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Design and Development of Arduino based Unmanned Ocean Debris Collecting Vehicle

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Abstract*—This paper presents the development of a waste collection device for ocean surface cleaning. Key considerations in designing such oceanic robots revolve around cost-effectiveness, durability, and resilience to harsh marine conditions. To address these challenges, we devised a square- base structure for the device, enhancing stability and maneuverability to efficiently gather floating waste across the ocean surface. A motorized conveyor belt system was incorporated to facilitate waste collection, seamlessly transferring it into a plastic container affixed to the platform. This design optimizes waste removal efficiency while conserving space, accommodating large volumes of waste within a compact footprint. The robust yet lightweight construction ensures the device can support substantial loads, including the collected waste, conveyor system, and electronic components. To safeguard against water damage, electronic circuits and motors are strategically positioned on the platform. Devices such as Arduino, motors, motor drivers, and Bluetoothmodules are used to control the device. The device is capable of handling up to 3 kg of trash, fulfilling the primary objective of creating a versatile equipment operable in diverse marine environments.

Keywords - Ocean surface waste collection, Robust marine equipment, Compact waste storage, Durability in marine environments

I. INTRODUCTION

The ocean is the largest ecosystem on Earth and contains 94% of the entire planet's wildlife. Ocean pollution has devastating effects on marine life and ecosystems. For example, plastic items can harm animals causing suffocation,entanglement, laceration, infections and internal injuries. 17% of the species affected by the presence of plastic in the ocean are on the International Union for Conservation of Nature Red List of Threatened Species. The increasing pollution of our oceans with plastic waste is a pressing global issue. It not onlyposes a threat to marine life but also impacts human health and the economy. To address this problem, we have developed a waste collection device tailored for ocean surface cleaning. Our project is inspired by existing solutions but introduces several innovations to improve efficiency and adaptability. The device uses a conveyor belt system for waste collection and two propellers for manoeuvring. The square box design provides ample space for waste collection, and the manoeuvring is controlled using two propeller motors. These motors are connected to an Arduino Uno, which is in turn connected to a Bluetooth module. This allows the device to be controlled via amobile application, offering a user-friendly interface for manoeuvring the device.

The future scope of this project includes many new specifications such as camera controlling, range extending,more load capacity, heavy duty toughness and more. These enhancements will further improve the device's efficiency and versatility, making it an even more powerful tool for ocean surface cleaning. The device's design revolves around key considerations such as cost-effectiveness, durability, andresilience to harsh marine conditions. This includes the collected waste, the conveyor system, and the electronic components. To safeguard against water damage, we havestrategically positioned the electronic circuits and motors on the platform.

That is, this project represents a significant step towards addressing the global issue of ocean pollution. Day by day the waste in ocean increases hence the need of waste removal is mandatory. By leveraging technology and innovative design, we can make a positive impact on our environment and pave the way for a cleaner, healthier planet. Also, this project can be implemented for large scale operations, which helps aquatic animals' life. We look forward to the future enhancements of this project and the potential they hold for improving ocean surface cleaning and by that we can conserve nature.

II. LITERATURE SURVEY

A.Design and Development of Ocean Debris Collecting Unmanned Surface Vehicle and Performance Evaluation of Collecting Device in Tank(2022, Jonghyun Ahn, Shunsuke Oda, Shota Chikushi, Takashi Sonoda, Shinsuke Yasukawa)

In recent years, the oceans debris is increased because of human's activity. Especially, the plastic debris, such as plastic bottles, is not biodegradable, and therefore those are creating serious environmental problems. The ocean debris collecting in the world is done through volunteer activities. However, these activities require a lot of time and labor. In this research, we proposed a method of ocean debris collecting USV operation method. Also, we designed and developed a USV (Unmanned Surface Vehicle) for the purpose of autonomous oceans debris collecting mission and evaluated the developed ocean debris collecting device. In the development of USV, electronic parts, which are to operate the mission autonomously, were selected.Then, each electronic part was placed inside the waterproof box according to the designed power and communication system diagram. In the development of oceans debris collecting device, we designed a belt conveyor type device. A motor was selectedto rotate the device and a decelerator, which used the planetarygear mechanism, was designed. To evaluate the performance ofthe developed ocean debris collecting device, we tested various types of plastic bottles in tank environment. As a result of the experiment, the developed USV collected various types ofplastic bottles with a 47.7% probability.

