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AQUATIC TRASH COLLECTOR BOT

Ishan Deshpande, Mohit Jagtap, Akash Satras, Mrs. Shreyasi Watve
Telecommunication Progressive Education Society's Modern college of Engineering
Pune,Maharashtra,India

Abstract- ndia's vibrant cultural traditions involve many water-based religious rituals, which unintentionally contribute to environmental pollution. During festivals such as Ganesh Visarjan and Kumbh Mela, water bodies like the Godavari River in Nashik often become heavily contaminated due to the disposal of idols, flowers, and plastic items. These pollutants accumulate on the water surface, disturbing the aquatic balance. To address this issue, we propose an eco- conscious solution—an automated bot system designed for surface waste collection. This bot uses renewable energy to operate and effectively removes plastic, debris, and water hyacinth from still water bodies, supporting a cleaner and more sustainable environment.

Keywords—. Environmental Pollution: This is the core problem being addressed.Water Pollution: Specifically focuses on the impact on aquatic environments.Religious Rituals: Identifies the context of the pollution source.Ganesh Visarjan: Specific festival linked to idol immersion and water contamination.Kumbh Mela: Another large-scale festival contributing to water pollution.Godavari River: The specific water body mentioned as affected.Nashik: The city where theGodavari River pollution is highlighted.Idol Immersion: The specific practice causing pollution, especially those made of Plaster of Paris (POP) and decorated with toxic paints.Flowers & Plastic Items: Additional pollutants disposed of in water bodies.Aquatic Balance: The negative impact of pollution on the ecosystem.

I. INTRODUCTION

Water is a fundamental resource for all living beings, but its availability and purity are declining rapidly due to increasing pollution levels. Although water covers a significant portion of the Earth's surface, only a small fraction is fit for human consumption. Over the years, pollution from urban expansion, industrial discharge, agricultural runoff, and population growth has led to the continuous dumping of waste into natural water bodies such as rivers, lakes, and oceans. These practices have severely degraded water quality, harmed aquatic life, and increased the risk of health issues for humans.

The presence of pollutants like plastic debris, non-biodegradable materials, and chemical waste has disrupted ecosystems and caused long-term environmental damage. Marine animals often mistake floating plastics for food, which can result in injury or death. Additionally, the accumulation of garbage in water bodies contributes to the formation of large-scale pollution zones such as ocean garbage patches.

Manual methods of water surface cleaning are commonly used but come with significant drawbacks. These methods are labor-intensive, time-consuming, and expose workers to hazardous conditions, especially in contaminated or deep water zones. Furthermore, manual operations lack efficiency and scalability when it comes to covering large water bodies.

To overcome these limitations, this project introduces an affordable and autonomous water-cleaning bot that can efficiently remove surface-level waste. The bot is designed to float on water and use a conveyor-belt mechanism to collect floating debris like plastic, leaves, and other waste materials. Controlled by a microcontroller and powered by solar energy or rechargeable batteries, the bot is equipped with sensors that help it navigate and identify areas with waste accumulation.

Initially, the system is intended for use in calm water environments such as ponds, lakes, or temple tanks. However, with future enhancements such as AI integration, GPS-based navigation, and increased motor power, it can be adapted to operate in flowing water sources like rivers and canals. The ultimate aim is to reduce water pollution.

II. LITERATURE SURVEY

Alejandro Mendoza Barrionuevo et al. (2024) [1] The authors proposed an intelligent coordination system using deep reinforcement learning, where surface robots are divided into two groups: scouts that identify polluted zones and cleaners that collect waste. This teamwork-based system improves efficiency and adaptability during water surface cleaning operations.

Aditya Sundarajan et al. (2023) [2] This research introduced a self-operating underwater rover aimed at cleaning water tanks. The robot leverages sensors and motor algorithms for path

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navigation and debris collection. It removes the need for human divers, ensuring safety and reducing operational costs.
Subhadeep Sahoo et al. (2020) [3] A fish-inspired underwater robot was presented, integrating advanced sensors and communication modules. It uses optical detection and edge computing to locate and store data about underwater pollutants, allowing for smarter and quicker cleaning using LTE and 5G networks.

