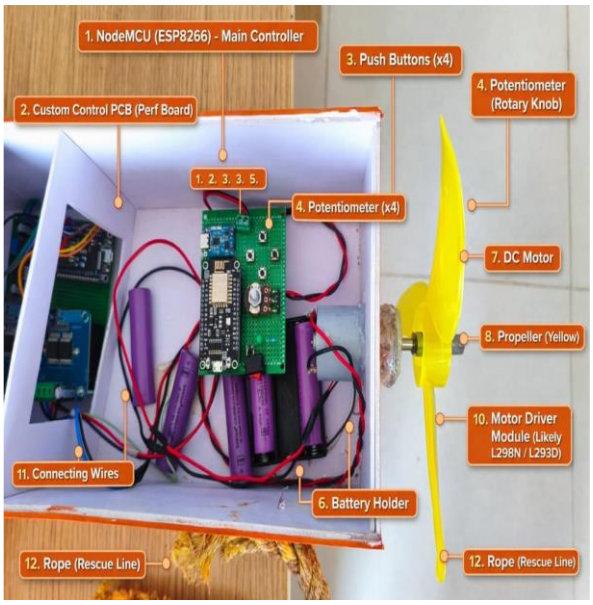
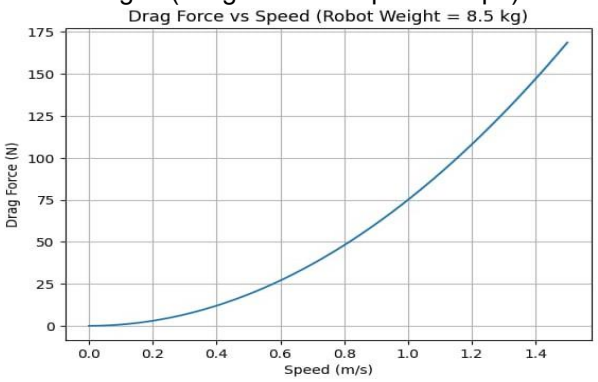


Fig 3: Components of the Sea Rescue Robo

Result and Conclusion:

1. Drag Force vs Speed Graph

Fig 4: (Drag Force vs Speed Graph)



The drag force vs speed graph shows a quadratic increase in hydrodynamic drag with velocity under a full load condition of 8.5 kg. The increased weight causes deeper submergence of the hull, increasing the effective frontal area and hence drag force. At the maximum operating speed of 4 km/h, the drag force is approximately 92 N.

2. Load vs Stability of Rescue Robot

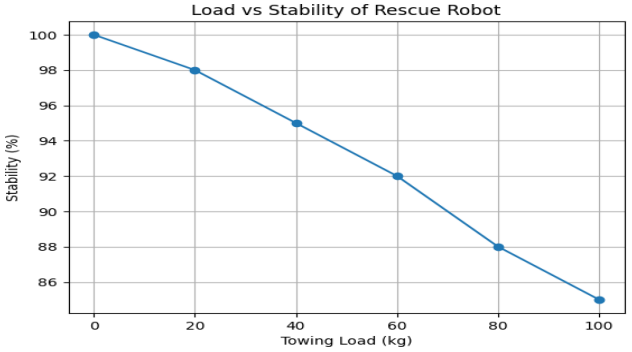


Fig 5: Load vs Stability of Rescue Robot

The graph illustrates the variation of stability with respect to towing load. Although stability slightly decreases with increasing load, the robot maintains adequate stability up to 100 kg, validating the effectiveness of the catamaran hull design.

3. Battery Voltage vs Time

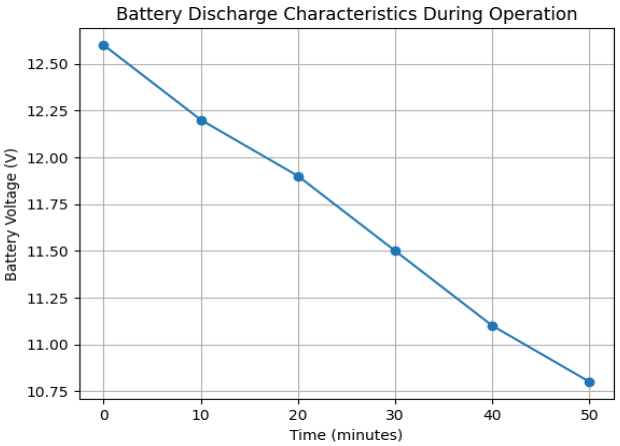


Fig 6: Battery Voltage vs Time

The battery discharge graph indicates a gradual reduction in voltage over time, demonstrating stable power delivery and an operational duration of approximately 40–50 minutes, suitable for emergency rescue missions

Conclusion:

1. The Smart Rope-Delivery Sea Rescue Robot has proven to be a practical and effective solution for improving water rescue operations. The results clearly show that the integration of wireless control using ESP8266, efficient DC motor propulsion, and a lightweight buoyant structure enables the robot to perform stable and reliable movements over water. Its ability to quickly deliver a floating rescue rope significantly reduces response time, which is critical in drowning situations.
2. The successful testing confirms that the system maintains good stability, maneuverability, and sufficient thrust even in moderate water conditions. By eliminating the need for direct human involvement in risky environments, the robot enhances the safety of both rescuers and victims. This demonstrates that unmanned rescue systems can serve as a valuable alternative or support to traditional rescue methods.
3. Overall, the project validates the feasibility of combining robotics, IoT, and marine design for lifesaving applications. With further improvements such as autonomous navigation, AI-based detection, and enhanced durability, the system has strong potential for real-world deployment and can play an important role in reducing drowning-related fatalities in the future.

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Future Scope:

The future scope of this project includes:

1. Integration of GPS and Autonomous Navigation: The system can be enhanced by incorporating GPS modules and navigation algorithms to enable autonomous movement toward the victim without continuous human control.
2. AI-Based Drowning Detection System: By integrating cameras and artificial intelligence, the robot can automatically detect drowning individuals and initiate rescue operations, reducing response time further.
3. Long-Range Communication Technology: The current Wi-Fi limitation can be overcome by using advanced communication technologies such as LoRa, RF modules, or 4G/5G networks to increase operational range.