B.Ocean Surface Trash Collector(2020, Shrikant Somal,Ghanashyam Phadke, Praful Gaikwad, Sagar Gavade,Mahesh Mane)

This paper describes the design of a robot for collecting waste floating on the water surface. Three important issues fordesigning the aquatic robots are a cost-effective solution along with robustness and durability. Due to the nature of the cleaningwork, we designed the robot structure with car like mechanism that can provide high stability, good ability in maneuver andcan easily collect all the waste flowing on the water. The plasticpipe container works best for this case and fulfils all structuralstability criteria. For collection of waste, a motor drivenconveyor belt has been designed for collecting the wastes anddeploy it into a plastic box connected to the platform. Thisdesign provides simple and effective waste removal and accommodates large amounts of waste within a little space.This light-weight and tough structure support the total weightof the collected waste, conveyor as well as the hardware components used. The rotating arms system based a differential drive mechanism has been designed, which allows the robots torequire a 360 turn on the spot and provides high thrust.Electronic circuit and motors have been placed on the platform,in order to protect them from water. The robot is automatically controlled by Arduino, sensors, motor driver, GPS and GSM modules. The testing of the robot prototype proved to be effective in waste collecting and getting back to the way-point.The maximum trash loads that robot can bear is up 5 kg. The main aim of the project is to optimize time, energy and overallprocess speed.

C.Ocean Waste Collection Technology(2023, Ms Geetanjali Rokade, Mrs. Laxmi Kale, Mrs. Sphurti Deshmukh)

With the increase in population and rising consumption the need for implementation of proper waste collection facilities rises. This need can especially be seen in the water bodies wheredisposal of waste is at high levels and poses a threat to the environment and the living organisms in water. The motive of this paper is to study the various currently employedtechnologies related to ocean surface waste collection and propose a new methodology for the sunken waste. Following steps were taken to write this paper: 1) Analyzed the current situation, 2) Identified the main approaches and technologies related to the cleaning and collection in various water bodies, 3) Listed the various electronic equipment, 4) Identified the research gaps. Based on all the research that we went through now we are proposing a new methodology which is filling the voids in the existing technologies.

D.Automated Trash Collector Design(2019, Hirdy Othman, Mohammad Iskandar Petra, Liyanage Chandratilak De Silva, Wahyu Caesarendra)

The objective of this paper is to study, analyze and investigate the main contributor of plastic pollution which has become the world major infamous problem nowadays, and to explain our platform design which

aim to help in reducing the issue of floating trash. Annually, more than 2 million tons of plastics have been tossed to water body and eventually washedaway to the sea. Not just living marine organisms become targets and carrier of harmful viruses but some of marine animals suffera direct mortality after plastic ingestion. Numerous negative impacts of plastic pollution to the environment and the society had been identified. This study shall include the methodology; classification of trash cleaning systems as well as the efforts to tackle this problem. Static and dynamic systems have been categorized to distinguish their effectiveness. As for this paper,the proposed design will be focusing on dynamic system which is fully autonomous. It is a multi-functional design which incorporated with different types of sensors. This paper also emphasizes the novelty and uniqueness of the proposed designas compared to existing ones; in terms of architecture and its functionality.

E.Autonomous Underwater Vehicle in Ocean Wastes Cleanup(2020, Aaron Don M. Africa, Gregory James Pe,Bianca Clarisse Tan)

As the world of technology continues to evolve, innovations and programs are integrated into the societal problems that the world is facing today. As robotics has opened a new chapter in the world of technology, there are so many ways to integrate this innovation and develop it to help solve the social and economicissues occurring, this paper emphasizes on how significantAutonomous Underwater Vehicles are in this world today as it aids in marine monitoring which can help in discoveries and marine protection. This paper also focuses on the function, system, and significant features of an Autonomous Underwater Vehicle. For the function the brief and most basic materials and software to develop the body of the device is studied, the system and process of data acquisition are covered, and the new and probable improvements that can be done shortly are also included in this paper. This study aims to establish the fundamental knowledge, the main functions, and the system ofan Autonomous Underwater Vehicle.

