IJARSCT

International Journal of Advanced Research in Science, Communication and Technology

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

ISSN: 2581-9429

Volume 5, Issue 6, June 2025

Impact Factor: 7.67

Remote Controlled River Surface Cleaning Robot

Sakshi Vijay Awari[1], Sudarshan Vijay Pulate[2], Saurabh Dattu Gadakh[3], Prof. Bhoir. N. V.[4]

[1,2,3,4]Department of E&TC Engineering

Vidyaniketan College of Engineering, Bota, A.Nagar, MH

Abstract: *With the rapid increase in water pollution due to urbanization and industrial activities, maintaining the cleanliness of rivers and other water bodies has become a critical environmental challenge. Traditional manual cleaning methods are labor-intensive, inefficient, and often hazardous for workers. This paper presents the design and development of a remote-controlled river surface cleaning robot aimed at providing an effective, safe, and cost-efficient solution for the removal of floating debris. The system utilizes an ESP32 Wi-Fi microcontroller for wireless control, interfaced with motor drivers to manage propulsion and conveyor belt operations, while a 12V Li-ion battery powers the entire system. The robot's debris collection mechanism consists of a conveyor belt that efficiently gathers floating waste into a storage bin as the robot navigates the water surface. Users can control and monitor the robot's operations in real-time through a mobile application using Wi-Fi communication, offering flexibility and safety during deployment. The proposed system not only enhances operational efficiency but also aligns with global sustainability goals by contributing to environmental conservation and reducing the flow of pollutants into larger marine ecosystems. Extensive testing validates the robot's functionality under various operational conditions, demonstrating its potential as a scalable solution for water pollution management.*

Keywords: River cleaning robot, water pollution, ESP32, remote control, debris collection

I. INTRODUCTION

Water bodies such as rivers, lakes, and canals play a crucial role in sustaining life, supporting ecosystems, and providing resources for human consumption, agriculture, transportation, and recreational activities. However, with the rapid pace of industrialization, urbanization, and population growth, these water bodies are increasingly subjected to various forms of pollution. One of the most visible and harmful forms of pollution is the accumulation of floating debris, including plastics, food wrappers, bottles, aquatic weeds, and other waste materials. If not addressed in a timely manner, this pollution can have severe consequences on aquatic ecosystems, biodiversity, public health, and the economy.

The accumulation of waste on water surfaces obstructs sunlight penetration, leading to reduced photosynthetic activity of aquatic plants and disruption of the food chain. Moreover, toxic substances leaching from plastics and other pollutants can poison aquatic species and lead to bioaccumulation of harmful chemicals up the food chain, ultimately affecting human health. Floating waste also provides a breeding ground for disease-causing pathogens, increasing the risk of waterborne diseases among populations dependent on these water bodies for drinking, bathing, or recreational purposes. Thus, addressing floating debris pollution is not only an environmental necessity but also a public health imperative.

Conventional methods of cleaning water surfaces generally involve manual labor or the use of large, specialized vessels, which are often expensive, labor-intensive, time-consuming, and dangerous for workers. Manual collection exposes workers to hazardous environmental conditions, including contaminated water and sharp or toxic waste materials. Furthermore, these traditional approaches are limited in scalability and cannot be deployed easily across a wide range of water bodies, especially in narrow canals, urban rivers, or remote areas. Hence, there is an urgent need for a safer, cost-effective, and more efficient alternative that can operate with minimal human intervention.

Recent advancements in robotics, automation, wireless communication, and Internet of Things (IoT) technologies offer a promising solution to this challenge. Autonomous or remotely controlled robots can significantly reduce the risks

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 6, June 2025
Impact Factor: 7.67

associated with manual labor while providing continuous and efficient surface cleaning operations. By integrating microcontrollers, motor drivers, Wi-Fi communication modules, and mobile applications, it is now feasible to develop compact, affordable, and highly functional robotic systems capable of addressing water surface pollution.

In this work, a remote-controlled river surface cleaning robot has been developed, utilizing an ESP32 Wi-Fi microcontroller as the core control unit. The robot features a propulsion system driven by geared DC motors for navigation, and a conveyor belt mechanism for continuous debris collection. The entire system is powered by a 12V Li-ion battery, with a voltage regulation circuit ensuring stable power delivery to sensitive components. Users interact with the robot via a mobile application using Wi-Fi communication, allowing real-time control and monitoring from a safe distance. This configuration not only enhances operational efficiency but also ensures user safety by eliminating direct human exposure to hazardous water conditions.

The robot's compact design allows it to be deployed in a variety of water bodies, from urban rivers and lakes to industrial canals and reservoirs. Its ability to collect and store floating waste continuously makes it highly suitable for both scheduled cleaning operations and emergency response situations, such as post-flood debris management. The system has been tested under various conditions to evaluate its performance, stability, and efficiency in collecting floating waste materials.

