Real-Time Vertical Temperature, and Velocity Profiles from a Wave Glider

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Award Number: N00014-12-1-0295

LONG-TERM GOALS

The long-term goal of this effort is to develop a system capable of active navigation/station keeping and able to measure profiles of temperature, conductivity and pressure in the upper part of the water column with an endurance of at least three months.

OBJECTIVES

The first objective of this project is to demonstrate that a wave glider fitted with an underwater winch can operate for at least two months without service and collect TD profiles in the upper 100 m of the water column. The second objective is to develop an electronic control system that will operate the winch acccording to pre-set environmental conditions and will download and transmit the TD data through Iridium.

APPROACH

The first phase of the project was the procurement of a wave glider with an ADCP and the design and procurement of the underwater winch system. A first set of tests was then designed to demonstrate the navigation and station keeping capabilities of the wave glider with the addition of the winch system. The second set of tests was designed to demonstrate the winch operation at sea with a mock-up TD probe. The third set of tests was designed to demonstrate the operation of the full system with an operational TD probe in controlled conditions off the SIO pier, to test also the data link between the dry payload developed by SIO to control the winch and communicate with the TD. The final test will be the navigation of the fully working system along the coast of California.

WORK COMPLETED

The first phase of the project is concluded. By April of 2013 the wave glider, ADCP and winch systems were in receipt at SIO.

Test 1: The Wave Glider (WG) deployment site was 3.5 miles offshore of Mission Beach San Diego. A continuous box pattern with 400 meter legs was programmed onto the WG prior to deployment (Figure 1).

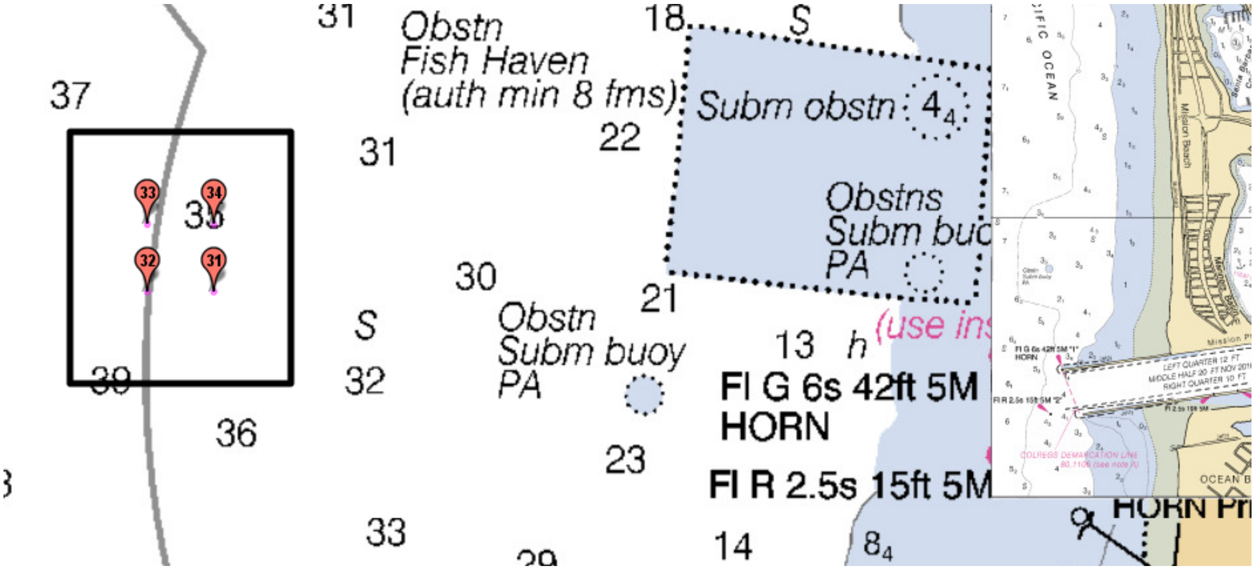

Figure 1: Waypoint box ~3.5 miles offshore of Mission Beach, San Diego

The WG was tested in two configurations, differing only by the winch shell attachment. The Aft payload box and weather station were removed for testing. The winch shell consisted of a mock-winch assembly, within the winch fairing (Figure 2). The mock winch was made up of PVC and lead weights, which replicated the winch's weight and trim in water. This was used in place of the winch to prevent damage of the prototype winch during deployment and recovery exercises.

