ID13- ACOUSTIC TAG TRACKING: FIRST EXPERIMENTS

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Abstract
Nowadays, the use of autonomous vehicles for ocean research has increased, since these vehicles have a better cost/performance ratio than crewed vessels or oceanographic ships. For example, autonomous surface vehicles can be used to localize underwater targets. Whereas different research works are focused in target tracking using acoustic modems (or USBL), in this paper a new method called Area-Only target tracking is presented, which uses the signal generated by acoustic TAGs. This document, the first tests are presented and their results discussed, which were conducted in the Monterey Bay.
Keywords— underwater target localization, autonomous vehicle, acoustic, area-only, tagged animals

I. INTRODUCTION

One of the main challenges in oceanographic research is that of underwater positioning. Is well known that GPS signals suffer a large attenuation underwater. Therefore different methods and architectures have been developed using acoustic signals, which have better underwater performance.

This paper presents a novelty Area-Only target tracking method, using a Wave Glider autonomous surface vehicle [1] that detects a tagged underwater target while moving on the surface. Using the detection/no-detection information, it is able to compute target position and follow it. The main algorithm used is the Particle Filter (PF), which has been used successfully in range-only target tracking [2]. Whereas in our previous work [2] the information used to track the target was the slant range measured using acoustic modems, in this case the only information available is the presence/absence of TAG's detection, which yields in a more complex scenario.

The method presented in this paper can be used in a wide range of applications using the long-duration, autonomous navigation and computational characteristics of the Wave Glider, to locate stationary or slowly moving tagged targets on the seabed or in the water column. In this work we present the first tests conducted in order to characterize the performance of the Area-Only method.

II. AREA-ONLY METHOD

The information that can be obtained using acoustic TAGs is presence or absence of the TAG in the area of its influence. Therefore, we only can know if the TAG is inside the area of reception but we do not have any information about its direction neither how close or far it is from the receiver. At this point, we can say that the algorithm developed is area-only, where only the area formed by the maximum range achievable by the TAG is used as an input of the filter. Fig. 1 illustrates this performance.

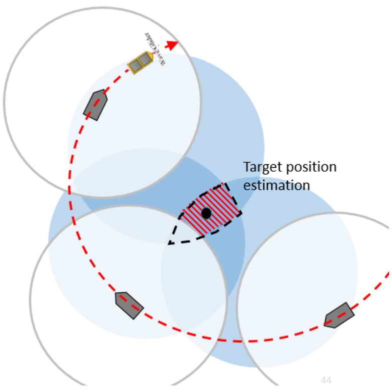

Figure 1. Area-Only target tracking problem representation.

Two kind of areas can be observed, one where the TAG is detected (blue circles), and a second area where the TAG is not detected (white circles). The target localization estimation can be computed overlapping all these areas, where the area with a main coincidence is where the target should be.

This method can be implemented using PF, where initially all the particles are drop in a specific area, and then for each new detection (or no-detection) the particles weight is updated until all of them converge in the target position estimation.

III. TEST CHARACTERISITICS

The following test was carried out on June 27-28, 2018. For this test, a Wave Glider (WG) and a Coastal Profiling Float (CPF) were used. The WG was equipped with a Vemco receiver, and two Vemco TAGs were installed on the CPF (Fig. 2).

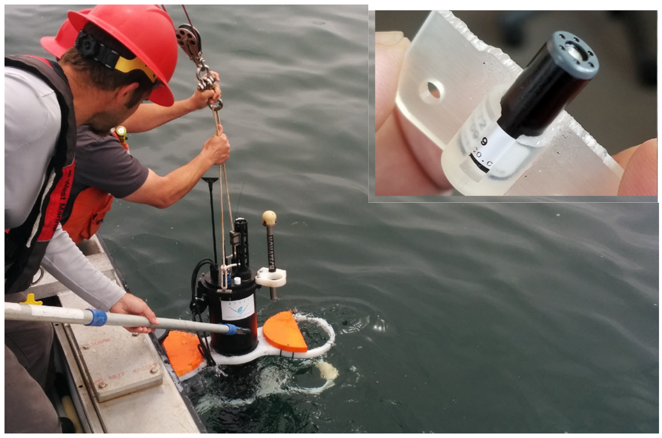

Figure 2. CPF's deployment during the test. Vemco TAG used (top).

