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Coastal Guardian Detection

Abhishek. I. Benjamin[1], Aditya Batkamwar[2], Aditya Sarkar[3], Gautam Kumar[4], Aashish.I. Benjamin[5], Prof. Manoj Chittawar[6]
Computer Science Engineering Department[1-6]
Rajiv Gandhi College of Engineering, Research and Technology Chandrapur,
Dr. Babasaheb Ambedkar Technological University Lonere Maharashtra, India

Abstract: *The* Coastal Guardian Detection *system is an innovative project aimed at addressing the growing issue of water pollution in coastal regions. This project involves the development of an intelligent waste collection boat equipped with both automated and manual operational modes. The boat features a built-in waste collection mechanism that efficiently gathers floating debris from the water surface and directs it into an attached waste container for storage. To enhance its functionality, the system integrates an ultrasonic ranger to measure distances and ensure safe navigation. Additionally, a human detection sensor is incorporated to identify the presence of individuals in the vicinity, enhancing safety and enabling real-time monitoring. The detected human activity is displayed on a radar interface, providing situational awareness to the operator. This hybrid system, combining waste management with detection capabilities, offers a practical solution for maintaining cleaner coastlines and promoting environmental conservation.*

Keywords: Waste Collection Boat, Ultrasonic Ranger, Human Detection Sensor, Automatic and Manual Operation, Environmental Monitoring

I. INTRODUCTION

Water pollution in coastal areas is a growing concern due to the increasing amount of floating waste such as plastic bottles, wrappers, and other non-biodegradable materials. These pollutants not only affect marine life but also degrade the natural beauty and ecological balance of coastal regions. Manual waste collection methods are often inefficient, labor-intensive, and pose safety risks. To tackle this issue, we propose the Coastal Guardian Detection system — an intelligent and semi-autonomous waste collection boat designed to clean floating debris from coastal waters. The core functionality of this system revolves around an innovative mechanism that collects waste from the surface of the water and directs it into an onboard storage container. This mechanism is designed to function in both automatic and manual modes, providing flexibility depending on environmental conditions and user preference.

In automatic mode, the system navigates and collects waste on its own, while in manual mode, operators can control the boat directly. An ultrasonic ranger is integrated into the system to measure distances, helping the boat avoid obstacles and navigate safely. This enhances the efficiency of the system by ensuring smooth operation in varying water conditions. In addition to waste collection, the boat is equipped with a human detection sensor. This sensor identifies the presence of people in or near the water and displays their location on a radar interface. This feature adds a layer of safety and monitoring, making the system not only effective in cleaning but also in ensuring human awareness and protection.

The Coastal Guardian Detection system is designed to be eco-friendly, cost-effective, and scalable. It aims to provide a sustainable solution to coastal waste management using automation and sensor-based technology. By integrating modern electronics with environmental awareness, this project contributes to cleaner coastlines, reduced pollution, and improved marine ecosystem health. Overall, the system presents a practical approach to modern environmental challenges and demonstrates how technology can be effectively used for ecological conservation.

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II. LITERATURE REVIEW

Recent studies show that over 11 million metric tons of plastic waste enter the oceans annually [1]. In response, several autonomous systems like ClearBot and WasteShark have been developed, demonstrating successful waste collection in coastal waters with efficiency rates of up to 80% in controlled environments

[2].Ultrasonic sensors (e.g., HC-SR04) are widely used for distance measurement due to their accuracy in detecting obstacles within a range of 2 cm to 400 cm [3]. The formula used for distance calculation is:

Distance=Time×Speed of Sound2\text{Distance} = \frac{{\text{Time} \times \text{Speed of Sound}}}{2}Distance=2Time×Speed of Sound

This ensures smooth and collision-free navigation. For human detection, sensors like PIR (Passive Infrared) and IR modules can detect body heat and motion within a range of 5–10 meters, adding safety features to the system [4]. These inputs can be represented as:

Hd=f(IR,PIR)H_d = f(\text{IR}, \text{PIR})Hd=f(IR,PIR)

where HdH_dHd = Human detection signal.

Radar interfaces enhance situational awareness by mapping detected humans or obstacles onto a screen, improving manual control and operator feedback. By integrating ultrasonic ranging (Ur)(U_r)(Ur), human detection (Hd)(H_d)(Hd), and radar visualization (Rv)(R_v)(Rv), the Proposed Coastal Guardian

Detection system combines multiple Existing technologies into a unified platform for effective marine waste management.