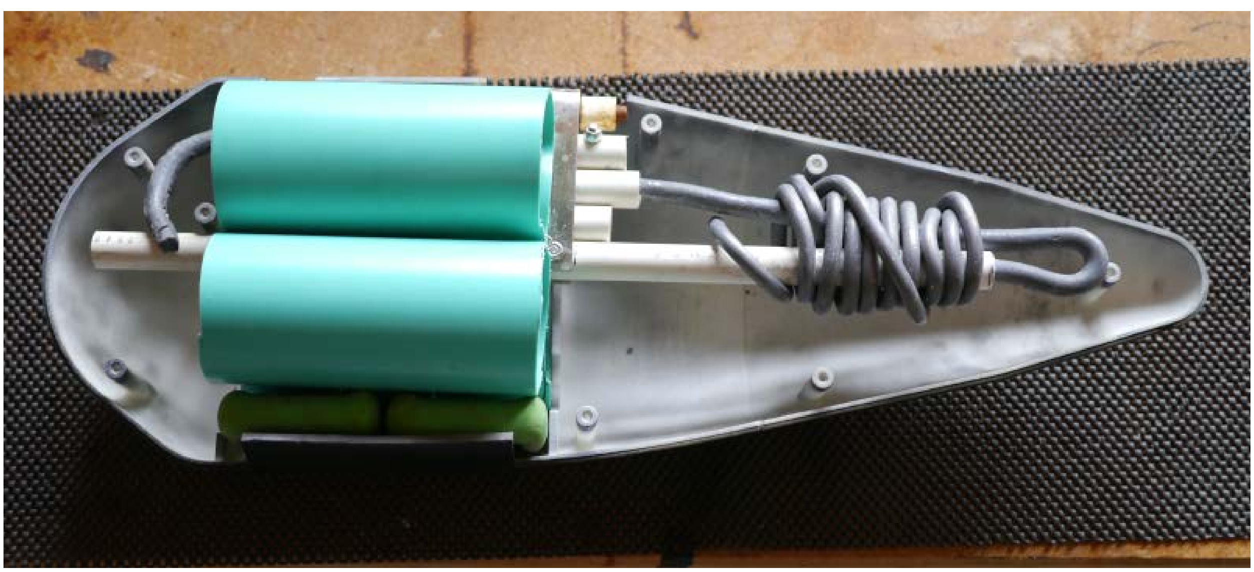

Figure 2: Cross section of winch shell with mock winch

The WG was configured to update position and water speed status every 2 minutes, and utilized the 'Line Following' PID control system for all legs except the initial Waypoint 31 to 32 transit.

The WG was deployed North-East of waypoint 31, and set to continuously loop through waypoints 31 to 34. For the initial deployment without the winch, from waypoint 31 en route to 32, the WG's Line

Following algorithm was not enabled. This caused the WG to drift northerly from the intended path. Thereafter, the WG utilized the line following algorithm to maintain course along the box pattern (Figure 3).

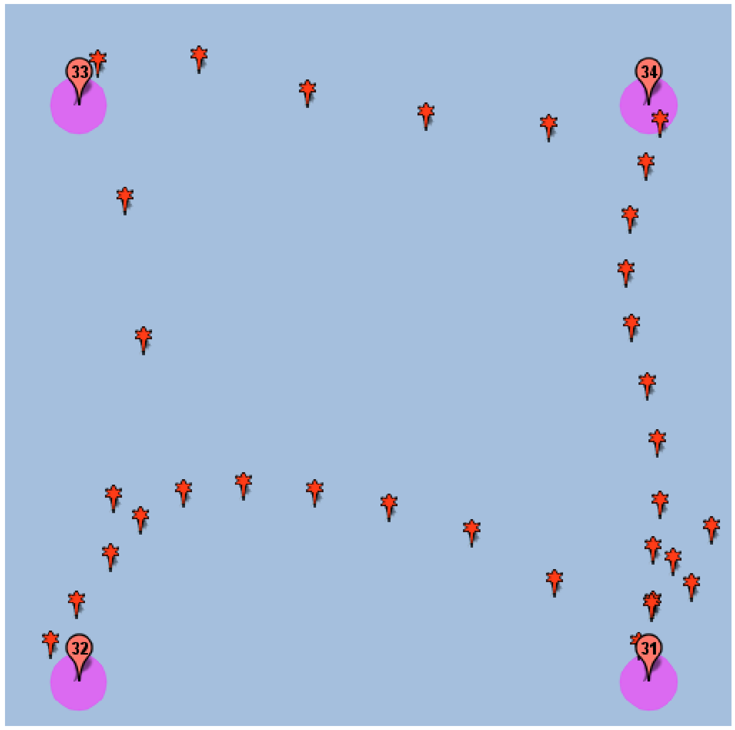

Figure 3: Box pattern without winch

The baseline speed through water of the WG is outlined in Table 1.