F.Autonomous Navigation of the Surface Autonomous Vehicle for Emergency Rescue (SAVER)(2021, Andrewskow)

Once dropped into the ocean, SAVER will autonomously navigate towards the Advanced Next-Generation Emergency Locator beacon, worn by every NASA astronaut, that emits a 121.5 MHz distress signal. Using a rotating directional loop antenna SAVER is able to detect and identify the direction of the distress beacon and navigate itself towards the signal source. The autonomous navigation system is dependent on several electrical, and mechanical systems to function properly and presents a novel system engineering problem. Given testing limitations, NASA requires that SAVER is designed to operateindoors and with an umbilical power supply. The radio direction finding (RDF) system demonstrated the ability to accurately identify the direction of a 121.5MHz distress signal. Upon completion, SAVER demonstrated the ability to accurately navigate towards a distress signal with approximately a 50% success rate when starting in the forward direction. Unsuccessful tests were primarily caused by mechanical issues with theantenna rotator and power cable.

G.SMURF: A Fully Autonomous Water Surface Cleaning Robot with A Novel Coverage Path Planning Method (2022, Jiannan Zhu , Yixin Yang and Yuwei Cheng)

In recent years, more attention has been paid to water surface environment protection. Current water surface waste cleaning mainly relies on manual operations, which are low-efficiency and dangerous. Therefore, in this paper, we design a fully autonomous water surface cleaning robot, SMURF, which achieves high-efficiency water surface cleaning without human operation and adapts to be used in various types of real-world water bodies. In addition, we propose a novel coverage path planning method on water surfaces and an improved nonlinearmodel predictive controller. The real-world experiment shows that SMURF works well in different kinds of water bodies and achieves much higher efficiency than traditional water surface cleaning methods.

H.A Spiral-Propulsion Amphibious Intelligent Robot for Land Garbage Cleaning and Sea Garbage Cleaning(2023, Yanghai Zhang, Zan Huang, Changlin Chen, Xiangyu Wu, Shuhang Xie, Huizhan Zhou, YihuiGou, Liuxin Gu and Mengchao Ma)

To address the issue of current garbage cleanup vessels

being limited to performing garbage cleaning operations in the ocean, without the capability of transferring the garbage from the oceanto the land, this paper presents a spiral-propulsion amphibious intelligent robot for land garbage cleaning and sea garbage cleaning. The design solution is as follows. A mechanical structure based on a spiral drum is proposed. The interior of thespiral drum is hollow, providing buoyancy, allowing the robot to travel both on marshy, tidal flats and on the water surface, in conjunction with underwater thrusters. Additionally, a mechanical-arm shovel is designed, which achieves two- degrees-of-freedom movement through a spiral spline guide andservo, facilitating garbage collection. Our experimental resultsdemonstrated that the robot exhibits excellent maneuverability in marine environments and on beach, marsh, and tidal flat areas, and that it collects garbage effectively.

I.A Water Surface Cleaning Robot (2019, E Rahmawati, ISucahyo, A Asnawi, M Faris, M A Taqwim, D Mahendra)

This paper describes the design of a robot for cleaning rubbish floating on the water surface. Three important issues for designing the aquatic robots are a cost-effective solution alongwith robustness and durability. Due to the nature of the cleaningwork, we designed the vehicle structure that can provide high stability, good ability in maneuver and can easily collect all thewaste flowing in between. A pontoon shaped hull works best forthis case and fulfils all the hydrostatic, structural stability criteria. For removal and collection of surface waste, a motor- driven collecting-arm system has been designed for collecting the wastes and redeploying it into a rectangular basket on the hull. This design provides simple and effective waste removal and accommodates large amounts of waste within a small space.For the prototype, the hulls were made up of styrofoam which iswrapped by fiber and then coated with waterproof and resin. Itsupported together by aluminum. This light and tough structure support the total weight of the system. The propulsion system based on a differential drive mechanism has been designed, which allows the robots to take a 360 turn on the spot and provides high thrust. Electronic circuit and motors have been placing inside the hull, in order to protect them from water. The robot is manually controlled by remote control based on Xbee Pro wireless modules. The testing of the robot prototype provedto be effective in waste collecting and removal. The maximumtrash loads that robot can bear is up 16 kg.

