

## **I. Abstract**

Our vision is a world where coral can stay alive and protect the animals outside and within the coral reef. We will accomplish this vision by building a small robot dubbed the "Coralbot". Our future technology bot will use sensors, artificial Intelligence, and stem cells to try to improve the coral population and its lifespan. With the Coralbot we will create a future with healthier and more plentiful coral.

# The Coralbot

## II. Description

### 1. Present Technology

Coral reefs are “a ridge of rock in the sea formed by the growth and deposit of coral.”<sup>1</sup> They are an incredible ecosystem for more than 4,000 species of fish, 800 other species of hard corals. The problem today is coral bleaching- when coral polyps expel algae needed in the tissue for survival. The coral will then lose its color and die. Coral is dying at an unprecedented rate, and it is also mined for its limestone. The causes for coral bleaching include cyanide fishing, high ocean temperatures, and changes in salinity.

Though currently there are not any specific technologies that focus on saving coral reefs, coral bleaching can be predicted with satellite tracking. This method is as simple as breaking the coral into pieces and making it grow back faster and more plentifully. We would like to apply this technique later in our design.

Today we have robots with cameras, sensors, and artificial intelligence. However, there are no robots that focus on coral reefs. We do have divers that take measurements and survey coral, but they are simply gathering data and not solving the coral dying.

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<sup>1</sup>“A Coral Reef Is a Ridge of Rock in the Sea Formed by the Gro.” *Prezi.com*, [prezi.com/gpsay1iqrkix/a-coral-reef-is-a-ridge-of-rock-in-the-sea-formed-by-the-gro/](https://prezi.com/gpsay1iqrkix/a-coral-reef-is-a-ridge-of-rock-in-the-sea-formed-by-the-gro/).

# The Coralbot

## 2. History

Currently, there isn't a lot of technology around the coral reefs, but there is science and history. The coral reefs have been around since after the ice age. This event affected marine life in the sense that more than 60% of the marine life in the oceans died. The first corals were composed of stromatoporoids- reef forming sponges- tabulate corals and rugose corals. Stony corals, (the kind we see today), did not show up until later in that period.

The first coral reef to be documented was found in 1770 by Captain James Cook. He discovered this coral reef by running aground on it. This reef is the most famous in the world and got its name because it is literally a barrier of coral. Hence its name- The Great Barrier Reef.

## 3. Future Technology

The future of coral reefs have been a massive question in the scientific world recently. Many people worry about the coral reefs permanently dying out. This would be such a tragedy for thousands of species of animals and coral. The direct problem is coral bleaching, when the coral turns a white pale color and loses life. In addition, the coral reefs only reproduce once a year at a mass producing event. Though this does grow more coral, it is not enough to repopulate the dying coral at the same rate.

## The Coralbot

The upper part of the robot will have sensors all over its body to guide it to the coral reefs. We want to continuously update the information on the robot and have it collect data as it makes trips all around the coral reefs. It would be very similar to how divers survey coral and ocean species, except the robot could stay underwater longer and scan the reefs getting more exact data than a diver. We would also have the robot collect data about what issues are on the reef and how we can solve them.

In the Coralbot there are many different parts that allow the whole unit to function. There is a "brain" that reads the information sent from the tentacles that have sensors reading the variables in the water. It will tell the manipulators to react in a way that is meant for what the situation is. We will have sensors all inside around the bot, and we will also have an additional sensor stick that will come out of the bot that will physically test the coral. The manipulators are to allow the bot to perform any necessary actions. The Coralbot will work by using artificial intelligence (AI) program.

