RESEARCH ARTICLE OPEN ACCESS

# IOT BASED AI ROBOTIC TRASH BOAT to DRIVE & HARVEST FLOATING WASTAGE from URBAN DRAIN

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**ABSTRACT**
The IoT based trash collection robot is an intelligent system designed to automatically detect and collect floating waste from water bodies such as lakes, ponds, canals, and drainage areas. Water pollution caused by plastic bottles, covers, and other floating garbage creates serious environmental problems and affects aquatic life. This project proposes a robotic solution that continuously monitors the water surface and removes waste without the need for manual cleaning. The system uses an ultrasonic sensor to detect the presence of waste or obstacles in the water. A microcontroller acts as the central unit that processes sensor data and controls the overall operation of the robot. When floating waste is detected, the motor driven mechanism moves the robot toward the waste and activates a conveyor mechanism to collect and store the garbage inside a storage container. The system is powered through a battery and regulated power supply to ensure stable operation of all components. A driver circuit controls the movement of motors responsible for robot navigation and waste collection. An LCD display is used to show system status and operation information. The robot is also integrated with an IoT communication module that sends alerts and status updates to the corporation department when the waste container becomes full or when large amounts of waste are detected, enabling timely cleaning and efficient waste management.

***Keywords***: IoT, Trash Collection Robot, Water Pollution, Floating Waste Detection, Ultrasonic Sensor, Microcontroller, Conveyor Mechanism, Smart Waste Management

## 1. INTRODUCTION

### 1.1 Overview

Water pollution has become a major environmental issue in many cities and towns due to the accumulation of floating waste in rivers, lakes, canals, and drainage systems. Plastic bottles, covers, food waste, and other debris are often thrown into water bodies, leading to severe contamination and blockage of natural water flow. This not only affects aquatic life but also creates unpleasant surroundings and potential health risks for nearby communities. In many places, the removal of floating waste is performed manually by sanitation workers, which is time consuming, labor intensive, and sometimes unsafe. Workers are often required to enter polluted water to remove garbage, which exposes them to harmful substances and diseases. As urbanization continues to increase, the amount of waste entering water bodies also increases, making traditional cleaning methods inefficient and difficult to manage.

To address these problems, there is a need for an intelligent and automated waste collection system that can detect and remove floating garbage from water surfaces effectively. The development of robotic technology combined with Internet of Things communication provides a practical solution for improving water cleaning operations. An automated trash collection robot can continuously monitor water surfaces and collect floating waste without requiring direct human intervention. By using sensors and control mechanisms, the robot can detect garbage and move towards it for collection. This approach helps in reducing manual effort and improving the efficiency of water cleaning activities. The integration of smart technologies also enables real time monitoring and reporting, allowing authorities to manage waste more effectively.

### 1.2 Sensors and Automation in Waste Detection

Sensors and automated control systems play a crucial role in modern environmental monitoring and cleaning applications. In water cleaning robots, sensors are used to detect floating objects and obstacles present on the water surface. Ultrasonic sensors are commonly used because they can measure the distance between the robot and nearby objects by transmitting sound waves and analyzing their reflections. When the sensor detects floating waste within a certain range, the information is sent to the microcontroller which acts as the central processing unit of the system.

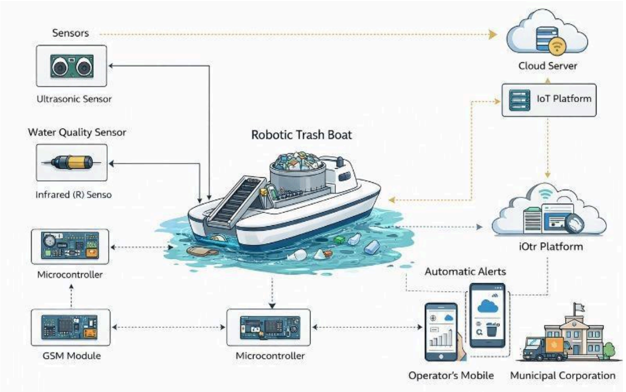


Figure 1.2 Sensor Based Waste Detection

The microcontroller processes the sensor data and controls the movement of motors that drive the robot across the water. Motor driver circuits are used to regulate the operation of the motors and ensure smooth movement. When waste is detected, the robot approaches the garbage and activates a conveyor or collection mechanism to pick up the waste and store it inside a container. An LCD display can also be used to show system status and operational messages. This automated process allows the robot to perform continuous waste collection operations without human assistance, making the cleaning process faster and more efficient

