# Save Our Shores

## Team Azerbaijan Report

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# Summary

## Who We Are?

We are a Team of 3 students from Lyceum named after academician Zarifa Aliyeva and a mentor from Sumgait State University.

**Ruslan Bayramov** is our Team Leader. He participated in International Challenges such as Infomatrix Final 2018, GoldenByte 2018, Genius Olympiad 2020, ISEF 2019, ISEF 2020, etc. He also was the Captain of National Robotics Team at First Global 2019. Now, he is doing a science project about Plant Diseases, Robotics, and Deep Learning. He will study Computer Science at Tsinghua University.

**Elvin Bilalov** is our Engineer. In his childhood, he went into a school of aeromodelling and shipbuilding. Since then, he started to build extraordinary robots that took place in different olympiads. He took the second place at Infomatrix World Final. He also was in the National Robotics team at First Global and Genius Oympiad. Currently, he is planning to study Robotics and Mechatronics in Russia.

**Suleyman Ismayilov** is our Designer. After passing into Lyceum named after academician Zarifa Aliyeva, he has joined IT lessons, which helped him to expand his knowledge about web-designing and 3D modeling. He will study in KU Leuven University next year.

**Dr. Samir Orujov** is our Mentor. He is currently Head of the Science Department and Docent at Sumgait State University and. He has also been the Director of the National ISEF tour for 8 years.

# Abstract

Environmental pollution is one of the biggest challenge we are facing today. Plastic waste has become such a huge problem that we have whole islands of plastic in the world ocean. A whopping 91% of plastic isn't recycled[1]. It has horrific effects on marine fauna, and even on humans via them. Humanity must find a way to solve this problem. We decided to create a solution that *combines* Robotics and Biology. Some types of **worms** can eat plastic and turn it into carbon dioxide and biodegradable substances. Mealworm[2], waxworm[3], and a worm named Zophobas[4] can decompose different types of plastic waste. We designed our robot in a way that it can collect the wastes, compress them, and feed it to the worms. Our robot needs to be fully autonomous, so we used solar panels for perfect battery life and **neural network** for recognizing plastic wastes.

# Problem

## Global Scales

The ocean has become a global repository for much of the waste we generate. Marine debris includes timber, glass, metal, and plastic from many different sources.

