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# Sensor-based Water Waste Impurities Detection and Design of Elevator Boat using Raspberry Pi and Motor Drivers

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**ABSTRACT:** This paper explores the development of a sensor-based system for detecting water impurities and designing an elevator-equipped robotic boat for autonomous waste collection. Leveraging RaspberryPi for real-time data processing and motor drivers for precise navigation, this project aims to address the pressing issue of water pollution. The proposed system integrates advanced sensors, robotics, and IoT technologies to enhance water quality management. Water pollution poses a significant threat to environmental and public health, driven by the accumulation of chemical impurities and solid waste in natural water bodies. This project proposes a smart, autonomous system that combines water quality monitoring and floating waste collection into a single mobile platform. Utilizing a Raspberry Pi as the core controller, the system integrates various water quality sensors—including pH, turbidity, and Total Dissolved Solids (TDS) sensors—to detect pollutants in real time. The boat's navigation is handled by DC motors driven by L298N motor drivers, while an elevator mechanism collects floating debris from the water surface. Additional features such as obstacle detection using ultrasonic sensors enhance the system's autonomy. Experimental results demonstrated the system's ability to accurately detect water impurities and efficiently collect surface waste, offering a scalable, low-cost solution for automated water pollution control. This design has the potential to contribute significantly to the preservation of clean water in urban and rural environments.

**KEYWORDS:** Water pollution, Sensor-based detection, Raspberry Pi, Motor drivers, Autonomous boats, Waste management.

## I. INTRODUCTION

Water pollution remains a global concern, impacting ecosystems and human health. Urbanization and industrial runoff are major contributors to water contamination. Traditional monitoring methods often lack real-time capabilities and scalability. This project introduces a system that detects impurities and autonomously collects waste. The system employs advanced sensors to measure turbidity, pH, and pollutants. Real-time data processing via Raspberry Pi enables efficient waste collection and disposal. Water pollution is one of the most critical environmental challenges of the 21st century, adversely affecting ecosystems, human health, and the availability of clean water. With increasing industrialization, urban runoff, and improper waste disposal, water bodies such as rivers, lakes, and canals are becoming increasingly contaminated with chemical impurities and solid waste. Traditional water cleaning methods often involve manual labor, which is inefficient, time-consuming, and sometimes hazardous. To address these issues, the need for intelligent, automated, and cost-effective water monitoring and waste collection systems has become more pressing than ever.



## II. LITERATURE SURVEY

IoT-enabled water quality monitoring systems have shown significant potential in environmental engineering. Autonomous boats equipped with waste collection mechanisms are gaining traction. Recent studies highlight the integration of Raspberry Pi for real-time data analysis. Research emphasizes the challenges of multisensor integration in dynamic aquatic environments. The increasing threat of water pollution in natural and urban water bodies has prompted researchers to explore automated solutions for water quality monitoring and waste removal. Several studies have focused on the use of sensor-based systems to detect impurities in water. For instance, Patil et al. (2019) developed a real-time water quality monitoring system using Raspberry Pi and IoT sensors, which demonstrated the feasibility of low-cost and continuous environmental monitoring. Similarly, Mehta and Bhanarkar (2018) successfully employed turbidity and TDS sensors integrated with microcontrollers for evaluating pollution levels in water samples. These studies underline the reliability of common water sensors in detecting real-time changes in chemical and physical parameters.

## III. METHODOLOGY

The methodology for the project titled "**Sensor-based Water Waste Impurities Detection and Design of Elevator Boat Using Raspberry Pi and Motor Drivers**" involves a systematic approach to designing an autonomous water-cleaning system. The project is divided into two primary functions: detecting water impurities and collecting floating waste using a boat mechanism. The system is powered by a Raspberry Pi, which acts as the central processing unit. Various water quality sensors such as pH, turbidity, and TDS sensors are integrated into the boat to continuously monitor water parameters. These sensors are connected to the Raspberry Pi using analog-to-digital converters, as the Raspberry Pi does not support analog inputs directly. The boat's movement is controlled using DC motors operated through motor driver modules like the L298N, which allow for directional navigation across the water surface.

An ultrasonic sensor is employed to avoid obstacles in the water, enhancing the boat's autonomous capabilities. When the sensors detect impurity levels beyond set thresholds, the Raspberry Pi processes the data and triggers the motor control system to guide the boat to the affected area. An elevator mechanism, driven by servo or DC motors, is then activated to lift and collect floating waste into a designated container on the boat. The entire system is programmed using Python on the Raspberry Pi, which handles real-time sensor data acquisition, motor control, and actuator operation. During the development phase, the system is tested in controlled environments to calibrate the sensors and fine-tune the boat's navigation and waste collection efficiency. Data such as impurity levels and GPS coordinates (if a GPS module is used) can be logged for further analysis and environmental monitoring. The design also considers waterproofing of electronics and environmental safety, aiming to provide a sustainable and scalable solution to water pollution.

## IV. EXPERIMENTAL RESULTS

The experimental setup was tested in a controlled water body, such as a medium-sized pond and a large water tank, to evaluate both the impurity detection accuracy and the mechanical performance of the elevator boat. Water samples with varying levels of pollutants were used to test the sensitivity and response time of the pH, turbidity, and TDS sensors. The pH sensor reliably detected values ranging from 5.5 to 8.0, showing immediate changes when acidic or basic substances were added to the water. The turbidity sensor accurately identified increased levels of suspended particles, with readings rising from 15 NTU (clean water) to over 120 NTU (polluted water). Similarly, the TDS sensor showed a measurable increase in dissolved solids, ranging from 150 ppm in clean samples to over 600 ppm in polluted ones. These results confirmed the effective calibration and responsiveness of the sensor system.

In terms of navigation and waste collection, the boat was able to move smoothly across the water surface with stable speed and direction control, responding effectively to the commands issued by the Raspberry Pi through the L298N motor driver. The ultrasonic sensor accurately detected obstacles within a 50 cm range, allowing the boat to avoid collisions.

The elevator mechanism successfully lifted small plastic debris, leaves, and other floating materials into the collection tray with minimal error. During multiple test runs, the system consistently responded to high impurity levels by navigating to the targeted location and activating the waste collection mechanism. Data logging through the Raspberry Pi showed consistent correlation between water quality readings and physical observations. Overall, the experimental results demonstrated that the integrated system could effectively detect water impurities and autonomously collect floating waste, supporting the project's goal of developing a low-cost, sensor-based environmental cleanup solution.

### **V. CONCLUSION**

The project titled "**Sensor-based Water Waste Impurities Detection and Design of Elevator Boat Using Raspberry Pi and Motor Drivers**" successfully demonstrates a practical and cost-effective solution for monitoring and cleaning polluted water bodies. By integrating various water quality sensors with a Raspberry Pi-based control system, the project effectively detects key impurities such as pH imbalance, turbidity, and total dissolved solids. The autonomous boat, powered by motor drivers and equipped with an elevator mechanism, efficiently navigates the water surface and collects floating waste materials. Experimental results validated the system's ability to respond accurately to varying impurity levels and perform real-time waste collection without human intervention. The use of low-power, open-source components makes the design scalable and suitable for deployment in lakes, ponds, and canals where manual cleaning is difficult. Overall, the system not only addresses environmental pollution but also lays the groundwork for future enhancements such as IoT integration, solar power, and AI-based waste recognition for smarter and greener water management solutions.

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