## 2. LITERATURE SURVEY

### 2.1 Machine Learning-Enabled Robotic Trash Collector

**Authors:** Choudhary, Ruchi, et al.

**Year:** 2024

**Description:**

This research presents a robotic trash collection system that utilizes machine learning techniques to improve the efficiency of waste detection and collection in water environments. The authors propose an intelligent robotic platform capable of identifying different types of floating waste using image processing and classification algorithms. The system integrates sensors, cameras, and machine learning models to detect waste objects present on the water surface. Once the waste is identified, the robotic mechanism moves toward the detected object and activates a collection system to remove the garbage. The machine learning model is trained using datasets containing images of plastic bottles, wrappers, and other common floating debris, enabling the system to distinguish waste from natural objects such as leaves or water reflections. The study highlights the importance of automation in reducing manual labor and improving water cleaning operations. Experimental results demonstrate that the robotic system can accurately detect and collect waste in controlled environments. The proposed solution contributes to environmental protection by providing an intelligent and automated approach for maintaining clean water bodies and reducing pollution in urban and rural areas.

### 2.2 Applied AI in Water Surface Robotics for Lake Sanitation and Sampling

**Authors:**Omar, Ahmed Abdullah, Zati Hakim Azizul, and Pouyan Asgharian

**Year:** 2025

**Description**:

This paper explores the application of artificial intelligence in water surface robotics for lake sanitation and environmental sampling. The authors propose a robotic platform capable of performing multiple tasks including waste detection, water quality monitoring, and sample collection. The system integrates AI algorithms to analyze sensor data and make intelligent navigation decisions. These algorithms help the robot identify polluted areas and optimize its movement path for efficient cleaning and sampling operations. The study highlights the importance of autonomous robotic systems in environmental monitoring and management. By using artificial intelligence, the robot can adapt to changing environmental conditions and improve its operational efficiency. The research also discusses the potential of integrating various sensors to monitor parameters such as temperature, turbidity, and chemical composition of water. Experimental demonstrations show that AI-based water surface robots can support lake sanitation efforts and provide valuable environmental data for researchers and authorities.

### 2.3 Optimizing Plastic Waste Collection in Water Bodies Using Heterogeneous Autonomous Surface Vehicles with Deep Reinforcement Learning

**Authors:** Barrionuevo, Alejandro Mendoza, et al.

**Year:** 2025

**Description:**
This study presents an advanced approach for optimizing plastic waste collection in water bodies using multiple autonomous surface vehicles controlled by deep reinforcement

learning algorithms. The proposed system consists of several robotic vehicles that cooperate to detect and collect plastic waste across large water surfaces. Deep reinforcement learning is used to train the vehicles to make intelligent decisions regarding navigation, task allocation, and waste collection strategies. The algorithm learns optimal movement patterns that minimize energy consumption while maximizing waste collection efficiency. The authors highlight the advantages of using multiple coordinated robots for covering large areas more effectively compared to single robot systems. Simulation results demonstrate that the proposed approach significantly improves waste collection performance and operational efficiency. The research contributes to the development of intelligent robotic fleets capable of addressing large-scale water pollution challenges and supporting environmental sustainability initiatives.

## 3.SYSTEM STUDY

### 3.1 EXISTING SYSTEM

Water pollution caused by floating waste has become a serious environmental problem in many urban and rural areas. Lakes, rivers, canals, and drainage systems often accumulate plastic bottles, food packets, wrappers, and other garbage due to improper waste disposal. In most locations, the cleaning of these water bodies is performed manually by sanitation workers. Workers use nets, sticks, or small boats to remove floating waste from the water surface. Although this traditional method helps in removing visible waste, it is slow, labor intensive, and inefficient for large water bodies.

