Development of an Eco-Friendly Arduino-Based Robot for Efficient Removal of River Waste and Pollution Mitigation

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***Abstract*— Plastic, Thermocol, and metal usage contribute to water plugging, which is causing problems and promoting diseases like typhoid and intestinal illness. Manually cleaning the wastes would not be sufficient because it frequently entails a large amount of work and effort and there is a chance that the irresistible germs present in the sewage could cause various illnesses. This study includes a suggested design for a garbage collection system that is practical and efficient for cleaning up trash from rivers, channels, and lakes. The system for collecting trash is specifically designed to work with applications for picking up a variety of materials, including gliding litter, trash bags, and others. IOT technology which has the ability to track and control the entire process, is utilized as part of the integrated system.**

Keywords—Alternating current, Direct current, light-dependent resistor, Revolution per minute, Battery-operated motor, Integrated development environment.

I. INTRODUCTION

The escalating crisis of water pollution, predominantly driven by the pervasive presence of single-use plastics, imperils the delicate balance of global ecosystems and poses significant risks to human well-being. Conventional cleanup approaches often prove inadequate in tackling the immense scale of plastic waste accumulating in our waterways. The advent of robotics presents a compelling and innovative avenue for addressing this challenge. Sophisticated robots, equipped with advanced sensor technologies and specialized collection apparatus, demonstrate remarkable potential for efficient and autonomous operation across a spectrum of aquatic environments.[1] Current research and development efforts are diligently focused on refining these robotic systems, with key areas of emphasis including the enhancement of their navigational capabilities within complex aquatic terrains, the development of more precise algorithms for waste detection and identification, and the design of more versatile mechanisms for debris collection under varying water conditions. The ultimate vision entails the deployment of widespread fleets of fully autonomous robots capable of continuous cleanup operations and comprehensive water quality monitoring.[2][3] The proactive development and strategic deployment of water-cleaning robots represent a pivotal stride toward realizing a cleaner, healthier, and more sustainable planet for future generations. This technological advancement underscores the indispensable role of innovation in environmental stewardship, shifting our focus toward proactive pollution prevention and ecosystem restoration. [4]

II. LITERATURE REVIEW

To carry out any project work, it is very essential to understand the current scenario and the technology merits and demerits. In this context literature survey has been carried out thoroughly to formulate and choose the objectives of the project work. Following are some of the literature that has contributed to the area chosen for the study.

Dibya Kumari and Kotla Anusha's "River Cleaning Robot" directly addresses the critical issue of river pollution, striving for sustainable water management. Their main goal is to create an automated system for efficiently cleaning rivers, ensuring healthier water for future generations. Recognizing the detrimental impacts of polluted rivers on ecosystems and human health, this project offers a scalable and efficient robotic solution to reduce pollutants and preserve these vital resources [1]

M. Mohamed Idhris and M. Elamparthi's paper introduces a remote-controlled sewage cleaning machine, prioritizing worker safety by enabling operation from a distance, thus avoiding hazardous contact with sewage waste and gases. This innovation focuses on the mechanical design for waste management and the remote control system, offering a safer and more efficient approach to sewage cleaning [2]

Savitha H.S. and Anushree N.R.'s "Design of Automatic River Cleaning Robot" integrates navigation, sensing technologies like computer vision and ultrasonic sensors, and a collection mechanism for autonomous debris removal. This system enables targeted and continuous river cleanup, minimizing human intervention and improving river ecosystem health by efficiently identifying, collecting, and autonomously disposing of waste[3]

Nurlansa, Istiqomah, and Pawitra's research presents AGATOR, an innovative automatic robot for waste collection in stagnant rivers, detailing its design, engineering, and rigorous testing for autonomous operation.

