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Mobile-Controlled River Cleaning Boat

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Abstract - Water pollution is a major environmental challenge, with floating waste in rivers and lakes contributing to ecological degradation. Our project, a WiFi-Controlled River Cleaning Boat, aims to provide an efficient and cost-effective solution for manual waste collection from water bodies. Unlike automated systems, our boat operates under direct human control, ensuring adaptability to different cleaning requirements.

The system is powered by an ESP8266 WiFi module, enabling wireless control through a mobile application. A L298N motor driver facilitates the movement of the boat, allowing precise maneuvering in water. The boat's structure is designed for stability and ease of operation, incorporating a mechanical collection system to gather floating waste efficiently.

By eliminating the need for Arduino and sensors, our design reduces complexity and cost while ensuring robust performance. The WiFi-based control system allows operators to guide the boat remotely, making it an accessible and effective tool for river cleaning. This project offers a practical, scalable, and environmentally friendly approach to maintaining clean water bodies.

***Key Words*:** IoT (Internet of Things), Water Surface Cleaning, ESP8266 WiFi Module, L298N Motor Driver, Gear Motors,

INTRODUCTION

In the past, cleaning floating waste from water bodies required manual labor, often involving small boats and significant human effort. This process was not only time-consuming but also hazardous. Ensuring clean water is crucial not only for human health but also for maintaining the ecological balance of aquatic life. While many organizations work toward cleaning water bodies, individual efforts play a vital role in sustaining a pollution-free environment.

Our project, a WiFi-Controlled River Cleaning Boat, is designed to simplify and enhance the efficiency of manual water cleaning. Unlike automated solutions, this boat is manually operated using a WiFi-based control system powered by an ESP8266 module. The movement of the boat is controlled via a L298N motor driver, enabling precise navigation for waste collection. The boat features a mechanical collection system that efficiently gathers floating garbage, ensuring an effective cleaning process.

India, with its growing population and urbanization, faces a severe water pollution crisis. Limited waste disposal facilities lead to excessive dumping of garbage into rivers and lakes, creating hazardous environmental conditions. Our project provides a cost-effective and accessible solution by eliminating the need for complex automation and expensive sensors. Through wireless manual control, users can navigate the boat to target polluted areas and remove waste efficiently.

By adopting IoT-based remote operation, this project encourages active participation in water conservation efforts. It is a scalable and sustainable approach that empowers individuals and organizations to contribute to cleaner water bodies. Our goal is to promote environmental awareness and offer a practical solution that can be easily deployed in various water bodies. Maintaining clean water is not just a responsibility but a necessity for future generations, and this project aims to make that effort more efficient and impactful.

METHODOLIGY

The project focuses on developing a WiFi-controlled river cleaning boat capable of efficiently collecting floating waste from water bodies. The system is designed for manual operation through a mobile-controlled web interface, eliminating the need for complex automation and expensive sensors. The

methodology follows a structured approach integrating hardware components, motor control, and remote operation to ensure efficient waste collection and navigation.

The boat operates using an ESP8266 WiFi module, which enables remote communication and manual operation via a mobile or web-based dashboard. The movement of the boat is controlled using an L298N motor driver, which facilitates navigation in four directions: forward, backward, left, and right. BO motors and wheels are employed to provide smooth movement across the water. The boat is equipped with a conveyor belt mechanism designed to collect floating debris and direct it into a trash compartment. The power supply is managed through a rechargeable battery, ensuring a consistent energy source for prolonged operation.

Unlike fully autonomous systems, this project allows manual control via a WiFi-enabled interface. The boat is connected to a web-based dashboard where the user can monitor movements, oversee the waste collection process, and operate the conveyor mechanism. The remote control interface enables precise navigation, allowing the boat to move forward toward waste accumulation zones, reverse when necessary, and maneuver left or right to avoid obstacles and optimize coverage.

The waste collection process begins with the deployment of the boat into a water body where floating waste is present. The operator remotely controls the boat using the web-based interface to navigate toward debris accumulation areas. Once the boat is in position, the conveyor belt is activated to collect the floating waste and deposit it into the onboard trash compartment. The process continues until the storage area is filled. The operator monitors the collection process in real time and, once the waste compartment reaches capacity, manually directs the boat back to shore for waste disposal.