Table 1: Performance without Winch shell

Waypoint	Avg. Speed (knots)
31 – 32	0.794
32 – 33	1.482
33 – 34	1.409
34 – 31	0.724

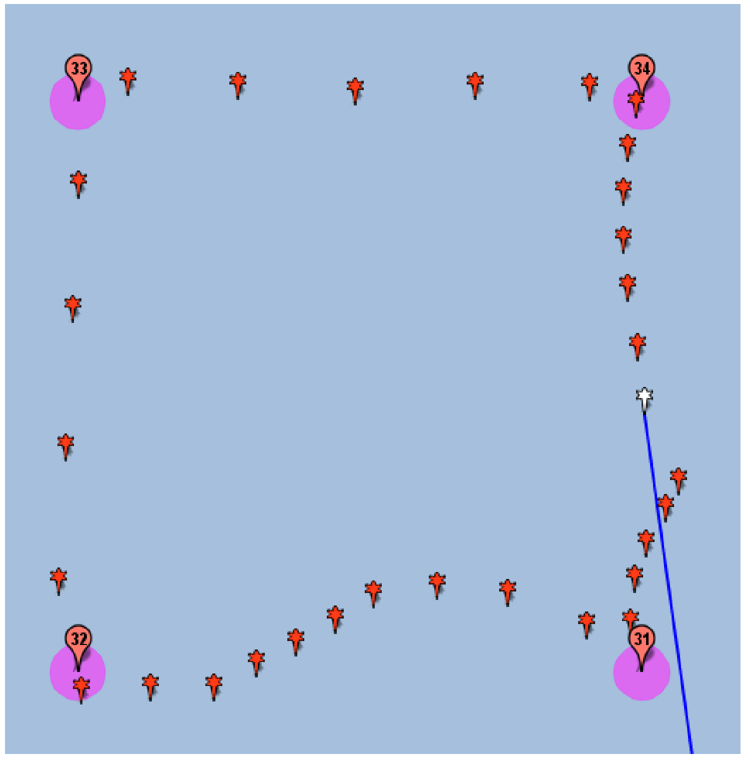

Figure 4: Box pattern with winch attached

After completing the first box, the WG was recovered, and the winch shell and ballast to trim the glider sub was added. The WG was redeployed to repeat the box pattern, starting at waypoint 31 (Figure 4). The performance of the WG with the winch shell is outlined in Table 2.

Table 2: Performance with Winch shell

Waypoint	Avg. Speed (knots)	Change in Speed (%)
31 – 32	0.658	-17.13
32 – 33	1.498	1.08
33 – 34	1.374	-2.48
34 – 31	0.599	-17.27

Preparation for test 2: In the SIO test tank, autonomous profiles were run continuously to a 10 meter depth for 30 minutes. It was noted that the winch position encoder drift will not negatively affect profiling with an applied find-home algorithm during spool-in. Profile speed is dictated by the 3A maximum peak current limit and the necessary torque required during spool-in. The level wind system was found ineffective at profiles exceeding 10 meters. The level-wind does not preform as designed when the spooled-in cable requires a change of direction along the drum. The level-wind guide falls out of sync with the cable spooled onto the drum, inducing cable overlap, and ultimately stalling the winch after repeated profiles. The winch vendor has been contacted to address these issues for the second winch.

Hardware and software has been developed to drive the winch autonomously with a proportional gain control algorithm as well as menu driven manual controls from a near-by support vessel via RF link. A developmental GPS-based Wave sensor is used for local wave condition monitoring. Computed spectral parameters are stored locally on a micro-SD card. The RDI Workhorse ADCP and Seabird SBE39 can be sampled and stored locally. Real-time datasets are sent to shore via Iridium SBD.

IMPACT/APPLICATIONS

We plan to use the profiling wave glider in regions of the ocean that cannot be accessed with R/V.

PUBLICATIONS

None