

Hydrosync: An App Controlled Waste Collector

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Abstract - Water pollution from floating waste demands efficient and cost-effective solutions. This paper presents a semi-autonomous river-cleaning robot, remotely operated via Bluetooth for enhanced flexibility. Built around an Arduino microcontroller with an HC-05 Bluetooth module, the system integrates DC motors for movement and a motorized conveyor belt, controlled via a relay module, for floating waste collection. A water level sensor monitors environmental conditions, with real-time data displayed on an I2C LCD. Bluetooth-based control improves usability over manual systems, while the low-cost design ensures accessibility for environmental agencies and municipalities. Unlike fully autonomous models, this approach retains human oversight, allowing adaptability to dynamic conditions. This paper advances sustainable water management by providing an efficient, scalable, and remotely operable waste removal solution. Future enhancements may include improved navigation algorithms and real-time environmental monitoring.

Keywords: Semi-Autonomous River Cleaning, Bluetooth Control, Arduino, Waste Collection, Environmental Robotics.

I. INTRODUCTION

Water pollution is a growing environmental concern mainly in urban water bodies where plastic waste and other materials accumulate, causing serious threats to aquatic ecosystems and public health[1]. Traditional waste removal methods rely on manual labour or large-scale equipment, both of which are inefficient, costly, and often hazardous for workers [2]. To address these challenges, we propose a surface water cleaning

system that efficiently removes floating waste with less human intervention [3].

The proposed system is a Bluetooth-controlled device equipped with a conveyor belt to collect waste from the water's surface[4]. Our system focuses on cost-effective and easy-to-operate Bluetooth-communication, and without any internet dependency. Additionally, a water level sensor is integrated to monitor the water depth, thereby allowing us to monitor the water environment.

Designed for small to medium-sized water bodies, such as ponds, lakes, and reservoirs, It reduces labour requirements, lowers maintenance costs, and enhances safety by allowing remote operation. This paper presents the design, implementation, and testing of the system, demonstrating its effectiveness in surface waste collection.

II. LITERATURE REVIEW

Basant Rai (2013) reviewed the major causes of Ganga River pollution and conservation efforts such as GAP and NGRBA, highlighting poor implementation and the need for integrated river management despite limited scientific analysis [1].

A rural North India case study emphasized that inadequate hygiene and sanitation continue to cause waterborne diseases, stressing the importance of awareness and behavioural change despite its limited regional scope [2].

Siddhanna Janai et al. (2020), R. Raghavi et al. (2019), and Soumya et al. (2018) proposed low-cost water cleaning robots for collecting floating waste. However, these systems lacked

automation, intelligent sensing, real-time monitoring, and adaptability to varying environmental conditions, limiting large-scale deployment [3]-[5].

Ketan H. Pakhmode et al. (2019) developed a solar-powered garbage-collecting boat, but its dependence on sunlight restricted continuous operation [6]. Similarly, Niramon Ruangpayoongsak et al. (2017) introduced a semi-autonomous floating waste scooper, though its environmental performance and energy efficiency were not comprehensively evaluated [7].

Dipanjana Rakshit et al. proposed a simple and cost-effective water level indicator, while an Arduino-based lighting control study demonstrated the usefulness of an I2C LCD for real-time system monitoring [8]-[9].

Houssam Albitar et al. (2014) designed an underwater cleaning robot with good stability but high mechanical complexity and cost, making it unsuitable for simpler applications [10]. The HC-05 Bluetooth interfacing tutorial provides practical support for implementing wireless communication in Arduino-based robotic systems [11].

M. Mohamed Idhris et al. (2017) and Ndubuisi C. Daniels (2014) proposed mechanized drainage and sewage cleaning systems to improve sanitation, although both lacked adaptability and extensive real-world validation [12]-[13].

Chikesh Ranjan et al. (2019) presented a manually operated garbage-collecting boat, while Ballade et al. (2017) proposed a waterwheel-driven river cleaning system. Although both are eco-friendly, their dependence on manual effort or calm water conditions limits efficiency, highlighting the need for automated and remotely controlled solutions [14]-[15].

