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IMPLEMENTATION OF ROBOTICS FOR OCEANS AND SEAS CLEANING

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Abstract. In this work, I considered the problem of ocean trash. Everybody knows that patches of trash are growing. But as for me, there are still not enough projects to clean up the oceans and coastal areas. The idea is inspired by NASA Space Apps Challenge. The solution proposed can help to get rid of micro- and macroplastic in the oceans.

Keywords: ocean trash, trash patches, oceans without plastic, robots for cleaning up trash, jellyfish, coastal areas, seas without trash

I.Introduction

Human civilization largely depends on the oceans. They affect the weather and climate of the entire planet. That is why the pollution of the oceans has become a serious environmental problem of our time. If we loose the ability to use the resources of the oceans, the economy will stop, and the world will plunge into chaos.

The development of civilization has led to increased pollution. The situation was worsened by the development of the chemical and oil refining industries. Nowadays, several types of pollution can be distinguished:

- physical (garbage, especially plastic). 80% of this garbage got into the oceans from the land, 20% - from the ships.
- biological (foreign bacteria and microorganisms);
- chemical (chemicals and heavy metals);
- oil;
- thermal (water from power plants);
- radioactive.

One of the main types of pollution is plastic waste. They form entire islands on the surface and threaten marine life. Plastic does not dissolve or decompose. Animals and birds take it for something edible and swallow glasses and plastic, that they cannot digest, and die. Under the influence of the sun, plastic is crushed to the size of plankton. And then it participates in food chains.

Many countries have attempted to rectify the situation or minimize the harm that human activities cause to the oceans. At the initiative of the UN, many important international agreements that regulate the use of ocean resources were signed.

II.Analytical review

The amount of global trash is expected to rise every year. Mostly plastic, chemical sludge, wood pulp, and other debris are grouped into trash patches. Despite the common public perception of the patch existing as giant islands of floating garbage, its low density (4 particles per cubic meter) prevents detection by satellite imagery, or even by casual boaters or divers in the area. This is because the patch is a widely dispersed area consisting primarily of suspended "fingernail-sized or smaller bits of plastic", often microscopic, particles in the upper water column.[1] The five biggest ocean garbage patches are located across the globe, found in the Pacific, Atlantic, and Indian Oceans. While the North Pacific patch (the Great Pacific garbage patch) is the most discussed, explored, and evaluated, the other four patches also contribute to global pollution on a major scale.[3] The Great Pacific Garbage Patch, a collection of plastic, floating trash halfway between Hawaii and California, has grown to more than 600,000 square miles, a study found. That's twice the size of Texas.[2] Precise measurements of the North Atlantic Garbage patch are unknown but scientists think it is hundreds of miles in size. The patch likely has a particle density somewhere around 7,220 pieces per square kilometer. The South Pacific Garbage Patch is estimated to have a surface area of 1 million square miles (2.6 square kilometers) and a particle density of approximately 396,342 particles per square mile in the center of the patch. Due to its remote location, the Indian Ocean garbage patch is difficult to study. Some studies estimate its size at 843,046 square miles (2,183,480 square kilometers), although some put it as high as 2 million square miles (5 million square kilometers). The South Atlantic Garbage patch is fairly small in comparison to other patches. This patch covers roughly 276,263 square miles (715,520 square kilometers), has a particular density of 40,000 pieces per kilometer, and contains about 2,860 tons of plastic. [3] Ocean trash is counted in three ways: through beach surveys, computer models based on samples collected at sea, and estimates of the amount of trash entering the oceans. The most recent counts involved computer modeling based on samples taken at sea. The models may not account for all of the trash, scientists say; nonetheless, the new numbers are helping address some of the questions.[4]

In spite of people’s awareness, there are still not enough solutions to clean up the oceans.

II.1 Ocean CleanUp

Dutch inventor Boyan Slat founded The Ocean Cleanup at the age of 18 in his hometown of Delft, the Netherlands. The Ocean Cleanup's team consists of more than 80 engineers, researchers, scientists and computational modelers working daily to rid the world's oceans of plastic. Their headquarters are located in Rotterdam, the Netherlands.

The Ocean Cleanup is designing and developing cleanup systems to clean up what is already polluting our oceans and to intercept plastic on its way to the ocean via rivers.

A significant percentage of the plastic that enters the oceans from rivers and other sources during a transfer that can take many years, drifts into large systems of circulating ocean currents, also known as gyres. Once trapped in a gyre, the plastic will slowly break down into microplastics and become increasingly easier to mistake for food by sea life.

Going after the plastic in the garbage patches with vessels and nets would be costly, time-consuming, labor-intensive, and lead to vast amounts of carbon emission and by-catch. That is why The Ocean Cleanup is developing a passive ocean cleanup technology, that moves with the currents – just like the plastic – to catch it. By deploying a fleet of systems, The Ocean Cleanup has estimated to be able to remove 50% of the Great Pacific Garbage Patch every five years.[5]

But this construction has some minuses:

- it is very expensive;
- it is used only in the Great Pacific Garbage;
- it collects only macroplastic.