## The Coralbot

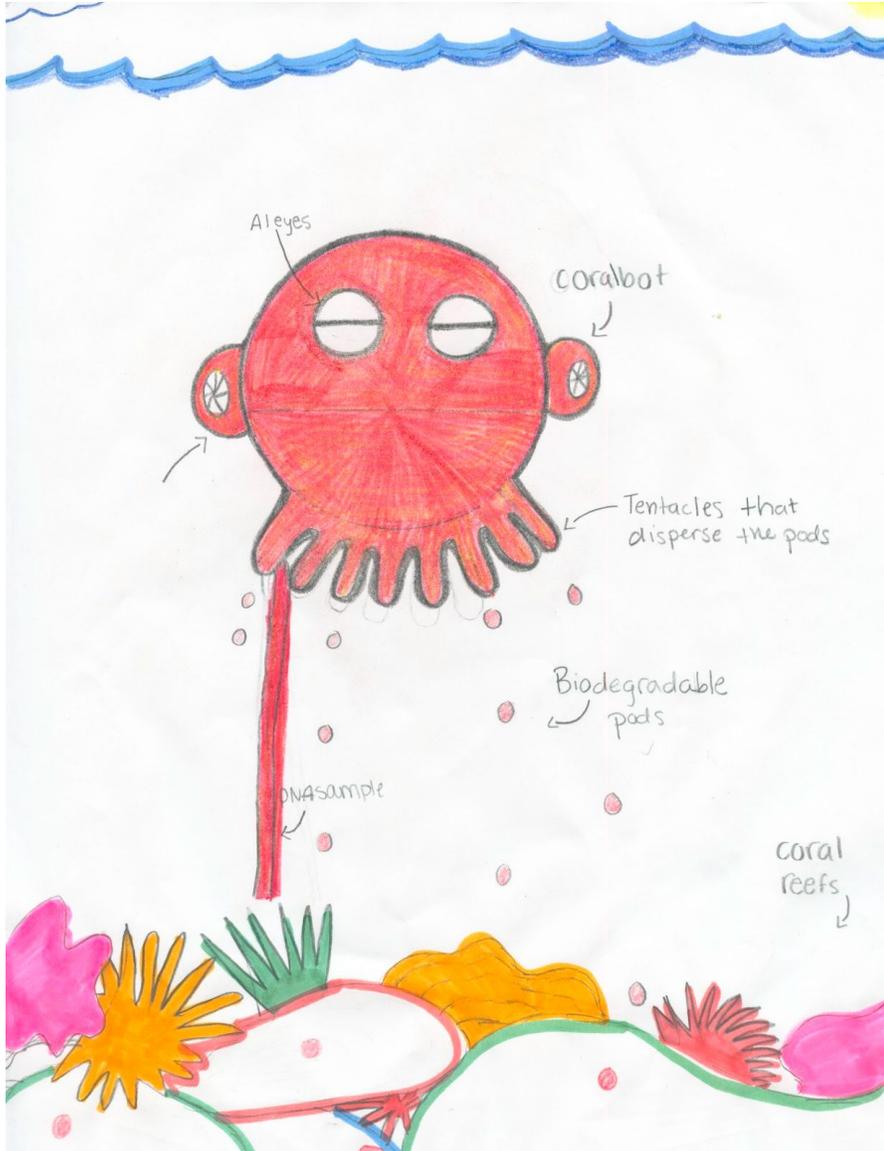


Figure 1: Coralbot

Our hope is that we could find actual coral stem cells that would be a breakthrough since currently stem cells have not been identified in coral. We will use Fluorescence-activated cell sorting (**FACS**), a software that can sort and find the stem cells. The Coralbot will then take the stem cells and differentiate into the reproductive

## The Coralbot

eggs and sperm. The egg and sperm will be together in the biodegradable pods and released to form larvae. As shown in figure 2, there are two ways to reproduce for the coral.

If the stem cells are not needed, another way would be to break the coral because it is a simple way for coral to regrow, depending on what the health of the coral is. Coralbot will use it's AI to decide if breaking the coral would be a better option and to determine where to break it. Coralbot will use its tentacles to break the coral. Depending on the issue, our robot would be able to analyze what to do to help the coral reefs the most.