PROBLEM STATEMENT

The increasing accumulation of floating waste in rivers poses significant threats to aquatic ecosystems, public health, and water quality. Traditional manual cleaning methods are inefficient, labor-intensive, and hazardous, highlighting the urgent need for an automated, safe, and cost-effective solution for continuous surface cleaning.

OBJECTIVES OF THE STUDY

- To design and develop a remote-controlled robot for cleaning floating debris from river surfaces.
- To integrate a conveyor belt mechanism for efficient collection and storage of waste.
- To utilize ESP32 microcontroller and Wi-Fi communication for remote operation via mobile application.
- To ensure safe, cost-effective, and continuous cleaning operations with minimal human intervention.
- To contribute towards environmental conservation and support sustainable water pollution management.

II. LITERATURE SURVEY

1. Vidhya Sagar N., Yogesh S. V., Vishwa S., Dr. Binu D. (2021). "River Surface Monitoring and Cleaning Robot."

This paper presents a stationary autonomous river surface cleaning robot powered by solar energy. It is designed to collect plastic waste from rivers before it reaches the ocean. The system uses a conveyor belt to pick up floating debris, and sensors are integrated for real-time monitoring of water quality. One limitation of this system is that it is stationary, and its effectiveness is dependent on the flow of the river and the strategic placement of the robot. The paper does not address how the robot would handle varying debris loads or operate in different water conditions.

2. Aman George Sebastian, Madhav Devnarayan, Bachu James, Abhishek Thomas (2024). "Water Surface Cleaning Robot."

This paper introduces a water surface cleaning robot designed to clean rivers and water bodies autonomously using a conveyor belt mechanism. The robot collects floating waste and conveys it into a storage compartment using the belt. The project emphasizes autonomous operation and real-time visuals via a camera for waste detection. However, the study focuses more on design and early-stage development, and lacks in-depth analysis of performance or real-world testing under different environmental conditions. Additionally, the paper highlights a future vision for handling large-scale debris but does not offer concrete solutions for certain challenges like underwater waste collection.

3. Kshitija A. Ingle, Akash G. Bhatkar, Rahul S. Tarmale, Tejashri D. Ingle, Mohan S. Bawaskar, Mangesh J. Nemade (2020). "River Cleaning Robot Using Solar Power."

This paper proposes a solar-powered river cleaning robot designed to collect floating waste using a conveyor belt. The robot uses DC motors and is controlled via Bluetooth. The conveyor collects waste and transfers it into a bin for

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 6, June 2025
Impact Factor: 7.67

disposal. The focus on solar energy provides a sustainable energy source for long-term operation. However, the design lacks in terms of addressing scalability and the ability to handle different types of waste across varying water conditions. The paper suggests the need for further modifications for larger water bodies and deeper rivers.

III. PROPOSED SYSTEM

The proposed system is a remote-controlled river surface cleaning robot designed to collect floating debris efficiently from water bodies such as rivers, lakes, and canals. The system integrates mechanical, electrical, and communication subsystems to achieve autonomous cleaning with minimal human intervention.

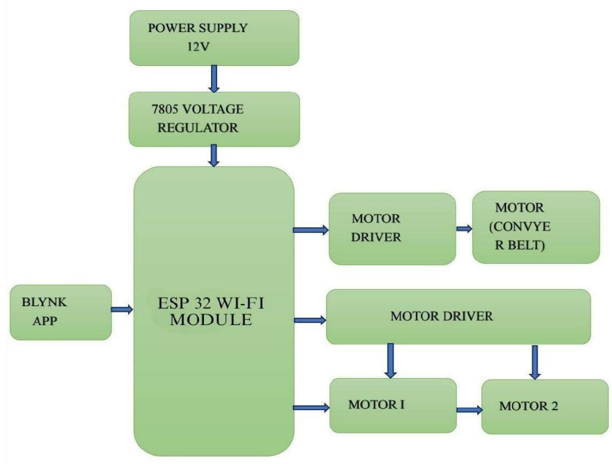

Fig. 1 System Architecture

The core of the system is built around the ESP32 microcontroller, which manages all operations including navigation, waste collection, motor control, and wireless communication. The ESP32 is chosen for its low power consumption, built-in Wi-Fi capabilities, and ease of integration with IoT platforms such as the Blynk App. Through the mobile application, users can remotely control the robot's movement and monitor its operational status in real-time.

For mobility, the robot utilizes two geared DC motors controlled via the L298N motor driver module. These motors enable forward, backward, and turning movements, allowing the robot to navigate efficiently across the water surface. Pulse Width Modulation (PWM) signals from the ESP32 are used to regulate the speed of the motors, providing smooth and precise control during operation.

