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REMOTE CONTROLLED WATER SURFACE CLEANING ROBOT

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ABSTRACT

This project presents the design and development of a Remote Controlled Water Surface Cleaning Robot aimed at reducing water pollution caused by floating debris. The system is built using an ESP32 microcontroller and controlled through the Blynk mobile application, offering wireless operation. A conveyor belt mechanism driven by gear motors is used to collect waste materials from the water's surface. Powered by a rechargeable battery pack, the robot operates efficiently without dependence on solar power. The lightweight and modular design make it suitable for use in lakes, ponds, and small reservoirs. The system showcases the potential for affordable, scalable water body maintenance, particularly in urban and semi-urban environments.

INDEX TERMS—*ESP32, Water Surface Cleaning, Remote Con- trolled Robot, Blynk App, Environmental Robotics, Gear Motor, Waste Collection*

I. INTRODUCTION

Water pollution is a significant environmental issue affecting ecosystems, human health, and the global economy. Among the various forms of water contamination, surface-level pollu- tion caused by floating debris such as plastic bottles, leaves, packaging waste, and other non-biodegradable materials is particularly challenging to manage. Traditional cleaning methods involve manual labor or large-scale machinery, both of which are inefficient, expensive, and often impractical in small or remote water bodies like lakes, ponds, or canals.

Recent advancements in embedded systems and wireless communication have paved the way for cost-effective and intelligent solutions to environmental problems. This project introduces a Remote Controlled Water Surface Cleaning Robot, a robotic system designed to collect floating waste from water bodies in a controlled and efficient manner. The robot operates using a mobile-based interface powered by the Blynk IoT platform and is driven by an ESP32 microcontroller. It employs gear motors to control both the movement of the robot and its conveyor belt mechanism, which is responsible for collecting waste and depositing it into a storage bin.

Unlike solar-powered or autonomous systems, which may have limitations due to weather conditions or complex pro- gramming requirements, our robot offers a user-friendly and reliable alternative through real-time remote control. Powered by a rechargeable battery, the robot can be deployed quickly and navigated precisely in the target area, offering flexibility in operation.

The main objectives of the project are:

- To design a low-cost, mobile-controlled robot capable of cleaning floating waste from water surfaces.
- To integrate IoT-based control for real-time operation and improved user interaction.
- To develop a modular and scalable platform that can be further enhanced with additional features like sensors or
- automation in future iterations.

This paper discusses the mechanical and electronic design of the system, the wireless control mechanism via the Blynk application, and the results obtained during initial testing. The project serves as a step forward in using embedded systems for environmental conservation and smart city applications

II. LITERATURE SURVEY

The need for clean and pollution-free water bodies has driven researchers and engineers to explore various technolog- ical interventions aimed at surface waste collection. Floating debris on water—ranging from plastics, leaves, and wrappers to chemical residues—poses a serious threat to aquatic life and human health. Manual cleaning methods, although still in practice, are inefficient, labor-intensive, and limited in scope, especially in areas that are difficult to access. As a result, multiple robotic and automated solutions have been developed in recent years to tackle this issue more effectively.

Several early designs focused on manual or semi-automatic systems. In one such study by D. Patel et al. [1], a manually operated water cleaning mechanism was developed using a mesh roller that collected floating waste from the surface.

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While the concept was functional, the system required hu- man intervention throughout the cleaning process, making it inefficient for large-scale or long-duration applications.

Other researchers have turned to solar-powered autonomous systems. A project titled ”Solar Aquatic Surface Cleaner” by Sharma et al. [2] integrated solar panels with an Arduino- based navigation system to create a fully autonomous cleaning boat. Although environmentally sustainable, its efficiency was directly affected by weather conditions and the position of the sun. Moreover, the absence of real-time control made it unsuitable for targeted or time-sensitive operations.

To overcome such limitations, recent advancements have explored the use of IoT-based and wireless communication technologies. The emergence of ESP32 microcontrollers and platforms like Blynk has enabled low-cost, real-time control over robotic systems. Research by A. Khan et al. [3] demon- strated the use of Wi-Fi-enabled microcontrollers to operate a land-based robot via a smartphone app, showcasing how user- friendly interfaces can empower non-technical operators to manage complex systems. However, their work was limited to dry-land robots, leaving the potential for aquatic applications unexplored.

In addition, conveyor belt-based waste collection systems have proven highly effective in capturing floating debris. A study conducted by R. Singh et al. [4] detailed a mechanical conveyor setup for water skimming operations. Their prototype demonstrated high collection efficiency but lacked remote control capabilities and flexibility in maneuverability.