Manual waste collection also exposes workers to contaminated water that may contain harmful chemicals, bacteria, and other pollutants. This creates serious health risks for workers who regularly perform cleaning operations. Another major limitation is that manual cleaning is usually done periodically rather than continuously, which allows waste to accumulate between cleaning cycles. As a result, the water bodies remain polluted for long periods.

Existing waste collection methods also lack automated monitoring and communication systems. There is no mechanism to detect the presence of floating waste in real time or to inform authorities immediately when waste accumulation increases. The absence of intelligent technologies such as sensors, robotics, and Internet of Things communication reduces the efficiency of waste management systems. Therefore, traditional water waste cleaning methods are not sufficient to maintain clean and healthy aquatic environments.

#### 3.1.1 DRAWBACKS

- Waste collection is performed manually by sanitation workers.
- Cleaning process is slow and labor intensive.
- Workers are exposed to polluted and contaminated water.
- No automatic detection of floating waste in water bodies.
- Waste accumulation occurs between cleaning operations.
- Lack of real time monitoring of water pollution levels.
- No automatic alert system to inform authorities.
- Inefficient for cleaning large water bodies.

### 3.2 PROPOSED SYSTEM

The proposed system introduces an IoT based trash collection robot designed to automatically detect and collect floating waste from water bodies. The system aims to reduce manual labor and improve the efficiency of water cleaning operations by using sensors, robotic mechanisms, and communication technologies. The robot is equipped with an ultrasonic sensor that detects floating waste or obstacles present on the water surface. The sensor continuously monitors the surroundings and sends data to the microcontroller which acts as the main control unit of the system.

The microcontroller processes the sensor information and controls the movement of motors through driver circuits. These motors enable the robot to move across the water surface toward the detected waste. Once the waste is located, a conveyor mechanism is activated to collect the garbage and store it in a container attached to the robot. The system is powered by a battery and regulated power supply that ensures stable operation of all electronic components. An LCD display is used to show the operational status of the robot and system messages.

The system also integrates Internet of Things technology to enable communication with the corporation or municipal department. A communication module sends alerts whenever a large amount of waste is detected or when the garbage container becomes full. This allows authorities to monitor the condition of water bodies and take timely action for waste removal and maintenance. The proposed system provides an automated and efficient solution for maintaining clean water environments.

Captions with table numbers must be placed before their associated tables, as shown in Table 1.

#### 3.2.1 ADVANTAGES

- Automatically detects floating waste using ultrasonic sensors.
- Reduces manual labor in water cleaning operations.

- Uses robotic mechanism for automatic waste collection.
- Provides continuous monitoring of water surfaces.
- Sends alerts to corporation authorities using IoT communication.
- Improves efficiency of waste management in water bodies.
- Reduces environmental pollution and water contamination.
- Suitable for lakes, rivers, canals, and drainage systems.

### 4.SYSTEM REQUIREMENTS

#### 4.1 HARDWAREV REQUIREMENTS

- Arduino Nano
- Ultrasonic sensor
- Battery
- Driver
- Motor Move
- Conveyer
- GSM
- Power supply
- LCD

