Diving Deep: HydroHook

Hawaii Coral Crusaders

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PROJECT OVERVIEW

Coral reefs are underwater structures that play a significant role in biodiversity, as they provide the habitat and resources that supports a diverse range of marine life. Additionally, they're essential for mitigating damage from natural weather events and coastal erosion. Despite their importance, coral reefs are continuously threatened and progressively damaged by pollution, climate change and overfishing. Therefore, we created the HydroHook (Double-pronged hook, Figure 7) that can plant healthy coral in destroyed reefs and remove debris.

Figures 1: Healthy Coral (Image from Coral Vita, *Why Reefs Matter*)

Figure 2: Healthy Coral (Image from Wildlife in Balance, *What Does Healthy Coral Reef Look Like?*)

Figure 3: Dead Coral (Image from Renew Economy, *Reef in crisis: Scientists despair - and tears - as corals perish*)

Figure 4: Dead Coral (Image from Earth.org, *Drone Imagery Shows 97% of Corals Dead in Northern Great Barrier Reef*)

BACKGROUND & RATIONALE

Coral Restoration
Coral restoration is the act of rehabilitating damaged coral reefs using natural processes. Coral reefs have been threatened for over 70 years, with 50% lost since the 1950s.

Hawaii houses more than 60% of the U.S.'s coral reefs, with an approximate 410,000 acres, and are crucial for the wellbeing of the land and people. Reefs act as a natural barrier against coastal erosion, have a significant role in Hawaii's fishing industry by generating $800 million annually, support a crucial part of the tourism industry, and act as a biodiversity hotspot.

Coral Bleaching
Despite their importance, coral reefs are threatened by coral bleaching. This is when the coral loses their vibrant colors and appear pale, due to the process of expelling algae that live inside their tissues. Although caused by other threats such as pollution and overfishing, the primary cause is climate change and its rising temperatures.

Climate Change & Rising Temperatures (Figures 5 & 6)
Since 1901–2023, the temperature has risen at an average of 0.14°F per decade. Rising water temperatures cause corals to expel their algae. The loss of algae results in a major food deficiency, increased vulnerability to disease, and thermal stress. In 2019, the Northwestern and some main Hawaiian islands experienced a mass coral bleaching event. This was due to a variety of factors, such as pollutant runoff, but was primarily because of a progressively growing El Niño event. This caused a widespread temperature increase, which had devastating effects on Hawaii's coral reefs. In 5 months, Hawaii had lost approximately 50% of its coral.

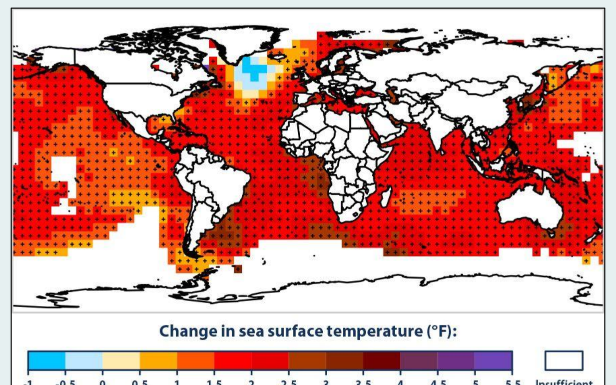

Figure 5: Change in Sea Surface Temperature (Image from Climate Check, *Rising Ocean Temperature and Climate Change*)

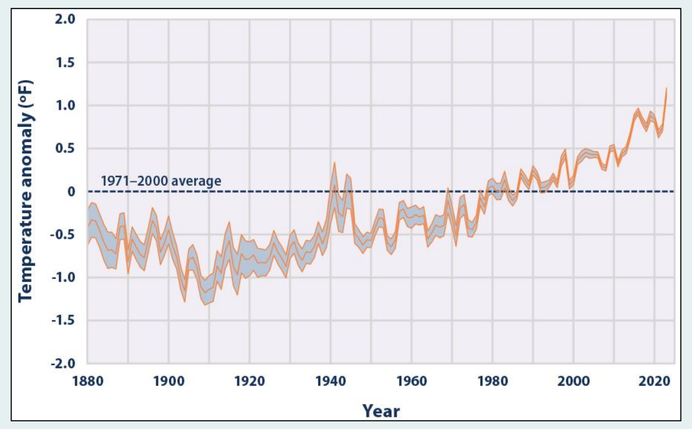

Figure 6: Average Sea Global temperature from 1880–2020 (Graph from EPA, *Climate Change Indicators: Sea Surface Temperature*)

APPROACH

We started by researching the root causes of coral bleaching and encountered a major source, pollution.