The debris collection mechanism consists of a conveyor belt system driven by an additional geared DC motor, also controlled by a separate L298N motor driver. As the robot moves, the conveyor belt continuously scoops floating debris and transfers it into an onboard collection bin. This continuous operation allows the robot to clean larger areas of the water surface without frequent interruptions for manual waste removal.

The entire system is powered by a 12V Lithium-Ion battery, providing sufficient power for extended operations. A 7805 voltage regulator is used to step down the 12V supply to 5V for powering the ESP32 and other low-voltage components, ensuring safe and stable operation of the electronics.

Communication between the robot and the user is facilitated through Wi-Fi, with the ESP32 connecting to the mobile device via the Blynk platform. This enables the operator to issue real-time commands, control the robot's movement, and activate or deactivate the conveyor belt remotely. The wireless interface also allows monitoring of essential system parameters, such as battery voltage and operational status.

The robot is designed to be compact, lightweight, and highly maneuverable, making it suitable for a wide range of water bodies, including narrow rivers and urban drainage systems where large cleaning vessels may not be practical. Its modular design also allows for easy maintenance, upgrades, and scalability for future improvements.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 5, Issue 6, June 2025
Impact Factor: 7.67

By combining modern IoT technology with mechanical cleaning systems, the proposed river surface cleaning robot offers a reliable, efficient, and environmentally friendly solution to the growing problem of floating water pollution.

Hardware Used:

- **ESP32 Wi-Fi Module:** Acts as the central controller for processing and wireless communication.
- **L298N Motor Driver:** Controls the speed and direction of DC motors.
- **Geared DC Motors:** Provide movement for the robot and drive the conveyor belt for debris collection.
- **Conveyor Belt System:** Collects floating waste and transfers it into the storage bin.
- **7805 Voltage Regulator:** Converts 12V input to 5V for powering low-voltage components.
- **12V Li-ion Battery:** Supplies power to the entire system for continuous operation.
- **Chassis and Floating Frame:** Physical structure that ensures stability and buoyancy on water.

Software Used:

- **Arduino IDE:** Used for programming the ESP32 microcontroller.
- **Blynk App:** Mobile application for remote control and real-time monitoring via Wi-Fi.
- **Embedded C/C++:** Programming language used to write the control algorithms.
- **Serial Monitor:** Used for debugging and monitoring sensor outputs during development.

IV. RESULTS & ANALYSIS

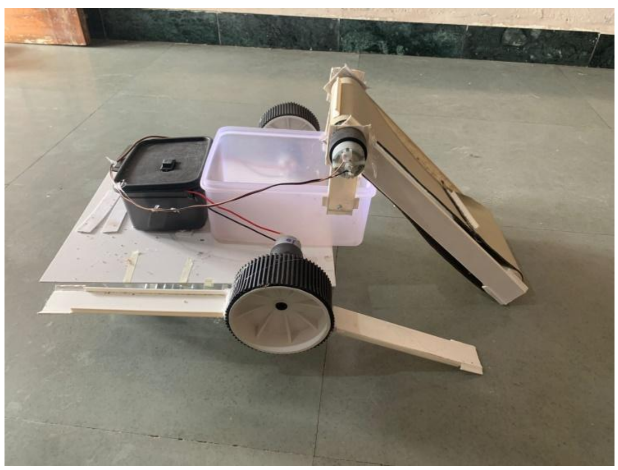

Fig. 2 Hardware Implementation

The proposed river surface cleaning robot was tested under various operational conditions to evaluate its performance, efficiency, and reliability. The system successfully demonstrated stable navigation, effective debris collection, and smooth remote-control operation via the Wi-Fi-based mobile application.

During the initial controlled environment tests, the robot exhibited smooth forward, backward, and turning movements, with the propulsion motors responding accurately to the commands issued through the mobile app. The conveyor belt mechanism operated continuously without jamming, successfully collecting floating debris such as plastic bottles, leaves, and lightweight floating waste into the onboard storage compartment.

Field testing was conducted in a local water body with moderate amounts of floating waste. The robot was able to navigate steadily despite minor water currents and successfully collected a significant volume of waste within a short time frame. The system maintained good stability and did not tip over during directional changes or collection activities, confirming the balanced design of the chassis and conveyor assembly.

IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429 Volume 5, Issue 6, June 2025 Impact Factor: 7.67

Power consumption was monitored during the tests. The 12V Li-ion battery provided sufficient operating time, averaging 2 to 3 hours of continuous operation before requiring recharging. The 7805 voltage regulator effectively maintained stable voltage levels for the ESP32 and motor drivers, preventing any power-related failures or overheating.
The Wi-Fi communication between the ESP32 and Blynk App remained stable throughout the testing, with minimal latency in command execution. Users were able to control the robot in real-time, and the app interface displayed accurate operational status and battery information.
Overall, the experimental results validate that the proposed system is capable of performing efficient and reliable water surface cleaning operations. The robot demonstrates practical usability for environmental clean-up efforts, offering a safer, more efficient, and scalable solution compared to traditional manual methods.