III. PROBLEM STATEMENT

Water pollution in coastal and marine environments has become a major global concern due to the increasing volume of floating waste, particularly plastic and other non-biodegradable materials. These pollutants not only endanger marine life and disrupt aquatic ecosystems but also contribute to long-term environmental degradation and health hazards for nearby communities. With coastal areas serving as hubs for tourism, fishing, and biodiversity, maintaining their cleanliness and ecological balance is crucial. Currently, most coastal waste collection is carried out using manual methods, which are time-consuming, labor-intensive, and limited in efficiency. Workers are often exposed to unhygienic and hazardous conditions, and cleaning large or inaccessible areas becomes a significant challenge. While a few automated solutions exist, they are either too expensive, lack flexibility, or do not address key safety concerns such as the detection of human presence in the operating area. Additionally, existing systems often lack intelligent sensing technologies and real-time monitoring. The absence of obstacle detection mechanisms such as ultrasonic sensors may lead to collisions or inefficient movement in water. Moreover, systems that do not detect human presence can pose safety risks during operation, especially in public or crowded water areas. There is a critical need for a hybrid (automatic and manual) waste collection system that can effectively navigate coastal waters, detect and collect floating waste, and ensure operational safety. Integrating technologies such as ultrasonic rangers for obstacle detection, human detection sensors, and a radar-based interface for real-time monitoring can significantly improve the safety, efficiency, and effectiveness of such a system. The Coastal Guardian Detection project aims to address this gap by developing a smart waste collection boat equipped with multi-sensor integration. The system is designed to automatically collect waste and store it in a container, while also allowing manual control when needed. By ensuring obstacle avoidance and human detection, it provides a safer, more efficient, and eco-friendly solution for managing coastal waste.

IV. WORKING

1) Waste Collection Boat: The boat detects floating waste and autonomously moves toward it. A vacuum suction mechanism draws the waste into the system, where it is separated and stored in a collection container. The process operates in both automatic and manual modes for flexible and efficient coastal waste removal.

2) Ultrasonic Ranger: In this model, the ultrasonic ranger is used to measure the distance between the boat and nearby obstacles or waste. It emits ultrasonic waves and analyzes the strength of the received signal to determine the proximity of objects. This helps the boat detect objects in its path, avoid collisions, and navigate safely toward the waste.

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3) Automatic and Manual Operations: Our waste collection boat is designed to operate efficiently with both fully automatic and manual control options. The automatic mode allows the boat to navigate and collect waste autonomously, utilizing advanced sensors and navigation systems to ensure precise operation even in challenging conditions. Meanwhile, the manual mode provides operators with the ability to control the boat through a user-friendly window interface, offering flexibility and safety during complex tasks or troubleshooting. This dual functionality enhances operational efficiency and safety, enabling seamless switching between modes based on real-time requirements. The integration of automation with manual control ensures reliable waste collection while reducing labor costs and minimizing environmental impact.

4) Alert Generation: In the Alert Generation system, when the radar detects a human, it triggers the model to activate a buzzer. The radar continuously scans the area; upon identifying human presence, it sends a signal to the model, which processes the detection. If confirmed, the model sends an output to activate the buzzer, producing an audible alert to warn of human detection.

5) Vacuum Suction Mechanism: In the Coastal Guardian Detection system, a vacuum suction mechanism is used to collect floating waste directly from the surface of the water. The vacuum creates a low-pressure zone that pulls in nearby water. As the water flows toward the suction inlet, any floating waste—such as plastic, paper, or organic debris—is carried along with it. This mixture is directed straight into a waste collection container mounted on the boat. Since the waste is mostly on the water surface, the vacuum effectively draws it in along with the top layer of water. The system is designedto ensure smooth flow and minimal blockage, making it efficient for real-time waste collection. This mechanism operates in both automatic and manual modes, offering flexibility based on environmental conditions. The vacuum suction method simplifies the collection process and helps in removing scattered and lightweight debris from coastal waters without the need for complex machinery.

6) Controlling Mechanism: The Coastal Guardian Detection model is equipped with both automatic and manual control modes to enhance flexibility and ease of operation. In automatic mode, the system independently detects and collects floating waste, directing it into the onboard container without the need for user input. To complement this, a custom-designed UI/UX interface has been developed for manual control. This interface allows the user to guide the boat's movement when needed, particularly for returning the boat to its starting position or navigating complex environments. The control system uses simple directional commands:

• L – Rotates the boat to the left
• R – Rotates the boat to the right

7) Radar: In the Coastal Guardian Detection model, a radar-based interface is implemented to enhance safety and situational awareness during operation. The radar system plays a key role in human detection around the boat. It continuously scans the surrounding area for the presence of any human activity or obstacles within its detection range. When the system detects a human presence, it immediately triggers an alert signal, such as a buzzer or visual alarm, to notify the operator. This is essential for preventing accidents or collisions, especially in crowded or sensitive zones near the coastline. The radar interface also visually represents the detection on the monitoring screen, allowing the user to view the position and distance of the detected object in real time. This mechanism is especially useful during manual mode or remote-control operation, ensuring that the boat does not approach or disturb people in the vicinity. It improves operational safety and adds an intelligent layer to the waste collection process. By integrating radar-based human detection with alert systems, the project ensures that both environmental and human safety concerns are addressed effectively during coastal waste collection operations.

