Eco Marine Trash Collector: A Raspberry Pi Based Smart Waste Collection for Still Water

Preshit Khadke
Dept. Of Electronics and Telecommunication
Pillai College of Engineering
Navi Mumbai, India

Bhargav Mahajan
Dept. Of Electronics and Telecommunication
Pillai College of Engineering
Navi Mumbai, India

Shridith Devadiga
Dept. Of Electronics and Telecommunication
Pillai College of Engineering
Navi Mumbai, India

Shravani Kumbhar
Dept. Of Electronics and Telecommunication
Pillai College of Engineering
Navi Mumbai, India

Prof. Aboli Khedkar
Dept. Of Electronics and Telecommunication
Pillai College of Engineering
Navi Mumbai, India

***Abstract* - Water pollution due to floating waste is a serious environmental issue that affects aquatic life and water quality. To address this problem, this paper conceptualizes a Smart Eco Marine Trash Collector using a Raspberry Pi controller. The system was designed specifically for still water bodies, such as lakes, ponds, and harbors, because waste likely to accumulate there. It uses a conveyor belt mechanism to collect floating trash and a imaging subsystem to continuously monitor the surface. The waste is transferred to a storage container that is attached to the boat after it has been collected. The Raspberry Pi enables human operated remote app interface to control conveyor mechanism . The proposed system is low- cost , efficient and reduces human efforts.**

Keywords - Raspberry Pi 3, Marine Waste, Trash Collector, Conveyor Mechanism, IOT

I. INTRODUCTION

Water pollution in still water bodies like ponds, lakes, and reservoirs has emerged as an increasing environmental hazard. The floating waste products mainly comprise plastic bottles, polythene, and organic leftovers, which not only affect the life of the aquatic organisms but also disturb the ecosystem. Manual cleaning of such surfaces is time-consuming, labor-intensive, and dangerous for the workers. Hence, the need for an effective, automated, and eco-friendly solution to clean floating waste from still water surfaces arises.

The proposed project, “Eco Marine Trash Collector”, deals with developing a small-scale, automated model for collecting waste from the surface of still water using IoT-based control. The main aim of this work is to design a cost-effective and energy-efficient boat able to move on still water, collect floating debris with the help of a conveyor mechanism, and store it in a waste container.

Primarilly, we defined the problem statement by studying the literature of research papers on marine waste collection systems. Using these studies as a reference, we structured the overall model structure by 3D modeling and cataloged the components such as Raspberry Pi 3, BO motors, H-bridge motor driver, USB camera module, PVC pipes, and conveyor belt assembly.

After concluding the design process, these components were to be assembled on the floating platform made of PVC pipes to ensure buoyancy. Wiring and connections would be done precisely to facilitate proper integration between the mechanical and electronic sections together. A mobile application has been built` enabling remote control of the boat's movement (forward, left , right) and the movement of its conveyor belt. The USB camera provides live video feed that helps the operator to monitor and collect waste efficiently. Additionally, the modular design of the eco marine trash collector is easy to maintain and potentially upgrades in the future.

The model proposed here provides a resource-efficient and accessible solution for cleaning surface waste in still water bodies. It also illustrates the incorporations of mechanical design, embedded systems, and IoT for environmental betterment and real worl applications.

II. LITERATURE REVIEW

“Water Surface Cleaning Robot’’ This robot collects floating waste from the water surface by using an Arduino UNO, ultrasonic sensors, and DC motors. It enhances cleaning efficiency by reducing human effort with the help of automated movements and gathering of wastes. [1]

“Solar Powered Water Body Cleaning Robot” A solar-powered cleaning robot using solar panels, batteries, motor drivers, and Arduino UNO efficiently removes floating waste, focusing on sustainable operation using renewable energies. [2]

“Design and Implementation of an Autonomous Water Surface Cleaning Robot” Equipped with Raspberry Pi, GPS, and ultrasonic sensors, an autonomous robot cleans up water bodies autonomously. It performs intelligent navigation for precision in the detection and gathering of garbage. [3]

“Modular Robot Used as a Beach Cleaner” This is a modular beach-cleaning robot with DC motors, servo motors, and a