The proposed system in this project combines several of these elements—real-time wireless control, a robust conveyor mechanism, battery-powered mobility, and IoT integration—to form a comprehensive solution for water surface cleaning. Unlike solar-dependent or fully autonomous bots, this robot prioritizes manual control via the Blynk app, enabling preci- sion navigation and waste collection even in constrained or unpredictable environments.

The novelty of this system lies in its simplicity, affordability, and remote operability, which make it particularly suitable for urban lakes, parks, canals, and community water reservoirs. Additionally, the modular structure of the robot allows future enhancements, such as integrating sensors for water quality analysis, GPS tracking, or even partial automation using ultrasonic or infrared obstacle detection modules.

Thus, this project builds upon existing technologies, ad- dresses the limitations of previous solutions, and contributes to the growing field of environmental robotics focused on real- world deployment and usability.

III. METHODOLOGY

The core of the system includes:

- ESP32 microcontroller for wireless connectivity and con- trol
- Gear motors to drive the robot and the conveyor mecha- nism
- Motor driver module to interface motors with ESP32
- Battery pack for power supply
- Blynk mobile application to control robot movement

The robot floats on a custom-designed chassis equipped with paddle-like wheels for propulsion. The conveyor belt mounted at the front scoops waste off the water’s surface and stores it in a collection tray. The entire system is enclosed in a water- resistant casing to ensure durability during operation.

IV. BLOCK DIAGRAM

Fig. 1: Block Diagram of the Remote Controlled Water Surface Cleaning Robot

The block diagram, as shown in Fig. 1, provides a compre- hensive overview of the functional architecture of the Remote Controlled Water Surface Cleaning Robot. The system begins with a 12V power supply, which is regulated using a 7805 volt- age regulator to provide a stable 5V output necessary for the ESP8266 Wi-Fi module and other low-voltage components.

At the heart of the system is the **ESP8266 Wi-Fi mod- ule**, which acts as the main controller and communication interface. It connects to the **Blynk mobile application** via Wi-Fi, enabling real-time remote control of the robot from any smartphone or compatible device. This wireless interface allows users to control both the movement of the robot and the operation of the cleaning mechanism.

Two motor drivers are connected to the ESP8266:

- The first motor driver controls a single DC motor con- nected to the conveyor belt, which is responsible for collecting floating waste from the surface of the water and depositing it into the collection tray.
- The second motor driver manages two additional DC motors that control the movement of the robot (forward, backward, left, and right).

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This separation of control logic ensures smooth operation and avoids overloading any single motor driver. The robot's maneuverability enables it to be directed toward areas with visible waste, while the conveyor mechanism efficiently gath- ers debris without requiring human intervention.

The modular nature of this design allows for easy upgrades in the future, such as integrating sensors for water quality monitoring or obstacle detection using ultrasonic or infrared modules. Furthermore, using the Blynk platform ensures a user-friendly interface, making the system suitable for non- technical users in environmental monitoring, municipal clean- ing, or educational applications.

This block diagram showcases a well-balanced system of mechanical and electronic components working in tandem to achieve effective and efficient water surface cleaning.

V. FLOW DIAGRAM

The flow diagram in Fig. 2 outlines the operational logic of the Mobile Controlled River Cleaning Robot. The process begins with the initialization of the I/O ports in the micro- controller. Once initialized, the system enters a loop where it continuously waits for control input from the user via a smartphone interface.
Upon receiving input signals, the robot checks whether the received command is related to the task of debris collection. If no relevant command is detected, the system remains in the monitoring loop. When a command to pick up debris is received, the robot activates its mechanical mechanism to collect floating waste and deposit it into the onboard trash bin. After executing the task, the system verifies whether any new task has been assigned. If yes, the loop repeats and the system awaits new instructions. If not, the system safely halts operations.

This logic ensures continuous and efficient task handling while reducing unnecessary movement or operation. The use of mobile-based commands provides real-time control, making the robot highly interactive and responsive to dynamic envi- ronments in water bodies like rivers or lakes.

VI. CIRCUIT DIAGRAM

The circuit diagram in Fig. 3 presents the electrical wiring of the Remote Controlled Water Surface Cleaning Robot. At the core of the design is the **ESP32-WROOM** microcontroller, which serves as the main processing and communication unit.