V. CONCLUSION

In this paper, a remote-controlled river surface cleaning robot has been successfully designed, developed, and tested to address the growing issue of floating water pollution. By integrating an ESP32 microcontroller, Wi-Fi-based remote control, geared DC motors, motor drivers, and a conveyor belt mechanism, the system efficiently collects floating debris while ensuring safe and user-friendly operation. The testing results confirm the robot's stability, reliability, and effectiveness in cleaning water surfaces under varying conditions. This solution offers a cost-effective, scalable, and environmentally friendly alternative to traditional manual cleaning methods, contributing towards improved water quality and supporting global sustainability efforts.

REFERENCES

[1] R. K. Singh, S. Sharma, and A. Kumar, "Design and development of a river cleaning robot," International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, vol. 8, no. 5, pp. 2245–2252, May 2019.
[2] M. Chen et al., "The role of IoT in environmental monitoring and management," IEEE Access, vol. 7, pp. 76627–76647, 2019.
[3] A. Patel and D. Mehta, "IoT based water surface cleaning robot," International Journal of Innovative Research in Science, Engineering and Technology, vol. 9, no. 6, pp. 4562–4567, June 2020.
[4] P. R. Bhatt and S. B. Naik, "Automation of water cleaning system using robotic technology," International Journal of Research in Engineering, Science and Management, vol. 3, no. 4, pp. 37–40, Apr. 2020.
[5] M. Tanaka, K. Saito, and H. Nakajima, "Development of floating waste collection robots for aquatic environments," Journal of Robotics and Mechatronics, vol. 31, no. 2, pp. 215–222, Apr. 2019.
[6] S. R. Yadav and A. M. Pathan, "Smart river cleaning system using IoT," International Journal of Computer Applications, vol. 182, no. 12, pp. 21–25, Sept. 2018.
[7] S. S. Kumar and G. Subramanian, "Autonomous water cleaning robot using solar power," International Journal of Engineering Research & Technology, vol. 6, no. 2, pp. 512–516, Feb. 2017.
[8] A. Verma, S. Tiwari, and P. K. Jain, "IoT based automated water cleaning robot," International Journal of Computer Sciences and Engineering, vol. 6, no. 10, pp. 546–552, Oct. 2018.
[9] S. L. Smith, "Plastic pollution in rivers and lakes: An overview," Environmental Science & Technology, vol. 52, no. 7, pp. 3763–3771, 2018.
[10] H. Zhou et al., "Floating waste detection and removal system for rivers using machine vision," IEEE Transactions on Automation Science and Engineering, vol. 17, no. 3, pp. 1490–1500, July 2020.
[11] J. Brown, "ESP32 microcontroller applications for wireless control systems," Journal of Embedded Systems, vol. 5, no. 1, pp. 15–22, Jan. 2020.
[12] A. Gupta et al., "Design of an autonomous robot for cleaning water surfaces," International Conference on Robotics and Automation (ICRA), pp. 6124–6129, 2019.
[13] United Nations Environment Programme (UNEP), "Marine Plastic Debris and Microplastics: Global Lessons and Research to Inspire Action and Guide Policy Change," United Nations, 2016.
[14] B. V. Patel and R. K. Sharma, "Design and simulation of L298N motor driver for robotic applications," International Journal of Control and Automation, vol. 12, no. 3, pp. 87–94, 2019.

[15] M. R. Islam, "Application of renewable energy in autonomous water cleaning robots," Renewable Energy Journal, vol. 78, pp. 85–90, 2019.

[16] K. L. Chawla, "Design and development of IoT-based remote controlled garbage collector for rivers," Journal of Water Resource and Protection, vol. 12, no. 2, pp. 112–120, 2020.

[17] P. Sharma and V. R. Joshi, "Low-cost IoT-based water surface cleaning system," International Journal of Electronics and Communication Engineering, vol. 10, no. 5, pp. 25–30, 2021.

[18] A. A. Khan and R. Yadav, "Real-time monitoring of water pollution using IoT," International Journal of Computer Applications, vol. 180, no. 40, pp. 1–5, Mar. 2018.

[19] S. K. Dey and M. S. Islam, "Wireless control of robots using Blynk platform," International Journal of Engineering Trends and Technology (IJETT), vol. 65, no. 3, pp. 123–127, 2018.

[20] V. Singh et al., "Microcontroller-based automated cleaning system for polluted water bodies," International Journal of Scientific & Engineering Research, vol. 9, no. 9, pp. 1143–1147, Sept. 2018.

[21] M. E. Ali and J. J. Martin, "Environmental robotics: The future of water body cleaning systems," Journal of Environmental Engineering, vol. 145, no. 2, pp. 04018098, 2019