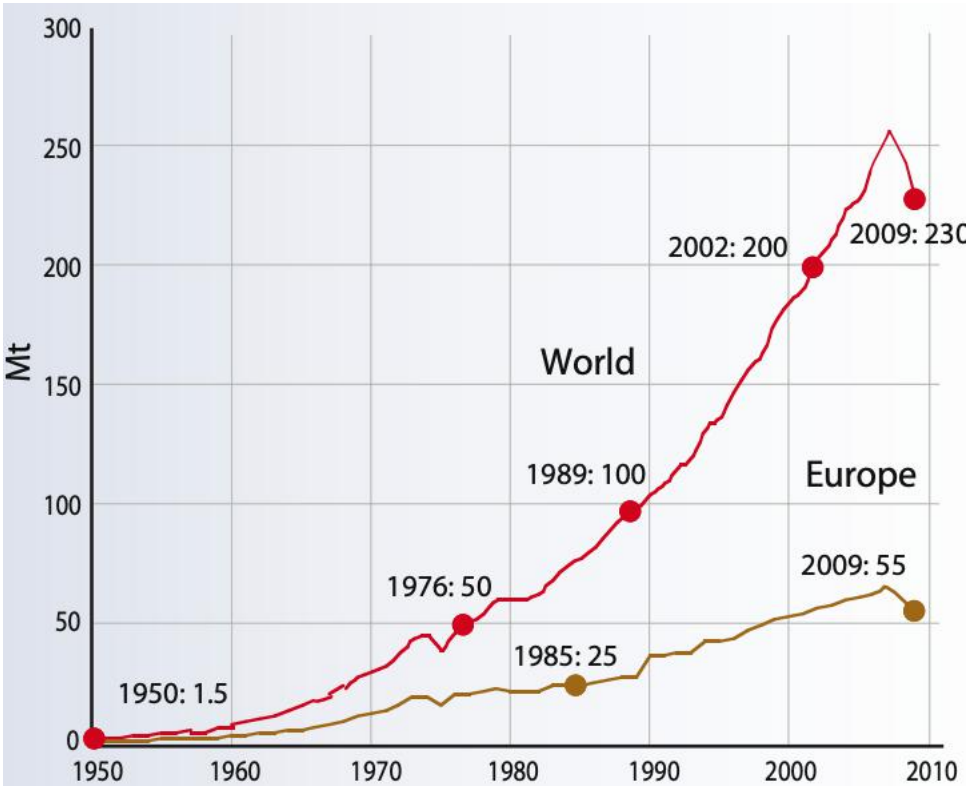



Figure 1: Growth in plastics production,1950-2009. After five decades of continuous growth in world plastics production, there was a drop in production in 2008 due to the economic downturn. Close to 25 per cent of world production takes place in Europe. Plastics represented in the figure are thermoplastics, polyurethanes, thermosets, elastomers, adhesives, coatings and sealants, and polypropylene fibres. PET, PA and polyacryl fibres are not included. *Source: PlasticsEurope 2010*[5]

# Pollution in Azerbaijan

We decided to focus on the environment that surrounds us everyday, Baku - our capital and our native city. A topic was chosen and the research was conducted, as  have an exit to the Caspian Sea, and the disposal of plastic waste there is a very serious issue.[6] [7] Therefore, we will focus on cleaning, saving and preserving this area's natural habitat.

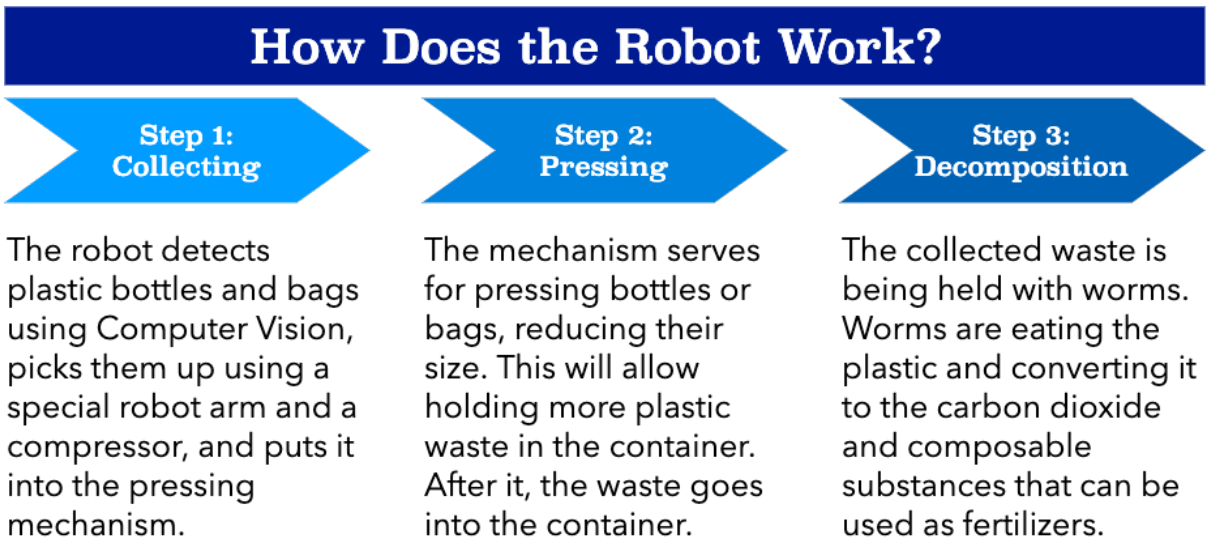
Plastic wastes in Caspian Sea[8]

The main sources of the pollution of the Caspian Sea are leaked oil waste products and plastic. There are  enormous amounts of plastic bottles and indecomposable bags at the shore. Because of the plastic wastes, hundreds of marine fauna die or  end up being injured or intoxicated. Moreover, remains of plastic in the result of biomagnification will get to the organisms of people who consume those animals, and this can cause serious health issues. Humanity must find a way to solve this problem autonomously. Otherwise, the problem can take on new dimensions.