8) Switch (Button): In our model, a power switch is installed to activate the entire system. When the switch is turned on, it provides electrical power to all components, including the ultrasonic ranger, human detection sensors, vacuum suction mechanism, radar interface, and control circuitry. The activation of the switch initiates the startup sequence, powering the microcontroller or embedded system that manages sensor operations and control logic. Once powered, the system automatically initializes sensor calibration routines and begins real-time monitoring. The ultrasonic ranger starts detecting obstacles, the human detection sensor begins scanning the surroundings, and the vacuum suction system prepares for operation. The user interface becomes active, allowing manual control inputs. This integrated power-up

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process ensures that all subsystems are synchronized and ready for autonomous or manual operation, providing a seamless and efficient startup procedure for the entire waste collection system.

V. FUTURE SCOPE

The Coastal Guardian Detection system has strong potential for future development and real-world application. With further improvements, the boat can be enhanced to cover larger areas using GPS-based path planning and AI-driven navigation. Integration of solar panels can make the system more energy-efficient and suitable for long-duration operations. Additionally, advanced sensors and cameras can be added for underwater waste detection, oil spill monitoring, and marine life observation. The data collected by the system can also be used for environmental analysis and policymaking. In the long term, a fleet of such autonomous boats could work collaboratively to clean large water bodies, contributing significantly to marine conservation and smart city initiatives.

VI. CONCLUSION

The Coastal Guardian Detection system presents a comprehensive solution to the growing issue of floating waste in coastal and marine environments. It features an intelligently designed autonomous boat equipped with integrated sensors and control mechanisms to ensure efficient and safe waste collection. The ultrasonic ranger plays a vital role in obstacle detection by accurately measuring the distance between the boat and surrounding objects, allowing for smooth and collision-free navigation. The system also incorporates human detection technology, which enhances safety by identifying the presence of individuals near the operating area. Detected humans are displayed on a radar interface, and an alert system (such as a buzzer or visual cue) is activated to prevent accidents or interference during the cleaning process. The vacuum suction mechanism draws waste-laden water toward the boat, effectively capturing floating debris and directing it into an onboard container. This direct collection method ensures that the operation remains clean, efficient, and continuous. To accommodate different operational needs, the system supports both automatic and manual control modes. A user-friendly

UI/UX interface allows remote control of the boat, including directional inputs for steering and returning the boat to its initial position. This project demonstrates a smart, eco-friendly, and scalable approach to waterway maintenance by combining automation, sensing technology, and practical design.

REFERENCES

[1] Kumar, Sudhanshu, et al. \"Wireless Controlled Lake Cleaning System.\" International Conference on Intelligent Computing & Smart Communication 2019. Springer, Singapore, 2020.

[2] Nagesh, Bh, Mr M. Upendra, and Ms T. Hadassah.\"Innovative and novel concept in river surface cleaning using river trash skimmer of zero emissions–its implementation, approach & methodology.\" Journal of Offshore Structure and Technology 6.3 (2020).

[3] Niu, Guanchong, et al. \"SuperDock: A Deep LearningBased Automated Floating Trash Monitoring System.\" 2019 IEEE International Conference on Robotics and Biomimetics (RO BIO). IEEE, 2019.

[4] Yazdi, J. \"Water quality monitoring network design for urban drainage systems, an entropy method.\" Urban Water Journal 15.3 (2018).

[5] Hossain, S., Debnath, B., Anika, A., Junaed-Al-Hossain, M.,Biswas, S., & Shahnaz, C. (2019). Autonomous Trash Collector Based on Object Detection Using Deep Neural Network. IEEE Region 10 Annual International Conference.

[6] P. Elavarasi1, S. A. Meenuppriya2, M. Monira3, P. Priya4, P. Reni5. “Artificial Intelligence Enabled Robotic Trash Boat to Drive and Harvest Floating Trash from Urban Drain” 2020 IJESC.