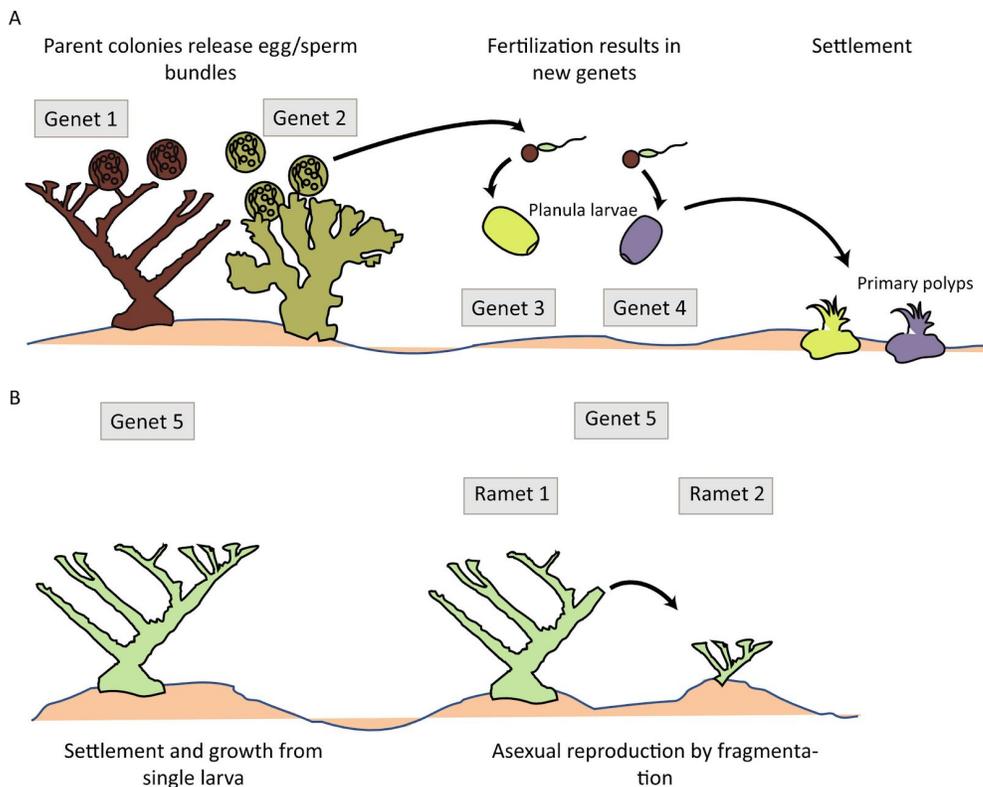


Figure 2: Coral Reproduction

# The Coralbot

There are many things in the ocean that are killing the coral reefs today. Some of them include coral mining, warming climate change temperatures, pollution, and deadly starfish. "Crown-of-Thorns Starfish, a native species whose numbers occasionally grow so out of control they endanger the reef, have been detected on 37 sections of the southerly Swain Reef, more than 60 miles offshore".<sup>2</sup> The New York Times says, the coral reefs are being eaten alive.

Also, starfish are eating the coral of the Great Barrier Reef. Right now divers in Australia are having to inject the starfish with ox bile to kill them before they eat too much coral, but these divers have to do this 250 days a year. Instead, we could have an aerosol sprayer in the bot and it could be filled with snail slime from the giant triton, it repels the starfish, in the sprayer to coat coral in it to discourage starfish from eating it.

## 4. Breakthroughs

The specific breakthrough would be finding out if the coral actually have stem cells to harvest and then differentiate, multiply, and release them. Scientists would need to figure out how to keep the cells alive inside the robot. The AI program would have to be able to do that and learn many new skills. Our advantage is that robots are more exact with their actions than humans, so if we teach it correctly, the copying process

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<sup>2</sup> Kwai, Isabella. "A Voracious Starfish Is Destroying the Great Barrier Reef." *The New York Times*, The New York Times, 5 Jan. 2018, [www.nytimes.com/2018/01/05/world/australia/starfish-coral-great-barrier-reef.html?ref=collection%2Fsectioncollection%2Fclimate](http://www.nytimes.com/2018/01/05/world/australia/starfish-coral-great-barrier-reef.html?ref=collection%2Fsectioncollection%2Fclimate).