J.Water Surface Cleaning Robot(2019, R. Raghavi, K. Varshini, L. Kemba Devi)

Clean water is a basic need for all living beings. Without water survival in the Earth is not possible. Water covers about 70% of the Earth's surface among that only 3% of that is pure water. Water gets polluted due to any reasons like industry waste, sewage waste, garbage waste. Hence it is important to maintain cleanliness and hygiene of water. We considered this water pollution as a serious issue and start to work on the project.We decided to incorporate technology to get the work done effectively and efficiently. Our project design is in such a way that it collects the waste which floats on water bodies. In presenttime almost all the people are familiar with robots. We are goingto design a very interesting robot that is RF controlled Robot. It is important to monitor the pH of a water body. An alteration innormal pH in a water body can be an indication of increased pollution or other environmental factors. Hence the solubility and biological availability of the chemical constituents of waterare determined by pH sensor.

K.Swachh Hasth- A Water Cleaning Robot(2020, Siddhanna Janai, H N Supreetha, Bhoomika S, Yogithashree R P, Pallavi M)

Water acts as a great essential life source. It is a well-known fact that life began with water and the water cleanliness is a veryimportant aspect of life to survive on earth. But, the byproducts of science laid their monstrous footsteps as pollutants. Most of these pollutants are toxic and are affecting adversely the water resources, living organisms in the water, and all dependent organisms. Also, due to the carelessness in the use & maintenance of water bodies, millions of tons of plastics and other floating wastes are dumped into the water daily. Most of the time, the water bodies are cleaned manually with human labor which requires a lot of time and cost. To address this, theproposed work in this article aims at the design and development of an Arduino-Uno controlled surface water trash cleaning semi- autonomous boat with a robotic arm. This work is simulated using the open-source simulation tool

TINKERCAD.Simulation results have shown that the proposed work would be an alternative for surface water trash collection and maintenanceof cleanliness of the water with low cost and minimum human effort.

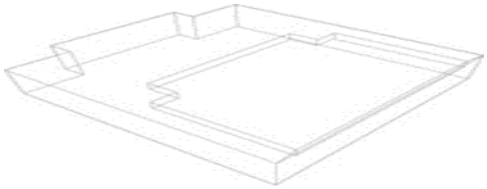
L.River Cleaning Robot(2022, Tobin Thomas, Subin Lukose, Jobin George, Ajith Babu Thundathil)

This Robot is a manually controlled river cleaning intelligent to achieve a sustainable environment. The work has done looking at the current situation of our national rivers which are dump with crore liters of sewage and loaded with pollutants, toxic materials, debris etc. This "River clean-up Robo" is placeswhere there is waste debris in the water body which are to be removed. This machine consists of waterwheel controlled by ajoystick which is having lift buttons that collect & remove the wastage, garbage & plastic wastages from water bodies. This also reduce the difficulties which we face when collection of debris take place. A machine will lift the waste surface debris from the water bodies, this will ultimately result in reduction of water pollution and lastly the aquatic animal's death to these problems will be reduced.

III. METHODOLOGY

1. Design and Construction

The first step in our methodology was the design and construction of the device. We opted for a square-base structureto enhance stability and maneuverability. This design allows thedevice to efficiently gather floating waste across the ocean surface.



For a bigger scale use we can utilize 316 Stainless Steel forbetter corrosion resistant base. The first image is the acrylic sheet we using here and second image shows the structural design to enhance stability and load balancing.

2. Waste Collection System

The next step was the incorporation of a motorized conveyor belt system to facilitate waste collection. The waste is seamlessly transferred into a container fixed to the platform. This optimizes waste removal efficiency while conserving space also it helps weight balancing, accommodating large volumes of waste within a compact footprint.

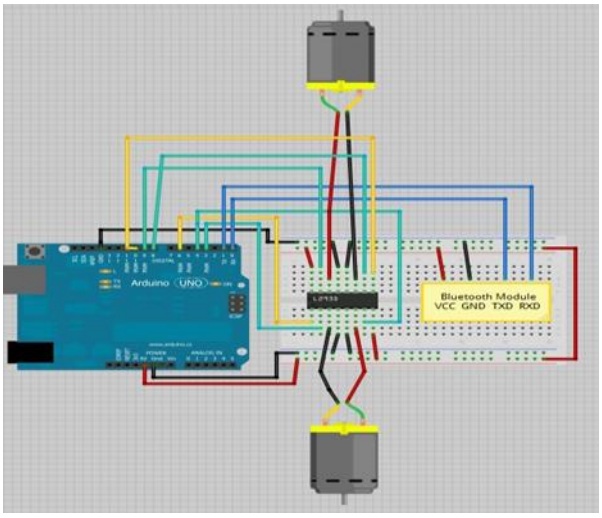
3. Robust Construction

We ensured the device's construction was robust yet lightweight. This ensures the device can support substantial loads, including the collected waste, conveyor system, and electronic components. Also, weight balancing is a main factor,we overcome this with adding more base to the platform.