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conveyor belt system. Its flexible design allows it to adapt to diverse terrains for effective collection of wastes. [4]

“Solar Operated Water Trash Collector” A solar-powered robot based on Arduino Nano, L293D motor driver, and DC motors cleans the trash in water bodies. Provides a cost-effective and environmentally friendly cleaning method. [5]

“Solar-Based River Water Garbage Collector” This system uses solar panels, batteries, and motor control circuits for the collection of floating waste from rivers, ensuring continuous pollution-free cleaning powered by sunlight. [6]

“Autonomous Floating Waste Collector with IoT-Based Water Quality Monitoring” The floating robot is equipped with IoT sensors, Arduino controller, and GPS to clean the water while measuring pH and turbidity. It merges automation with real-time tracking of water quality. [7]

“Marine Trash Classification Robot Based on Color Recognition” The color sensors and cameras are used in this marine robot for trash detection and sorting. The system applies image processing for proper waste classification. [8]

“Solar Powered Trash Collector on Land and Water” A solar panel-powered, DC motor-driven, Arduino-controlled hybrid robot cleans land and water areas. It is designed for managing waste on dual surfaces using renewable energy. [9]

“Autonomous Ocean Garbage Collector” That robot alone has been employed for obstacle detection and waste collection on oceans using ultrasonic sensors, propeller motors, and Arduino. It cleans surface waste, protecting marine life. [10]

“Design of an Autonomous Water Cleaning Bot” A bot based on Arduino employs servo motors, ultrasonic sensors, and a conveyor system to collect floating debris autonomously. It presents an inexpensive, highly effective way of cleaning water. [11]

IV. SYSTEM AND ARCHITECTURE

The Eco Marine Trash Collector system is made to pick up trash that is floating in calm bodies of water like ponds, lakes, and harbors. The system's design includes both hardware and software that work together to find, pick up, and keep an eye on trash. The Raspberry Pi 3 is the main part that controls everything. It runs everything, like streaming video from the camera, controlling the motors, and talking to the user interface.

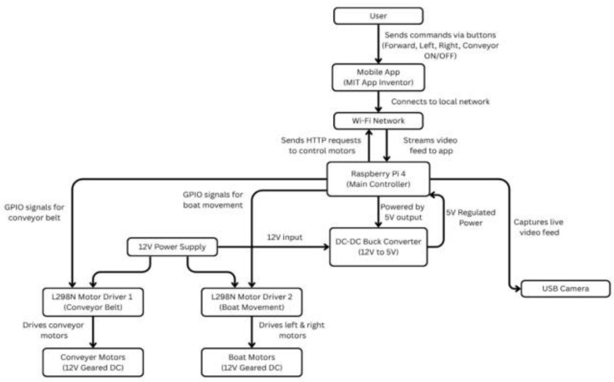

Fig 1. Block diagram

Fig. 1 illustrates the working of the Eco Marine Trash Collector system, which gives an overview of the functional flow between the user, mobile application, Raspberry Pi controller, and the motors.

The operation starts with a command sent by the user via a mobile application interface developed on MIT App Inventor. Under this circumstance, both the application and the Raspberry Pi are connected to the same Wi-Fi network to enable real-time wireless communication.

When any of these control buttons on the app-such as Forward, Left, Right, Stop, or Conveyor ON/OFF-is pressed, the command gets transferred as an HTTP request via Wi-Fi to the Raspberry Pi. The Raspberry Pi functions as the central controller , receiving these commands and further processing these signals to generate a corresponding control signal.

The Raspberry Pi is connected with two H-bridge (L298N) motor drivers. One of the drivers is dedicated to control the motors responsible for the movement of the boat, and the other one is used for the motors that power the conveyor belt. According to the operation request it receives, the Raspberry Pi sends appropriate GPIO signals to the respective motor driver for the required action to be performed, moving the boat in some direction or activating the conveyor mechanism.

The camera module connected to the Raspberry Pi onto the mobile application continuously streams live video ; thus, users can monitor the surface of the surrounding water instantaneously and manually set the system in motion with better precision.

The entire setup runs on a 12V power supply, the same battery feeds the DC–DC buck converter to deliver a steady 5V for the Raspberry Pi. This ensures the power supplied is accurate for the motor drivers during operation.

