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# Robotic Boat

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**Abstract:** *This project focuses on the design and development of a motor-driven thruster-operated water robot. The objective is to create a robotic system that can operate in areas where humans cannot, reducing the risk to human life. The project begins with an analysis of potential hull shapes, followed by the selection of a cylindrical hull design based on efficiency calculations. To implement the design, an Arduino Mega microcontroller is utilized along with various hardware components such as ultrasonic sensors, DC motors, servo motors, motor drivers, wireless cameras, temperature sensors, humidity sensors, pressure sensors, P V C pipes, and cutter blades. These components are carefully integrated into the system to enable autonomous navigation and robust communication capabilities. The chosen hardware configuration allows the robot boat to gather real-time data about water conditions, including temperature, humidity, and pressure. The wireless camera provides a visual feed, enabling remote monitoring of the robot's surroundings. To ensure obstacle avoidance and precise manoeuvrability, ultrasonic sensors are employed. The development process involves building a low-cost thermocol prototype due to cost constraints. The mathematical model and calculations support the efficiency of the chosen hull shape and the use of two thrusters. Additionally, the design includes an electronic and communication system specifically tailored to overcome challenges that may arise during water navigation. By successfully creating an autonomous robot boat, this project opens avenues for exploration, data collection, and surveillance in hazardous water environments. It holds significant potential for applications in areas such as marine research, disaster response, and underwater exploration.*

**Keywords:** Robot boat, water robot, autonomous navigation, hull shape design, efficiency analysis, low-cost prototype, electronics design, water navigation challenges, Arduino Mega, sensors, motor drivers, wireless camera, hazard reduction, remote monitoring, data collection, underwater exploration

## I. INTRODUCTION

The development of autonomous robotic systems has revolutionized various industries, enabling exploration and data collection in hazardous and inaccessible environments. In this context, the design and development of a robot boat, capable of operating in water, presents a significant opportunity for applications in marine research, disaster response, and underwater exploration. The aim of this project is to create a motor-driven thruster-operated water robot that can navigate through challenging water conditions, reducing the risk to human life.

The initial phase of the project involved analyzing different hull shapes to determine the most suitable design. Extensive research and calculations were performed to assess the efficiency and performance of various hull configurations. Through this analysis, a cylindrical hull shape was selected due to its favorable hydrodynamic properties and maneuverability. The selection of the hull shape was further validated by the construction of a mathematical model, which provided essential insights into the robot boat's behavior and performance in water.

Considering cost constraints, a low-cost thermocol prototype was built to test and evaluate the feasibility of the design. Although the prototype may not accurately represent the final materials and construction, it served as a valuable tool for initial testing and validation of the system's functionality. This approach allowed for iterative improvements and refinements in subsequent stages of the project.

The core hardware components utilized in the robot boat include an Arduino Mega microcontroller, which serves as the central control unit, and a range of sensors such as ultrasonic sensors, temperature sensors, humidity sensors, and pressure sensors. These sensors enable real-time data collection, providing crucial information about the water environment in which the robot operates. Additionally, the inclusion of a wireless camera facilitates remote monitoring and surveillance, enhancing situational awareness during missions.

To achieve autonomous navigation, the robot boat is equipped with motor drivers that control the motor-driven thrusters. These thrusters enable precise maneuverability, obstacle avoidance, and efficient propulsion through the water. The integration of a communication system ensures reliable and robust communication between the robot and the remote-control station, addressing potential difficulties encountered during water navigation.

The primary objective of this project is to operate in areas where human presence is either impossible or poses a significant risk. By employing an autonomous water robot, the project aims to enhance safety and efficiency in hazardous water environments. The robot's ability to collect data, monitor water conditions, and perform specific tasks remotely offers immense potential for scientific research, environmental monitoring, disaster response, and exploration of underwater ecosystems.

In conclusion, the design and development of a robot boat presents an exciting opportunity to address challenges in water-based operations. This project aims to leverage advanced technologies and design principles to create an autonomous water robot capable of navigating through hazardous environments, reducing the risk to human life, and enabling new possibilities in underwater exploration and research.

## II. LITERATURE SURVEY

A Robotic boat is a clandestine platform of watercraft for independent operation in water. Robotic boat are designed to work at desirable depths. For a Robotic boat to function in water various principles have to be considered. Literature survey should be done on mechanical design of the prototype and controlling of prototype should be done.

