

# IoT Enabled Cost Efficient River Trash Collection Machine

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**Abstract.** Water Pollution at alarming rate is treacherous to the freshwater ecosystem and for the people who consumes it. With cost effective tools and sustainable materials, it is possible to prevent the pollution in freshwater bodies like rivers because rivers are the veins of the nation which serves as basic water resource for millions of people. Rivers are contaminated at various levels that are hazardous and it covers the river surface which are quite serious thing that need to be removed immediately. In order to assist the pollution prevention, we have proposed the IoT- enabled Autonomous River Trash Collection Machine in this paper. It works autonomously that captures diverse types of waste, particularly the debris, biomedical waste and plastics and collects it, more efficiently than manual and traditional practices. With robust mechanical frame and maintainable materials which comprises of PVC pipes, Propellers, DC motors along with microcontrollers and Bluetooth module for remote controlling and monitoring, the machine accomplishes the cost effective, sustainable and effectively performing solution which are the main objectives of this project.

## INTRODUCTION

Rivers, vital ecosystems sustaining diverse life forms, face a growing threat: river pollution. This problem stems primarily from solid waste like plastic, debris, and discarded materials originating from various sources, including coastal industries, illegal dumping, and domestic waste. The issue is further exacerbated by climate change, with increased flooding and extreme weather events leading to increased river flows that carry and disperse debris. This not only poses a significant environmental threat to aquatic life and ecosystems but also impacts public health and safety by contaminating water sources and potentially harboring harmful pathogens.

Traditional river cleaning methods, often relying on manual labor or fixed barriers, are plagued by limitations. They are typically labor-intensive requiring significant manpower, expensive due to operational costs, and inefficient in terms of coverage and effectiveness. Additionally, these methods can be environmentally disruptive by disturbing river ecosystems and may be ineffective in capturing diverse types of waste, particularly with the ever-increasing volume and spread of debris.

The need for innovative, sustainable, and cost-effective solutions to address the growing challenge of river pollution is paramount. This research project introduces the IoT-Enabled Autonomous River Trash Collection Machine, a novel approach that leverages advancements in machine, Internet of Things (IoT) technology, and sustainable principles to revolutionize river cleaning efforts.

## Proposed Methodology

IoT-Enabled Autonomous River Trash Collection Machine, integrates cutting-edge technologies to revolutionize river cleaning efforts. This innovative machine surpasses traditional methods by leveraging the

power of the Internet of Things (IoT) to achieve a new level of efficiency, effectiveness, and sustainability in collecting trash from waterways.

**Central Processing Unit (CPU):** The machine utilizes a compact and energy-efficient CPU, such as the Raspberry Pi Pico microcontroller, to serve as the core control unit. This unit manages the machine's movements, sensor data processing, and trash collection operations [3].

**IoT Communication Module:** The IoT-based river monitoring systems allow the machine to incorporate a robust communication module, like the Bluetooth Module HC 05 [4]. This enables real-time data transmission and remote-control capabilities. Operators can monitor machine performance, receive data on trash collection, and control the machine's movements from a smartphone or computer, enhancing operational flexibility and effectiveness.

**Propulsion and Collection System:** The machine employs powerful yet energy-efficient 12V DC motors to drive the propulsion system, ensuring efficient navigation across diverse river conditions [4]. Additionally, a conveyor belt system, constructed with durable and potentially biodegradable materials facilitates efficient trash collection [6].

### *Uniqueness and Advantages*

**Real-Time Monitoring and Control:** The integration of IoT technology facilitates real-time data transmission and remote control, enabling operators to make informed decisions, optimize operations, and ensure effective cleaning even in remote areas.

**Sustainable Design and Operation:** The focus on potentially biodegradable materials and the exploration of renewable energy sources, such as solar power investigated by, minimizes the machine's environmental footprint and promotes a cleaner solution for river cleaning.

