DESIGN AND ANALYSIS OF SUSTAINABLE BEACH CLEANER

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Recepción: 14/09/2021 **Aceptación:** 12/11/2021 **Publicación:** 14/02/2022

Citación sugerida:
Ebrahim, H., Sheikh, W., y Saeed, A. (2022). Design and analysis of sustainable beach cleaner. *3C Tecnología. Glosas de innovación aplicadas a la pyme, Edición Especial,* (febrero 2022), 167-179. https://doi.org/10.17993/3ctecno.2022.specialissue9.167-179

ABSTRACT

This is the research paper for our project, an efficient and innovative Beach Cleaner. This consists of an introduction to the goals we wish to accomplish with this beach cleaner project that we have designed and analyzed. Our strategy also consists of a literature review of similar beach cleaner projects we found that have been developed in the past by various organizations, companies and students of universities worldwide, we discuss the problems that each of them aimed to eradicate, the problems they faced, how they strategized the whole project and discuss the results. The paper also comprises of a discussion on the steps we used to design and analyze the beach cleaner, and its functionality. Furthermore, we also studied the motion and stress graphs of the design, and concluded our research. We believe that this is the perfect solution to the pollution at the beach. We have successfully designed a beach cleaner that can be implemented easily into a working device.

KEYWORDS

Beach Cleaner, Sustainable, Robot, Ecofriendly, Pollution, Garbage cleaner.

https://doi.org/10.17993/3ctecno.2022.specialissue9.167-179

1. INTRODUCTION

Sustainability is the consideration that the resources we have on earth are limited and we must use them wisely to protect the planet. In the events that we do not adopt sustainable behavior, generations to come will suffer greatly. It is our role as inhabitants of earth to take care of it. Being an engineer, that role multiplies itself as we now have a choice to use technology to serve the earth or damage it. We, as engineering students, aimed to target the following three goals of the seventeen sustainable development goals laid out by the United Nations:

Goal #11: Sustainable Cities and Communities

Our project aims toward cleaning the beaches in the city. It will help with the sanitation issues in the city. The pollution control is weak, leading to unhealthy and inefficient cities, our project will help control pollution.

Goal #14: Life below Water

Waste on beaches is normally washed off into the sea and is extremely harmful for the marine life. Cleaning the beach improves the coastal and ocean ecosystem by making sure that none of the trash kills marine life or is toxic enough to disrupt the marine life cycle.

Goal #15: Life on Land

Life on land is also greatly affected by the waste found on beaches. Trash makes the living conditions for human beings unsanitary. It has adverse effects on human health. Be that as it may, trash is also unpleasant to look at and may physically hurt visitors on the beach. The main goal of this project is to develop and implement a machine which will help in the beach environment. There is a lot of pollution that is affecting the beach and the marine life, hence, here we introduce an innovative and efficient beach cleaner.

In public places, cleanliness is vital as hundreds and thousands of people visit them every day. Beaches, for example, are visited for leisure by many people, including children and the elderly. If they aren't kept clean their health can be affected which is a very serious issue. Moreover, places with trash are extremely unpleasant to look at and enjoy in, which proposes a risk to the tourism system as well.

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The struggling economy and the crippling solid waste management system in Pakistan specially is in dire need of a cheap, efficient and easy to use solution to work on our beaches not to just solve waste management issues but also to help speed up the process to make the beaches more attractive for tourism purposes and to boost the economy as well.

Garbage Cleaners are a perfect solution for this crucial task of picking up trash from places like the beach. Our solution is a 4-wheel drive vehicle chassis equipped with a cleaning mechanism and a trash bag for garbage collection. The structure will be driven through a motor and the rotational motion of the wheels will further drive the lifter mechanism. The lifting mechanism is a rake attached to a chain which is connected with a chain sprocket. When the wheels are turned Which will collect the garbage from the beach and deposit it in the trash bag.

1.1. LITERATURE REVIEW

A. Promoteo:

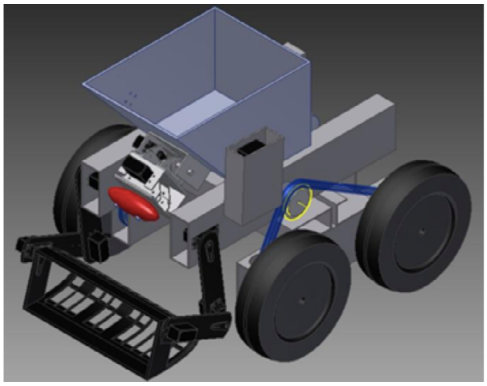

Figure 1. Promoteo.
Source: own elaboration.