Michael Fulton et al. (2018) [4] This study focused on marine litter detection using deep learning. A dataset of underwater waste images was created to train neural networks capable of identifying trash in real-time. The approach helps enhance the visual capabilities of underwater cleanup robots. Their dataset contributed to training algorithms capable of detecting microplastics and varied debris types.
Harsh Sankar Naicker et al. (2021) [5] They designed a solar-powered bot that can clean floating waste from water surfaces. Using computer vision and a virtual fencing mechanism, it detects pollution and alerts authorities when needed. Control and monitoring were enabled via mobile and web applications. The system's alert mechanism helps in reporting illegal dumping activities in real-time. It also provides a preventive layer using virtual boundaries for pollution control.
Aditya Sundarajan et al. (2023) [6] The same underwater tank cleaning rover was mentioned again in the original paper. To avoid repetition, you can either remove this duplicate reference or expand on a different feature—like energy efficiency or tank cleaning precision if needed. This variation focuses more on energy optimization and error handling in autonomous operation.

III. METHODOLOGY: PROPOSED SYSTEM

A. Introduction

Rapid urban growth and industrial activities have intensified water pollution, posing serious health threats and damaging aquatic ecosystems. Manual methods for cleaning water bodies are often unsafe, labor-intensive, and not scalable. Workers may be exposed to hazardous biological waste or physical injury, and such operations require significant time and manpower to cover even small areas. To address these limitations, this project introduces an eco- friendly and automated aquatic cleaning robot that targets floating waste in ponds and lakes. The robot operates using a conveyor-based collection mechanism and is powered by sustainable energy sources such as solar panels or rechargeable batteries, reducing the need for grid power. The system integrates sensors to detect water boundaries and waste objects, ensuring efficient navigation and obstacle avoidance. The use of ESP32 microcontroller allows for wireless communication and real-time control, which can be further enhanced using mobile-based interfaces. By automating the cleaning process, this system aims to offer a scalable and cost-effective alternative to traditional methods. The bot is lightweight, easy to deploy, and designed to minimize maintenance. Future enhancements may include AI-based waste detection, integration with cloud-based data systems for reporting, and extension to flowing water bodies like rivers and canals. The main goal of this project is to reduce the environmental impact of surface waste, protect aquatic life, and support sustainable waste management through innovative engineering.

System Overview

Here given a brief overview of Aquatic Trash Collector Bot with the help of block diagram along with detailed explanation of each block defined in Fig. 1.

Power Supply

Supplies regulated power to all components. A rechargeable battery provides necessary voltage levels (like 3.3V or 5V) to run the microcontroller and sensors, ensuring stable operation. The use of portable and rechargeable batteries makes the bot suitable for remote areas without direct power access.ESP-32

Acts as the central brain of the system. This Wi-Fi and Bluetooth-enabled controller processes input from sensors, executes control logic, and sends commands to motors and other peripherals. Its built-in wireless capabilities also support real-time control through smartphone apps, enhancing user interaction.

Motor Driver (L298N)

Interfces between the ESP32 and motors. Since ESP32 alone can't deliver the power required by motors, this driver allows precise control over motor direction and speed using PWM signals. The dual H-bridge design of the L298N allows control of two motors simultaneously, ensuring smooth and synchronized movement.

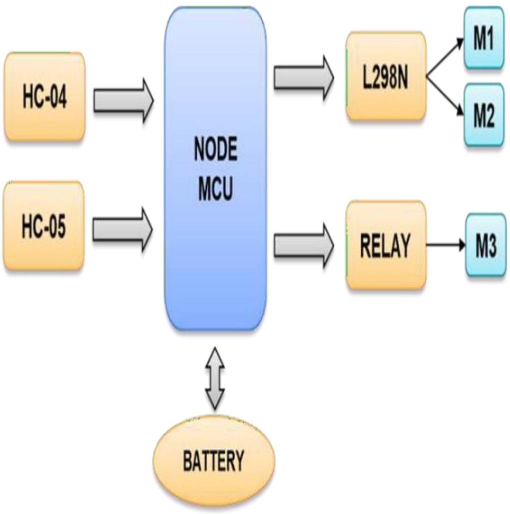

Fig. 1. Block Diagram: Aquatic Trash Collector Bot

Buzzer

A sound-alert module used to indicate specific states such as obstacle detection, low battery, or task completion. It helps with real-time feedback during operation. Additionally, the buzzer can assist in fault diagnosis by producing distinct beep patterns for different system errors.

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DC Motor
These motors convert electrical energy into motion to drive the bot forward, backward, or to turn. Their actions are based on commands from the ESP32 through the motor driver. The motors are selected based on torque and RPM suitable for floating platforms, allowing effective control even in water resistance.

