

Design and Implementation of a Mobile-Controlled River Water Cleaning Robot

E Channaveeramma¹, Mamata khatke², Supriya³, K Venkatachalam⁴

Department of Electronics and Communication Engineering
Navodaya Institute of Technology Raichur, Karnataka

ABSTRACT:

In this paper, a mobile-controlled river water cleaning robot is designed and implemented to address the growing issue of river surface pollution caused by floating waste such as plastics, bottles, and organic debris. The proposed system consists of a floating robotic platform equipped with a conveyor belt mechanism, BO gear motors, and an Arduino Uno microcontroller that manages motor control and wireless communication. A Bluetooth-based mobile application (Arduino Bluetooth Controller App) enables real-time navigation and operation of the robot, ensuring efficient and user-friendly waste collection. The prototype demonstrates a low-cost, portable, and energy-efficient solution capable of reducing manual labor while enhancing the effectiveness of river cleaning activities. This work contributes to sustainable waste management practices and supports ongoing efforts to maintain healthy aquatic ecosystems.

Components & Formatting: Arduino/ microcontroller, Bluetooth/Wi-Fi module, motor driver (L298N), Bo-gear motors + wheels, floating chassis, waste collection conveyor, rechargeable battery , and mobile app interface.

INTRODUCTION:

Water pollution in rivers has become a serious environmental problem due to the continuous accumulation of plastics, debris, and other pollutants that degrade aquatic ecosystems, threaten human and animal health, and reduce water quality. Traditional cleaning methods rely heavily on manual labor and stationary systems, which are often inefficient, costly, and unable to access all contaminated areas. To address these limitations, a mobile-controlled river water cleaning robot offers an innovative and practical solution that can be guided remotely via a mobile device, enabling precise navigation and efficient removal of floating waste. By integrating sensors, waste-collection mechanisms, and wireless control technology, this robot enhances cleaning efficiency, reduces human intervention in hazardous conditions, and supports sustainable waterway maintenance. This design and implementation focus on developing a cost-effective,

environmentally friendly system capable of improving cleanliness in rivers and contributing to long-term water pollution mitigation efforts.

LITERATURE SURVEY:

1. “Implementation of a River Water Cleaning Machine” [1]

Author: Mr. Chandan r p

Summary: River water pollution is a major environmental issue caused by the dumping of solid waste, plastic, and sewage. To address this, various methods have been implemented ranging from manual cleaning to automated machines. The goal of this survey is to explore existing systems and technologies used in river cleaning and identify gaps for improved implementation.

2. “Implementation of River Surface Cleaning Machine-A Review” [2]

Author: Divya Deepak todurkar

Summary: Several methods have been developed for cleaning river surfaces, focusing primarily on the removal of floating waste such as plastics, leaves, and other debris. Traditional manual methods, though simple, are labor-intensive and inefficient for large-scale or continuous operations. Recent innovations include semi-automated and solar-powered machines equipped with conveyor belts and floating barriers to collect waste from the river surface. Projects like Baltimore’s “Mr. Trash Wheel” have demonstrated the effectiveness of such systems in urban waterways. Research studies also propose designs with rotating arms, mesh collectors, and sensor-based automation for better performance. However, most systems still face challenges related to scalability, maintenance, and real time adaptability to varying water flow conditions. Hence, there is a growing need for cost-effective, eco-friendly, and smart river surface cleaning machines that can operate efficiently under diverse environmental conditions.

3. “Design and Fabrication of Automatic River Cleaning Machine Using Arduino and Mobile Control” [3]

Authors: J.Zhao,x. Zhang and Q.Pan

Summary: Several studies and projects have explored automated solutions for river and water body cleaning to address the growing problem of aquatic pollution caused by floating waste. Traditional manual methods are labor-intensive and inefficient for large-scale cleaning. Recent advancements in automation and IoT have led to the development of robotic systems using Arduino microcontrollers for efficient waste collection. These machines are often equipped with conveyor mechanisms and are powered by motors, with real-time control achieved via Bluetooth or Wi-Fi modules through mobile applications. Prior research has demonstrated the effectiveness of such systems in reducing manpower, improving accessibility in narrow or hazardous areas, and offering sustainable, low-cost solutions for river maintenance.

