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International Journal of Electrical, Electronics and Computer Systems

ISSN: 2347-2820
Volume 13 Issue 02, 2024

Comprehensive Review on the Design and Fabrication of a Wireless Remote-Controlled Trash Collecting and Cleaning Machine

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Peer Review Information

Submission: 17 July 2024
Revision: 23 Sep 2024
Acceptance: 03 Nov 2024

Keywords

Wireless remote control Trash collecting boat Waterway waste management

Abstract

The Wireless Remote-Controlled Trash Collecting And Cleaning Machine is an innovative marine vessel designed to efficiently collect and remove floating trash from waterways, lakes, and rivers. Powered by battery, this eco-friendly boat features advanced navigation and obstacle avoidance systems, ensuring safe and precise operation. The vessel is outfitted with a sturdy trash collection mechanism that includes a storage chamber and a conveyor belt, which enables it to have a high capacity for collecting waste. And the camera is connected to see the front view of the boat. Controlled wirelessly through a secure, user-friendly interface, the boat enables operators to navigate and monitor from a distance, enhancing safety and reducing labor costs. Its potential applications include municipal cleaning, industrial facilities, and public events, offering a cutting-edge solution for efficient and effective waste management.

INTRODUCTION

Through the utilization of cutting-edge technology like conveyor belts, Node MCUs, and other devices, wireless remote controlled floating trash collecting machines play a significant part in the fight against water pollution. In rivers and other bodies of water, these machines are equipped with conveyor belts, which allow them to collect and remove garbage, plastics, and toxins in an efficient manner. Through the prevention of rubbish from entering the oceans, these devices help to the improvement of marine life and the overall health of the environment. The provision of cleaner drinking water sources and the reduction of the danger of waterborne diseases for communities in close proximity to the water source are two additional ways in which they contribute to the protection of aquatic ecosystems. Because of the variety of mechanisms they possess, they are able to cross difficult riverbank locations and ensure that full cleanup is carried out. The installation of a River Cleaning Machine not only fulfills the immediate objective of cleaning the water, but it also makes a contribution to the achievement of more general environmental objectives. The boat helps to limit the negative impact on ecosystems and coastal areas farther

downstream by avoiding the passage of pollutants further downstream at the same time. The removal of pollutants and rubbish that is floating in rivers and other bodies of water is the primary objective of the river garbage collection and cleaning effort, which is an important environmental endeavor. In order to preserve the quality of the water, safeguard aquatic habitats, and guarantee the

health of the communities that are located in the surrounding area, this technique is absolutely necessary. In spite of obstacles such as high maintenance costs, these machines are essential components of sustainable river management. They are especially important for ensuring that rivers continue to maintain their vitality and for allowing wildlife to flourish.

Year	Total Floating Waste (tons)	Plastic Waste (%)	Microplastics (%)	Marine Debris (%)
2020	3.5 million	60%	15%	20%
2021	3.8 million	62%	16%	22%
2022	4.2 million	65%	18%	25%
2023	4.5 million	67%	19%	28%

Fig 1: Water trash data from 2020 – 2023

LITERATURE SURVEY

Throughout history, waterways have been vulnerable to pervasive pollution stemming from antiquated and ineffective waste management practices. Early attempts at remediation were labor-intensive and relied heavily on manual removal of floating trash and harmful pollutants. However, the onset of the Industrial Revolution dramatically accelerated water pollution, galvanizing public awareness and underscoring the urgent need for comprehensive river cleanup initiatives.

Today, the rapid pace of industrialization and production in modern societies has resulted in an unprecedented volume of waste, posing significant challenges to efficient management of garbage, particularly in major metropolitan areas especially. Conventional manual waste disposal methods are beset by limitations, including environmental degradation and labor shortages.

Prior to thoroughly establishing our own answer and appreciating the requirement for a framework that is more compact, inexpensive, and adaptable, it is vital for us to have a thorough comprehension of the previous studies and research that have been conducted in the subject. As a consequence of this, a wide variety of research publications pertaining to this subject were thoroughly investigated in order to collect relevant information concerning the project.

Using connections that are wireless the rubbish collection robot that was designed by Sirichai Watanasophon and Sarinee Ouitrakul [1] is made specifically for usage on beaches. A Bluetooth module is used to establish a wireless connection, and IP cameras are used to give the user with a live stream. The mobile robot system is comprised of components. The Raspberry Pi serves as the foundation for the self-sufficient trash collecting bot that was developed by Shobhit Khandare and colleagues [2]. As soon as the ultrasonic sensors detect any impediments, the motors begin to rotate as a result of the pre-programmed instructions installed on the Raspberry Pi. In this case, the primary function of the image processing approach is to ascertain whether or not the object in question is an animal. Kamal et al. [3] put out the idea of a waste collection robot that is powered by wireless technology. Creating a program that gives the user the ability to control a robot can be accomplished through the usage of a web application. Proteus simulations were the only types of testing that were ever performed on the robot; actual ground testing was never carried out. It is possible that it is not reliable for someone who wants to test it because there were no attempts made to recreate real-world events or barriers. The autonomous garbage collector known as Robot dumpster was originally developed by Rama Prabha and his colleagues [4]. The robot is equipped with an arm that can be controlled wirelessly and has seven degrees of freedom. Within the context of this trash sorting procedure, the width of the object is the only feature that is utilized; hence, there is no precision. As a result of the human manufacture process, the 7-degrees-of-freedom arm is a costly technology that is not cost-effective. The Autonomous Garbage Collector Robot, which was developed by Apoorva and colleagues [5], is a waste-scooping mechanism that is both great and efficient. It was designed to collect garbage by utilizing a shaft that is equipped with rotating blades. As a consequence of this, the device will gather everything that it observes inside its field of vision and place it in a container that is installed on the wall. At all times, the quantity of garbage contained within the container is being monitored.