## The Coralbot

will be very exact. AI is only so advanced, but with new brilliant minds, there is hope for advanced developments. We would need to transmit signals from the sensors to the CPU to make the arms move and release the larvae. We need the AI to get all of this information and analyze it and learn the new things that it is analyzing. It will help us make decisions about the coral reefs, and then help the save the coral. Luckily there are some technologies advanced enough to use such as GPS. Satellites are a large part used in monitoring ocean temperatures and can track where coral reefs are.

To test the AI's ability to grow the coral inside the bot, we would need to correctly use and the AI's ability to recognize and react to threats. Conducting an experiment in a lab to test our idea with different scenarios would help a lot. To test the AI to make sure it works right, we could make a few targets for the bot too spray with stem cells. To test the bots ability to not be destroyed by bigger animals such as sharks, we are going to design it to go faster when the AI recognizes large animals or threats such as a boat.

### 5. Design Process

As we were working on our project, we realized that we needed to restyle some of our thoughts based on what we had learned along the way. We had learnt so much about the coral reefs and how they operate, including our initial vision. We learned that rather than having just one way to help the coral reefs, we could do multiple things with the same technology, including clearing out evasive coral-eating starfish, taking stem cells and regenerating them, and breaking the coral for faster growth.

## The Coralbot

About the starfish, we learnt that they are called Crown-of-Thorns Starfish that occasionally over produce and they endanger the reefs. Based on this information, we thought that the manipulators could pull them off of the coral in order for them to get away from the reefs, no longer endangering them. We made no changes to the manipulators, we just realized that we could use them to pull them off.

We also learnt that breaking the coral is essentially better for the coral to regrow, depending on what the health of the coral is. We would resolve this problem using the manipulators on the coral bot to break the coral in half, hopefully curing the coral. The Coralbot would know what coral to break because of the sensors all around the bot. In the bot, there is also a testing stick that comes out of the bot when alerted by the AI, that can take a small physical sample to analyze it for further information. We thought that the stick would be necessary because we would get a formal sample to test further. We redesigned it by adding the testing stick, which is a coral color, and we didn't add anything new to the manipulators. All-in-all, we hope that our Coralbot will be able to help cure the dying and unwell coral.

Another thing that we added to our bot are AI controlled sensors. We decided to add them so that the bot would have a sense about what is happening around it. The sensors will be all externally around the bot. They will be on the perimeter of the bot, and they will be little circles. We thought that this would be a good idea because it will be great if something happens, like a predator mistakes the Coralbot for an actual animal. These sensors will allow the bot to react in a way related to the situation.

## The Coralbot

Our vision has changed so much along the way. We have all learned so much about the coral reefs and how much they mean to the Earth, and that the ocean would not be the same without them. Our design of the Coralbot is the main way that it could work one day, and that is why we came up with the idea for designing this amazing idea. This is why we hope that in the future the Coralbot will be able to make our world a better place.

### 6. Consequences

There are many positive impacts that will come with more coral in the world, but there are also possibly very bad outcomes, but first the good news!

First of all, coral reefs are home to millions of diverse species including fish, sharks, sponges, starfish, and octopi. There are also many endangered animals in coral reefs, some are species of sea turtles, whale sharks, certain species of dolphins, and sperm whales. So, if there is more coral in the world these endangered species will possibly not be as close to extinction and possibly even taken off the endangered list.

Second of all, coral reefs protect coastlines from damaging effects that come from wave action and tropical storms. They protect the coastlines by acting like a

## The Coralbot

buffer, which also helps prevent loss of life. Also, because much prime real estate is near water, coral reefs would protect those properties from erosion.

Sadly, one bad thing that could happen is that the AI could malfunction, but that is not very likely. Another huge consequence that can happen, is that our robot design could be mistaken for prey, and one of the predators could accidentally try to eat it. The reason why the chances of that happening are very low are because the color of the design will be coral so it will blend in, and it will look like a baby octopus, and the predators of octopus' are large fish like sharks, some birds and whales, these animals are not usually close to the coral reefs.