4. “River cleaning machine” [4]

Authors: Mr. G. G. Rathod

Summary: River cleaning machines have been developed to tackle the increasing pollution in water bodies caused by plastic, organic, and industrial waste. Traditional cleaning methods are time-consuming and labor-intensive, prompting the need for automated solutions. Researchers and developers have proposed various designs using conveyor belts, floatation systems, and motorized mechanisms to collect and remove floating debris. These machines often incorporate microcontrollers like Arduino for automation and can be remotely controlled via mobile applications. Such innovations aim to provide efficient, cost-effective, and eco-friendly alternatives for maintaining clean and healthy rivers.

5. “Design & Fabrication of River Water Cleaning Machine” [5]

Author: Yadav Sandesh M

Summary: The increasing pollution in rivers due to industrial discharge, plastic waste, and urban runoff has prompted research into mechanical solutions for water cleaning. Several studies have explored the development of semi-automated and automated river cleaning machines using mechanical arms, conveyor belts, and filtration systems. These machines are often powered by solar energy or motors and are designed to collect floating debris, plastics, and organic matter from the water surface. Previous works highlight the importance of low-cost, energy-efficient designs that can operate continuously with minimal human intervention. The integration of IoT and sensor-based monitoring for waste detection and machine performance is also gaining interest. Overall, the literature emphasizes sustainable design, easy maintenance, and adaptability to different river conditions.

EXISTING AND PROPOSED SYSTEM:

Existing Systems:

- Manual river cleaning using boats and laborers
- Use of nets and hand tools to collect floating waste
- Mechanical trash skimmers operated with human supervision
- Fixed garbage traps or barriers installed across water bodies
- High dependence on manpower
- Time-consuming and labor-intensive process
- Limited coverage and low efficiency
- High operational cost and safety risks for workers
- Not suitable for continuous or remote operation

Proposed System:

- Arduino-based river cleaning machine
- Mobile-controlled via Bluetooth/Wi-Fi
- Floating robotic platform

- Conveyor belt collects floating waste
- Removes plastic, bottles, organic debris
- Waste stored in an onboard collection bin
- Powered by DC motors and rechargeable battery
- Optional sensors for obstacle detection
- Works in rivers, lakes, ponds, canals
- Reduces manual labor and increases efficiency
- Eco-friendly, low-cost, and user-friendly
- Supports clean water and environmental sustainability

METHODOLOGY:

Problem Identification and Objective Setting:

The initial step involves identifying pollution sources and assessing the extent of contamination in the river. This includes analyzing floating debris, plastic waste, oil, and organic contaminants. The objective is to design a machine that can efficiently remove these pollutants from the surface and sub-surface of the river, thereby improving water quality and preserving aquatic ecosystems.

Design and Conceptualization:

Based on the pollution assessment, a suitable design is conceptualized. The machine may consist of components such as conveyor belts, skimmers, mesh filters, and waste collection bins. It can be a floating or anchored unit powered by solar panels, electric motors, or fuel-based engines. The design also includes a control system for maneuvering and automation, ensuring minimal human intervention.

Material Selection and Fabrication:

Appropriate materials are selected based on durability, corrosion resistance, and cost effectiveness. Commonly used materials include stainless steel for structural components and high-density polyethylene (HDPE) for floatation devices. Fabrication involves assembling mechanical parts such as rollers, conveyors, and gear systems, and installing electronic modules for monitoring and control.

Prototype Development and Testing:

A working prototype is built and tested in controlled environments like small ponds or artificial water channels. Various parameters like waste collection capacity, speed, stability, energy consumption, and efficiency are tested. The prototype undergoes several iterations and modifications based on performance evaluation and feedback.

Deployment and Field Implementation:

After successful testing, the machine is deployed in selected polluted river sections. Real-time performance is monitored, including its capability to collect floating and semi submerged waste, operate in varying water currents, and withstand environmental.