It follows that the block diagram represents the flow of data and control signals, whereby the user issued commands are converted into physical action by the boat and conveyor mechanisms, with live video feedback supporting proper manual control.

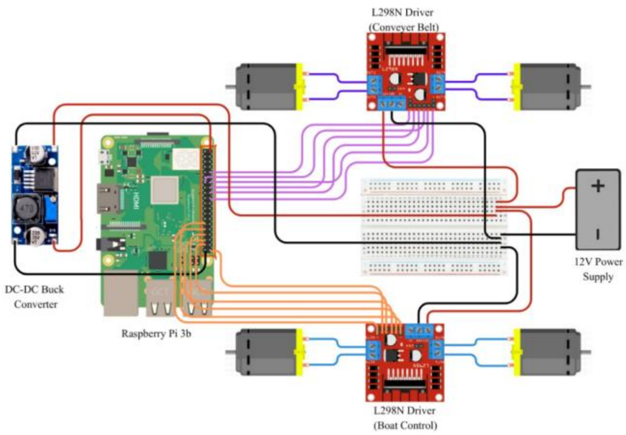

Fig 2. Circuit diagram

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This is the circuit connection for the Eco Marine Trash Collector system. Figure 2 shows the interconnection of the different components: Raspberry Pi, motor drivers, DC motors, DC–DC buck converter, and power supply. This permits smooth and coordinated functioning of the boat and the conveyor mechanism within it.

The system is powered by a 12V DC supply that feeds into both the motors and the controller. This is further connected to a DC–DC buck converter, which offers a regulated output at 5V to power the Raspberry Pi. In this way, it is ensured that Raspberry Pi has an incoming regulated power supply, hence saving it from voltage fluctuations.

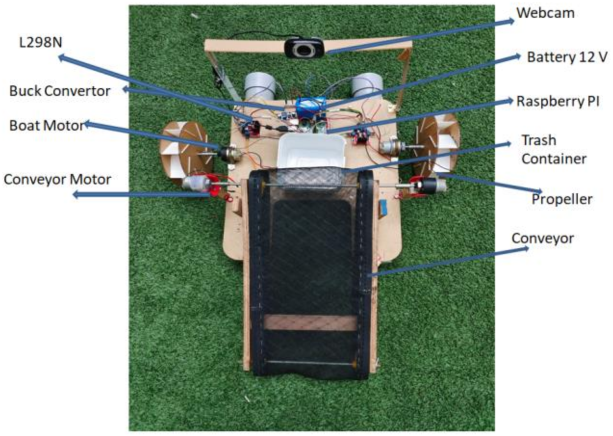

Fig 3. Eco Marine Trash Collector Model

The central part of the circuit is occupied by the Raspberry Pi 3B, which is used as the main controller of the system. It processes commands received from the MIT App Inventor mobile interface and gives out control signals to the motor driver modules through its GPIO pins. There are two L298N motor driver (H-Bridge) modules connected in this setup, one for the boat propulsion motors and the other for the conveyor belt motors. Motor drivers act as an interface between low-power control signals from the Raspberry pi and high-current requirements of DC motors.

The first L298N motor driver controls the movement of the propeller, driving both left and right DC motors for forward, left, and right movements. The second L298N driver is used for the conveyor belt mechanism that picks up the marine litter and transfers it to the collection container. The drivers draw power directly with 12V from the power supply in order to provide sufficient torque to the motors, while the operation logic is driven by a Raspberry Pi via GPIO outputs.

The 12V geared DC motors are the type of DC motors used for both the conveyor and propulsion systems. Due to their high torque, low-speed characteristics, these motors are well suited for stable operation in water and optimal collection of trash.

In the circuit, a breadboard is utilized as a connection hub to which power and ground lines are connected to feed all components neatly. It helps in organizing the circuit and simplifying the wiring layout.

Additionally, the camera module is interfaced with the Raspberry Pi using the USB interface. This provides a live video feed to the mobile application for the user to monitor in real time the movement of the boat and its surroundings. The camera source its power from the Raspberry Pi 5V supply.