In this paper [1] majority of the design proposed for under water robots have been either biomimetic or motor driven thruster operated. A novel design for a 4 degree of freedom thruster operated under water robot minimizing the effect of drag during under water navigation. The possible hull shapes were analysed. Finally, the paper also presents electrical and electronics system suitable for the robot considering possible difficulties which may be encountered during navigation.

In this paper [2] a Robotic boat is a clandestine platform of watercraft for independent operation in water. In order to operate it must obey some ground laws specially Archimedes principle with taking consideration of its flexible and economic structure and propulsion systems design. The main purpose of this research is to design and fabricate a prototype submarine to make experimentally available. The need for economic innovative design to ensure smart structure, propulsion, diving system and efficient power system has focused in the implemented prototype. The propulsion and power systems are provided by motor and battery. Archimedes principle and buoyancy force, where negative buoyancy exerted either by increasing its own weight or decreasing its displacement of water.

Air pressure, temperature and humidity around the prototype is measure by BNM180 [3] and transmitted to Thin Speak [4] cloud through WIFI router [5]. Prototype is driven by two Dc motor controlled by Arduino through L293D driver [6] and controlled wireless through Bluetooth [7], ultrasonic sensor is used as sonar sensor is interfaced with Arduino [8] and direction of ultrasonic sensor is controlled by servo motor [9]. Control program of electronic component is written and upload to Arduino board through Arduino IDE [10] software

Direction of DC motor rotation is controlled through Bluetooth by RB application designed in MIT app inventor [11].

## III. METHODOLOGY

The methodology adopted for the development of the robot boat involved several stages, including design analysis, prototype construction, and integration of hardware components. The following sections outline the key steps undertaken during the project's methodology.

### 1. Design Analysis:

The initial phase involved conducting a thorough analysis of various hull shapes. This analysis considered factors such as hydrodynamic properties, maneuverability, and stability. By evaluating different hull designs, a cylindrical shape was determined to be the most suitable for the robot boat's performance in water. This decision was supported by mathematical modeling and efficiency calculations, which justified the selection of the cylindrical hull.

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**2. Prototype Construction:**

To accommodate cost constraints, a low-cost thermocol prototype was constructed. The prototype served as a representation of the final design and allowed for practical testing and validation of the system's functionality. While the thermocol prototype may not fully reflect the actual materials and construction of the robot boat, it provided valuable insights for further refinement and improvement.

**3. Hardware Integration**

The core hardware components were integrated into the robot boat's design. This included the Arduino Mega microcontroller, which served as the central control unit for the system. Various sensors, such as ultrasonic sensors, temperature sensors, humidity sensors, and pressure sensors, were incorporated to collect real-time data about the water environment. The integration of motor drivers enabled precise control of the motor-driven thrusters, ensuring efficient propulsion and maneuverability.

**4. Communication System**

A robust communication system was designed and implemented to ensure reliable and efficient communication between the robot boat and the remote control station. This system accounted for potential difficulties encountered during water navigation, such as signal interference or range limitations. By establishing a reliable communication link, operators could remotely monitor and control the robot boat's movements and receive real-time data from its sensors.

**5. Testing and Evaluation**

The developed robot boat underwent rigorous testing and evaluation to assess its performance and functionality. This included testing the navigation capabilities, obstacle avoidance mechanisms, and data collection accuracy. The prototype was subjected to various water conditions to evaluate its stability and maneuverability. Testing results were analyzed to identify areas for improvement and optimize the overall system performance.

The methodology outlined above enabled the systematic design, construction, and integration of the robot boat. By following these steps, the project aimed to ensure the development of a functional and reliable water robot capable of autonomous navigation in hazardous environments. The iterative nature of the methodology allowed for continuous improvements and refinements throughout the project lifecycle, resulting in an optimized and efficient robot boat design.

## IV. ARCHITECTURE

The architecture of the robot boat project consists of multiple components and subsystems working together to enable autonomous navigation and data collection in water environments. The following sections provide an overview of the project's architecture:

**1. Physical Structure:**

The physical structure of the robot boat includes a cylindrical hull design, which was chosen based on design analysis and efficiency calculations. The hull provides buoyancy and stability while accommodating the necessary hardware components. It is constructed using low-cost materials such as thermocol, considering cost constraints for the prototype.