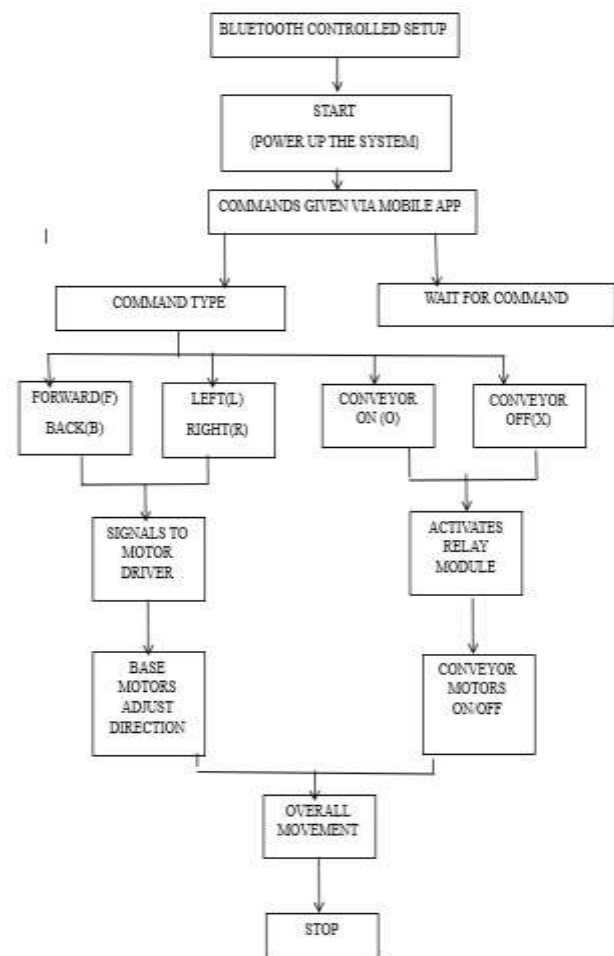


Fig 2 : Operational Flowchart

The flowchart in Fig 2, illustrates the working of a Bluetooth-controlled water surface cleaning robot operated through a mobile application. The process begins by powering on the system and establishing a Bluetooth connection between the mobile device and the Arduino controller. Once connected, the system waits for user commands.

The user can control the robot's movement by sending forward, backward, left, or right commands. These signals are processed by the motor driver, which controls the base motors and enables the robot to navigate across the water surface. The user can also switch the conveyor mechanism ON or OFF through the mobile application. A relay module controls the conveyor motor, allowing the robot to collect and transport floating waste efficiently.

The movement and conveyor mechanisms operate independently but in coordination, ensuring effective cleaning while allowing precise navigation.

III. METHODOLOGY

3.1 DESIGN

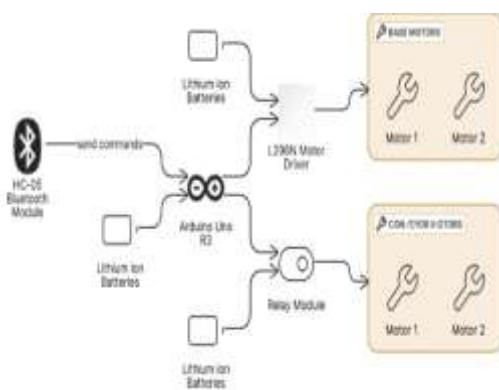


Fig 1 : Block Diagram of Aimed Setup

The Block Diagram in Fig 1, is a virtual representation of how we visualise and aim to design our hardware setup practically. The necessary connections and setup are briefly interpreted in the above block diagram.

3.2 SOFTWARE

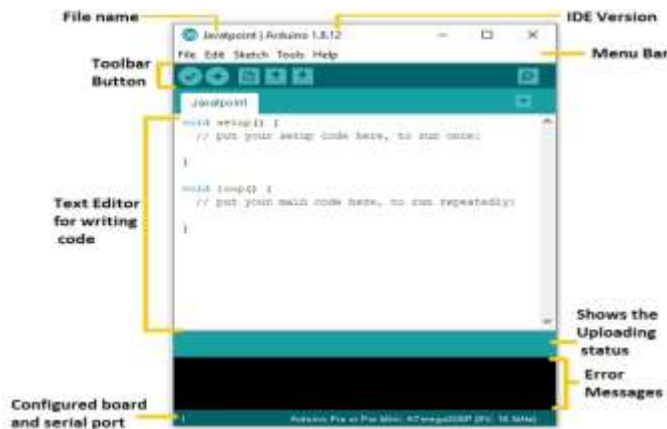


Fig 3 : Arduino IDE

The Arduino IDE(Integrated Development Environment) is an open-source software used for writing, compiling, and uploading code to Arduino microcontrollers. It features a simple code editor with syntax highlighting, a compiler, a serial monitor for debugging, and built-in support for various Arduino boards.



Fig 4: Homepage of Bluetooth controller App

Fig 4, indicates the homepage of the Bluetooth Controller App that is used to obtain the output for our designed setup.



Fig 5 : Proposed Hardware Setup

The device is built on a lightweight chassis that houses all mechanical and electronic components. Two geared DC motors drive the rear wheels, while front caster wheels provide balance and smooth movement. The conveyor mechanism consists of a mesh belt supported by rollers and driven by a geared DC motor to collect and transport floating waste efficiently.