# Solution

## Planning

We planned to make an amphibious robot, which can collect the plastic bottles and bags and decompose them biologically after it. Robots are effective in the process of garbage collection because they cost less than human labor, and they lack the human factor. Also, with proper programming, robots can work more accurately and faster than humans. We already did some project work on the plastic decomposition in the past, so we immediately came up with this scheme.

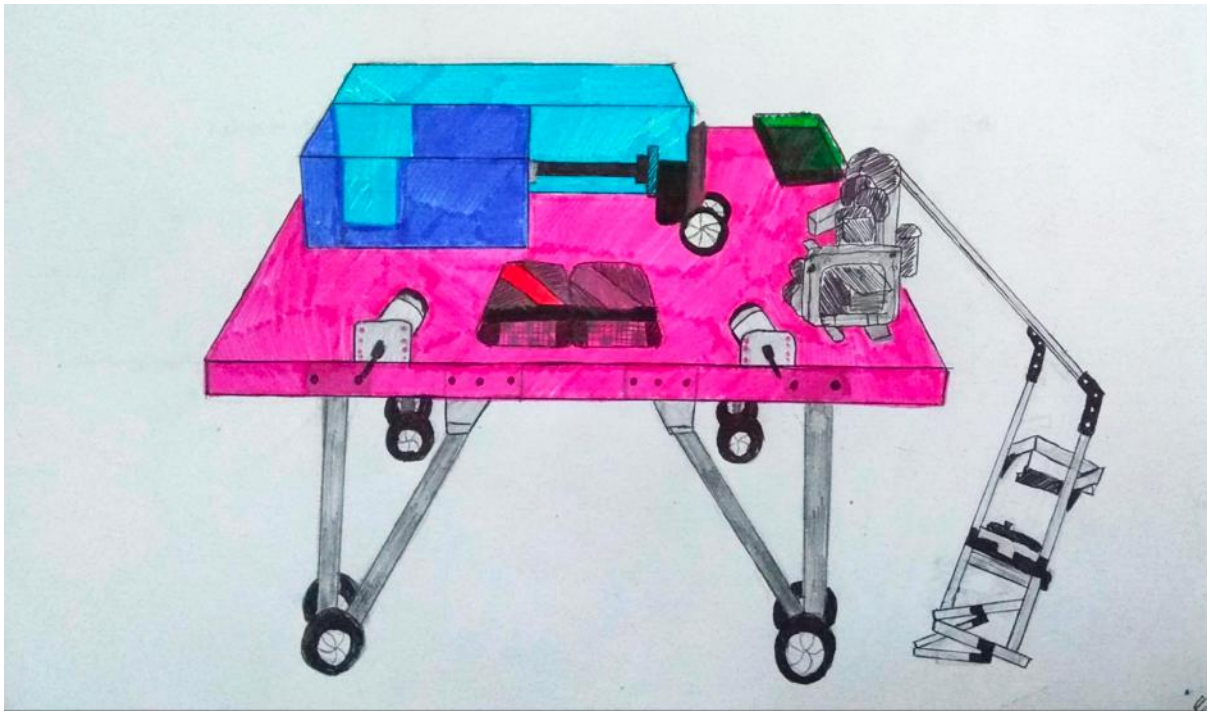


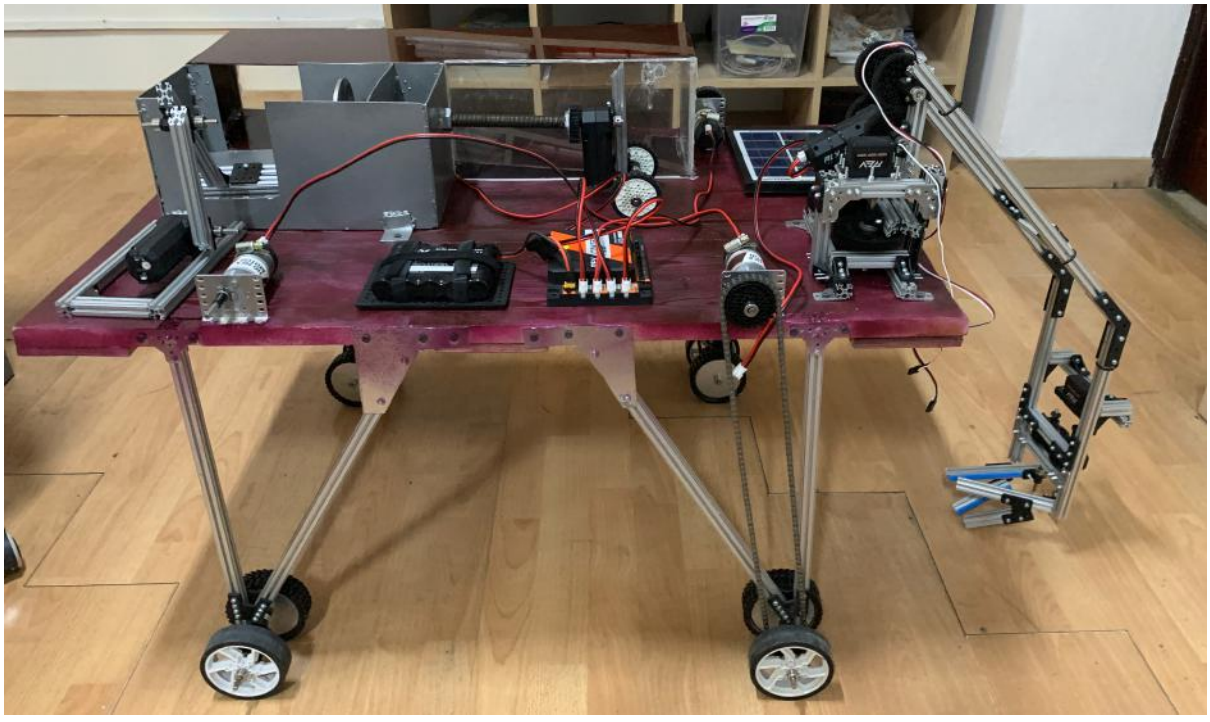

We have assigned our roles - everyone did what he was best at. At the same time, we helped each other with problems and conducted brainstorming sessions to resolve contentious issues.[our roles]

Because of the quarantine, we did most of our work online. We tried to meet as often as possible and even made our school permit us to work at school.

# Inspiration

We were inspired by Mars rover Opportunity , launched on July 7 2003, as a part of Nasa's Mars Exploration Rover program. We developed a sketch of a prototype and even constructed it.