Image 1 - Ocean CleanUp construction

II.2.Ocean Ride

Ocean Ride is a microplastic collection system that works differently than others. There are two main products: first use as a dockable object on any boat and in addition is a fixed platform strategically positioned in the areas of sea currents that is where has the largest flow of these materials.

They will use thousands of existing vessels that make trips around the entire maritime territory, docking our collection system to take advantage of the sea routes and use them to our advantage and helping to clean up the ocean. Moreover, on fixed platforms, we will take advantage of the sea currents that converge to a strategic place that throws the waste towards the positioning of our platform.

The economic viability will make companies embrace our solution while enabling sustainability and cleanliness of the ocean, which will provide additional profit for ship companies. In addition, NASA will have a low cost to implement.

Van Der Graff's generator principle is the heart of the project, and it is responsible for all the attraction of microplastics across a specific field to attract only that plastic. The device works similar to a magnet. In addition, there is a conveyor belt that will be electrified and attract the debris, when it comes into contact with the Van Der Graff generator orb. A blade mechanism with a maximum hole size of 5mm. will be inserted into the treadmill.

Right after the process of attracting the microplastic, waste will be stored and compacted to optimize as much space as possible.

When the maximum storage capacity will be filled, this waste will be removed at the destination of the vessel or if it is the fixed platform there will be a vessel responsible only for changing containers, removing the full and replacing for another one.[6]

The only minus is that the project is not implemented yet.

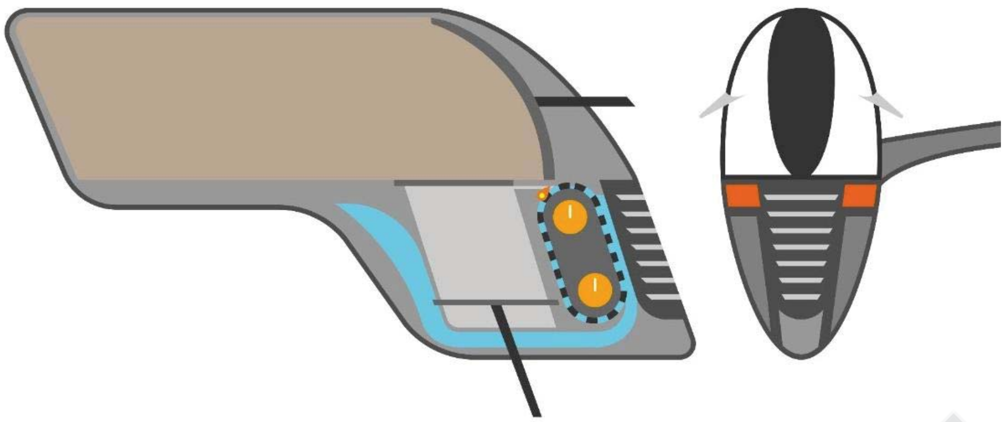


Image 2 - Ocean Ride device inside

III. Object, subject and tasks of research

The object of research is to rid the oceans and seas of plastic.

The subject of research is solutions for cleaning up oceans from micro- and macroplastic.

Goals of research work:

- find weaknesses of existing solutions;
- make an interactive way of the plastic collection;
- design and explain a new solution.

IV. Results of work

I analyzed all the collected information and all the disadvantages and difficulties of existing developments. And I came up with a solution that fights against large and small plastic. The first version of the design looked like a jellyfish, for which it got its name.

What is Jellyfish?

Jellyfish is a system of plastic collection that can be managed from your phone. I actually designed 2 versions of how we can use Jellyfish: in the ocean space and in the coastal areas. Now I want to show you the second one.

Jellyfish for coastal areas

Jellyfish consists of 2 parts. The first part is the control unit. The logic of the construction is concentrated here. It consists of:

- Raspberry Pi 3 Single Board Computer;
- solar panels, which provide the energy necessary for the operation of a computer;
- additional battery;
- camera;
- sonar device;
- ultrasound device (to scare away marine life);
- small motor to manipulate the Jellyfish;
- Bluetooth - receiver;
- GPS - receiver.

