# SmartHook - An Underwater Robot for Attaching Recovery Lines

Imants Smidchens, Hero Alldredge, Ethan Donnelly, Jared Schein, Joydeep Saha
Mechanical Engineering Department & Electrical and Computer Engineering Department
**Capstone Sponsor:** Aaron Marburg, UW Applied Physics Laboratory (APL-UW)

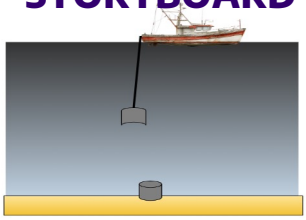
## BACKGROUND

Ocean floor sensors are crucial to the study of a variety of ocean processes. Many such sensors are tethered to floating buoys for location and retrieval, but boat traffic, permitting, and depth may necessitate a tetherless sensor. In these cases, existing retrieval methods are expensive, depth limited, and lack adaptability on-site. Our project, **SmartHook**, is an autonomous underwater ROV which will locate, align, and latch onto the sensor using image recognition software before being winched back to its deployment point at the surface.

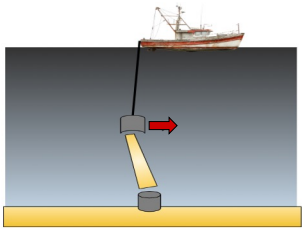
## Problem Statement

Underwater sensor recovery currently requires costly and logistically complex retrieval methods. We aim to redesign a BlueROV vehicle to autonomously locate and attach to underwater sensors to enable cheap and simple sensor recovery.

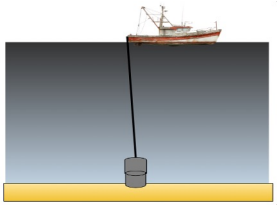
## STORYBOARD



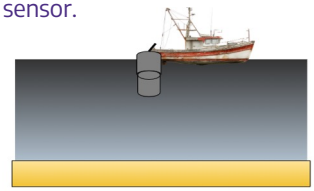
1. ROV is deployed from the ship and lowered to be above the sensor.



2. The ROV uses April tags to locate the sensor and autonomously adjusts its position to be directly above the sensor



3. The ROV will then lower itself and latch onto the sensor.

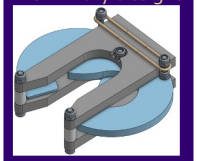


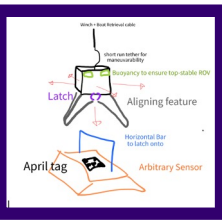
4. Finally, it will alert the crew it has been attached to the sensor to be winched up.

## CORE DESIGN REQUIREMENTS

- Must withstand a maximum load of 500 N
- 80% Success rate within 3 meters
- Fully autonomous
- Operational in saline/corrosive environments
- All major components removable with good tool access
- Cost under an overall $1000 budget
- Must operate under the limitations of the BlueROV ratings

Preliminary Designs






## Design Approach

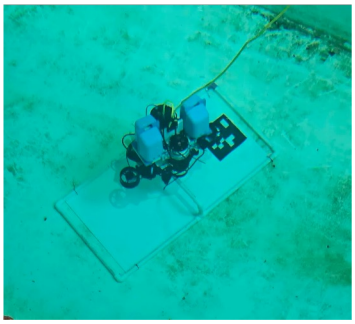
**Hook:** Wanted a 3D Printed design, which uses no additional electronics, based on a simple frog hook.
**Frame:** Rearranged the BlueROV parts to make it suitable for a pull-through design, where a single winch attachment at the top of the ROV could pull both the ROV and the sensor up simultaneously. Also wanted to keep the BlueROV's thruster layout the same (X pattern) to avoid reprogramming controls.

**Final design:** Composed of 3 identical waterjet cut marine board sheets, the 3D printed hook, and donor components from the BlueROV with 3D printed brackets holding them together.

## Software Architecture

The software is written in python using pymavlink and openCV2. The image processing is threaded to increase efficiency. We utilize a custom PID class to control each separate degree of freedom that the robot needs. Then the controller utilizes a case statement to move between different modes of operation.

## RESULTS/VALIDATION



We experienced a few major setbacks and roadblocks during spring quarter that slowed progress. Because of this we were not able to test as rigorously as we had hoped and did not reach the consistent autonomous operation we were aiming for. We did, however, develop software that consistently recognized and navigated towards the sensor as well as building a prototype ROV that was able to attach to the sensor under manual control, proving the viability of the overall project. We also achieved the rest of our core design requirements, including coming in well under budget.

## CONCLUSION & FUTURE WORK

While we were not able to achieve all of our core design requirements (success rate and autonomy), we successfully demonstrated a viable route to recovering ocean floor sensors that can be implemented more practically in the future.

**Future Work:**

- Further refinement and testing of autonomous software
- Improvement of ROV hardware to make servicing the ROV, attaching ballast easier
- Implementation of wireless communication from the ROV to the surface (to signal when sensor is attached)

## Acknowledgements

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