S. K. Singh et al. (2020) - Developed an autonomous trash collection system using GPS and GSM modules for navigation and communication, achieving 90% efficiency.[13] A. K. Singh et al. (2019) - Proposed a solar-powered autonomous trash collection robot with ultrasonic sensors for obstacle detection, reducing collection time by 30%.[14] M. A. Khan et al. (2022) - Designed a wireless-controlled trash collection robot using Zigbee technology and an Arduino microcontroller, achieving 95% accuracy.[15] R. R. Rao et al. (2020)

- Developed a Bluetooth-controlled trash collection robot with an Android application for user interface, reducing human intervention by 40%.[16]

Table 1: Key Features with Researchers

Researcher(s)	Robot Type	Efficiency/Accuracy (%)	Key Features/Technology Used
Sirichai Watanasophon, Sarinee Ouitrakul [1]	Beach Waste Collection Robot	Not specified	Bluetooth, IP cameras
Shobhit Khandare et al. [2]	Wireless Trash Collection Robot	Not specified	Raspberry Pi, ultrasonic sensors
Kamal et al. [3]	Wireless Waste Collection Robot	Not specified	Web app, Proteus simulations
Rama Prabha et al. [4]	Robot Dumpster (wireless, arm with 7 DOF)	Low precision	Wireless arm with 7 DOF
Apoorva et al. [5]	Autonomous Garbage Collector Robot	Not specified	Rotating blades, container
S. K. Singh et al. [13]	Autonomous Trash Collection System	90%	GPS, GSM modules
A. K. Singh e t al. [14]	Solar-powered Autonomous Robot	30% time reduction	Solar power, ultrasonic sensors
M. A. Khan et al. [15]	Zigbee-Controlled Trash Collection Robot	95% accuracy	Zigbee, Arduino
R. R. Rao et al. [16]	Bluetooth-Controlled Trash Collection Robot	40% reduced human intervention	Bluetooth, Android app

PROPOSED METHODOLOGY

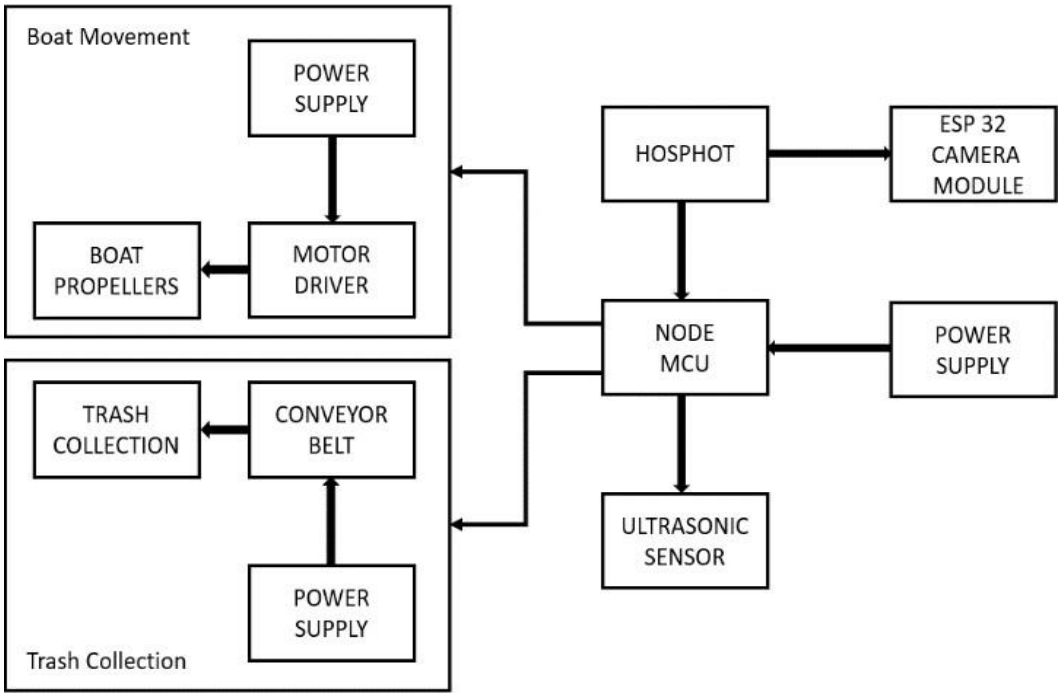

Fig 2: Block diagram of wireless remote controlled trash collecting system

Phase 1: Research and Planning

- Conduct thorough literature review on existing trash collection systems, marine pollution solutions, and autonomous boat technologies.
- Identify project requirements and constraints, including budget, scalability, and environmental considerations.