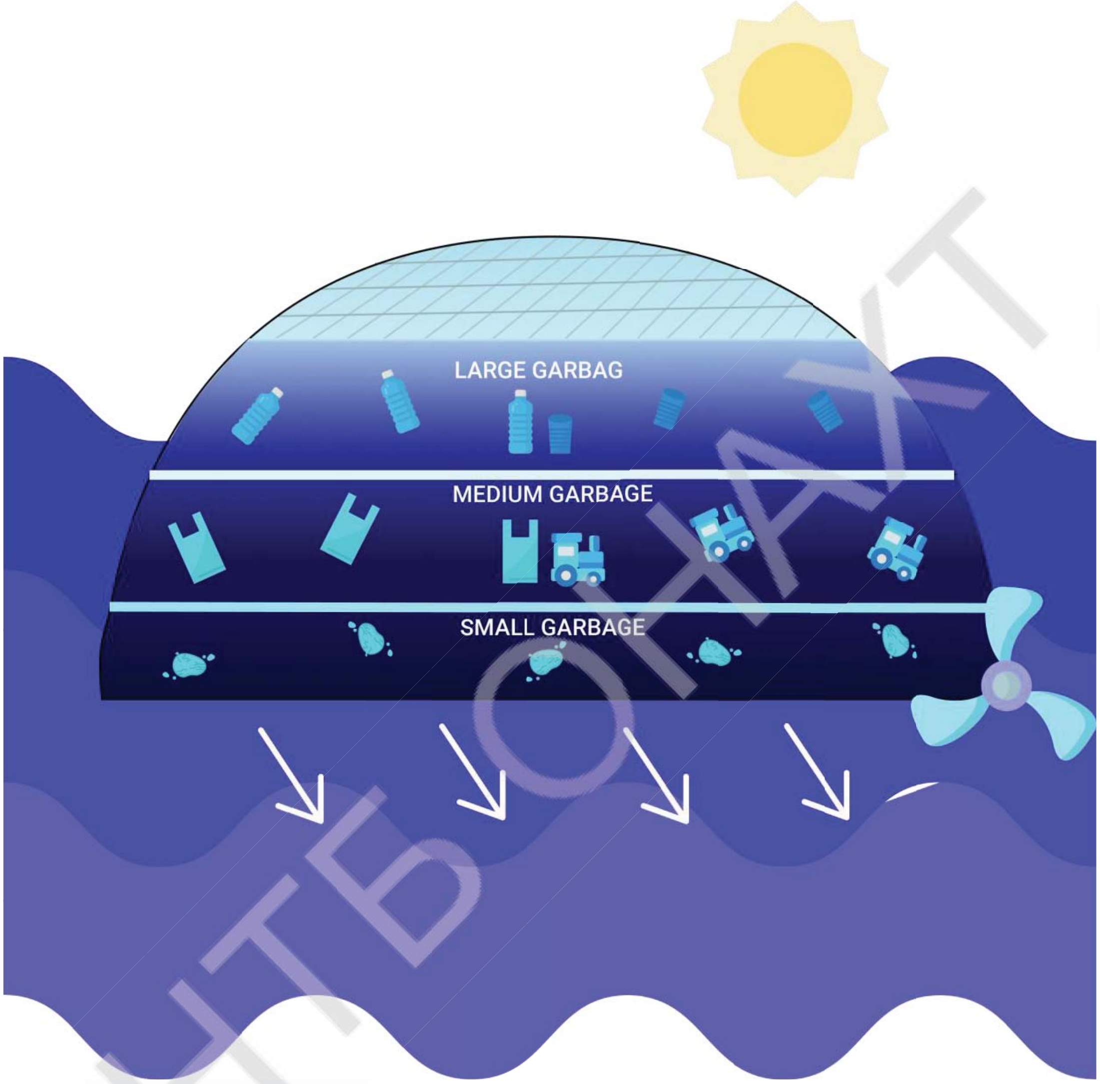
The second part is focused on the filtration and collection of garbage. The system uses 3 stages of plastic filtration. It consists of:

- “wings” to increase the angle of captured flow of contaminated water;

- section for large garbage (fishing nets, bottles, plastic bags, etc.);
- section for screening medium debris (things in a state of plastic splitting);
- section for requesting small plastic with mesh on roller shutters (microplastic).

All of the sections for plastic are equipped with nets, but the difference between them is the size of the net's cells.

You can also add other sensors to monitor water indicators (temperature, salinity, etc.), indicators for weather stations (wind direction, pressure), etc.



That is how Jellyfish looks like.

How to manipulate?

The robot has 2 control modes: manual and automated.

Manual mode: you can manipulate the robot with a mobile application. If necessary, you can turn the camera on and off, track the path of the robot on the map, and track the occupancy rate of the garbage compartments.

Automated mode: all control is taken over by the computer, and with the help of Machine Learning it can recognize garbage and collect it. You can track his path, connect to the camera, etc.

By connecting other sensors, you can also track their measures in real-time.

How the app will look like.

V.Conclusions

The designed construction is aimed at cleaning coastal waters from plastic, which can be very dangerous if it becomes a part of the food chain. The implementation and integration of this robot in a water treatment program will help the environment quickly and interactively. The captured plastic can be recycled or independently used in your ideas, including art. Also, you can use additional modules for tracking indicators if you want to make researches.

The robot is designed for people who worry about the environment, pollution of the oceans and coastal zones, and the future of the planet.

During the design of this product, the following tasks were solved:

- engaging users interactively;
- separation of the control unit from the filters and collectors;
- automatic sorting of micro- and macroplastic.

VI.References

1.https://en.wikipedia.org/wiki/Great_Pacific_garbage_patch

2.https://www.usatoday.com/story/tech/science/2018/03/22/great-pacific-garbage-patch-grows/446405002/

3.https://www.ranker.com/list/worlds-biggest-ocean-garbage-patches/sarah-blumert

4.https://www.nationalgeographic.com/news/2015/1/150109-oceans-plastic-sea-trash-science-marine-debris/

5.https://theoceancleanup.com/about/

6.https://2019.spaceappschallenge.org/challenges/earths-oceans/trash-cleanup/teams/cafeina/project