Lastly, a natural disaster could happen, causing the coralbot to crash, breakdown, get stuck, etc. and the Coralbot would sink down to the ocean floor.

# The Coralbot

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Figure 2: Baums, Iliana B., et al. "Considerations for Maximizing the Adaptive Potential of Restored Coral Populations in the Western Atlantic." *The Ecological Society of America*, John Wiley & Sons, Ltd, 19 Aug. 2019, [esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.1978](https://esajournals.onlinelibrary.wiley.com/doi/full/10.1002/eap.1978).

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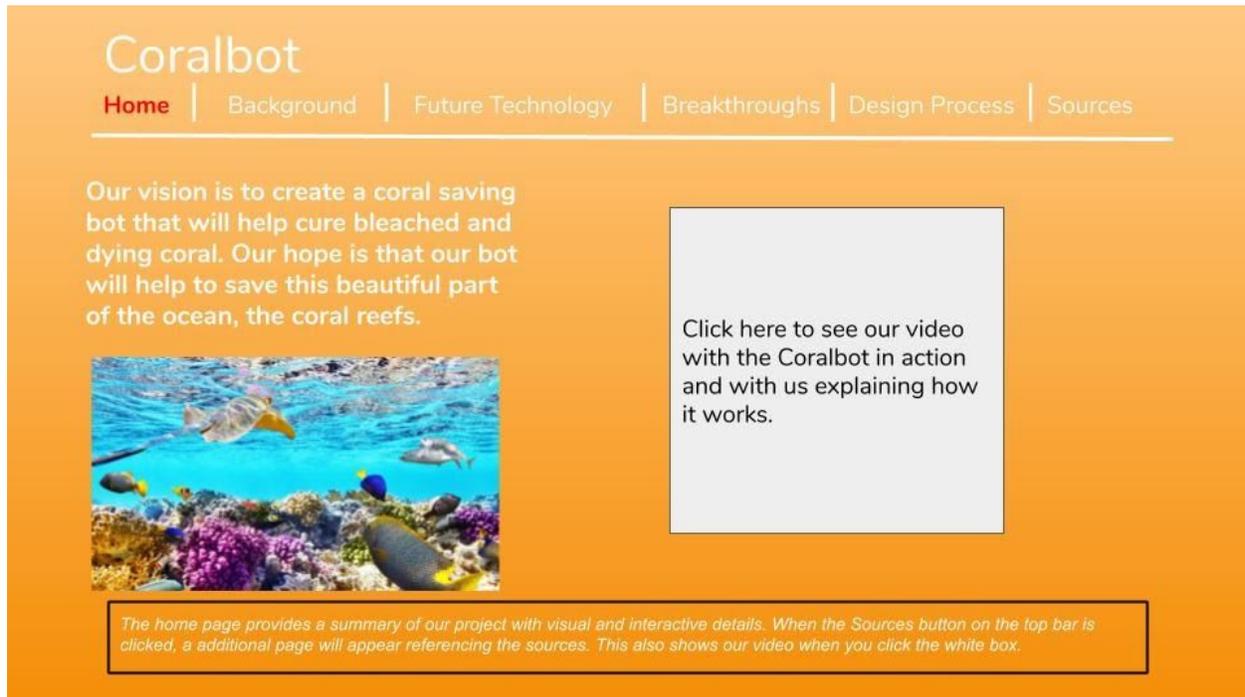
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# The Coralbot

## IV. Web Page Design

### Page 1



The screenshot shows a web page with an orange background. At the top left, the word "Coralbot" is written in white. Below it is a navigation bar with the following links: "Home" (highlighted in red), "Background", "Future Technology", "Breakthroughs", "Design Process", and "Sources".

Below the navigation bar, on the left, is a paragraph of text: "Our vision is to create a coral saving bot that will help cure bleached and dying coral. Our hope is that our bot will help to save this beautiful part of the ocean, the coral reefs." Below this text is a photograph of a coral reef with various colorful corals and fish.