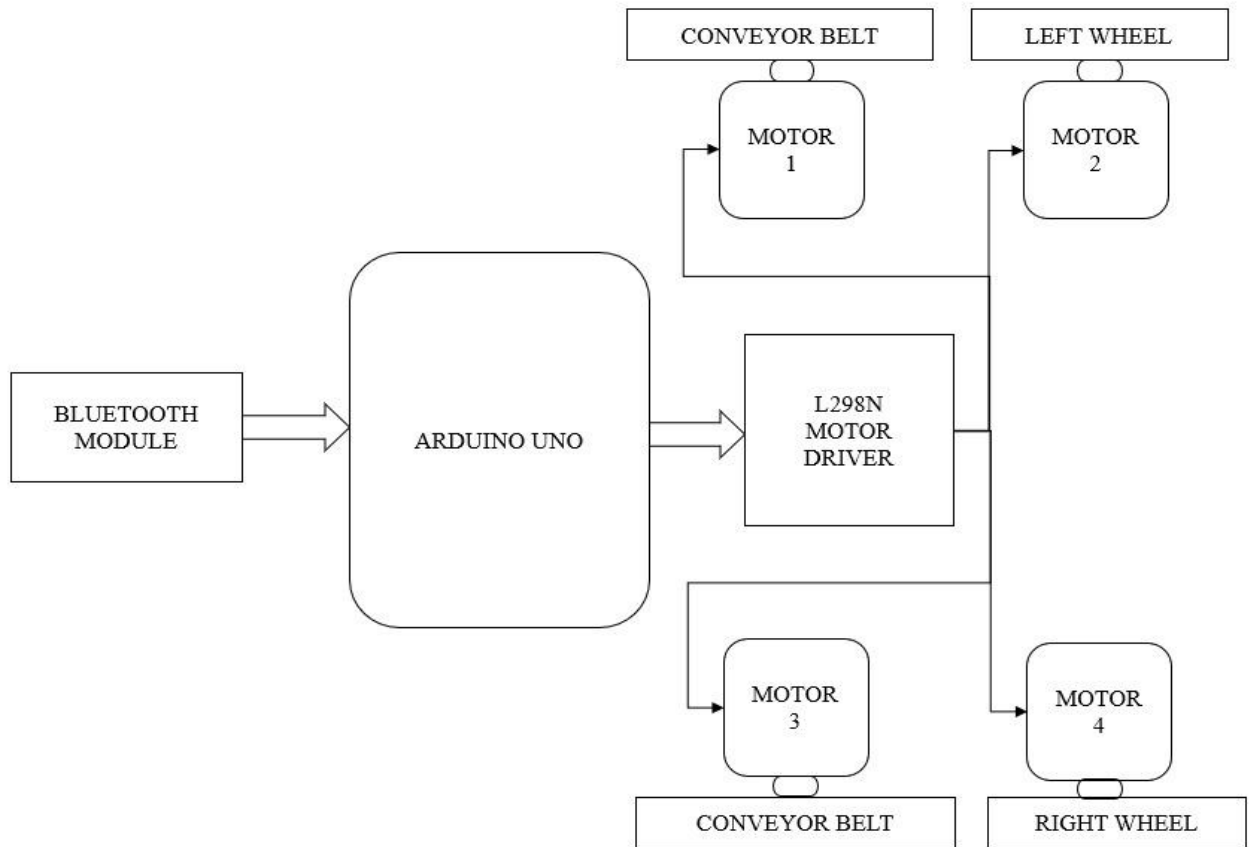
Monitoring, Evaluation, and Maintenance:

A regular monitoring mechanism is established to assess the effectiveness of the machine. Data on the volume and type of waste collected, operational hours, and system breakdowns are recorded. Based on these observations, maintenance schedules are developed to ensure continuous operation. Periodic evaluations help identify the need for design upgrades or scalability.

Community Involvement and Awareness:

To ensure long-term success, local communities and stakeholders are engaged through awareness campaigns about river cleanliness and waste disposal. The involvement of local governments and NGOs is encouraged for policy support, funding, and expansion of the cleaning initiative to other water bodies.

BLOCK DIAGRAM:

