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Long Baseline (LBL) Positioning System for the Crawler Tele-operated Underwater Vehicle in OBSEA Observatory

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I. ABSTRACT

Due to the increased interest in maritime exploration, underwater robots, or remotely operated underwater vehicles, are essential to marine research projects like monitoring ocean pollution. [1], marine biology exploration [2], [3], and industry applications [4], [5]. Reliable navigation data is necessary for effective navigation and control of the tele-operated underwater vehicle, and precise placement is required. [6]. A long-baseline system (LBL) is an acoustic positioning technology for underwater vehicles, affording high accuracy and a broad operational spectrum [7], [8]. But in a low signal-to-noise ratio (SNR) and reverberation environment, biological noise, multipath fading channels, and other environmental noise commonly affect an LBL positioning system, reducing the underwater vehicle distance measurement accuracy and ultimately affecting the vehicle positioning accuracy.

Designing a special configuration of an LBL system in the OBSEA cabled observatory[9] environment, we will be able to detect with more precision the objects that are under the water and incorporate them to improve the navigation and, therefore, the mapping of the robots. This work is based on the OBSEA cabled observatory, which is part of the EMSO (European Multidisciplinary Seafloor and water column Observatory), and the underwater Crawler [10], a Remote Observation Vehicle (ROV), which is a modified version of the "Wally" platform series. The Crawler is easily deployable for monitoring to depths up to 50 m. In this work we use an acoustic system of uWave modems [11] with the NeXOS hydrophones [12] for getting a LBL position system. Later, we used this system to determine the position of the Crawler using triangulation around the OBSEA platform.

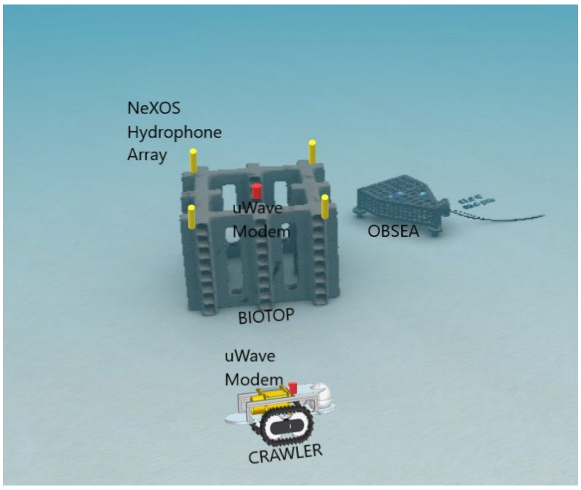

Figure 1 Architecture of Crawler LBL at OBSEA observatory

As it is illustrated in the Figure 1 we position the four hydrophones and a modem on the top of the artificial reef, at 3 meters high from the seafloor, close to the OBSEA, in order to avoid interferences in the acoustic link between the modem from LBL assembly and the crawler. The modem sends a ping request that is received by the modem that is located in the Crawler, and responds with a ping. During this time, each hydrophone is recording the acoustic communication in wav format. When we have the audio file, we start processing it and after denoising we extract the transmission and reception time, by detecting the exact time between the transmission and reception of the two modems in each hydrophone. With this information we determine the time difference between the four hydrophones and we triangulate and obtain the angle with respect to the modem located on the Crawler. The distance is given by the modem and the time difference of arrival (TDOA) give us the direction. With this information we can know the position of the Crawler around the OBSEA. Moreover, we detail the results obtained for the acoustic acquisition system calibration test done in air, small aquarium, pool and sea scenarios.

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