The system relies on a WiFi-based interface instead of pre-programmed automation, providing a real-time, user-controlled experience. The web dashboard serves as the primary interface, displaying boat movement status and conveyor operation. The controls are simple, allowing the user to navigate the boat and operate the conveyor mechanism through a touch-based system. The manual control aspect ensures that waste collection remains efficient and adaptable to different water conditions and varying amounts of debris.

In contrast to automated garbage collection boats that rely on Arduino-controlled IR sensors and IoT-based automation, this system prioritizes manual control for increased flexibility and cost efficiency. Traditional automated systems use IR sensors to detect when the boat is filled with waste and automatically stop operation. However, this manual control approach offers several advantages, including lower costs, greater flexibility, and the ability to precisely manage the waste collection process in real-time.

By providing a cost-effective, manually controlled, and scalable solution, this project ensures that water bodies can be cleaned efficiently while minimizing reliance on expensive automation technology. The integration of WiFi-based remote control and an effective waste collection system presents a practical and accessible solution to combating water pollution. The project emphasizes the importance of real-time monitoring, user adaptability, and enhanced navigation capabilities to optimize the cleaning process.

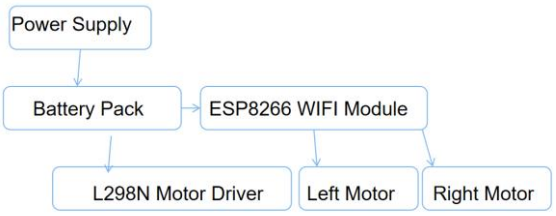

Fig -1: Block Diagram of Boat Controller

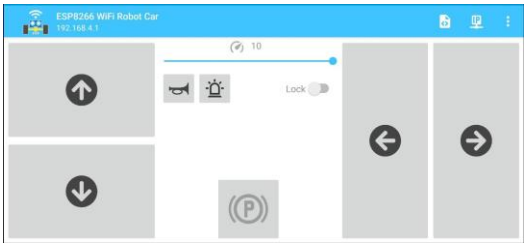

Fig-2: Web Dash Board

HARDWARE COMPONENTS

NodeMCU ESP8266: The NodeMCU ESP8266 is a low-power WiFi microcontroller module that serves as the core of the river cleaning boat's control system. It facilitates remote communication and allows users to manually operate the boat using a web-based interface. The ESP8266 connects to a wireless network and enables real-time control over the boat's movement and conveyor belt operation.

L298N Motor Driver Module: The L298N motor driver module is used to control the movement of the boat. It manages the direction and speed of the BO gear motors, allowing for smooth forward, backward, left, and right navigation. The module enables dual-channel motor control, ensuring efficient and stable movement across the water.

DC Motors: The boat is powered by high-torque DC motors that provide stable propulsion across water surfaces. These motors, combined with the L298N motor driver, allow for precise movement control. The motors are essential for ensuring smooth navigation and directional adjustments while collecting debris.

Conveyor Belt Mechanism: The conveyor belt is responsible for collecting floating debris from the water. It is powered by a DC motor and operates continuously until the trash compartment reaches capacity. The belt moves waste into the onboard storage area, making the cleaning process more efficient.

Jumper Wires: Jumper wires are used to establish electrical connections between the components, including the NodeMCU, motor driver module, sensors, and motors. They simplify circuit connections and allow for easy modifications and troubleshooting.

12V Rechargeable Battery: A 12V rechargeable battery provides power to the entire system, ensuring continuous operation during cleaning missions. The battery supplies sufficient energy to drive the motors, sensors, and NodeMCU module.

Boat Frame (PVC Structure): The boat's body is constructed using lightweight and durable PVC material. The frame is designed to support the motor assembly, conveyor system, and electronic components while maintaining buoyancy. The structure ensures stability and efficient movement across the water.

