REEF RESCUE & RECOVERY

SHS Robotics - Tiger Sharks

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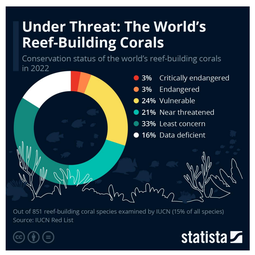
Abstract

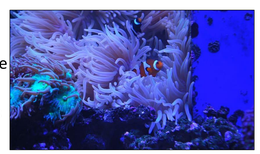
The SHS Tiger Sharks discussed issues around coral restoration as well as the reason why coral was important to the world. While discussing these problems, tourism was brought up as benefits of coral, as well as one main reason why coral was being damaged. The team started to discuss potential solutions; and through a lot of brainstorming and tireless effort, the SpongeROV was born. Marrying coral restoration and tourism, the SpongeROV is a multi-attachment underwater Remotely Operated Vehicle (ROV) that plants nursery-grown coral in the most needed areas. It is also equipped with cameras to take pictures of the coral for sponsors to receive via email periodically to check in on growth and development. The ROV would use systems such as photogrammetry, and various sensors to map and maintain the structure of the reef, staying true to its natural habitat.

Background & Motivation



Coral has been under threat for decades as humanity pollutes the oceans, changes the temperature of the ocean, the salinity of coral habitats, and cloudiness, or turbidity, of the water. Coral is very sensitive to environment changes and can be damaged in weeks or months. As the ocean becomes more inhabitable to coral, the Tiger Sharks have designed an ROV to help coral make a stand.

One important function of coral is the shelter it creates for various sea creatures to use as protection from predators. Coral reefs provide shelter and food for an estimated 25% of all marine species. Coral also protects the coasts from storms and erosion by reducing wave height and power by as much as 75%.



Another reason coral is important is that everyone really enjoys breathing. Coral is responsible in one way or another for about 50% of the world's oxygen and it absorbs about 33% of the world's carbon dioxide. Since coral is such a large part of the world's ecosystem, the team wanted to make sure the focus was on coral restoration.

The team really wanted to flip the script on the effect tourism has on coral reefs. We looked at the whole picture and thought, "Why can't tourism help coral restoration, rather than hurt it." This thought process shaped our ROV and impacted the sensors, cameras and purpose of SpongeROV.

Methodology

The team participated in several brainstorming sessions to determine topics that needed to be researched, then broke into smaller groups to deep dive on the below topics.

Areas of Focus:
Coral growth, threats to coral growth, and current efforts to help coral growth or coral restoration with ROVs or technologies.

The team brainstormed several systems that would be needed on the ROV:

- Sensors
- Attachments
- Imaging software
- Location and Navigation (GPS)
- Photogrammetry

Coral Plantation - The ROV would be carrying lab grown coral bases to plant so it would need to have enough propulsion to carry itself and the base. It would need to maneuver around the coral so would also need precise movement.

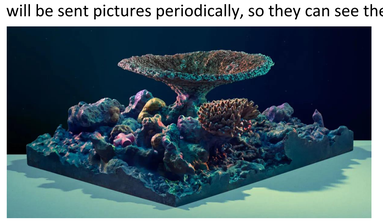
GPS - The ROV would require Global Positioning System (GPS) to know the location of where it will be planting the coral and locate areas of previous plant locations.

Sensors - The ROV will need a variety of sensors. One important type is distance sensors to know its location in relation to other objects. Think of sensors used in a car to indicate if the car is too close to an object. Similar technology will be used to avoid coral and other obstacles, keeping coral and the ROV safe. Temperature and salinity sensors will be utilized to make sure the conditions of the water will allow the coral to flourish. The ROV will have light sensors since light levels are important to coral growth. All of this data will be stored for the scientists to understand any changing conditions.

Attachments - The attachments are important. They need to be strong enough to hold the coral and delicate enough to not damage it. There will be three attachments, one on either side and one on the bottom to hold the base. The attachments will have rubber tipped prongs to limit any damage caused by the ROV.

Photogrammetry - The ROV will have a photogrammetry device to take detailed photos of the target area and turn it into a 3D model. The ROV will use the 3D model to assess the area and determine whether the possible coral reef location has the right conditions. It will also be used to determine if the coral is growing in future months and years.

Imaging Software - The ROV will use imaging software to take pictures that capture the progress of the coral growth. These will mainly be used to promote the sponsorships that will help fund the program. The sponsors will be sent pictures periodically, so they can see their coral grow.



Results & Discussion

While the team was conducting research on various concepts, a multi-attachment ROV started to take shape. ROVs are used in almost every underwater task or mission by the Navy and other marine organizations. While designing the ROV, we learned about tools to help preserve coral, photogrammetry to take pictures of the reefs, and sensors to measure the temperature and salinity of the water. As well as ways to safely move the coral to its new home!