On the right side of the page, there is a white rectangular box containing the text: "Click here to see our video with the Coralbot in action and with us explaining how it works." This box is intended to be a clickable link to a video.

At the bottom of the page, there is a small white box with a black border containing the following text: "The home page provides a summary of our project with visual and interactive details. When the Sources button on the top bar is clicked, a additional page will appear referencing the sources. This also shows our video when you click the white box."

# The Coralbot

Page 2.

## Coralbot

[Home](#) | [Present](#) | [Future Technology](#) | [Breakthroughs](#) | [Design Process](#) | [Sources](#)

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### The Problem Today

The problem today is coral bleaching- when coral polyps expel algae needed in the tissue for survival. The coral will then lose its color and die. The causes for coral bleaching include cyanide fishing, high ocean temperatures, and changes in salinity.

Coral is dying at an unprecedented rate and is also mined for its limestone.

### Technology Today

Today we have robots with sensors, AI, and cameras, but they are not focused on saving the coral reefs.

Scientists have GPS and satellite maps to see where bleaching events can be predicted, but there is not a lot to stop bleaching.



*Click on the coral reef picture to learn more about coral reefs and their history.*

# The Coralbot

Page 3.

## Coralbot

[Home](#) | [Background](#) | **[Future Technology](#)** | [Breakthroughs](#) | [Design Process](#) | [Sources](#)

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### Coralbot Design

The Coralbot has a "brain" that reads the information sent from the tentacles, which are the manipulators that can perform tasks.

Sensors along with a sensor stick that will come out of the bot will physically test the coral and variables in the water.

The Coralbot will work by using artificial intelligence (AI) program to understand how to save the coral.



Click to see detail information on how the Coralbot technologies work to save coral reefs.

- [Reproduce coral using stem cells](#)
- [Reproduce coral by breaking coral](#)
- [Repel Crown-of-Thorns Starfish from eating coral](#)

*Click on the technology to save corals will pop up detail pictures and information on how the Coralbot will help save the coral using that technology.*

# The Coralbot

Page 4.

## Coralbot

[Home](#) | [Background](#) | [Future Technology](#) | [Breakthroughs](#) | [Design Process](#) | [Sources](#)

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Coralbot will need breakthroughs in finding coral stem cells and differentiating the stem cells for reproduction. We also need advancements in AI. The AI program would have to be able to do that and learn many new skills. We need the AI to get all of this information, analyze and learn from it. We need AI to help us make decisions about the best way to save the coral reefs!



[Click here to see the studies we will conduct to test our Coralbot.](#)

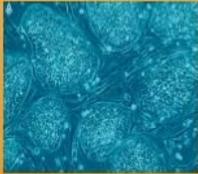
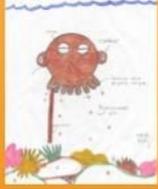
# The Coralbot

Page 5.

## Coralbot

[Home](#) | [Background](#) | [Future Technology](#) | [Breakthroughs](#) | **[Design Process](#)** | [Sources](#)

Through our research, we learned that there are many different ways to solve a problem. This allowed our team to learn new ideas and add them to our design.

First Idea	Second Idea	Third Idea	Fourth Idea
<p>At first we were trying to figure out how we can save the coral from dying. We thought of how stem cells work for humans, and we applied that idea to ours. We learned we needed a way to find stem cells in coral.</p>	<p>We learned about how breaking coral make it grow back faster. This strategy helps different types of coral and is more efficient. We added this to our Coralbot.</p>	<p>Another thing we added were sensors located all around the perimeter of the bot that is controlled by the AI. We thought this would be a good idea so the bot would know how to respond in a situation.</p>	<p>The last thing that we added is a testing stick that will take a physical sample of the coral that will be tested for further information if the sensors sense that something is unusually unique to the type of coral.</p>
			

*When a circle on the timeline is clicked, the attached text and/or photo will enlarge. To exit back to this page, click the "x" on the corner of the text. When you click on a box, it will enlarge.*