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BEACH CLEANING ROBOT

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Abstract: Marine debris has become a serious concern globally. It causes severe damage to the coastal and marine habitat since a part of it is washed ashore along the coast and the remaining is swept off the coast leading to the sinking and persisting of the debris in the form of sediments for years. The motivation for building this project arose from the need to address the adverse effects of climate change around the globe and its detrimental impact on the beaches.

This paper showcases the fabrication of a semi-automatic beach cleaning robot that is used to segregate beach debris from the sand bed. We have used the ESP32 CAM board for the functioning of BCR which also consists of sensors for obstacle detection and automated debris collection. The camera of ESP32 can be used for the surveillance of the region which makes it safer and easier for the authorities to enforce a certain degree of legislation. The ESP32 acts as an interface between the BCR and the created web server on existing Wi-Fi via which the BCR is controlled. Through the ESP32 web server, we can give the BCR the required commands for its smooth operation and optimum performance on the beaches. The BCR can be operated and controlled both manually and automatically.

Keywords **-** Beach Cleaning Robot (BCR), Camera (CAM), Printed Circuit Board (PCB), Internet of Things (IoT), Hypertext Transfer Protocol (HTTP), Uniform Resource Locator (URL).

I. INTRODUCTION

The large volume of marine debris is one of the main threats to aquatic ecosystems worldwide. Marine life is now exposed to adverse effects like the injection of polymers, consumption of debris as food, entangling into ropes, plastic can holders, nets, and other debris. In addition to the pollution of land as well as water, plastic deposition is another major problem because its decomposition takes a much longer time as compared to other materials. As a consequence, the fertility of the sand on the coast is reduced. The pollution of the coastal environment limits our ability to use beaches for economic, recreational, and aesthetic purposes. It further degrades and destroys the unique beach habitat required for animals and plants to thrive.

A polluted beach is a threat to public health which leads to a reduction in the property value and hence gets in the way of the economic growth of the community. Every year approximately eight million tons of plastic waste including fragments and bits of constant polluting plastics gets deposited on the beaches and is swept away by the waves into the ocean. Despite the efforts of people participating in the beach cleaning drives, the magnitude of the beach debris is such that it is difficult to be able to collect it all, especially the smaller debris. The Beach cleaning robot is specifically designed to tackle this issue by mechanically sieving through the sand and gathering the waste with the help of the mesh attached to it. This robot can be operated both manually and automatically and it requires minimum maintenance ensuring the cleaning of the area with minimal effort. The robot can also be operated from anywhere with the use of IoT and it consists of features such as live streaming, and obstacle detection which makes the cleaning of large beaches a manageable endeavor. Additionally, it can also be used for other common landscaping applications, like stone picking, litter picking, seed-bed prep, and dethatching. This makes our Beach cleaning robot a multi-season investment.

II. LITERATURE SURVEY

1. Design and analysis of sustainable beach cleaner [2022] H. Ebrahim, W. Sheikh, A. Saeed. This paper analyzes various beach cleaner projects with the motive of eradicating the limitations they consist of. It also presents a detailed study of the functionality of these beach cleaners along with the motion and stress graphs of the same. The designed machine is a combination of different features adapted from their research. The mechanism of the machine is a simple chain sprocket arrangement wherein the sprocket turns the chain and the rakes attached to the chain lift the trash.[1] This project had limitations such as inconsistency in picking up small debris and will pick up any obstacle in its way. Our prototype is able to collect finer debris due to the presence of mesh. Also, with the help of live surveillance the person handling the system can avoid picking up obstacles other than the debris.

2. Manufacturing of Beach cleaning Machine at UMS prototype design and analysis [2021] N. Bolong, I. Saad, M. Amran Madlan. In this paper, the team has assembled a beach cleaner by integrating both raking and sifting mechanisms. It consists of a sprocket chain arrangement with components like a collector, conveyor, motor, and gears which requires manual handling of the machine. The main objective was to fabricate a simple and budget-friendly beach cleaning machine feasible for one person to handle. The paper also includes a detailed examination of the operation of the prototype, on-site testing, and user survey.[2] This prototype is operated manually. Keeping in mind the detailed examination and results of the survey presented in this paper we have improved upon the user feasibility by adding additional features like the use of live surveillance and remote automated operation.