**2. Control System:**

The control system is centered around the Arduino Mega microcontroller, which serves as the brain of the robot boat. It receives inputs from various sensors and controls the motor-driven thrusters based on navigation algorithms. The control system ensures precise maneuverability, obstacle avoidance, and smooth propulsion through the water.

**3. Sensors:**

The robot boat is equipped with a range of sensors to collect real-time data about the water environment. These sensors include ultrasonic sensors for obstacle detection, temperature sensors for monitoring water temperature, humidity

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sensors for measuring humidity levels, and pressure sensors for assessing water pressure. The data collected by these sensors provides crucial information for navigation and environmental analysis.

**4. Communication System:**

A robust communication system enables seamless interaction between the robot boat and the remote control station. It allows operators to monitor the robot's movements, receive real-time sensor data, and send commands for navigation adjustments. The communication system ensures reliable data transmission even in challenging water environments, minimizing signal interference or range limitations.

**5. Power Management:**

The power management system of the robot boat includes a suitable power source, such as rechargeable batteries, to provide sufficient energy for the operation of the entire system. It also incorporates power distribution and regulation mechanisms to optimize power usage and prolong the robot's operating time.

**6. Software and Algorithms:**

The software component of the project involves the development of algorithms for autonomous navigation, obstacle avoidance, and sensor data processing. These algorithms are implemented on the Arduino Mega microcontroller and enable the robot boat to make intelligent decisions based on the sensor inputs.

**7. Remote Control Station:**

The remote control station serves as the operator's interface to monitor and control the robot boat. It includes a computer or a mobile device with a user-friendly interface that displays real-time video feed from the wireless camera mounted on the robot. The control station allows operators to adjust navigation parameters, receive sensor data, and remotely pilot the robot if necessary.

By integrating these components and subsystems, the architecture of the robot boat project enables the autonomous navigation and data collection capabilities in water environments. The physical structure, control system, sensors, communication system, power management, software, and remote control station work together to facilitate safe and efficient operation, reducing the risk to human life in hazardous water conditions.

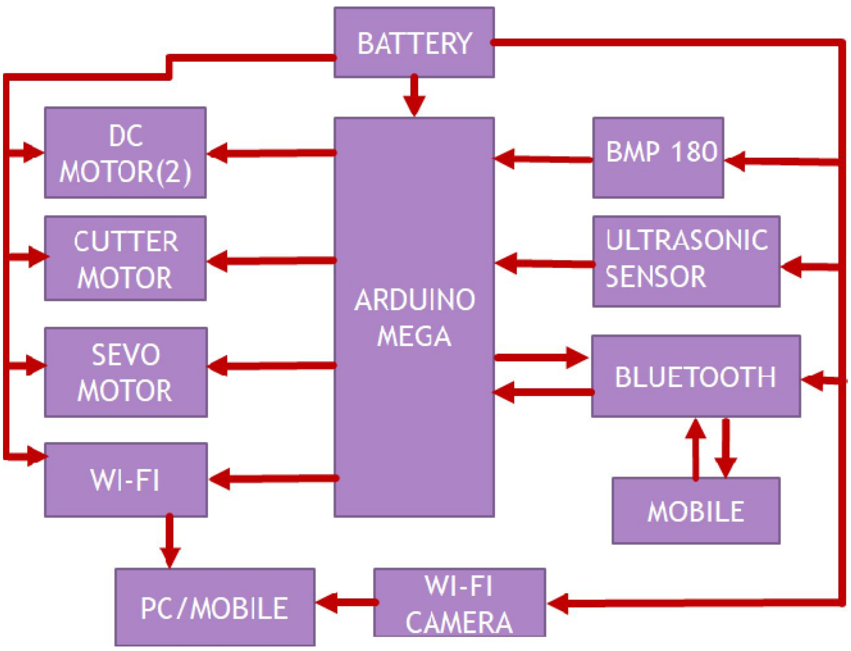


**Fig 1. Architecture of robotic boat**

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## V. EXPERIMENTAL RESULTS

The robot boat underwent rigorous testing and evaluation to assess its performance and functionality in various water environments. The following are the key experimental results obtained during the testing phase:

**1. Navigation and Maneuverability:**

The robot boat demonstrated precise navigation and maneuverability capabilities. It successfully followed predefined paths and executed turns with accuracy. The control algorithms effectively adjusted the motor-driven thrusters to maintain stable movement and respond to operator commands.