4. Electronic Circuit and Motor Placement

We use Arduino as mainboard and the maneuvering is controlled by using two propellors. To safeguard against waterdamage, we strategically positioned the electronic circuits and motors on the platform to resist that shock from ocean waves.

The control we used here is basic two motor maneuveringsystem where it is controlled via mobile application.



5. Control Mechanisms

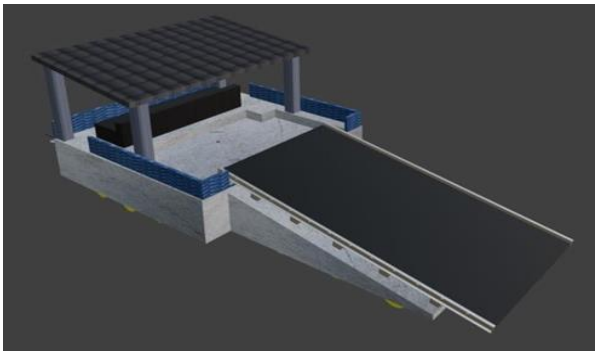
The control mechanisms employ Arduino, motors, motor drivers, and Bluetooth modules. The device is capable of handling up to 3 kg of trash, fulfilling the primary objective of creating a versatile equipment operable in diverse marine environments. Here we use special type of three leaf design which is highly essential for oceanic voyage and its more usefulwhile maneuvering with high payload at high waves from ocean.

Integration with Mobile Application

The final step in our methodology was the integration of the device with a mobile application. The application sends commands to the Arduino via Bluetooth, and the Arduino controls the motors based on these commands. Here we use an application which is created using MIT App Inventor. MIT App Inventor is a prominent tool for creating android applications for these kinds of projects. It works by dragging and dropping commands, hence it is more user friendly.

IV. RESULTS AND DISCUSSION

The results of our project have been highly encouraging. The waste collection device, tailored for ocean surface cleaning, has shown promising results in terms of cost- effectiveness, durability, and resilience to harsh marineconditions.



1.efficiency

The motorized conveyor belt system incorporated for waste collection has proven to be highly efficient. It seamlessly transfers the waste into a plastic container affixed to the platform. This design has optimized waste removal efficiency while conserving space, accommodating large volumes of waste within a compact footprint.

2. Load Handling Capability

The robust yet lightweight construction of the device ensures it can support substantial loads. This includes the collected waste, the conveyor system, and the electronic components. In our tests, the device was capable of handling up to 3 kg of trash, fulfilling the primary objective of creating a versatile piece of equipment operable in diverse marine environments.

3. Protection Against Water Damage

To safeguard against water damage, we strategically positioned the electronic circuits and motors on the platform. This design decision has proven effective in our tests, with the device showing no signs of water damage even after extended periods of operation in marine conditions.

4. Future Scope

The future scope of this project includes many new specifications such as camera controlling, range extending, and more. These enhancements will further improve the device's efficiency and versatility, making it an even more powerful tool for ocean surface cleaning.

Hence, the results of our project have been highly promising, and the discussions around its future potential are exciting. We look forward to continuing our work on thisproject and making further strides in the field of ocean surface cleaning.

V. CONCLUSION

In conclusion, the development of our waste collection device tailored for ocean surface cleaning has been a significantachievement. The device, with its square-base structure, has proven to be effective in gathering floating waste across the ocean surface. Its design, which enhances stability and maneuverability, addresses the key considerations of cost-effectiveness, durability, and resilience to harsh marineconditions. Motorized conveyor belt system to facilitate waste collection has been a successful innovation. It seamlessly transfers the waste into a plastic container affixed to the platform, optimizing waste removal efficiency while conserving space. This design allows the device to accommodate large volumes of waste within a compact footprint. So, our ocean waste collector project not only stands as a testament to innovative engineering, but also paves the wayfor future advancements. As we continue to refine and expand upon this work, we remain committed to our mission of preserving the health and beauty of our world's oceans for generations to come.

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