This comprehensive work addresses the specific challenges of these environments to ensure effective waste management [4]

Albitar, Ananiev, and Kalaykov's research focuses on developing an in-water surface cleaning robot designed for the efficient removal of floating debris and pollutants. The paper emphasizes the robot's design, particularly its movement and stability, crucial for effective operation on the water surface. This automated approach aims to provide a more efficient alternative to manual labor for maintaining cleaner aquatic environments [5]

III. Proposed System

The robot utilizes an elevator system to lift surface debris into a holding container. Its operation is governed by a control algorithm on an Arduino Uno, managing navigation, obstacle avoidance, waste detection, and Bluetooth communication. The robot follows a cycle of navigating, collecting debris, and returning to a disposal site. A rechargeable battery pack provides reliable power for all electronic components and motors. The Arduino Uno functions as the robot's central microcontroller, processing sensor data and generating control signals. It is programmed with algorithms to precisely control the robot's movement and cleaning mechanisms.

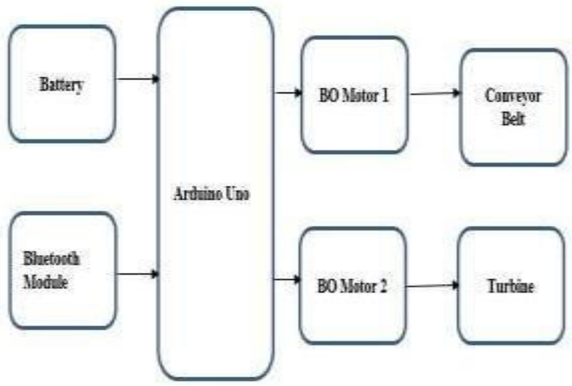

Fig 1: Block diagram of a system

An L298N Motor Driver acts as an interface between the Arduino and the motors. The L298N amplifies control signals from the Arduino to drive the motors with the desired speed and direction. This enables the Arduino to achieve precise control over the robot's movement within the water. The integrated system allows for autonomous or remote-controlled operation for efficient waste collection.

Arduino Uno: The brains of the system are managed by the microcontroller. It analyzes sensor data and controls output.

Motor driver shield(L298N): The L298N is the H-bridge motor driver integrated circuit (IC) that serves as its foundation. It facilitates the DC motors' operation.

Fig 2:Circuit Diagram **Lithium rechargeable battery:** It is a kind of rechargeable battery a lithium-ion battery, also known as a Li-ion battery.

BO motor and wheels: A BO motor is a particular kind of DC motor that may run at a lower speed and generate more torque because it has a gearbox or gear assembly inside the motor housing.

Jumper Wires & Connecting Wires: A longer cable called a connecting wire is used to join devices or other circuit components. It is employed to establish a long-term link between two locations.

Arduino IDE: It is an open-source integrated development environment (IDE). From this, we can write, compile, and upload the code to the Arduino board.

Bluetooth Module: The HC-05 is a widely used, inexpensive Bluetooth module enabling wireless serial communication in Master or Slave modes. It communicates via UART and is configurable with AT commands for settings like baud rate.

Turbines: Turbines in water robots mainly provide propulsion by converting water flow into rotational power for movement. They can also harvest energy from currents to power the robot's systems, increasing its operational duration.

Conveyor belt: Turbines in water robots mainly provide propulsion by converting water flow into rotational power for movement. They can also harvest energy from currents to power the robot's systems, increasing its operational duration.

IV. DESIGN AND IMPLEMENTATION

To assemble the components follow the steps:

- Battery takes the power supply from the solar panel and the solar panel observes the sunlight and Light energy is transformed into electrical energy by it.
- Then connect the battery positive terminal to the L298N Motor driver +ve, negative terminal is connected to the GND of the motor driver.

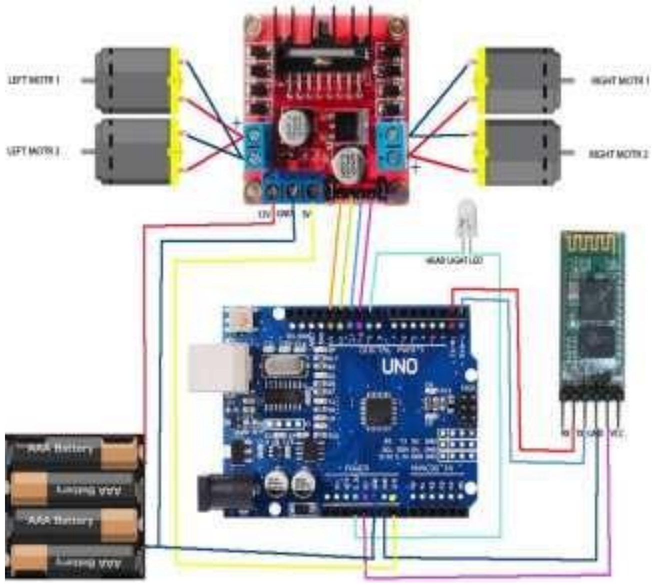

Fig 2: Circuit Diagram

- Bluetooth Module GND and VCC pin are connected to the Arduino Board GND and VCC respectively. Then the TRIG pin is connected to the A2.