3. Beach cleaning system and surface cleaning system [2020] Prof. J. Shelke, B. Bhakare, K. Lute, A. Pateshwari, H. Khodiyar. This paper proposes a cleaning system consisting of a front servo motor that controls the arm for collecting the debris and 4 base motors for the movement of the robot. The basic mechanism includes the control system receiving commands or instructions from the user via Bluetooth module HC-05 and thereby executing the task of cleaning with the help of an arm shaped like a claw attached to the servo motor. Atmega32 microcontroller is used for processing the commands. [3] In this project the maximum range of communication of this beach and surface cleaning system is 10m. Automatic operation of the system as well as control from remote distance are its limitations that we have tried to overcome in our prototype.

4. Design and Fabrication of Beach Sand Cleaning Machine [February 2020] V. Mepani, H. Patel, Vataliya Mohil, Prof. R. Sahu. This paper describes the fabrication of an inexpensive manually operated sand cleaning machine along with the analysis and comparison of various methods employed for cleaning beaches. When the machine is pushed forward the motion of the machine leads to the movement of the conveyor. The rotation of the shaft indirectly rotates the conveyor belt and further the spokes mounted on the belt locks in the debris which is then transferred up the conveyor belt and is deposited in a container. [4] While the raking mechanism in this machine can efficiently remove debris, it cannot be used for smaller areas and beaches with sensitive habitats. The system that we have adopted consists of a sifter that collects the debris and sand on a mesh allowing the sand to fall through the mesh back to the beach bed and is able to collect finer debris as well.

5. Design and fabrication of beach cleaning machine [2019] V. Dhole, O. Doke, A. Kakade, S. Teradale, Prof. R. Patil. This paper presents design and construction of a mechanical beach cleaner and it discusses the various techniques and technologies applied for cleaning beach debris. The proposed system consists of a motor chain drive system wherein the motor drives the chain which is connected to the lifters that collect the debris and deposits it in a container. The sand is sieved through the lifter teeth back to the sand bed and is levelled with the help of a bend plate. The main objective of this system is to provide a semi-automatic and a better alternative for beach cleaning as compared to the time consuming and labour-intensive process of picking debris and sifting the beach manually. [5] Beaches with fine grained sand and low gradient have high moisture content. The machine will collect and aerate the sand and dry it out causing the erosion of finer sand. The mesh in our proposed system will sieve the finer sand keeping the sand bed intact.

6. Prevalence of marine litter along the Indian beaches: A preliminary account on its status and composition [2017] P. Kaladharan et al. This paper sheds light on the condition and composition of beach litter along certain coasts of India. It presents a detailed study which discusses the results of a survey that assessed the quantity and quality the of beach litter from 254 selected beaches along the coast of India as well as the Union Territories of Andaman and Lakshadweep Islands. The paper suggests colour coding the beaches to identify critically polluted beaches and assist the planners and policymakers to adopt stringent measures. It also suggests that the origin of all plastic waste being land, control measures need to start from land by tackling the issue at production as well as disposal level. This paper showcases the need for beach cleaning for preservation of our natural treasures. [6]

7. Control system design for a surface cleaning robot [2013] Zhai Yuyi, Zhou Yu, Luo Huanxin, Liu Yunjia, Liu Liang. The objective of this paper is to analyse in detail the control system for a surface cleaning robot. The control system receives the information sent by the host computer and executes the command related to controlling motors. The monitoring centre gives the instruction to the microcontroller which further controls the movement of the robot. [16] Our proposed system adapts this control mechanism and has additional features such as a wireless communication module as well as a live surveillance camera.

III. METHODOLOGY

The Beach Cleaner consists of a four-wheel vehicle along with a chassis that has the cleaning mechanism mounted on it. It is driven by an electrical motor and the system is controlled by the ESP32 CAM Board Microcontroller. The coding of the ESP32 CAM Board Microcontroller is done with the help of the open-source Arduino IDE software. Furthermore, the movement of the beach cleaner is controlled by sending it commands from the ESP32 HTTP server using the existing Wi-Fi. The beach cleaner employs a sieving mechanism and has ultrasonic sensors for the detection of debris in the form of obstacles. Also, a 12V rechargeable battery is fitted into it. Live streaming of the beach cleaner can be viewed on the server. The system and the mobile both require an internet connection enabling remote operation and therefore in this case the use of ESP32 CAM board microcontroller comes in handy since it has an inbuilt Wi-Fi feature.