Prometeo is a mobile robotics research group. They have designed a robot to oppose the environmental pollution. Their robot is able to traverse on the beach, collect trash found in the vicinity and transport it to a dumpster.

They use cameras on the robot to detect the presence of garbage and also for avoiding obstacles. It has two powered motors for locomotion and nine servomotors for the excavator arm, the pan tilt camera system and the reservoir.

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The robot is an efficient modern-day vehicle but the use of computers and a complex operating mechanism makes this robot a little hard to use but as far beach cleaning and remote operation are concerned this project resulted in success.

B. RF Controlled Beach Cleaner Robotic Vehicle:

Figure 2. RF Controlled Beach Cleaner Robotic Vehicle.
Source: own elaboration.

Nevon Projects created this remote-controlled beach cleaner to rid the shoreline of garbage and rubbish spread by visitors.

This project is based on a four-wheel drive vehicle and the chassis consists of a chain sprocket setup for picking up the trash and a plastic bag is attached for deposition of said garbage. A microcontroller is used to navigate the system and the remote-controlled motor is used to drive the vehicle.

This was a basic beach cleaning mechanism and results showed that it picked up small plastic bottles and cans but it had inconsistency in picking up other smaller trash such as plastic bags etc. and bottle caps.

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C. HS-GreenFist: Beach Cleaner Robot:

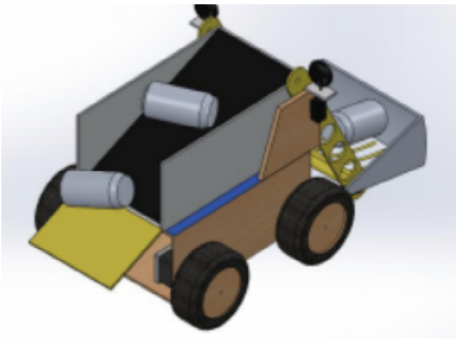

Figure 3. HS-GreenFist: Beach Cleaner Robot.
Source: own elaboration.

The HS-GreenFist is a design developed by a group of students studying Systems Engineering at the National University of St. Agustin in Arequipa, Peru. The fundamental purpose of this project is to help the pollution problems which is affecting the environment. This robot can navigate in sand and it is designed so that it picks up trash and deposits it somewhere else.

The robot has a separate robotic arm to pick up the cans. In addition, the robot uses four wide tires to move under the same principle on which the caterpillar moves. The excavator arm has a claw on the end that allows the robot to collect the cans through the sand, it will also have a small scanning system as an actuator fixed to the claw. The movement of the excavator arm is defined by two movements one to raise the claw and the other to collect cans both Movements are commanded by servomotors.

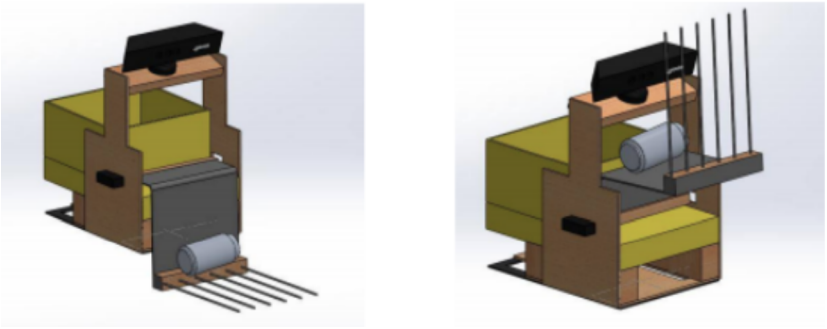

Figure 4. HS-GreenFist: Beach Cleaner Robot.
Source: own elaboration.

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The project successfully picks up cans from there different positions. The controlling of the arm using servo motors and actuators had efficient results.

D. Dr. Recare:

The Dr. Recare us designed by Mingyu Jeong. It is a mobile doctor that solves the environmental problem and issue of the polluted seashores.