Pollution
Pollution is a significant problem on Oahu, with a concerning amount of marine debris being found all over the island. This debris often snags onto coral, blocking the necessary sunlight needed for photosynthesis and deteriorating them.

Planting Coral
To help counteract this issue, our team can design an attachment to plant new, healthy coral fragments grown from nurseries. Planting these nursery-grown coral provides a vital pathway to begin coral recovery and regenerative initiatives.

The HydroHook (Double-pronged Hook)
We used the Engineering Design Process (EDP) to design an attachment that could efficiently pick up debris and plant new coral fragments. Our team modeled the HydroHook attachment using the 3D CAD software OnShape. This approach allows the ROV to pick up debris that would otherwise be difficult to with one hook.

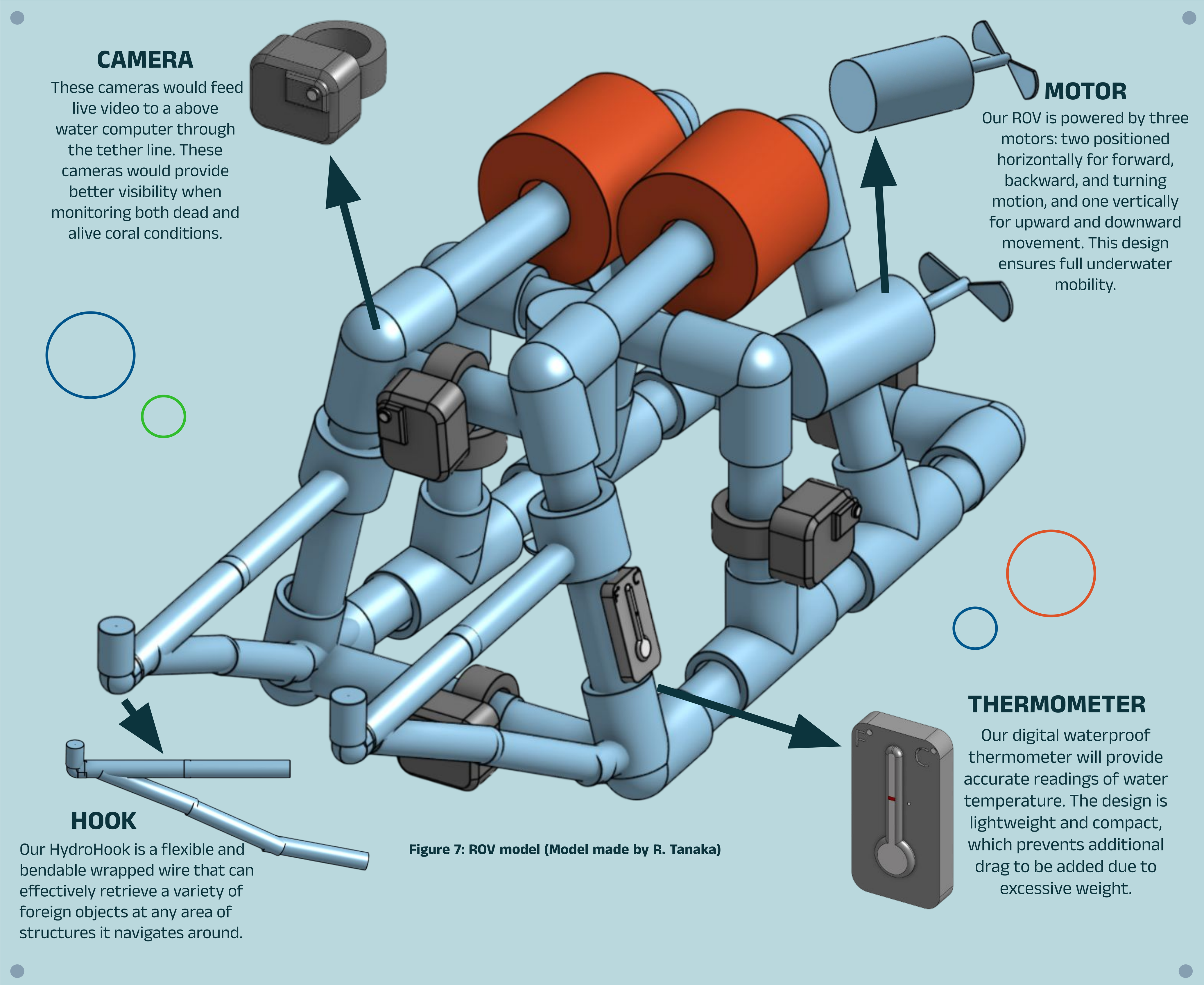

Figure 7: ROV model (Model made by R. Tanaka)