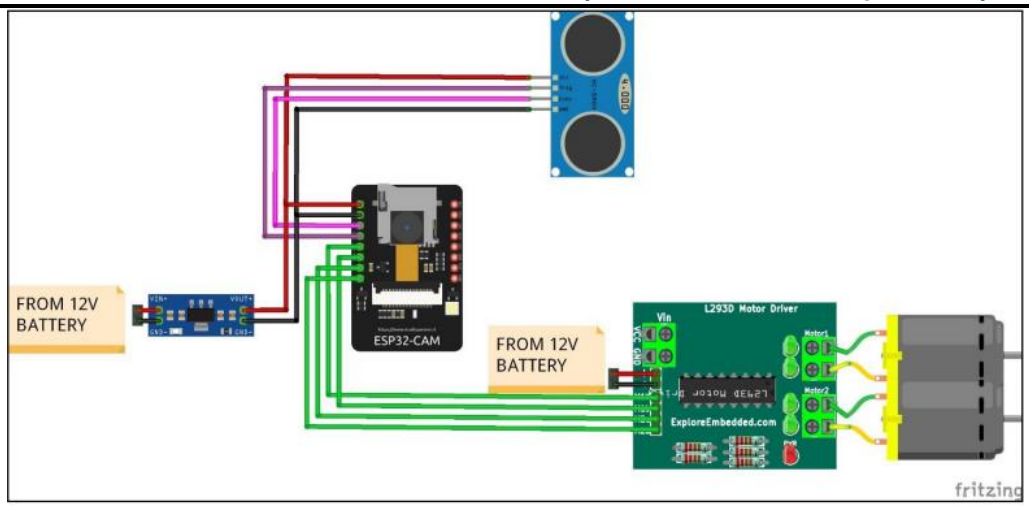

Fig 1. Circuit diagram

A. Hardware Requirements:

1) ESP32 CAM Board
2) Ultrasonic Sensor - 5V, 40 kHz, Sensing range 2 to 450 cm
3) L293D Motor Driver – Operating voltage 4.5 to 12 V, Peak current 600 mA
4) AMS1117 Voltage Regulator
5) DC Motor – 12V, 200 rpm, Rated torque 1.5 kg-cm, Stall torque 5.4 kg-cm, Load current 0.3A, No-load current 0.6A
6) Rechargeable Battery
7) Chassis
8) Dummy Wheels
9) Tires
10) Zero PCB (Perf Board)
11) Female Burg Strip
12) Jumper Wires
13) Connecting Wires

B. Software Requirements:

1) Arduino IDE – For coding ESP32 Cam Board Microcontroller
2) Fritzing – For Circuit Designing
3) Fusion 360 - For designing the prototype

