Abstract

A remotely operated underwater vehicle (ROV) is a tele-robotic submarine commonly used for ocean exploration and inspection work on offshore oil rigs. The goal of the Triton project is to modify an existing open source underwater drone to allow scientists from the Department of Environmental Conservation at University of Massachusetts Amherst to conduct research and record the spawning behavior and pattern of the declining river herring population. In addition, two new components will be implemented; a buoy that enables wireless connection and a piston ballast to allow depth control. The purpose of these new modifications is to improve the overall performance of the vehicle in addition to reducing research costs at the Gloucester Marine Research Station.

System Overview

The system consists of four subsystems; the base station, Wi-Fi buoy, ROV, and piston ballast. The base station is where the user controls the ROV through a Google Chrome web-browser user interface. The Wi-Fi buoy enables the user to connect to the ROV without a tether up to 250 feet. In addition, this greatly improves tether management. However, there are tethers that run along from the buoy to the underwater drone. The ROV is an open source underwater drone called OpenROV 2.6. Majority of the electronic components on the drone were replaced due to water damage from previous operations. The final subsystem is the piston ballast. It allows the user to set the depth of the ROV without having to rely on the vertical motor. This greatly reduce power consumption and provides more stability underwater.

Specifications

<table>
<thead>
<tr>
<th>Specification</th>
<th>Goal</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery Life</td>
<td>&lt;3h</td>
<td>&lt;2.2h</td>
</tr>
<tr>
<td>Wi-Fi Range</td>
<td>&lt;300ft</td>
<td>250ft</td>
</tr>
<tr>
<td>Depth</td>
<td>20ft</td>
<td>&lt;20ft</td>
</tr>
<tr>
<td>Video Quality</td>
<td>1080p Full HD at 30fps</td>
<td>1080p Full HD at 30fps</td>
</tr>
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</table>

Results

Based on multiple lake tests, the estimated battery life for the ROV is < 2.2 hrs. The user does not face major drop in video quality up to 250 feet. The ROV can reach up to 20 feet underwater without experiencing any sign of water leakage. In addition, the video quality on the ROV is 1080p full HD at 30fps.

Acknowledgement

We would like to first thank our faculty advisors; Prof. Andras Moritz and Prof. Frank Sup, for helping us through the difficult of designing and implementing our project. We would like to also thank our evaluators for allowing us to present our project and providing us feedback. We would also like to thank the faculty members at the Department of Environmental Conversation; Prof. Charles Schweik, Prof. Allison Roy, and Prof. Adrian Jordaan, for providing us the ROV to work with.
Subsystem 1: Base Station

- The ROV is controlled through a google Chrome web-browser user interface called the cockpit.
- Live video feed is taken and saved from a camera located inside the ROV.
- Depth, orientation, and humidity levels are displayed on the cockpit.
- Videos can be saved on a local hard drive.

Subsystem 2: Wi-Fi Buoy

- The Wi-Fi setup is a raspberry pi with a USB Wi-Fi adapter and Ethernet plug adapter.
- Wireless signal is up to 250 feet with acceptable latency.
- The buoy is a watertight enclosure for the raspberry pi, Ethernet plug adapter, battery supply, and driver for the piston ballast.
- The subsystem helps improve cable management by reducing the length of the tether from 300 feet to 22 feet.

### Cost

<table>
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<th>Part</th>
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<th>Part</th>
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<tr>
<td>Piston ballast</td>
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<td>Piston Ballast</td>
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<td>Wi-Fi setup</td>
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</table>

Subsystem 3: ROV

- The underwater drone is an open source ROV called OpenROV v2.6.
- Previous electronics were replaced due to water damage.
- The depth/compass and humidity sensors were imbedded on the ROV.
- The ROV features a 1080p HD quality camera.

Subsystem 4: Piston Ballast

- The piston ballast consists of a stepper motor that displaces water in and out of a PVC tube.
- The subsystem is controlled through a driver located in the buoy.
- The driver takes inputs from the user and pressure sensor to determine the depth of the ROV.

### Experiment

- The plot above shows a distance test for the Wi-Fi setup. After 250 feet, the video feed experiences significant loss in quality.
- The ROV was taken to several pools to test for water tightness. Once there were confirmation of no water leakage, it was taken to a lake.
- The humidity sensors were tested by leaving water in the electronic cylinder.