By integrating these unique features, the IoT-Enabled Autonomous River Trash Collection Machine offers a significant advancement in river cleaning technology. It has the potential to revolutionize how we address river pollution, paving the way for a more sustainable and efficient future for our waterways.

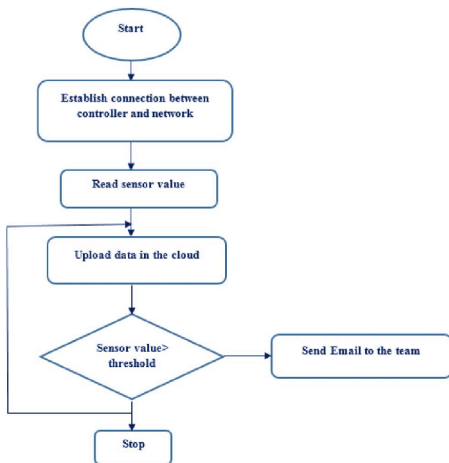
## **Design And Implementation**

The machine is equipped with various sensors to gather information about its environment and status. These sensors include:

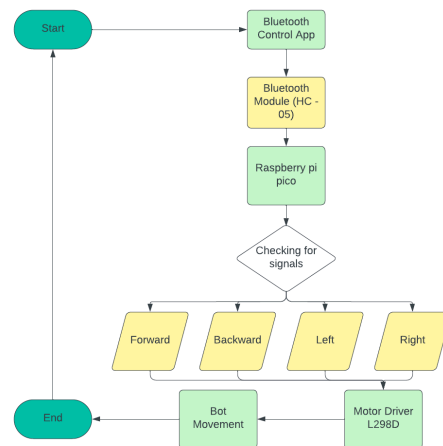
- **Battery level sensor:** Monitors the charge level of the machine's battery to ensure continuous operation.
- **Trash level sensor:** Detects the amount of trash collected by the machine in its receptacle.
- **Location sensor (GPS or similar):** Determines the precise geographical coordinates of the machine's current position.
- **Data Collection:** The sensors continuously collect data on the battery level, trash level, and location of the machine as it navigates the river and collects trash.
- **Data Transmission:** The collected data is transmitted wirelessly using communication protocols such as Wi-Fi, cellular networks, or satellite communication to a central server or cloud-based platform.
- **Cloud Platform:** The data is received and stored in a cloud-based platform or server, where it can be processed, analysed, and accessed remotely.
- **Analysis and Visualization:** Data analytics algorithms can process the collected data to extract meaningful insights, such as trends in battery usage, trash accumulation patterns, and the machine's movement patterns. Visualization tools can then present this information in a user-friendly format, such as charts, maps, or dashboards.
- **Remote Monitoring and Control:** Stakeholders, such as machine operators or environmental agencies, can remotely monitor the machine's status and performance in real-time through web-based or mobile applications. Alerts can be generated for critical events, such as low battery levels or high trash accumulation, allowing for timely intervention or maintenance.



**FIGURE 1.** *Assembled Design of the Machine*



**FIGURE 2.** *Flow Diagram of IoT*



**FIGURE 3.** *Flow Diagram of Controller*

Condition	Operation
Robot turn right	Right motor = OFF Left motor = ON
Robot turn left	Right motor = ON Left motor = OFF
Robot forward movement	Right motor on + Left motor on +
Robot backward movement	Right motor on - Left motor on +

**TABLE 1.** *Motor Function*

The Bluetooth technology is employed to enable remote control and management of the river trash collecting machine. By integrating Bluetooth capabilities into the machine's control system, operators can interact with the machine wirelessly using compatible devices such as smartphones, tablets, or dedicated control interfaces.

The Bluetooth control functionality allows operators to perform various tasks from a distance, enhancing convenience and flexibility in managing the machine's operations. For example, operators can start or stop the machine, adjust its speed and direction, activate specific cleaning modes, and monitor its performance and status in real-time, all through a Bluetooth-enabled interface.