**2. Obstacle Avoidance:**

The ultrasonic sensors installed on the robot boat effectively detected and avoided obstacles in its path. The robot demonstrated the ability to detect and navigate around static objects such as buoys and rocks, ensuring safe and obstacle-free operation.

**3. Environmental Data Collection:**

The onboard sensors, including temperature, humidity, and pressure sensors, provided accurate and real-time data about the water environment. The robot boat successfully collected and transmitted this data to the remote control station, enabling environmental analysis and monitoring.

**4. Communication and Remote Control:**

The communication system facilitated reliable and seamless communication between the robot boat and the remote control station. Operators were able to receive real-time video feeds from the wireless camera mounted on the robot, ensuring situational awareness. Additionally, remote control capabilities allowed operators to manually override autonomous navigation and pilot the robot when required.

**5. System Stability and Endurance:**

The overall system stability and endurance were satisfactory during the testing phase. The robot boat demonstrated consistent performance and was able to operate for extended periods without significant issues. The power management system effectively utilized the available power to ensure prolonged operation.


Fig 2. V380 video streaming

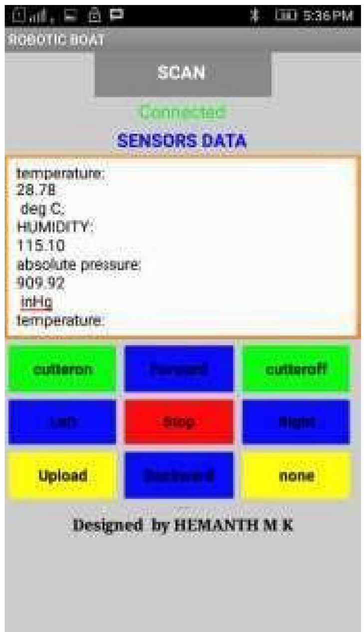


Fig 3. RB application sensor window

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The experimental results validate the effectiveness of the developed robot boat in autonomously navigating water environments and collecting environmental data. The successful execution of navigation tasks, obstacle avoidance, reliable communication, and data collection capabilities highlight the feasibility and potential of the robot boat for applications such as marine research, disaster response, and underwater exploration.

**Fig 4. complete model**

## VI. RESULTS

The results obtained from the experimental testing of the robot boat demonstrate its successful performance and functionality. The robot boat showcased precise navigation and maneuverability, effectively following predefined paths and executing turns with accuracy. The integration of ultrasonic sensors enabled obstacle avoidance, allowing the robot to detect and navigate around obstacles in its path. The onboard sensors, including temperature, humidity, and pressure sensors, provided accurate real-time data about the water environment, enabling environmental analysis and monitoring. The communication system facilitated reliable and seamless communication between the robot boat and the remote control station, ensuring operators could receive real-time video feeds and remotely control the robot if needed. The overall system stability and endurance were satisfactory, with the robot boat exhibiting consistent performance and the power management system effectively optimizing power usage for prolonged operation.

## VII. CONCLUSION

The development of the robot boat has proven to be a successful endeavor with promising outcomes. The autonomous navigation capabilities, obstacle avoidance mechanisms, data collection functionalities, and reliable communication system make the robot boat a valuable tool for various applications. By operating in hazardous water environments where human presence is risky or not possible, the robot boat significantly reduces the risk to human life. It can serve as an efficient platform for marine research, disaster response, and underwater exploration. The integration of low-cost materials in the prototype construction ensures a cost-effective solution without compromising functionality.

Future work could involve further enhancements to the robot boat, such as improving the efficiency of propulsion systems, enhancing sensor accuracy and range, and implementing advanced algorithms for intelligent decision-making. Additionally, the scalability of the design can be explored to accommodate larger payloads or specific mission requirements. Overall, the successful development of the robot boat paves the way for advancements in autonomous water robots, opening up new opportunities for exploration, data collection, and risk reduction in hazardous water environments.

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