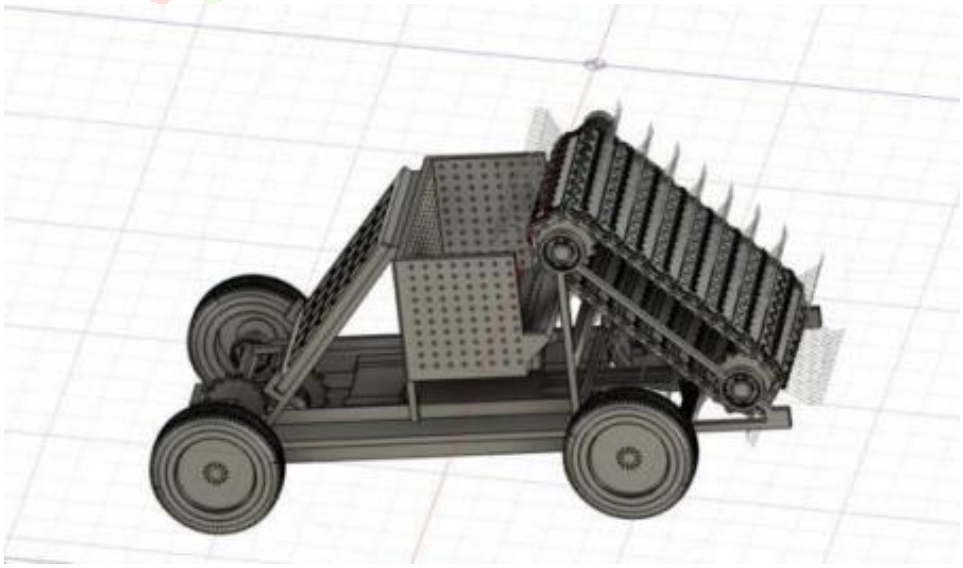

Fig 2. Side view of the designed prototype

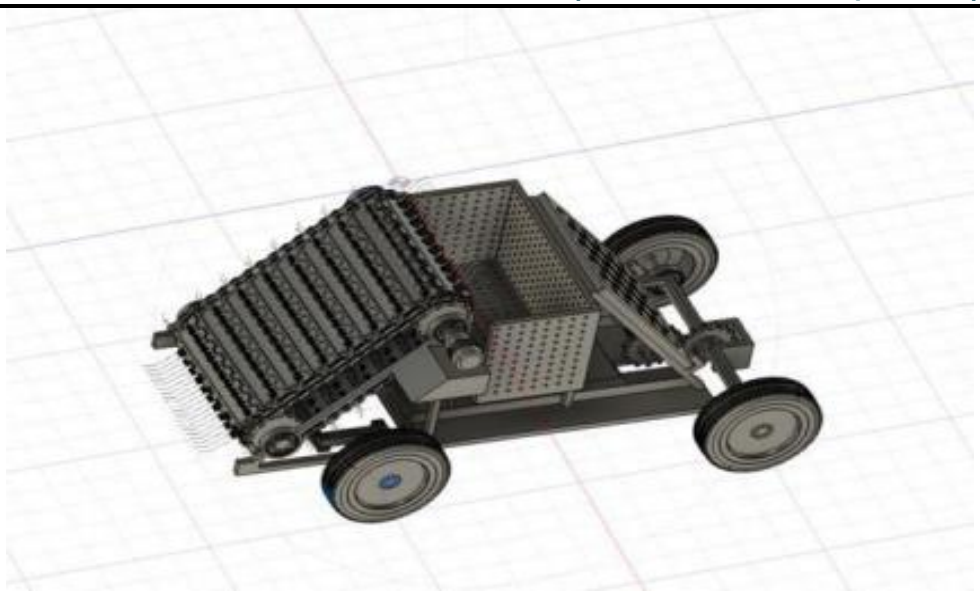

Fig 3. Top view of the designed prototype

IV. RESULTS

Some of the features in our prototype were influenced by the projects that we reviewed in our literature survey also, we enhanced the existing ideas by adding features such as live surveillance and remote operation of the beach cleaner. We were able to implement and create an ESP32 web server and were able to send commands to the beach cleaner over Wi-Fi. So, when the user inserts a URL in the browser, it sends an HTTP request to the server. Basically, when a user accesses the specific URL the browser will send an HTTP request to the ESP32 module. The web page in this case showed commands in form of buttons that indicated left turn, right turn, forward and backward controls of the beach cleaner. When ESP32 reads this request, it is able to comprehend that the user wants to give a specified command to the beach cleaner and thus the user can handle the remote operation of the beach cleaner. Similarly, we were able to implement a live streaming server whose IP address can be accessed remotely to get live surveillance from the ESP32 CAM.

