Marine Data-Ferrying Using Swarms of Autonomous Underwater Robots to Network Sensor Modules with a Surface Ship

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Introduction

The emerging field of Ocean Big Data (OBD) aims to create efficient methods of collecting marine data used for military, environmental research, oil & gas, and fishing industries. Traditionally, sensors must be deployed, retrieved and then have their data collected. With the use of autonomous underwater vehicles (AUVs), sensor packets can be placed, recharged and have data collected without being retrieved each time. Our team has modified an OpenROV (an open source AUV) to deploy, retrieve, recharge and collect seismic data from sensor packets. While AUVs are often used for surveying tasks, tasks that require an underwater robot to interact with its environment directly are still manually operated. Our research aims to combine contributions to underwater communications, path planning and swarm robotics to advance the capabilities of underwater robots to perform complex tasks in a challenging environment.

Objectives

- To reduce human labor involved in ocean data-mining.
- Enable robots to perform complex tasks underwater autonomously as a swarm.

Communication and Positioning

Magnetic Inductance Antenna
The AUVs are equipped with magnetic inductance antennas. Magnetic inductance will be used to estimate bearing information between close AUVs.

GPS-enabled Surface Ship
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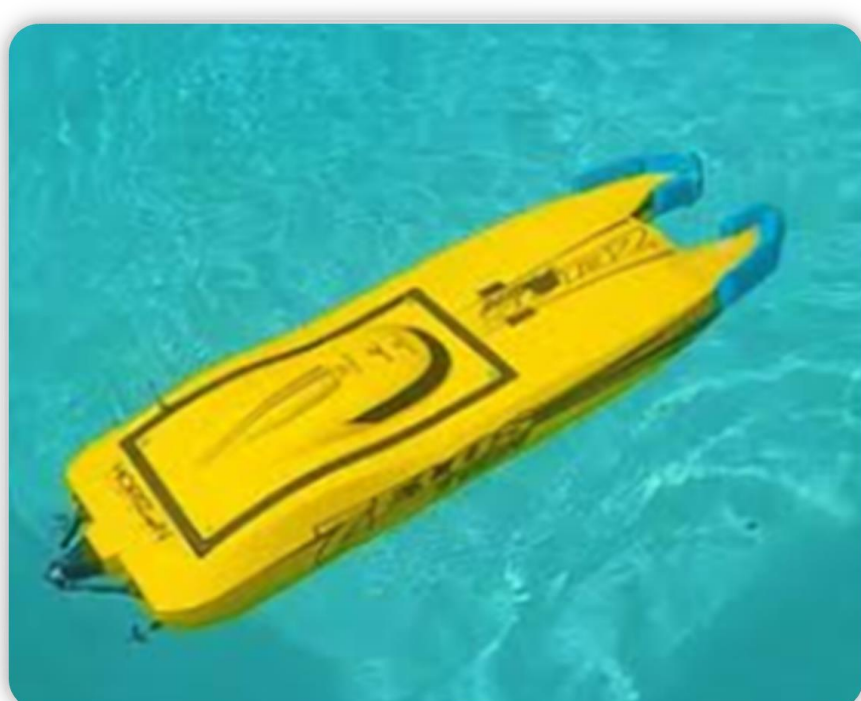
IMU
The AUV is equipped with an inertial measurement unit (IMU). Using a Kalman filter, positioning data from the IMU will be processed with positioning data received through magnetic inductance to mitigate drift error from the IMU and reduce noise from the magnetic inductance.
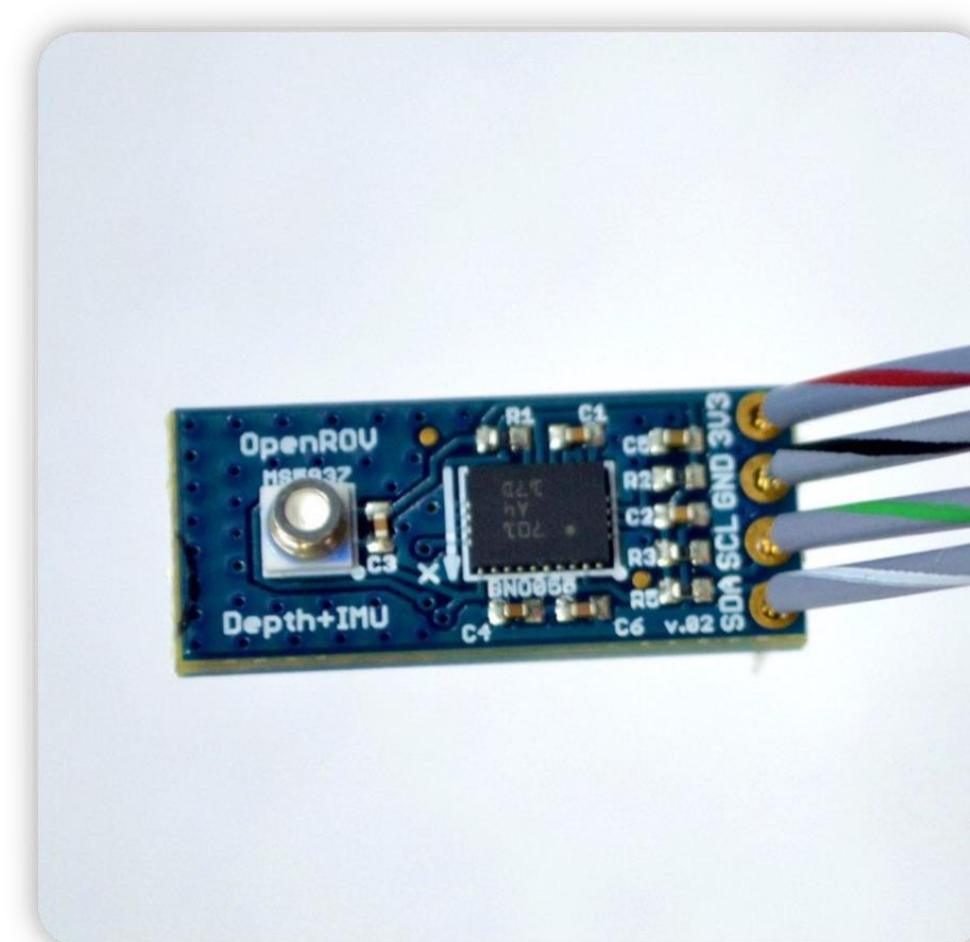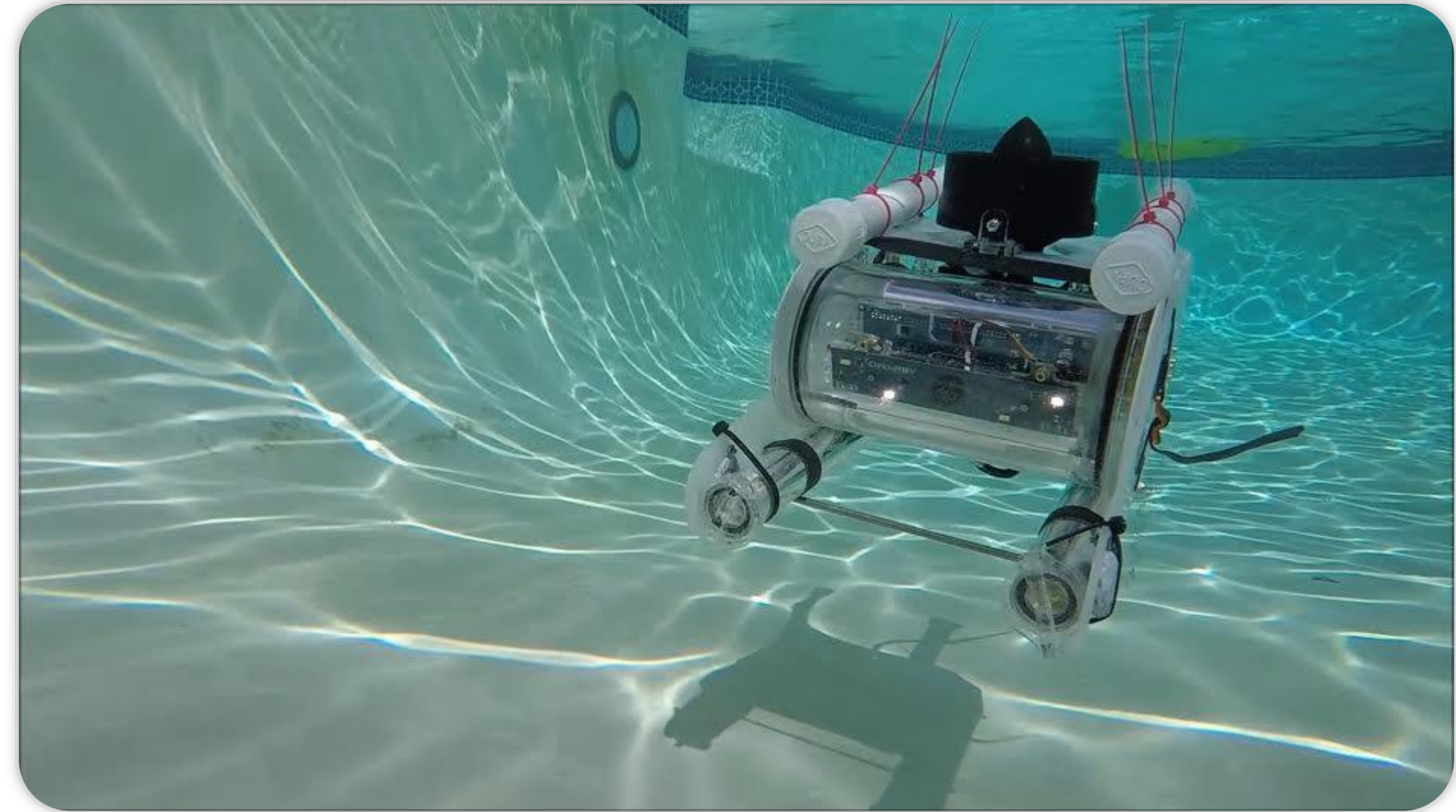
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The AUV

The swarm is comprised of v2.7 OpenROVs and are equipped with LEDs, laser range finders, IMU and a video camera.