#### 4.2 SOFTWARE REQUIREMENTS

- Arduino IDE

## 5. SYSTEM DESIGN

## 5.1 PROPOSED BLOCK DIAGRAM

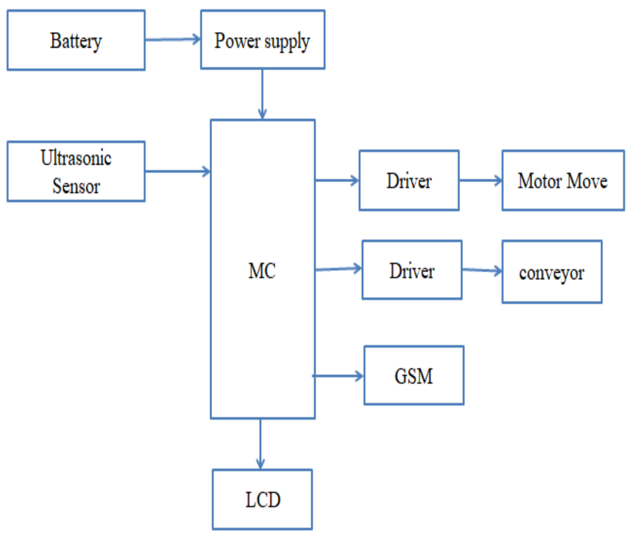


Figure 6.1 Proposed Block diagram

#### 5.2 BLOCK DIAGRAM DESCRIPTION

The IoT based trash collection robot operates using a combination of sensing, control, mechanical movement, and communication modules as illustrated in the block diagram. The system is powered by a battery which provides electrical energy to the power supply unit. The power supply regulates the voltage and distributes stable power to the microcontroller and other electronic components. The microcontroller acts as the central control unit that manages the entire operation of the robot. An ultrasonic sensor is connected to the microcontroller to detect floating waste or obstacles present on the water surface. The sensor continuously measures the distance between the robot and nearby objects and sends this information to the microcontroller. When floating waste is detected within a certain range, the microcontroller processes the data and sends control signals to the motor driver circuits. One driver controls the motor responsible for the movement of the robot across the water, allowing it to move toward the detected waste. Another driver activates the conveyor mechanism that collects the floating garbage and stores it in the waste container. The LCD display is connected to the microcontroller to show system status and operational messages. A GSM communication module is also integrated with the microcontroller to send alert messages to the corporation department when waste is detected or when the collection container becomes full.

#### 5.3 MODULES DESCRIPTION

**1. Waste Detection Module**

The waste detection module is responsible for identifying floating garbage present on the water surface. This module mainly uses an ultrasonic sensor to detect the presence of objects in front of the robot. The ultrasonic sensor continuously emits high frequency sound waves and receives the reflected signals when these waves hit an object. By measuring the time taken for the sound waves to return, the sensor calculates the distance between the robot and the detected object. The sensor sends this distance information to the microcontroller for processing. This allows the robot to identify floating waste such as plastic bottles, covers, or other debris present on the water surface.

The microcontroller continuously monitors the data received from the ultrasonic sensor and compares the measured distance with predefined threshold values. When the detected object is within the specified range, the system recognizes it as potential waste that needs to be collected. This process enables the robot to automatically detect floating waste without human intervention. The detection module plays an important role in ensuring that the robot moves toward waste only when it is detected within the operational range.

This module also improves the efficiency of the cleaning process by enabling the robot to monitor the surrounding water surface continuously. The ultrasonic sensor helps the robot detect waste even in environments where visibility is low or lighting conditions are poor. Since the sensor works using sound waves rather than light, it can operate effectively in different environmental conditions such as bright sunlight or cloudy weather. This makes the detection system reliable for outdoor water environments.

Another advantage of the waste detection module is its ability to prevent collisions with obstacles. The ultrasonic sensor can also detect other objects such as rocks, walls, or large floating items present in the water. By detecting these obstacles, the robot can adjust its movement and avoid collisions. This improves the safety and stability of the robotic system while performing waste collection operations.

**2. Robot Movement Control Module**

The robot movement control module is responsible for controlling the navigation and movement of the trash collection robot across the water surface. This module includes the microcontroller, motor driver circuits, and DC motors that work together to move the robot in different directions. The microcontroller acts as the main control unit that receives input signals from the waste detection module and processes them to determine the appropriate movement of the robot.

When the ultrasonic sensor detects floating waste within a specific range, the microcontroller sends control signals to the motor driver circuit. The motor driver acts as an interface between the microcontroller and the motors because the microcontroller cannot supply sufficient current to drive the motors directly. The driver circuit amplifies the control signals and provides the required power to operate the motors.