## Result and Discussion

The proposed IoT-Enabled River Trash Collection Machine holds immense potential to revolutionize river cleaning efforts. Its core strength lies in the integration of cutting-edge technologies. The machine leverages advanced sensors which enables efficient operation and adaptation to diverse river environments. Additionally, the integration of IoT communication allows for real-time data collection and remote control, enhancing operational flexibility and facilitating informed decision-making. This combination of features surpasses the limitations of traditional methods, offering significantly improved efficiency and effectiveness in tackling the growing challenge of river pollution.

Features	Traditional Method	Proposed System	Importance
Efficiency	20% - 50%	60% - 85%	High
Effectiveness	10% - 30%	70% and above	High
Scalability	10%	100%	High
Sustainability	10% - 20%	70%	High
Safety	5%	100%	High
Cost	High	Low	High

**Table 2.** Comparison of Ability and Importance with Previous Solution

This proposed method has enormous advantages as it can be used effectively at a large scale with utmost efficiency also ensuring the safety of the operator.

Developing a river trash collecting machine has both positive and negative environmental impacts. On the positive side, it helps remove trash from rivers, improving water quality, preventing habitat destruction, and reducing water contamination. Additionally, it raises public awareness about the importance of river cleanliness. However, there are negative aspects, such as energy consumption during operation, environmental impacts from manufacturing and maintenance, potential disruption to wildlife, and the risk of unintended consequences like damage to the riverbed. Overall, while there are challenges, the benefits typically outweigh the drawbacks, as the machine contributes significantly to reducing pollution and enhancing the health of river ecosystems.

As this method is based on IoT this can introduce a degree of technical complexity and might require specialized expertise for operation and maintenance. Addressing these potential challenges through cost-effective design choices and readily available training programs will be crucial for ensuring the widespread adoption and successful implementation of this innovative solution.

Overall, the proposed IoT-Enabled River Trash Collection Machine offers a promising solution with significant potential to address the growing challenge of river pollution. While acknowledging the development costs and technical complexities, the machine's enhanced efficiency, effectiveness, scalability, and potential for a sustainable design outweigh the limitations and highlight its importance compared to traditional methods.

The table i.e. **table 3** illustrates how IoT-enabled river trash collecting machines can provide valuable insights into the status of cleaning operations. By quantifying trash collection levels, battery status, and location coordinates, the management system can prioritize areas with high trash accumulation, schedule maintenance when battery levels are low, and optimize collection routes based on location data. Real-time monitoring and analysis enable proactive decision-making, leading to more efficient resource utilization and improved river cleanliness. Additionally, the system facilitates data-driven evaluation and refinement of cleaning strategies over time, contributing to sustainable river management practices.

Trash Collection Level	Battery Level	Location Status
200g	90% - 100%	GPS Coordinates: [30.2672, -97.7431]
350g	70% - 90%	GPS Coordinates: [40.7128, -74.0060]
410g	50% - 70%	GPS Coordinates: [51.5074, -0.1278]
480g	30% - 50%	GPS Coordinates: [35.6895, 139.6917]

**Table 3.** Data Collection Result from Sensors

## Conclusion

River pollution poses a significant global challenge, impacting global sustainability at very high levels. As this paper proposes the robot, which leverages autonomous differential steering navigation, a conveyor belt system for trash collection with ultrasonic sensors for trash level monitoring and renewable power source. Along with that, cutting-edge technologies including remote control through IoT integration for real time navigation and real-time data collection which supports enhanced efficiency, performance, and cost-effectiveness, are also its key advantages.

Besides that, challenges also exist regarding initial development costs and technical complexity. The potential benefits of this system outweigh these limitations. This research project serves as a foundation for further development and refinement of the proposed system. Future should focus on exploration of alternative sustainable materials and energy sources to minimize environmental impact and development of advanced algorithms for improved autonomous navigation and decision-making capabilities.

By addressing these areas, the IoT-Enabled Autonomous River Trash Collection Robot has the potential to become a widely adopted solution and the paper presents a promising solution for tackling river pollution.

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