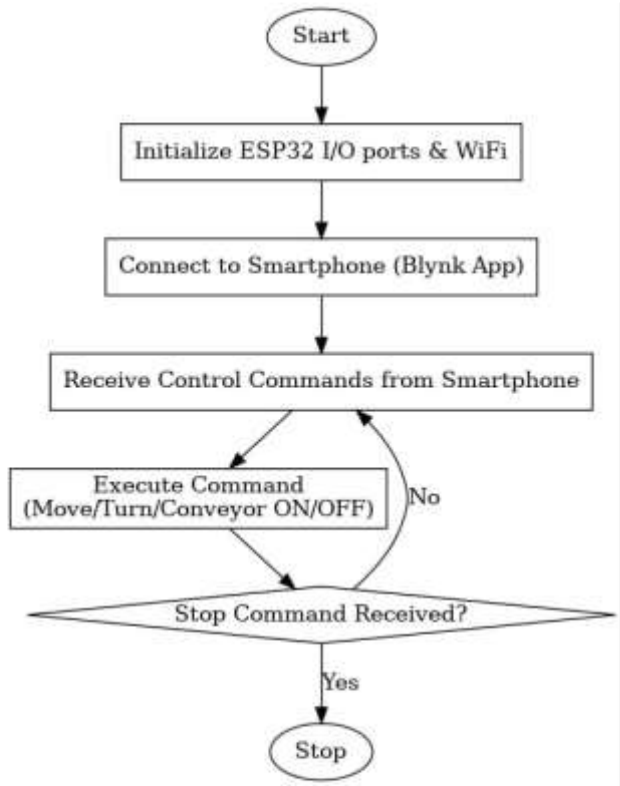

Fig. 2: Flow Diagram of the Mobile Controlled River Cleaning Robot

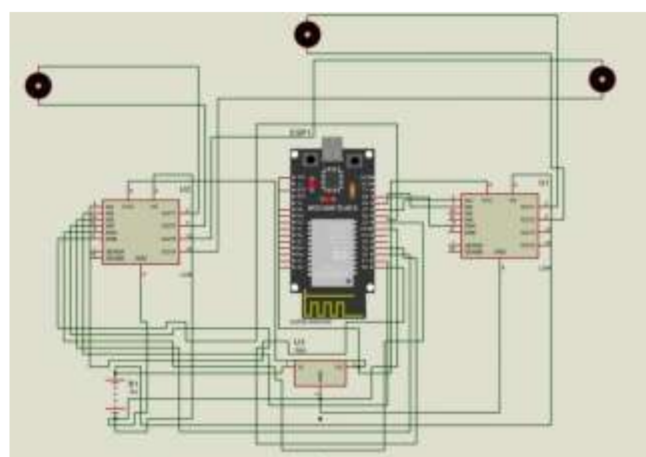

Fig. 3: Circuit Diagram of the Remote Controlled Water Surface Cleaning Robot

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This module is responsible for interpreting control signals from the Blynk application and directing the robot's move- ments and cleaning mechanism accordingly.

A **12V battery** (B1) supplies power to the entire system. The voltage is regulated using a **7805 voltage regulator** (U3), which provides a consistent 5V power supply suitable for the ESP32 and other components.

Two **L298N motor driver modules** (U1 and U2) are used to control multiple DC motors. Each L298N can handle two motors, providing bidirectional control. One motor driver operates the drive motors responsible for robot movement, while the other controls the conveyor belt mechanism for collecting surface debris.

The wiring connections include enable pins (ENA and ENB) to activate the H-Bridge in the motor drivers, input pins (IN1–IN4) to control direction, and power connections (VCC and VS) to energize the motors. The ESP32 GPIO pins are interfaced with these control lines to manage direction and speed via PWM signals.

This hardware setup ensures reliable communication and smooth operation of all motors, allowing real-time wireless control and effective execution of cleaning tasks. The design is compact, scalable, and easily modifiable for future upgrades like sensors or additional automation.

VII. Figures and Tables

TABLE I: Sample Command Log (Blynk App Control)

Timestamp	Command	Action Taken
10:00	Forward	Robot moved forward
10:01	Conveyor ON	Waste collection began
10:02	Stop	Robot halted
10:03	Reverse	Robot reversed motion

VIII. Conclusion

The Remote Controlled Water Surface Cleaning Robot is a compact and efficient solution for collecting floating waste from water bodies. It demonstrates how embedded systems, IoT platforms, and basic mechanical design can be combined to solve real-world environmental issues. The robot offers scal- ability, ease of use, and remote operability, making it suitable for both public and private water maintenance applications.

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