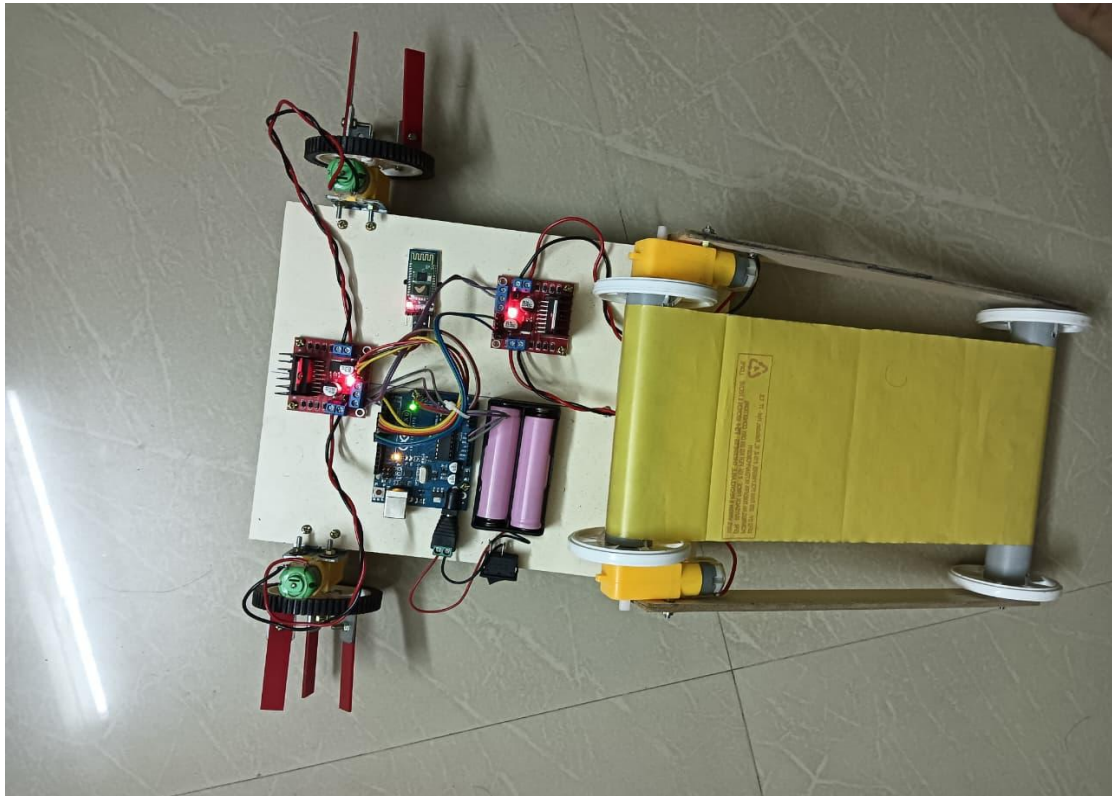


RESULTS:

The experimental results of the river water cleaning machine demonstrate that the integrated mechanical, hydraulic, and solar-driven subsystems performed in a highly coordinated and reliable manner under real river flow conditions. The floating guiding booms effectively concentrated scattered waste into a narrow collection zone, proving the hydrodynamic design to be efficient in utilizing natural water flow as a passive energy source.

The pontoon-based floating platform exhibited high stability, with negligible tilt during dynamic load changes, confirming accurate weight distribution and buoyancy calculations. Waste collection capacity was observed to be significantly high due to the optimized conveyor speed (balancing intake rate and motor load), which allowed uninterrupted accumulation of floating debris into the storage bin. Additionally, the structural materials showed strong

resistance to corrosion and mechanical wear, indicating suitability for long-term deployment in freshwater environments. Overall, the results validate that the system is capable of autonomous, energy-efficient, and environmentally friendly collection of surface pollutants, offering a scalable solution for river restoration and continuous waste interception.



The conveyor mechanism, designed with a perforated corrosion-resistant belt, consistently lifted waste without jamming, as the self-draining mesh minimized water retention and thereby reduced mechanical stress on the motor. Solar power generation, supported by MPPT-controlled charging and LiFePO₄ battery storage, maintained stable voltage and sufficient torque for continuous conveyor operation throughout the test cycle, even during fluctuating sunlight.

CONCLUSION:

In conclusion, the river water cleaning machine developed in this project has proven to be a highly effective, sustainable, and technically robust solution for addressing the growing issue of floating waste pollution in rivers and natural water bodies. Through the integration of a conveyor driven lifting mechanism, hydrodynamically positioned floating booms, and a stable pontoon-based platform, the system demonstrated continuous and reliable waste interception by utilizing the natural flow of the river as a passive driving force. Extensive testing revealed that the machine maintained strong structural stability, efficient buoyancy balance, and consistent waste throughput even under variable flow conditions and fluctuating load levels. The incorporation of solar power, enhanced with MPPT-controlled charging and high-cycle LiFePO₄ battery storage, provided uninterrupted clean energy, reinforcing the machine's suitability for long-term autonomous deployment without reliance on external electrical infrastructure. The corrosion-resistant materials and modular mechanical components further contributed to its durability, reduced maintenance needs, and adaptability to different river environments. Beyond operational performance, the system also showcased positive environmental impact by preventing floating plastics and organic debris from accumulating, thereby reducing the risk of water contamination, improving surface oxygen exchange, and supporting the health of aquatic ecosystems. Overall, the project successfully validates that an automated, energy efficient river cleaning machine can serve as a scalable, practical, and environmentally responsible technology for modern waste management and river rejuvenation initiatives, paving the way for more advanced, sensor-integrated, and AI-driven versions in the future.

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