Augmented reality to enhance remote submersible piloting

HMC Computer Science Clinic 2024-25

Background

- The Monterey Bay Aquarium Research Institute (MBARI) uses **remotely operated vehicles (ROVs)** to collect deep-sea specimens for oceanographic research
- Pilots control ROVs by referencing **multiple monitors** and using joysticks
- **Augmented reality (AR)** immersion can make ROV piloting easier, but sometimes, it would be useful to incorporate information from the external screens into the AR environment

Project Goals

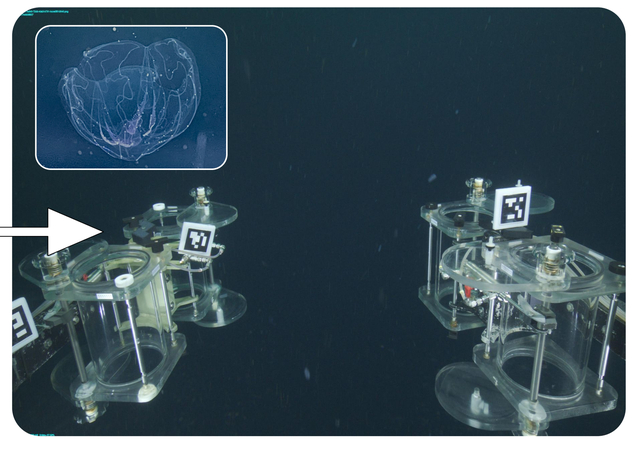
- Improve **user interface** to make a more comfortable and customizable headset experience
- Develop a **dynamic environment** for pilots and biologists to better communicate with one another
- Add **visual indicators** to UI to alert pilots when biological targets are in position to be captured
- Provide automated tools for improved **spatial awareness** of the vehicle

User Interface

To improve navigation using the VR headset, we created a **Picture-in-Picture (PiP)** to display another monitor.

There are two screen modes: **environment-locked** (which locked the PiP in space) and **head-locked** (where the PiP follows the user).

Users set the PiP's size, location, and modes in their **user preferences** which **saves between dives.**



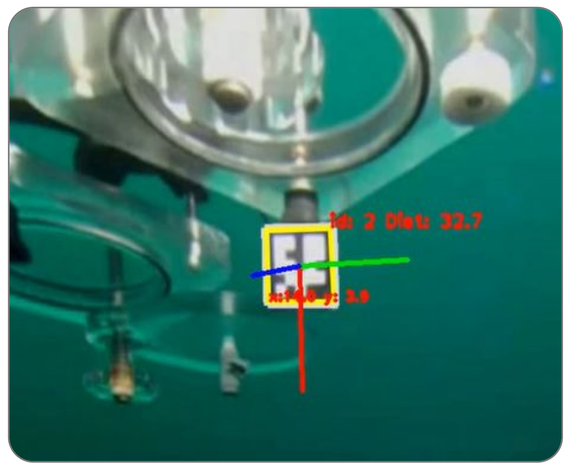
Depth Perception Model

It is often difficult for pilots to get samples lined up with the samplers on the ROV, even while using the stereo cameras.

We use computer vision techniques to get the precise **distance** of objects from the camera. This helps pilots detect when organisms are within the sampler's range.

We use **stereo depth estimation** to detect how far away specimens are from the cameras and **ArUco markers** attached to samplers to track sampler positions.

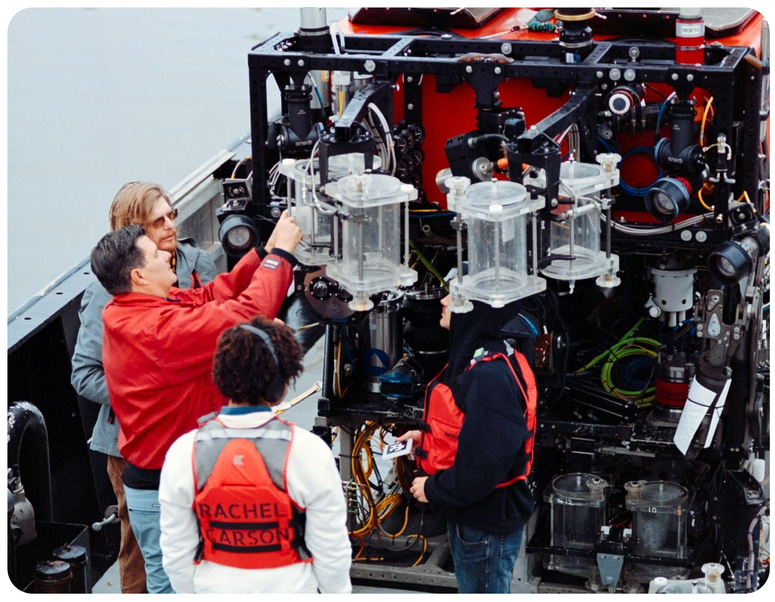
We then prototyped translucent **3D cylinders** in Unity that project out from the sampler and change color when a sample is in range.



Conclusions and Future Work

During our second site visit to MBARI, we deployed our code in real time on an offshore research cruise where the pilots and biologists used the AR headset to capture various species of jellies. After attempting to capture specimens both with and without the headset, they reported that using AR was helpful for the sampling process.

Future work on this project should focus on making depth perception features more smoothly integrated into the UI, as well as adding eye-tracking functionality to give users more immersive control within the AR space.



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