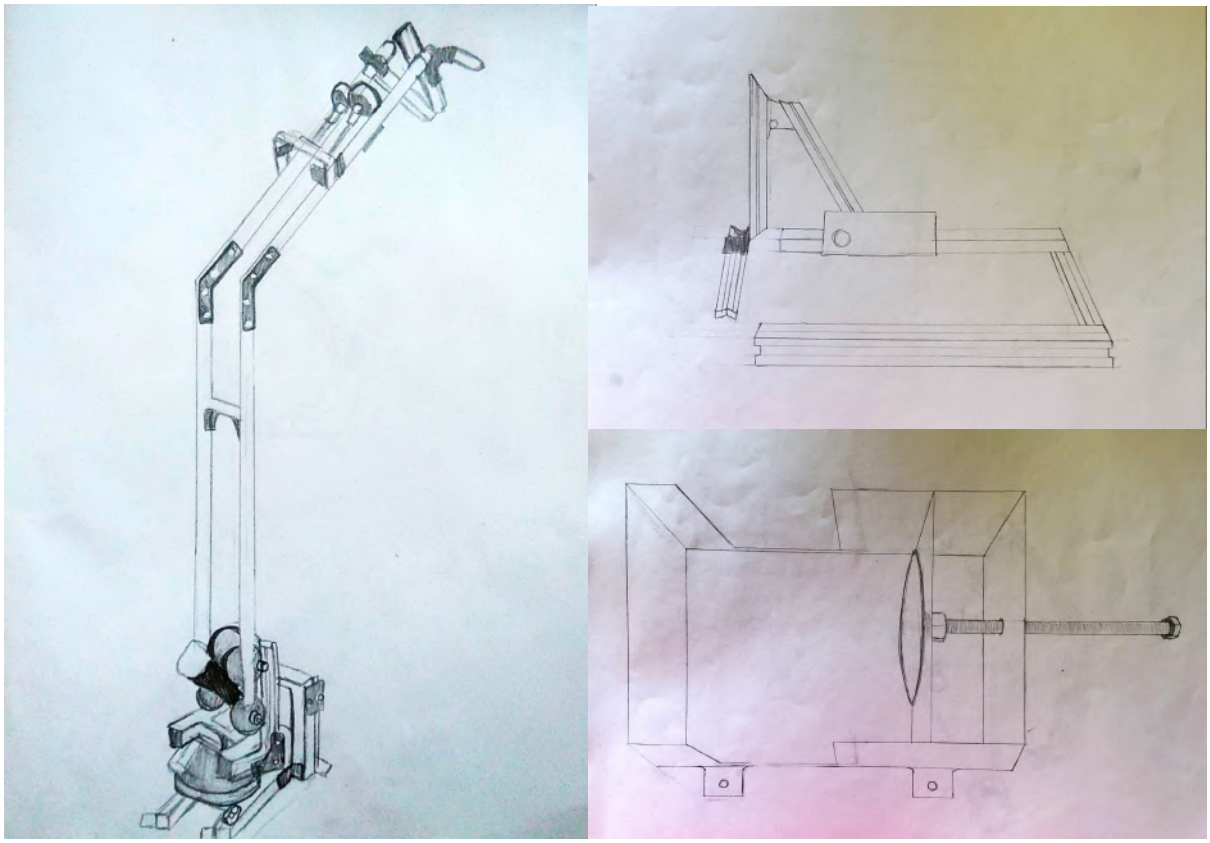


# Design

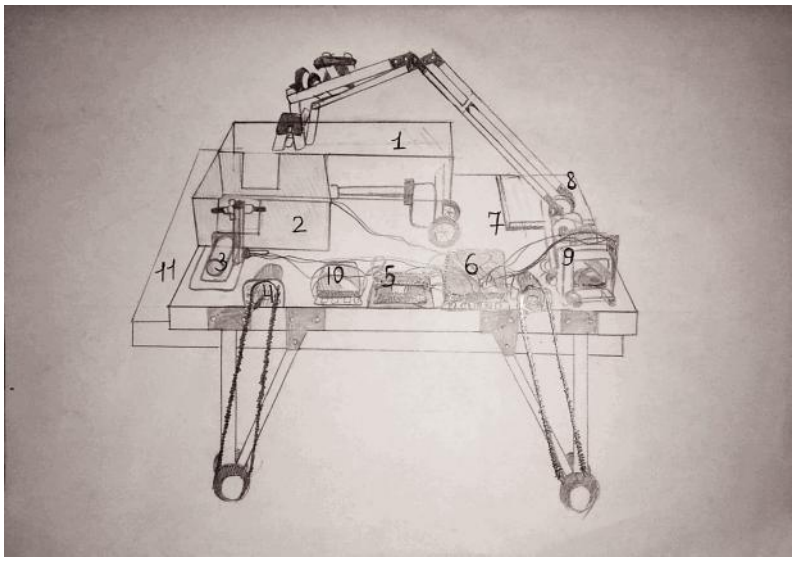
Our solution combines Robotics and Biology. Some types of worms can eat plastic and turn it into carbon dioxide and biodegradable substances. Mealworm, waxworm, and a worm named Zophobas can decompose different types of plastic waste. We designed our robot in a way that it can collect the wastes, compress them, and feed it to the worms. Our robot needs to be fully autonomous, so we used solar panels for perfect battery life and neural network for recognizing plastic wastes. One full charge is enough for 3 hours nonstop working.