This combination of hardware components ensures a reliable, manually controlled river-cleaning boat capable of navigating and collecting debris efficiently using a remote-controlled web interface.

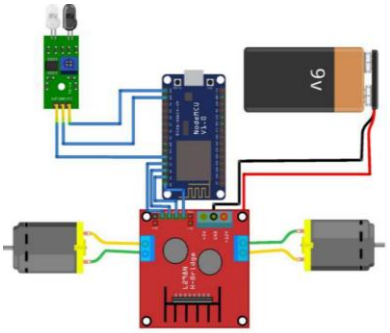

Fig-3 Circuit Diagram

SOFTWARE TOOLS

Arduino IDE: The Arduino IDE is the primary development environment used for writing, compiling, and uploading code to the ESP8266 microcontroller. It provides a user-friendly interface with built-in libraries to facilitate programming. In this project, the Arduino IDE is used to code the ESP8266 to control the boat's movement, conveyor belt operation, and sensor integration. The code is written in C/C++ using the Arduino framework and is responsible for processing sensor inputs, controlling motors, and managing communication with the mobile app.

ESP8266 Mobile App: A mobile application is generated using the ESP8266-based IoT control interface. The app enables users to manually navigate the boat, start and stop the conveyor belt, and receive alerts when the trash compartment is full. The interface consists of buttons for directional movement (forward, backward, left, and right) and a status display showing real-time updates from the IR sensors and conveyor belt. The app communicates with the ESP8266 via WiFi, ensuring smooth operation without requiring a physical connection.

RESULT

When the river-cleaning boat is released into the water, it is controlled remotely using the Arduino IoT Mobile Application. The conveyor belt starts rotating automatically to collect floating debris as long as the IR sensors detect available space in the collection area. Once the boat accumulates a sufficient amount of debris, the IR sensors send a signal to the ESP8266 microcontroller, instructing it to stop the conveyor belt to prevent overloading.

Simultaneously, feedback is sent to the Arduino IoT Cloud, updating the mobile application to notify the user that the trash compartment is full. At this point, the user

can use the mobile app to navigate the boat back to shore for waste disposal. The app provides real-time control over the boat's movement, allowing users to steer it forward, backward, left, or right as needed.
This system ensures efficient and automated river cleaning while providing remote control functionality, reducing manual effort, and improving operational efficiency.

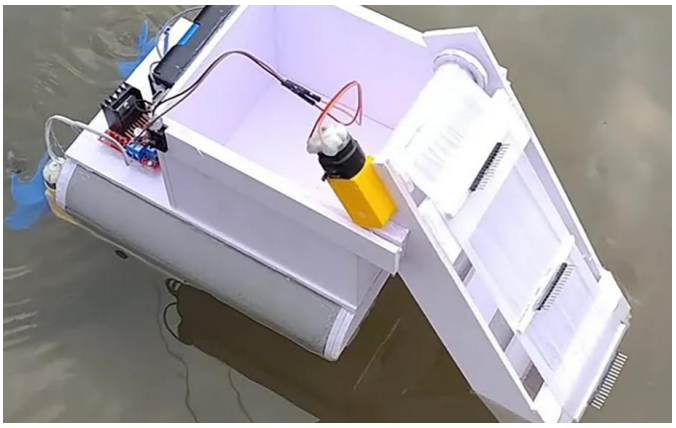
Fig 4: River Cleaning Boat

ADVANTAGES

Efficiency: Water surface cleaning bots efficiently remove debris, pollutants, and floating waste from lakes, ponds, or other water bodies, maintaining cleanliness without manual intervention.

Environmental Impact: They help in preserving the ecosystem by preventing contamination and preserving the habitat for aquatic life, ensuring cleaner water for flora and fauna.

Time-Saving: Automating surface cleaning tasks reduces the time and effort required for manual cleaning, allowing for regular maintenance without extensive labor.

Versatility: These bots can navigate various water surfaces, adapt to different debris types, and operate in diverse conditions, offering a versatile solution for multiple environments.

Cost-Effectiveness: Over time, the use of water surface cleaning bots can lower maintenance costs, as they reduce the need for frequent manual clean-ups and help prevent potential damage caused by accumulated debris.