The system is controlled by an Arduino microcontroller, which receives commands from an HC-05 Bluetooth module. An L298N motor driver controls the wheel motors for movement, while a relay module switches the conveyor motor ON and OFF. A 16×2 LCD which is connected with the water level sensor displays the water depth level in figures. The robot is operated wirelessly through a Bluetooth-enabled mobile application.



Fig 6: Terminal Screen in App

The application sends single-character commands to the Arduino for real-time control. F (Forward) moves the robot ahead, B (Backward) moves it in reverse, L (Left) and R (Right) turn the robot in the respective directions, S (Stop) halts all movement, O (Conveyor ON) activates the conveyor belt to collect floating waste, and X (Conveyor OFF) stops the

conveyor motor. These commands enable precise navigation and coordinated waste collection during operation.



Fig 7 : Remote Operation

Rather than giving commands, remote control operation can also be performed for controlling the device movement using the controller as shown in Fig 7.

IV. RESULTS

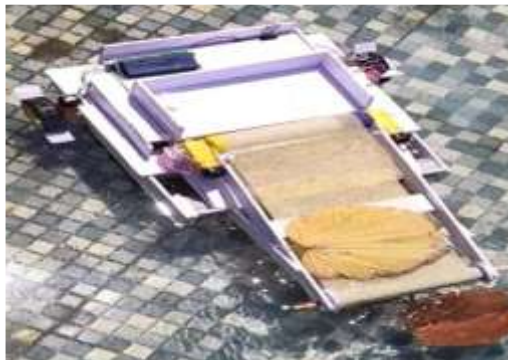


Fig 8: Waste collection using Conveyor belt

The Fig 8 showcases the collection of waste when the device is placed in the water. According to the given commands through the app, the conveyor belt starts operating and collects the waste, dropping into the bin situated above on the setup.



Fig 9 : LCD display initiation

Through the code given to the system, initially the Liquid Crystal Display showcases the message as shown in Fig 9.

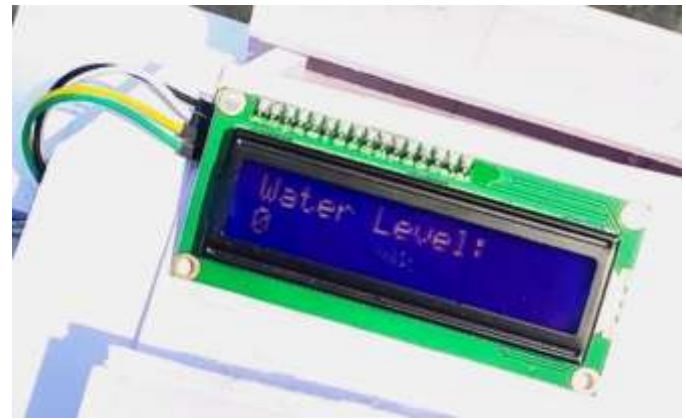


Fig 10: Initial Water Depth

The main reason for implementing a water level sensor in our setup is to take a step towards real time data monitoring. Even though real time monitoring is a complex analysis, we believe, we can manage the device remotely and carefully with certain precautions and measures such as calculation of the water level etc.

The water level is measured when a command of 'W' is given through the app and the level is displayed accordingly.



Fig 11: Depth Indication when placed in Water

V. DISCUSSION

The proposed Bluetooth-controlled water surface cleaning robot provides a practical and cost-effective solution for removing floating waste from small water bodies such as ponds, lakes, and canals.

By reducing the need for manual cleaning, the system helps minimize human exposure to polluted water while improving environmental sanitation. The integration of wireless Bluetooth control, Arduino-based automation, and a conveyor mechanism demonstrates the feasibility of using embedded systems for efficient waste collection.

Its simple and modular design makes it suitable for educational projects and small-scale community applications.

The device offers a scope for future enhancements. One area being integration of machine learning and path planning algorithms which would allow the device to make smarter navigation decisions and obstacle detection in real time.

The device would benefit from AI-powered analytics that would allow it to monitor its surroundings but also predict and identify issues, thereby enhancing reliability

VI. CONCLUSION

The device presented in this paper works semi- autonomously and provides a cost effective solution. It helps in reducing water pollution and enhances flexibility for adapting into dynamic environments. This device can be easily implemented by municipal and other local agencies for maintaining proper aqua hygiene. This also involves less manpower, thereby reducing the risk of people working in polluted water environments.

However , due to the fundamental prototype level design, our device has a few constraints. It has a limited operation range due to use of the basic bluetooth module. Our device is to clean smaller water bodies. The cleaning capacity and operating time are dependent on conveyor size and battery capacity, which could provide a scope for future enhancement for increased automation and compact yet complicated designing methods.

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