Picking Up Sensor Packets

Sensor packets, shown in the image to the right, are equipped with a buoyant ring and retrieved through the use of a hook attached to the bottom of the AUV.
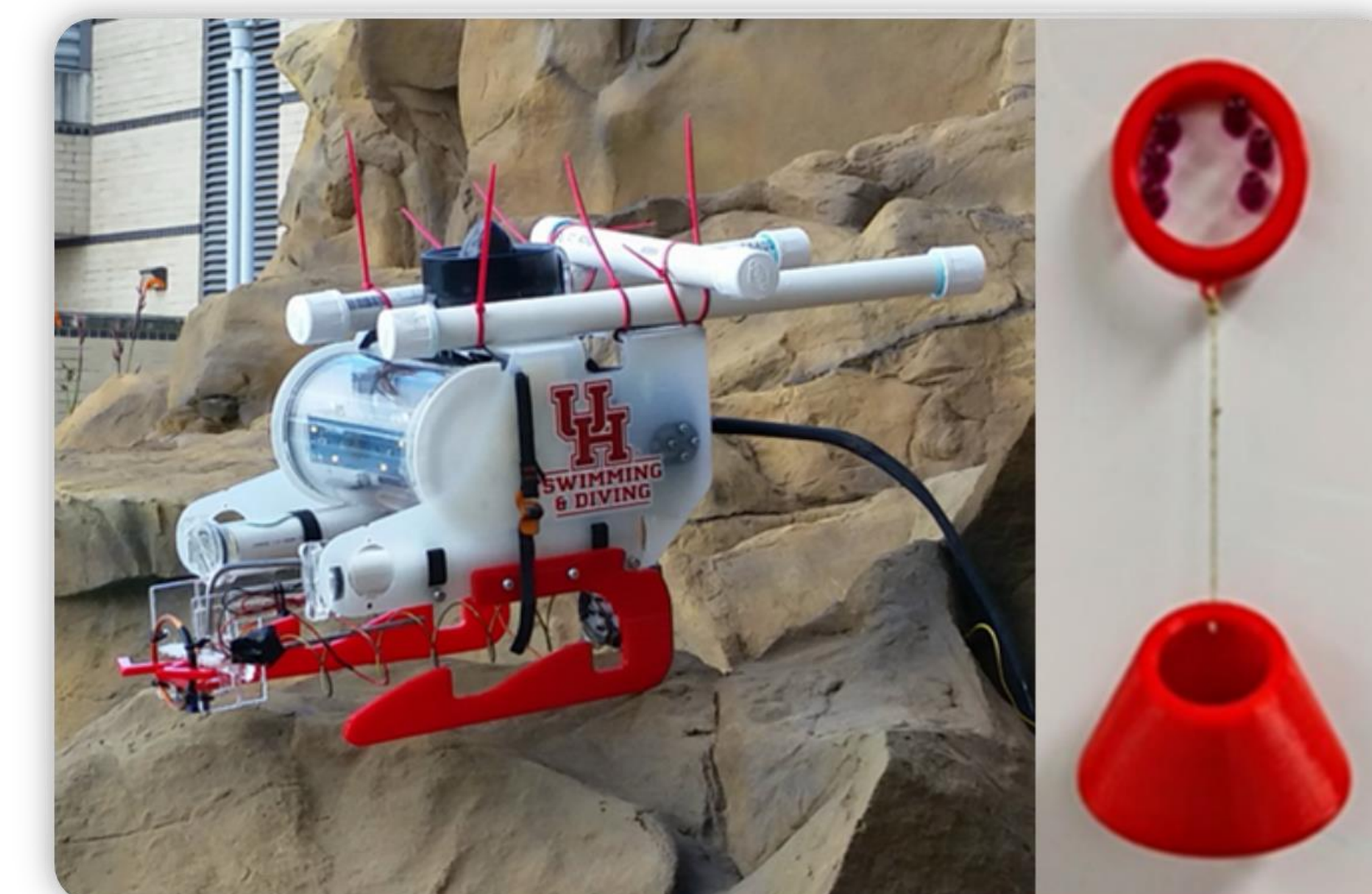

Image Processing

1. The bright red sensor packets are detected by subtracting the blue and green components of the video from the AUV's onboard camera.
2. Object tracking is performed by processing the video from the camera through a kernelized correlation filter.
3. The orientation of the ring with respect to the AUV is determined by the ratio of the object's height and width.
4. The AUV can then maneuver to correct it's bearing with respect to the sensor packet and estimate the distance to the sensor packet based on the size of the object in the image.
5. Video feedback to the AUV is then used to insert the hook through the ring.