C. Functional Overview
a. Flowchart

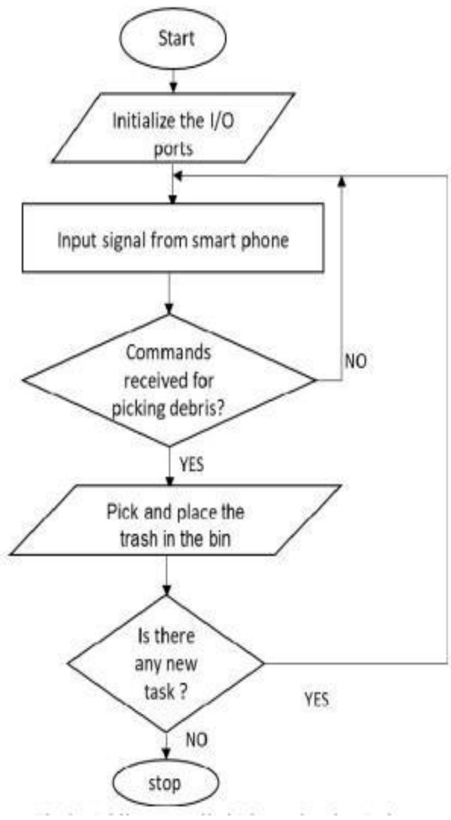

Fig. 2. Flowchart: Aquatic Trash Collector Bot
b. Algorithm

Start: The process begins.
Initialize the I/O ports: The input/output ports are initialized, likely for communication with the smartphone or other sensors.
Input signal from smartphone.
Commands received for picking debris? A decision point where the system checks if any commands have been received to pick debris.
If NO, it loops back to check for a signal.
If YES, it moves forward.
Pick and place the trash in the bin: The robot/system picks up the debris and places it in the bin.
Is there any new task? A check to determine if there are any further tasks.
If YES, the process loops back to receive new commands.
If NO, the process stops.

IV. RESULT

The Aquatic Trash Collector Bot performed reliably during initial testing in stagnant water bodies. It navigated smoothly, responded accurately to manual commands, and maintained consistent movement. The conveyor belt setup, supported by clamps and a collector bin, effectively picked up surface waste with minimal loss. Additionally, the soil moisture sensor contributed to safety by stopping the bot if it moved onto land unexpectedly, preventing potential mechanical

issues. The IR-assisted flashlight enhanced visibility during low-light operations, confirming the bot's potential as a practical, semi-autonomous cleaning solution. Tests also confirmed that the bot remained stable even with variable load conditions in the bin, showcasing its balanced design. Its components consumed low power, supporting the use of battery-based or solar-powered energy systems for extended runtime.

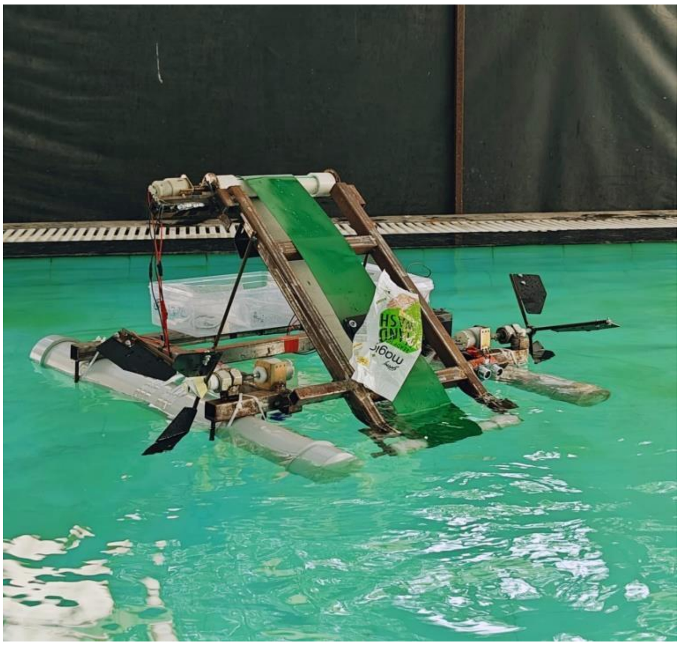

Fig. 3. Structure of Aquatic Trash Collector Bot

V. CONCLUSION

To conclude, the proposed aquatic trash collector bot offers a simple yet effective approach to cleaning surface-level waste from water bodies. Utilizing the ESP32 microcontroller along with sensors, motors, and a conveyor-based system, the bot operates with minimal human involvement. It contributes directly to reducing pollution and safeguarding aquatic ecosystems by removing harmful debris. The system's eco-friendly design and potential for future automation make it a valuable tool for sustainable water management efforts.

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