Our robot moves with 4 DC motors which make it all-wheel drive and help when driving through mud and obstacles. The robot detects plastic bottles and bags using Computer Vision, picks them up using a special robot arm[image] and a compressor, and puts it into the pressing mechanism[image]. The arm mechanism is productive when it comes to the plastic bottles which are trapped in mud. The pressing mechanism reduces the size of the wastes and also pours out the remaining liquid. This will allow holding more plastic waste in the container. After it, the waste goes into the container[image] where our worms eat the plastic and convert it to the carbon dioxide and composable substances that can be used as fertilizers. The container capacity can be increased. Our prototype can hold up to 20x 0.5l plastic bottles and 70x plastic bags. The dimensions of the robot are 90x60x75cm (with arm mechanism down).

We equipped our robot with LED lights, so people can see it in the evening and night shift. We additionally installed a foam panel underneath our robot's main body[image], so that it can float on water. Also, we installed a camera with night vision which with the help of the neural network will help to avoid obstacles.



Robot Arm, Pulling & Pressing Mechanisms




1. Container
2. Pressing Mechanism
3. Pushing Mechanism
4. DC Motor
5. Batteries
6. Control Hub
7. Base
8. Solar Panel
9. Robot Arm
10. Expansion Hub
11. Styrofoam

# Software

One of the main trends in Artificial Intelligence today is Deep Learning.[10] We decided to use it in our robot for detecting plastic wastes productively. There are lots of datasets for training a neural network which can detect plastic bottles. We are planning to implement a Convolutional Neural Network in our robot, so it can train while working and 'think' as a human.[11]

# Our Experience

During this project, we all have gained useful knowledge and skill in Computer Science and Biology field. Moreover, we learned how to work in quarantine time, when most of our work was did online.

We also have experienced some hardships during the work process. The first mechanism we built was not powerful enough, so we had to reconstruct it and make him more powerful. However, due to quarantine, local shops were closed and we couldn't buy the needed materials. Instead, we tried to use the ones we already had in our houses and also in the school lab. Not only the materials acquired during our work, but also as I told before quarantine made us work online, so it was harder to work than before.

Our final model works well in our experiments but we can't demonstrate its work in on the shores of the Caspian Sea as planned, due to quarantine restrictions. However, we made a video that shows how it is working in our school and we believe it is a practical solution to the problem.

# Disadvantages and Advantages

### Wheels

Due to quarantine, the shops in which we could buy wheels for our robot were closed. Because of this, we made some of the wheels on a 3D printer.

### Battery Life

We equipped our vehicle with 2x 3000mAh batteries. The battery life without alternative energy sources is about 3 hours. We increased it a little with solar panels and trying to improve more.

### Weight

Our robot weights 25 kg because of metal parts. We think we can make it easier by picking the components with lighter materials.

### 100% Decomposition

Unlike other solutions, our robot not only collects plastic waste but also decomposes it biologically using worms.

### Lack of human factor

This allows the robot to work accurately, continuously, and without errors continuously.