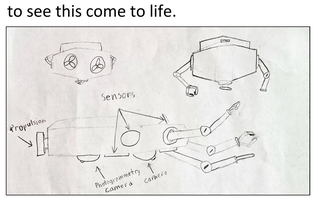
Sensors
Our robot will have many different sensors installed to help measure the temperature, salinity and turbidity of the water. The sensors will be used in real time along with AI technology to determine if the water has the right conditions to plant coral. The ROV will also keep all of the data to be later downloaded to help scientists all over the world.

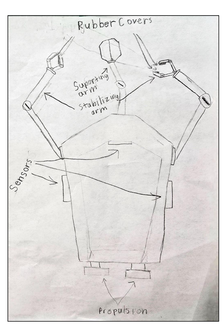
Cameras and Photogrammetry
A camera will be attached to the front of the robot to take pictures of the coral. These pictures of the coral growth progress will be sent to the person or group of people who donated to our cause. A photogrammetry camera will be attached to the back of the robot. The two cameras will not interfere with each other as they will not use flash or other light sources. Photogrammetry takes hundreds of photos and then stitches the pictures together to make a 3D image of the coral plant. Photogrammetry will be used to scan the area that the ROV will plant the coral. AI technology will also be used to determine the best spot for new coral growth.

The Movement of the Robot
The robot will use GPS for initial positioning and navigation when near the surface of the water. GPS uses radio waves and they are quickly absorbed by water. Most coral is near the surface of the water due to the amount of light it needs for growth. Once the ROV is at the desired location it will use sensors and the photogrammetry cameras to navigate to the final spot under the surface of the water to plant the coral.

Attachments
The SpongeROV has several attachments designed to increase effectiveness and efficiency. To start, a long, rubber tipped, claw-like arm is attached to the front to place the new coral into the habitat. That arm is on an axis so it can fully rotate, giving the robot more movement and range. The second attachment is a cup like scooper that collects water to be taken back to the lab. These can then be tested to make sure standards are being met for marine health. The team decided on these arms because each completes its respective task in the least amount of time with the least amount of mistakes.

The SpongeROV finally started to come to life. The team sketched out some ideas and eventually came up with our final drawing. We are excited to see this come to life.





Conclusion

While researching, we learned about equipment and systems that we didn't know existed or were widely used. The team now has a renewed excitement about the practical use of ROVs. The team also learned more about AI and some useful applications to an ROV. An important challenge to AI is finding the balance between too little and too much information, as well as understanding which decisions can be made by AI and which decisions need to be made by people. We learned about why coral is important to us and how it can affect the environment.

Next Steps

For our next steps, we wanted to make sure our project had the biggest impact possible. We decided by involving kids our own age, we could influence the next generation to protect the coral reef ecosystem and create a ripple effect of change.

Did you know there are over 16,000 middle schools in the United States of America according to Education Weekly? If we focus on getting the support of 3rd, 4th and 5th graders to adopt a reef segment, we could have access to potentially 48,000 supporters. If 25% of classes participated and each adopted a 3 x 3 square foot reef segment, in 5 years we could help plant 540,000 sq ft of coral. That's 9 football fields, or 5 city blocks! Since we would space each coral segment apart from each other to allow them to grow - it would be even more area covered!

To get schools on board, we would design an interactive website for schools to adopt and watch their coral segment grow before they graduate 8th grade. This website would let them see their coral grow, and help them learn new things, such as how to manage coral and take care of it.

Over time, we will keep improving our ROV by updating the robot itself and attachments to carefully move and maintain the coral without destroying or damaging it. We hope to improve our onboard cameras and overall underwater experience for kids. We hope to turn this project into something that will safely restore coral, while teaching people about how coral forms, how it's protected, and why it's important to our oceans.

Acknowledgements

The Tiger Sharks would like to express our gratitude to everyone who supported the SeaPerch program. We recognize that many of the work is behind the scenes, and though we may never know your names, we are thankful for your dedication to making this program possible so we can learn all of these amazing technologies.

A special thanks to our coaches. Head coach Mr. Mann, who founded the team in 2022, has been instrumental in teaching us buoyancy, electronics, fluid dynamics, and teamwork. His guidance and constant encouragement have been crucial to our success. Assistant coach Mr. Laub taught us circuit building, soldering, and how to use modeling software. His positive energy and mentorship have been a huge influence on the team. Mrs. Ford managed the team, helped with presentations, and provided valuable advice. She also organized our notes and kept us on track.

Lastly, we appreciate Mr. Rick and the school maintenance staff for providing and cleaning a place for us to meet. Thank you to everyone who made this journey possible. We cannot wait to pass our knowledge to others and inspire others as we have been inspired.