The motors connected to the driver circuit are responsible for propelling the robot across the water surface. These motors control the forward, backward, and directional movement of the robot. By adjusting the speed and direction of the motors, the robot can move toward the detected waste and position itself correctly for the collection process. This movement mechanism allows the robot to navigate efficiently in water bodies such as ponds, lakes, or drainage systems.

The robot movement control module ensures smooth and stable navigation during operation. Proper coordination between the microcontroller and motor drivers helps maintain controlled movement even when environmental conditions change. This module plays a crucial role in enabling the robot to reach the detected waste accurately and perform effective cleaning operations.

**3. Waste Collection Mechanism Module**

The waste collection mechanism module is responsible for physically collecting the floating garbage detected by the robot. This module mainly consists of a conveyor mechanism connected to a motor and controlled through a motor driver circuit. When the robot approaches the detected waste, the microcontroller activates the conveyor system to collect the garbage from the water surface.

The conveyor mechanism works by rotating a belt or paddle system that lifts the floating waste from the water and transfers it into a storage container placed on the robot. The movement of the conveyor is controlled by a motor that receives signals from the microcontroller through the motor driver circuit. Once the waste is collected, it is stored in the container until the container reaches its capacity.

This automated collection mechanism reduces the need for manual waste removal and improves the efficiency of the cleaning process. The conveyor is designed to handle different types of floating debris such as plastic bottles, food packets, and other lightweight waste materials. By continuously collecting waste during operation, the robot helps maintain cleaner water surfaces.

Another important feature of this module is its ability to operate automatically based on sensor input. The conveyor mechanism is activated only when waste is detected, which helps conserve power and extend the battery life of the robot. This smart operation ensures efficient waste collection while minimizing unnecessary energy consumption.

**4. Communication and Alert Module**

The communication and alert module is responsible for sending notifications and status updates to the corporation or municipal department. This module uses a GSM communication system that enables the robot to transmit information through a wireless communication network. The GSM module is connected to the microcontroller and receives commands to send alert messages when specific conditions occur.

When the waste container becomes full or when a large amount of garbage is detected, the microcontroller triggers the GSM module to send a notification message to the responsible authorities. This alert allows the corporation department to take necessary action such as emptying the waste container or performing maintenance on the robot. Real time communication improves the efficiency of waste management operations.

The GSM module operates using a SIM card and communicates through mobile network infrastructure. It can send SMS alerts or other notification messages to predefined phone numbers. This ensures that the system can communicate with authorities even if the robot is operating in remote water locations where direct monitoring is not possible.

This module plays a critical role in transforming the robot into a smart environmental monitoring system. By integrating communication technology, the robot not only collects waste but also provides useful information to authorities responsible for maintaining clean water bodies. This helps improve environmental management and ensures timely waste removal operations.

**5. Monitoring and Display Module**

The monitoring and display module is responsible for providing real time information about the operational status of the robot. This module includes an LCD display that is connected to the microcontroller. The LCD screen shows various system parameters such as detection status, robot movement information, and operational messages. This allows users or operators to easily monitor the functioning of the robot.

The microcontroller continuously updates the LCD display based on the sensor readings and system operations. For example, when waste is detected by the ultrasonic sensor, the LCD can display messages indicating that garbage has been detected and the collection mechanism is activated. Similarly, it can show messages when the robot is moving, collecting waste, or sending alerts through the GSM module.

The display module improves system transparency by providing clear visual feedback about the robot's activities. It helps operators understand the system's current state and verify whether all components are functioning correctly. This feature is particularly useful during testing, maintenance, and troubleshooting of the robotic system.

In addition to displaying operational information, the monitoring module also helps ensure the reliability of the system. If any component fails or unusual conditions occur, the system can display warning messages on the LCD screen. This allows operators to identify problems quickly and take corrective action. Overall, the monitoring and display module enhances user interaction and improves the overall performance of the trash collection robot.