The whole circuit, therefore, integrates power management, control operations, and mechanical actuation in a coordinated manner. In operation, upon powering, the Raspberry Pi receives control commands from the mobile app via Wi-Fi, analyzes them, and activates the motors through the motor drivers to control the movement of both the boat and the conveyor mechanism. This structure assures that all parts interact cohesively to accomplish a stable, remotely operated, and eco-friendly method of trash collection.

V. MOBILE APPLICATION INTERFACE

The Eco Marine Trash Collector system is controlled through a mobile application developed in MIT App Inventor. An application enables user interaction with system to allow the boat and its conveyor mechanism, through Wi-Fi communication to the Raspberry Pi controller, to function remotely from the controlling device. An intuitive and friendly layout of the app includes direction control buttons and options for the control of the conveyor, as shown in Fig.4

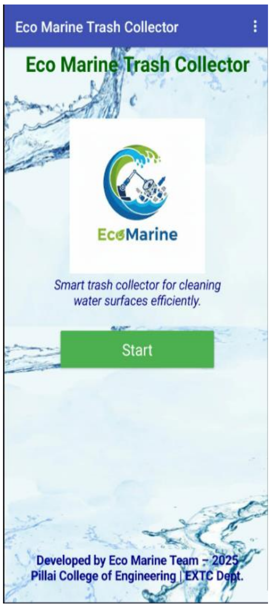

Fig 4 App Interface Screen 1

Fig 4 App Interface Screen 1 acts as the primary interface, featuring the project logo along with a short description of the systems function. It includes a Start button on first screen interface for quick access to the control panel thus enhancing usability and interaction. The design is simple and streamlined providing users easy navigation during real-world operation.

The main control panel of the application consists of buttons - Forward, Left, Right, and Stop, which allow the user to operate the boat in still water as needed. Besides these, two buttons, labeled Conveyor On and Conveyor Off, have been provided for operating the conveyor belt system in charge for picking up

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the floating garbage. It also includes a Back to Home Screen button for easy access to home screen.

All the necessary instructions are sent from the mobile application to the Raspberry Pi using a local Wi-Fi network, which allows for low-latency communication. The Raspberry Pi will process these commands further and accordingly trigger the motor drivers to control the motion of the boat and the operation of the conveyor.

Fig 5. App Interface Screen 2

Additionally, the system is interfaced with a live video streaming feature to view surroundings and movement of the boat in real time. The video feed is captured by a USB camera connected to the Raspberry Pi, which streams directly to the application screen. This live feed enhances the precision of manual control, making the trash collecting job truly effective without the need for physical supervision.

The general design of the mobile interface focuses on simplicity, real-time responsiveness, and operational reliability suitable for the environmental monitoring and waste collection industry.

The mobile application interface of the Eco Marine Trash Collector consists of simple and well-labeled control buttons for easy operation. The Forward, Left, Right, and Stop buttons allow the user to manually navigate the boat in still water. The Conveyor On and Conveyor Off buttons control the conveyor belt mechanism, enabling the user to start or stop trash collection as required. All these commands are transmitted to the Raspberry Pi via Wi-Fi, which then drives the corresponding motors through the motor drivers. A live video feed from the onboard camera is also displayed above the control buttons, helping the user to monitor the surroundings of the boat in real time while operating the system.

VI. APPLICATION

The Eco Marine Trash Collector system has a wide range of applications in environmental cleanup and waste management. Its compact design, low cost, and semi-automated control make it suitable for various real-world scenarios. Some major applications include: Lakes and Ponds:

Effective for collecting floating waste such as plastic bottles, wrappers, and leaves from still water surfaces in public or private lakes and ponds.

1. Harbors and Docks: Can be used to maintain cleanliness in small harbors, boat parking zones, and dock areas where waste accumulation is common.

2. Water Treatment Plants: Useful for removing surface debris before filtration or treatment processes, preventing system blockages.

3. Industrial and Residential Water Reservoirs: Helps keep storage or cooling water reservoirs clean by removing surface pollutants and debris.

4. Environmental Monitoring and Research: Can assist research institutions and environmental agencies in studying pollution patterns and testing cleanup technologies.

5.Municipal Waste Management: May be deployed by local authorities for regular maintenance of urban water bodies, reducing manual labor and operational costs.

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