DISCUSSION & REASONING

Hook
The hook we used was designed specifically to have the ability to handle the weight and size of an average young Pocillopora coral. We chose to base the measurements of the HydroHook with this type of coral because it's a common type in Hawaii and is native in the Pacific Ocean. We will be planting young coral, which would allow for the coral to grow into their own colonies. We made the hook 7 inches long to support young coral. For reference, fully grown coral averages about 12 inches.

Camera
There are five cameras placed on the ROV. Two cameras are placed on the bow end, with one under and one over the hook. These allow us to see closer to the seafloor. The last three are placed on the starboard and port sides, and the stern of the ROV, enabling us to see around the ROV to prevent it from hitting sea objects or marine life.

Thermometer
Measuring the water's temperature is critical to coral health. Corals thrive within a very limited temperature range, as even slight increases in water temperature can cause coral bleaching. The data gathered of temperature ranges can allow us to predict bleaching events and take action to prevent further disturbances.

CONCLUSION

Our project aimed to address specific major threats to coral populations, such as pollution. Coral restoration efforts are capable of recovering previous natural benefits of coral populations, including mitigating the currents that waves generate and sheltering a variety of species. Our ROV was designed to explore the potential applications that underwater devices could carry out to effectively aid in coral restoration. Looking ahead, we plan to add additional features to enhance the performance of our ROV.

NEXT STEPS

Clamp Hook (Figure 8)
Using a clamp would allow for any coral to be picked up as it would be able to adapt to any dimension given. This clamp would be controlled by a on/off switch on the control box, which is connected via the tether. This mechanism enables the ROV to efficiently secure new coral fragments, remove dead or diseased coral, and collect waste.

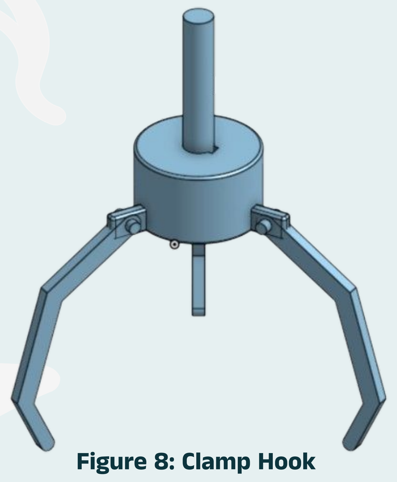

Figure 8: Clamp Hook (Model made by R. Tanaka)

Water Quality Tools (Figure 9)
Currently, the ROV can only transports objects and measure temperature. By adding an attachment that could (either) check on pH or salinity, it would allow the ROV to monitor coral health through mitigation plans backed by pH or salinity levels.

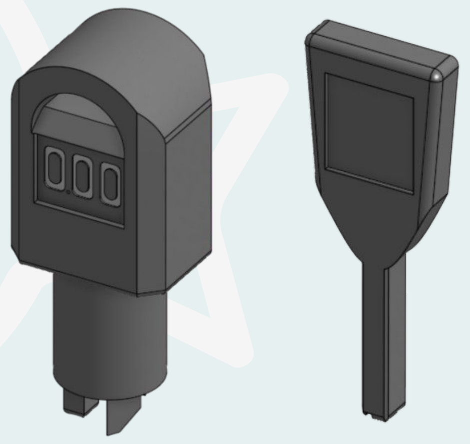

Figure 9: Salinity Tester (Left) & pH Tester (Right). (Model made by R. Tanaka)

Limit Tether
Using all attachments simultaneously requires a larger tether to upkeep whilst severely reducing maneuverability. To counteract, we will only test required attachments needed dependent on the active objective. A detachable tether enables rapid exchange between different types based on the goal.