## 6.RESULT AND DISCUSSION

The implementation of the IoT based trash collection robot demonstrates an effective solution for detecting and collecting floating waste from water bodies. The system was tested under different conditions to evaluate its ability to identify floating garbage and perform automatic collection operations. During the testing process, the ultrasonic sensor successfully detected objects placed on the water surface within a predefined distance range. Once the waste was detected, the microcontroller processed the sensor signals and activated the motor driver circuits to move the robot toward the detected object. The movement system allowed the robot to navigate smoothly across the water surface and position itself correctly near the floating waste. The conveyor mechanism was then activated to collect the garbage and transfer it into the storage container attached to the robot.

The experimental results showed that the robot was capable of collecting lightweight floating waste such as plastic bottles, paper covers, and small debris effectively. The conveyor system worked efficiently in lifting the waste from the water surface and storing it in the collection container. The LCD display successfully provided real time information about system status such as waste detection, robot movement, and waste collection activity. This feature allowed users to monitor the operational condition of the robot easily. The integration of the GSM module also performed successfully by sending alert messages to the corporation or municipal department when waste was detected or when the storage container reached its maximum capacity.

The discussion of the results indicates that the proposed system reduces the need for manual cleaning operations in polluted water bodies. Traditional cleaning methods require workers to manually remove garbage from water using nets or boats, which can be time consuming and unsafe. The automated robotic system significantly reduces human effort by performing continuous monitoring and waste collection. The sensor based detection mechanism improves operational efficiency by allowing the robot to respond immediately when waste is detected. In addition, the IoT communication feature ensures that authorities receive timely notifications regarding waste accumulation or system status.

Overall, the project demonstrates the practical feasibility of using an automated robotic system for environmental cleaning applications. The combination of sensors, microcontroller control, mechanical collection mechanisms, and IoT communication provides an integrated solution for managing floating waste in water bodies. Although the prototype operates effectively for small scale waste collection, further improvements such as enhanced navigation systems, larger storage capacity, and solar powered energy sources could improve the performance and scalability of the system for large scale environmental applications.

## 7.CONCLUSION & FUTURE ENHANCEMENT

### 7.1 CONCLUSION

The IoT based trash collection robot provides an effective and innovative solution for cleaning floating waste from water bodies such as lakes, ponds, rivers, and drainage systems. The system combines sensor technology, microcontroller control, mechanical collection mechanisms, and wireless communication to perform automatic waste detection and removal. The ultrasonic sensor continuously monitors the water surface and detects floating garbage, while the microcontroller processes the sensor data and controls the movement of the robot. The motor drivers and motors enable the robot to move toward the detected waste, and the conveyor mechanism collects the garbage and stores it in the container.

The integration of IoT communication through the GSM module allows the system to send alert messages to the corporation or municipal department whenever waste is detected or when the collection container becomes full. This real time communication improves waste management efficiency and ensures timely cleaning operations. The LCD display also provides system status information, allowing users to monitor the operation of the robot easily.

Overall, the project demonstrates that an automated robotic system can significantly reduce manual labor and improve the efficiency of water waste management. The proposed system helps in maintaining cleaner water bodies, reducing environmental pollution, and supporting smart city initiatives. The successful implementation of this project highlights the importance of integrating robotics and IoT technologies for environmental protection and sustainable waste management.

### 7.2 FUTURE ENHANCEMENT

Although the developed system performs basic waste detection and collection effectively, several improvements can be implemented in the future to enhance its functionality and performance. One possible enhancement is the integration of advanced sensors or camera based detection systems that can identify different types of waste more accurately. Computer vision and artificial intelligence algorithms can be used to classify waste materials and improve the detection capability of the robot.

Another improvement could involve incorporating solar panels to power the robot, which would reduce dependency on batteries and allow longer operational time in outdoor environments. Solar powered systems are environmentally friendly and suitable for continuous water cleaning applications. Additionally, the robot can be equipped with GPS technology to track its location and enable remote monitoring through IoT platforms.

Future versions of the system could also include larger waste storage capacity and improved navigation systems that allow the robot to cover larger water areas more efficiently. Autonomous navigation algorithms and multiple sensors could help the robot avoid obstacles and operate independently without human supervision. By implementing these enhancements, the IoT based trash collection robot can be developed into a more advanced and scalable solution for large scale water pollution control and environmental management.

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