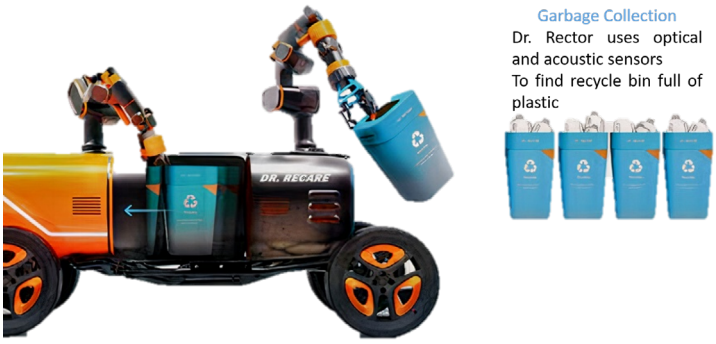

Figure 5. Dr. Recare.
Source: own elaboration.

The robot itself has optical and acoustic sensors which allow it to sift through sand and gather plastic. The plastic is then melted and through an integrated 3d printer is converted into recycled trash cans which can be used as bins to dump garbage rather than pollute the sea bed.

Figure 6. Dr. Recare.
Source: own elaboration.

The robot was a success and used to encourage people to actually use trash cans. This was an innovative way to recycle and use 3d printing.

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E. Garbage Collection Robot on the Beach using Wireless Communications:

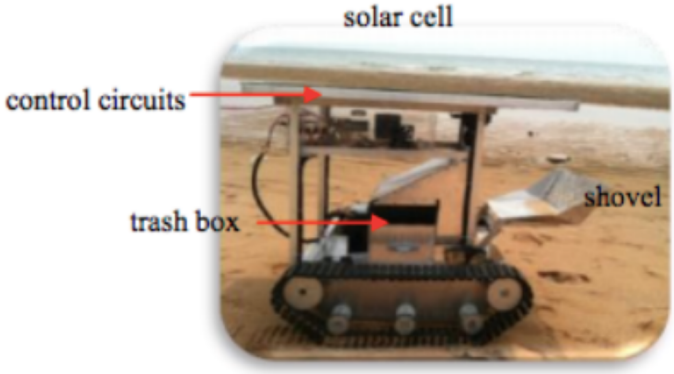

Figure 7. Garbage Collection Robot on the Beach using Wireless Communications.
Source: own elaboration.

The project was developed by students of Electrical Engineering at the University of Si Racha Kasetsart in Chonburi, Thailand. They wanted to engineer something which could controlled wirelessly and was environment friendly. The main aim of this project is to handle tasks more conveniently which is collecting the garbage and controlling capability while considering environmental effects.

To control the robot, they used Visual Basics Applications. The robot moves based on the commands sent via Bluetooth to the micro-processor. The garbage collection robot collects both glass bottles and plastics. The robot can move in a speed of 0.5 meters per second on the sand via the wireless communication.

To summarize their end result, we can observe the hardware implementation of the system. The complete system of garbage this collection robot is divided into 5 major parts: power consumption, structure and configuration of the robot, microcontroller, wireless communication module and IP wireless camera.

F. Autonomous Garbage Collector Robot:

The main aim of the mechanism in this project is to collect garbage which is of similar dimensions to that of juice cartons, plastic bottles, crushed papers, and all light items whose height is between 5 to 20cms.

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This trash collection system consists of a set of blades rotating about a shaft connected to the motors. The mechanism will not operate for entirety of the vehicle operation it will operate only when needed. This collection mechanism is mounted on the front side considering some ground clearance. Two motors are mounted on the two sides of the shaft and is connected to Arduino to perform rotating mechanism.

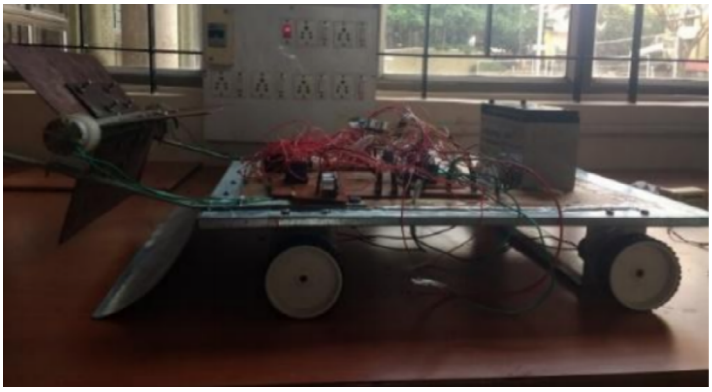

Figure 8. Autonomous Garbage Collector Robot.
Source: own elaboration.

As a result of how the collection mechanism is built it suits public places like gardens, bus stands, footpaths. When the sensor detects stationary obstacles, the mechanism rotates and the garbage is directed into a collection bin which is placed right behind the mechanism.