APPLIATIONS

The proposed Water Cleaning Bot is suitable for a wide range of operations, including :

Ponds and Lakes Maintenance: These bots are employed in ponds, lakes, and reservoirs for routine cleaning to remove debris, algae, and pollutants, preserving water quality.

Swimming Pools: Automated cleaning bots efficiently remove leaves, insects, and debris from the surface of swimming pools, ensuring a cleaner and safer environment for swimmers.

Marinas and Harbors: They help in maintaining the cleanliness of marinas and harbors by removing floating debris, trash, and oil spills, preventing water pollution.

Water Treatment Facilities: Bots aid in maintaining intake areas and reservoirs at water treatment facilities, ensuring the water quality before the treatment process.

Recreational Water Bodies: In recreational areas such as water parks or public beaches, these bots help in keeping the water surfaces clean for activities like boating, kayaking, and other water sports.

Industrial Applications: In industrial settings like cooling ponds or tanks, these bots aid in removing surface debris or contaminants, ensuring smooth operations and preventing equipment damage.

Environmental Conservation: Used in natural reserves or ecological habitats to maintain the cleanliness of water bodies, preserving the ecosystem and protecting aquatic life.These applications showcase the versatility and importance of water surface cleaning bots in maintaining cleanliness, preserving water quality, and supporting various industries and environments

FEATURES ENHANCEMENT :

Advanced Sensory Technology: Integration of more sophisticated sensors to detect and identify various types of debris, pollutants, or contaminants on the water surface with higher accuracy.

AI and Machine Learning: Implementation of AI algorithms and machine learning models to enhance the

bots' decision-making capabilities, enabling them to adapt and optimize their cleaning strategies based on real-time data.

Improved Navigation Systems: Enhanced navigation systems utilizing GPS, computer vision, or other technologies for better path planning, obstacle avoidance, and more efficient coverage of larger water surfaces.

Autonomous Fleet Management: Development of systems allowing multiple cleaning bots to work collaboratively and autonomously in a coordinated manner to cover larger areas or respond to cleaning requirements more effectively.

Energy Efficiency: Integration of more efficient power sources or renewable energy options, such as solar or kinetic energy, to increase the bots' operational autonomy and reduce environmental impact.

Modularity and Scalability: Designing bots with modular components to facilitate easier upgrades, maintenance, and scalability, allowing for customization based on specific cleaning needs and different water body sizes.

Environmental Monitoring Features: Inclusion of additional sensors or capabilities to monitor water quality parameters (such as pH levels, dissolved oxygen, etc.) alongside surface cleaning, providing comprehensive environmental data.

Smart Maintenance and Diagnostics: Implementation of self-diagnostic systems to identify and address technical issues proactively, reducing downtime and enhancing overall reliability.

Regulatory Compliance and Safety Features: Integration of features ensuring compliance with local regulations and safety standards, enhancing the bots' suitability for various environmental conditions and settings.

CONCLUSION :

In conclusion, the development of an IoT-enabled river-cleaning boat using the ESP8266 and Arduino technology offers an efficient and automated solution for tackling water pollution. By integrating IR sensors, a conveyor belt mechanism, and remote control functionality, the boat effectively detects and collects floating debris from water bodies, reducing manual intervention and enhancing the efficiency of cleaning operations. The use of Arduino IoT Cloud and a mobile application ensures real-time monitoring and control, making the system user-friendly and adaptable to different environments.

The implementation of this system not only provides a cost-effective and scalable solution but also opens avenues for future enhancements. Additional features such as water quality monitoring, GPS-based navigation, and AI-driven obstacle avoidance can further improve the effectiveness of the boat. By leveraging automation and IoT, this project contributes to environmental sustainability, promoting cleaner water bodies and minimizing pollution.

Overall, the river-cleaning boat powered by ESP8266 and Arduino technology stands as a significant step towards addressing water pollution through innovation, automation, and sustainability. It serves as a practical and impactful solution for both urban and rural areas, ensuring a cleaner and healthier environment for aquatic life and human communities alike.

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