Fig 4. Implementation of the prototype

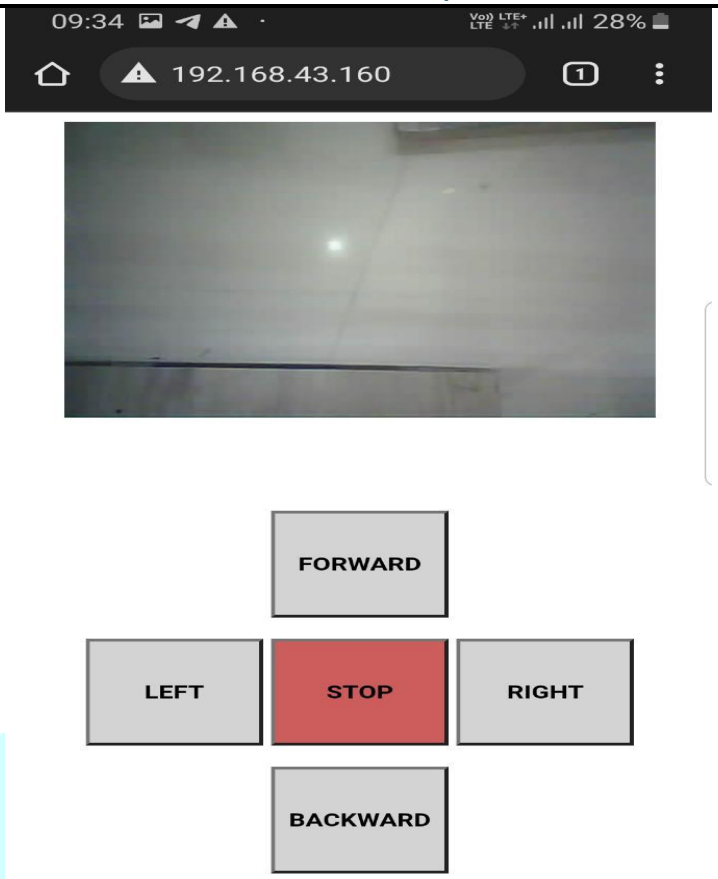

Fig 5. Live streaming and BCR controls

V. Conclusion

This paper proposes the design of a semi-automatic beach cleaning robot that facilitates the cleaning of beach debris to prevent further degradation in the quality and health of the marine ecosystem. It is a semi-automated wireless system that prevents direct contact between the volunteer and the debris, thus reducing human labor. In this robot, we have incorporated the sifting technology which sieves the sand segregating the debris, along with a wireless communication module with a surveillance and monitoring system ensuring efficiency, flexibility, and reliability of the system. The beach cleaning robot performs operations such as cleaning, path changing, obstacle detection, and remote controlling along with surveillance. It is economic, easy to operate, and is a small step towards beach restoration.

For future scope, this prototype can be enhanced by incorporating solar panels thereby making it eco-friendly. It can also be enhanced by integrating a 3D printer which will melt the plastic debris and convert it into plastic bins thus providing a complete solution to the debris issue on the beaches. This BCR can also be made fully automatic by including artificial intelligence to recognize the debris apart from other obstacles in its path.