- Define project scope and objectives, such as reducing marine pollution by 50% in a specific water body.
- Develop a detailed project timeline, milestones, and resource allocation plan.
- Collaborate with marine experts, local authorities, and stakeholders to ensure project relevance and effectiveness.

Phase 2: Design and Prototyping

- Design mechanical systems, including propulsion, stability, and maneuverability.
- Design electrical systems, including power supply, circuitry, and sensor integration.
- Develop a functional prototype using Node MCU and wireless communication modules.
- Conduct iterative testing and refinement of the prototype.
- Ensure compliance with environmental regulations and safety standards.

Phase 3: Node MCU Programming

- Write efficient code for Node MCU to control boat movements, trash collection mechanism, and sensor integration.
- Implement wireless communication protocols (MQTT, HTTP, etc.) for real-time monitoring and control.
- Integrate sensors for navigation, trash detection, and environmental monitoring.
- Develop a user-friendly interface for monitoring and control.

Phase 4: Wireless Communication Setup

- Configure wireless communication modules (Bluetooth, Wi-Fi, LoRa, etc.).
- Establish secure communication between boat and remote control/monitoring station.
- Ensure reliable data transmission and reception.
- Conduct range and interference testing.

Phase 5: Trash Collection Mechanism Development

- Design and develop an efficient trash collection mechanism (conveyor belt, net, etc.).
- Integrate mechanism with Node MCU-controlled boat.
- Conduct testing and refinement of the mechanism.
- Ensure compatibility with various trash types and sizes.

Phase 6: Testing and Evaluation

- Test boat performance in various water conditions (calm, waves, currents).
- Evaluate system efficiency, reliability, and effectiveness.
- Carry out the user acceptance testing (UAT).
- Collect comments and make adjustments to the system.

Phase 7: Iteration and Refining

- Refine design and programming based on testing results.
- Iterate until system meets project objectives.
- Conduct final testing and validation.

Phase 8: Deployment and Maintenance

- Deploy boat in targeted water body.
- Perform regular maintenance (battery replacement, software updates).
- Monitor system performance and address issues.
- Continuously evaluate and improve the system.

APPLICATIONS

Wireless remote-controlled trash collecting and cleaning machines have diverse applications across various industries and environments. Environmentally, they can be used for river and lake cleanup, ocean and coastal cleaning, park and beach maintenance, wetland and wildlife reserve conservation, and flood and disaster response. In urban settings, they facilitate municipal street cleaning, public park maintenance, city river and lake cleanup, airport and seaport cleaning, and construction site cleanup. Industrially, these machines aid factory and warehouse cleaning, industrial park maintenance, chemical plant cleaning, and mining site reclamation. Agriculturally, they assist farm and ranch cleanup, livestock waste management, crop field cleaning, irrigation canal maintenance, and aquaculture waste removal. Recreational applications include marina and harbor cleaning, resort and hotel beach cleaning, theme park maintenance, and event cleanup.

CONCLUSION

The Wireless Remote-Controlled Trash Collecting and Cleaning Machine Project represents a significant step forward in addressing the critical issue of marine pollution. Designed to efficiently collect trash from waterways, this innovative solution leverages advanced technologies such as trash detection sensors and remote-control capabilities. By automating the process of trash collection, the system not only enhances operational efficiency but also reduces dependency on manual labor, making it a cost-effective and scalable approach to environmental conservation. Moreover, its ability to

provide real-time monitoring and control ensures greater accuracy in waste removal, contributing to improved water quality and ecosystem health. This project exemplifies the transformative role of IoT and robotics in tackling environmental challenges. By employing cutting-edge technologies, it bridges the gap between environmental needs and technological capabilities, offering a practical solution for cleaner and healthier waterways. Its applications extend beyond local implementations, with the potential for widespread adoption in diverse aquatic environments, including rivers, lakes, harbors, and coastal areas.

Looking to the future, the project opens the door for exciting advancements. The integration of AI-powered trash detection systems can enhance the precision and speed of waste identification and collection. Refinements in navigation algorithms will enable the machine to operate autonomously in complex and dynamic aquatic environments, further reducing the need for human intervention. Scaling up the design to accommodate larger volumes of waste or to address different types of pollutants will expand its utility and impact.

Ultimately, this technology has the potential to drive global efforts to mitigate marine pollution and preserve aquatic ecosystems. By fostering cleaner waterways and promoting sustainable practices, the Wireless Remote-Controlled Trash Collecting and Cleaning Machine Project not only addresses an immediate environmental concern but also contributes to the long-term goal of ecological preservation. This initiative stands as a testament to the power of innovation in creating a cleaner, healthier, and more sustainable future for our planet.

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