2. METHODOLOGY

After thorough study of projects with a similar goal, we were ready for our own design. We used measurements that were ideal for both manual use, and use when a motor is attached.

The essential concept is when the assembly is pushed forward, the wheels turn and cause the sprocket to rotate. The sprocket turns the chain assembly with it. Attached to the chain assembly are rakes. These rakes lift any trash that gets in the way.

Basically, we wanted the device to pick up trash as it moved. So, we placed the rakes onto the chain using an adapter. Then we placed the belt roller chain onto the sprockets which were kept synchronized with the wheel using a pin. The pins were inserted through the sprocket and the rod. The rod holds everything together. So now as the wheel moves, the rod rotates and as the rod rotates the sprocket also rotates because of the pin and hence the

https://doi.org/10.17993/3ctecno.2022.specialissue9.167-179

sprocket causes the chain to rotate which has the rake attached to it. This lifts up the trash and by the rack and pinion connection it is leaded to the trash bag which is connected by hooks at the back of the assembly.

3. RESULTS

3.1. MOTION STUDY – BASIC MOTION

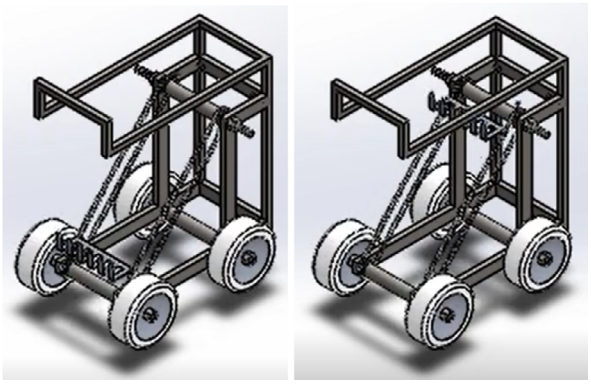

Figure 9. Movement of rake.
Source: own elaboration.

3.2. TORQUE CALCULATION

The mass of the assembly, as evaluated by Solid works mass properties is 216.89lbs. Torque to move the assembly can be calculated by:

$$\text{Torque} = \text{Force} * \text{radius}$$

Here the radius is the radius of the tyre and Force is the weight.

$$\text{Torque} = 216.98 \text{ lbs} * 5 \text{ in}$$

$$\text{Torque} = 1098.55 \text{ lb.in}$$

$$\text{Power} = \frac{\text{Torque} * \text{Speed}}{63025}$$

$$\text{Power} = \frac{1098.55 \text{ lb.in} * 20 \text{ rpm}}{63025}$$

$$\text{Power} = 0.349 \text{ HP}$$

https://doi.org/10.17993/3ctecno.2022.specialissue9.167-179

Since, we will use two motors, torque of each motor can be given by:

$$\text{Torque} = \frac{1098.55 \text{ lb.in}}{2}$$

$$\text{Torque} = 549.275 \text{ lb.in}$$

Therefore, we require two motors of minimum 550 lb.in torque for a speed of 20 rpm. The power of the system would be 0.349 hp.

* In these calculations, we have not considered the weight of the trash, it will be added to the assembly and hence we must use a motor with a slightly higher torque than calculated.

4. CONCLUSIONS

To conclude, there are numerous other projects similar to the Beach Cleaner project. The studied articles that were presented were from different companies, organizations, and universities worldwide. It was observed from the reviewed articles how each group of designers strategized their development. Many remarkable features were observed that can be added to our project to further develop it. The literature review was successfully helpful in improving the knowledge of how to develop and design this project.

Our design uses a mix of different features from different projects around the world we used the chain sprocket arrangement from a certain project and the structure of another, the trash picking technique from one and trash deposition method from another hence our design is a successful innovative combination of a number of beach cleaner devices that have been invented and designed in the past.

Our designed machine consists of 11 parts including a chain sprocket arrangement. It can be used with or without a motor. We believe that this is the perfect solution to the pollution at the beach. We have successfully designed a beach cleaner that can be implemented easily into a working device.

ACKNOWLEDGMENT

We would like to thank the department of Mechatronics at Shaheed Zulfiqar Ali Bhutto Institute of Science and Technology for providing us with opportunities to grow. We would

https://doi.org/10.17993/3ctecno.2022.specialissue9.167-179

also like to thank the faculty and our teachers for always guiding us. Our thanks extend to our friends and family for their utmost support.

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