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REFERENCES

[1] H. Ebrahim, W. Sheikh, A. Saeed, "*Design and analysis of sustainable beach cleaner*", 3C Technology. Glosses of innovation applied to SMEs, Special Edition, ISSN: 2254-4143, https://doi. org/10.17993/3ctecno.2022.specialissue9.167-179, 14 Feb 2022.
[2] N. Bolong, I. Saad, M. Amran Madlan, "*Manufacturing of Beach Cleaning Machine at University Malaysia Sabah (UMS) Prototype Design and Analysis*", Transactions on Science and Technology, Volume: 08, No. 3-2, 281 - 289, 02 Nov 2021.
[3] Prof. J. Shelke, B. Bhakare, K. Lute, A. Pateshwari, H. Khodiyar, "*Beach cleaning system and surface cleaning system",* International Research Journal of Modernization in Engineering Technology and Science, Volume:02, Issue:06, e-ISSN: 2582-5208, June 2020.
[4] V. Mepani, H. Patel, Vataliya Mohil, Prof. R. Sahu, "*Design and Fabrication of Beach Sand Cleaning Machine*", International Research Journal of Engineering and Technology, Volume: 07, Issue: 02, e-ISSN: 2395-0056, p-ISSN: 2395-0072, Feb 2020.
[5] V. Dhole, O. Doke, A. Kakade, S. Teradale, Prof. R. Patil, "*Design and fabrication of beach cleaning machine*", International Research Journal of Engineering and Technology (IRJET), e-ISSN: 2395-0056, Volume: 06 Issue: 04, Apr 2019.
[6] P. Kaladharan, K. Vijayakumaran, V. V. Singh, D. Prema, P. S. Asha, Bindu Sulochanan, P. Hemasankari, L. Loveson Edward, Shelton Padua, S. Veena, A. Anasukoya H. M. Bhint, "*Prevalence of marine litter along the Indian beaches: A preliminary account on its status and composition*", Journal of Marine Biological Association of India, Volume: 59, No 1, June 30, 2017.
[7] C. Balasuthagar, D. Shanmugam, K. Vigneshwaran, "*Design and fabrication of beach cleaning machine*", IOP Conf. Series: Materials Science and Engineering 912 (2020) 022048 IOP Publishing doi:10.1088/1757-899X/912/2/022048, 2020.
[8] Prathamesh Jangam, Sneha jangam, Rutuja kadu, Mubbashir Kazi, Prof. Sanobar Shaikh, "*Beach Cleaning Robot*", International Research Journal of Engineering and Technology (IRJET), ISSN: 2349-6002, Volume:6 Issue:12, May 2020
[9] Ramamoorthi R, Ramachandran N, Nikiles PD, Jayasurya R, Natheesh MD, Nithin K Biju, "*Design and fabrication of beach cleaning machine*", International Journal of Innovative Technology and Exploring Engineering, ISSN:2278-3075, Volume: 08, Issue:12, Oct 2019.
[10] D. Vaishnavi, Sabeesh Kumar.S, "*Swachh yantramanav: A multipurpose cleaning robot*", International Journal of Innovative Science and Research Technology, ISSN:2456-2165, Volume:02, Issue:05, May 2017.
[11] M.Bhavani, S.Kalaiselvan, S.Jagan, S.Gopinath, "*Semi-Automated Wireless Beach Cleaning Robot Vehicle*", International Journal of Recent Technology and Engineering (IJRTE), ISSN: 2277- 3878, Volume:8 Issue:1S2, May 2019.
[12] Dr. F B Sayyad, Dr. Md. Imran Ansari, Dr. S F Sayyad, "*Design and Development of Beach Cleaning Machine*", International Journal for Research in Applied Science & Engineering Technology, ISSN: 2321-9653, Volume:07, Issue:06, June 2019.
[13] T. Subba Reddy, P. Satya Priyanka, L. Himaja, K. Sravani, N. Mounika, "*Design and Fabrication of Beach Dust Collector",* Research and Development in Machine Design, Volume:03, Issue:03, DOI: http://doi.org/10.5281/zenodo.4043052, Oct 2020.
[14] R Praveen, L Prabhu, P Premjith, Adarsh. K. Mohan, Ajayraj, "*Design experimental of RF controlled beach cleaner robotic vehicle*", IOP Conf. Series: Materials Science and Engineering 993 (2020) 012030 IOP Publishing doi:10.1088/1757-899X/993/1/012030, 2020.
[15] S. Das, P. Jha, A. Chatterjee, "*Assessing Marine Plastic Pollution in India*", IEG Working Paper No. 389, Apr 2020.
[16] Zhai Yuyi, Zhou Yu, Luo Huanxin, Liu Yunjia, Liu Liang, "*Control System Design for a Surface Cleaning Robot*" International Journal of Advanced Robotic Systems, Volume:10, Feb 2013.
[17] Ankita Paste, Prerna Pisal, Ameya Shinde, Tanvi Upaskar, Dr. Baban U Rindhe," Smart *Beach Cleaner Vehicle*", ISSN: 2581-4419, Volume:1 Issue:1
[18] Amit Kumar Yadav, Animesh Singh, M. A. Murtaza, Ajendra Kumar Singh, "*Eco Beach Cleaner*", International Journal of Engineering and Management Research, ISSN (ONLINE): 2250-0758, ISSN (PRINT): 2394-6962, Volume:08, Issue:03, June 2018
[19] Francisco Cuellar et al., "*IEEE Open Category: Beach cleaner*", Team PUCP – Team Description paper, LARC 2013.
[20] Kuson Prakobkarna, Banyat Saitthitib, Sakda Intaravichib," *Design and Construction of Beach Cleaning Trailer by Finite Element Method*", International Transaction Journal of Engineering, Management, & Applied Sciences & Technologies, ISSN:2228-9860, eISSN:1906-9642, Volume:03, No.02, 2012.