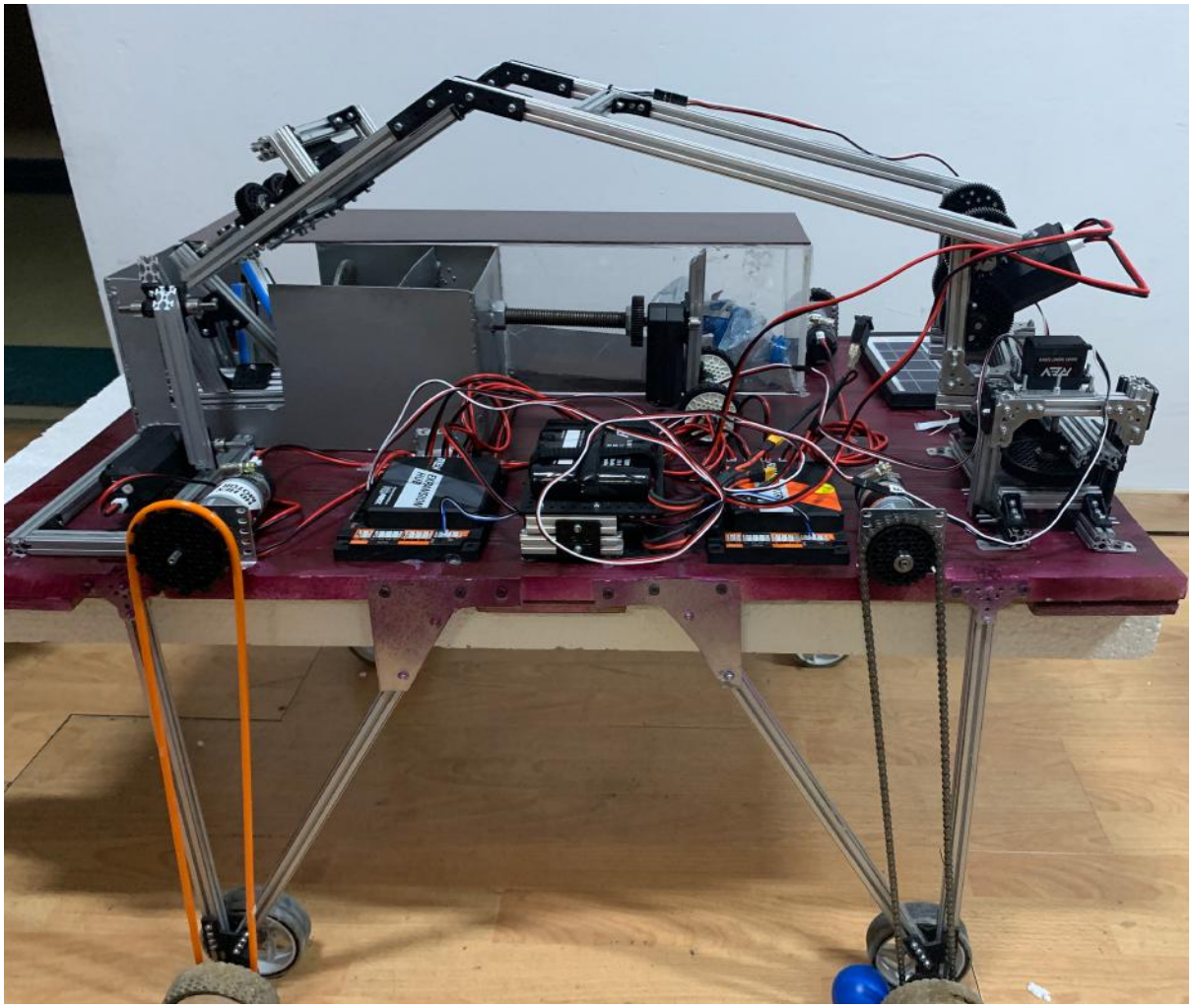
### Neural Network

A neural network allows the robot to detect plastic waste accurately and create the desired route.

# Conclusion

We designed a modern solution for solving one of the major global problems. Our project combines technology with live-being. The neural network is responsible for the efficient work of the robot and worms are used in recycling bottles and bags that are collected. It also has alternative power sources, like solar panels, and the robot is amphibious.

Despite all the hardships we went through, we are proud of the work we have done.



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