- The Motor enable is connected to the Arduino pins 10,11, Turn 12,13.
- ON switches which give supply to Arduino UNO and Motor Driver.

V. FLOW CHART

Command Generation (User): The user interacts with a Bluetooth-enabled device (smartphone/computer) running a control application.

Command Processing (Arduino Microcontroller): The Arduino receives the commands from the Bluetooth module.

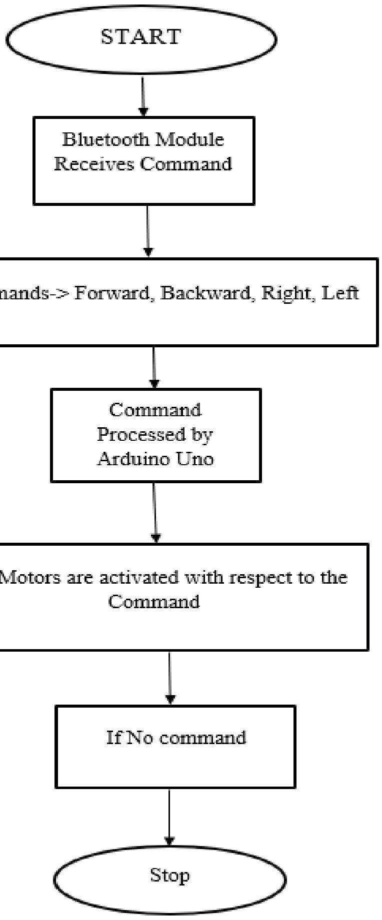

Fig 3: Flow chart

Motor Control (Motor Driver): The Arduino's control signals are sent to a motor driver circuit (like the L298N). The motor driver amplifies these signals to provide sufficient power to the DC motors.

Movement (DC Motors and Wheels): The DC motors rotate the robot's wheels based on the signals from the motor driver. This rotation causes the robot to move in the commanded direction (forward, backward, left, or right).

No Command Condition (Safety Stop): The Arduino uses a timer that resets upon receiving a new command. If no new command arrives within a set timeout period, the timer expires. Upon timeout, the Arduino sends signals to the motor driver to stop all motors, bringing the robot to a halt.

RESULT AND DISCUSSION

The following figure shows the result of the proposed system:

Fig 3: Complete model of river cleaning robot

The "River Cleaning Robot" prototype visually demonstrates a motorized roller system designed to collect floating surface debris and move it into an internal storage area. Its wheels and motor suggest mobility, though the control mechanism isn't evident. Constructed from materials like cardboard, it serves as a basic proof-of-concept. While showcasing a collection method and potential for movement with internal storage, the prototype has limitations in material durability for real-world use. Its small scale likely restricts collection capacity, and navigation, control systems, and waste sorting are not apparent. A robust power source, buoyancy, stability features, and obstacle avoidance capabilities are also areas needing further development for practical river cleanup applications. This initial model highlights the core collection principle but requires significant advancements for real-world deployment.

CONCLUSION

River cleaning robots are a major technological advancement offering an automated solution to water pollution, overcoming limitations of manual methods with continuous operation and access to difficult areas. They also collect crucial water quality data, aiding ecosystem restoration and promoting sustainable practices by minimizing human intervention and chemical use. However, widespread adoption faces challenges like high costs, potential malfunctions, and limitations in complex environments, requiring careful integration with existing management plans. Despite these hurdles, their benefits are

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substantial, with future advancements promising improved navigation, efficiency, and environmental monitoring. Successful implementation demands collaborative efforts in research, responsible deployment, and public engagement, paving the way for cleaner rivers and a sustainable future.

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