This test was conducted as follows:

a) Test 6.1:
- Script: tracking.py with 50 meters of radius
- Start: 16:00 (PDT)
- Stop: 20:00 (PDT)
- File: *cpf_ivan-2.out

b) Test 6.2:
- Script: tracking.py with 150 meters of radius
- Start: 20:03 (PDT)
- Stop: 21:43 (PDT)
- File: *cpf_ivan-3.out

c) Test 6.3:
- Script: tracking.py NO STALKING
- Start: 22:17 (PDT)
- Stop: 08:39 (+1) (PDT)
- File: *cpf_ivan-6.out
- In parallel during the no stalking test (6.3) different watch circles were conducted manually with the WG as follows:

1. Radius: 50 m. Start: 21:53 (PDT)
2. Radius: 100 m. Start: 23:03 (PDT)
3. Radius: 150 m. Start: 02:11(+1) (PDT)
4. Radius: 200 m. Start: 05:17(+1) (PDT)

5. Radius: 250 m. Start: 07:35(+1) (PDT)
6. Stop: 08:40 (+1)(PDT)
d) Test 6.4:
• Script: tracking.py with ODSS improvements done by Brian
• Start: 08:40 (+1)(PDT)
• Stop: --:-- (PDT)
• File: *cpf_ivan-7.out

IV. RESULTS

The results and issues observed are addressed below.

a) Range differences

The first problem that can be pinpointed is the differences between the ranges measured using acoustic modems (DAT) and the range computed using the GPS positions of the Wave Glider (WG) and CPF. This error is highlighted using the red circle (Fig. 3). This issue is probably due a bad GPS measurement of the CPF, which only takes one or two positions while it is in the surface, and strong currents can move the CPF far away from its initial position.

a) Surface detections

Finally, another issue to take into consideration is the TAG's reception rate while the CPF was in the surface. We observed in previous tests that when both TAG and Receiver were placed too close to the sea surface the reception rate was not good. This behavior can be observed also in this case, as it is shown in the Fig. 4, where the TAG reception drops rapidly when the CPF reach the sea surface (green line in the middle plot).

V.CONCLUSIONS

This work describes a field test conducted to acoustically localize a benthic Rover deployed at 4000 m depth from an autonomous surface vehicle. For this purpose a new application using a Wave Glider as a single-beacon LBL has been developed. The work presented in this paper proves the good performance of this method.

ACKNOWLEDGMENT

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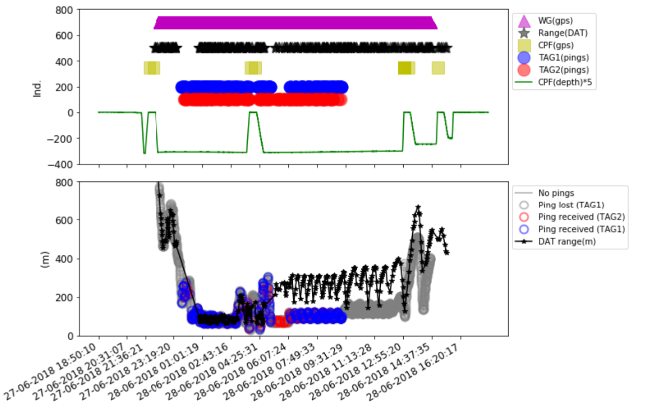

Figure 3. Data representation with their timestamp (top). Ping reception, range, and range error representation (bottom).

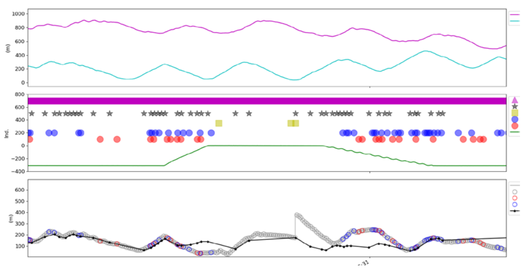

Figure 4. TAG reception (blue and red dots) is missing when the CPF is in the surface (green line), middle graph.