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Processing acoustic images for the exploitation of fish farms

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***Abstract* – This work presents a processing methodology that uses data from a SONAR sensor located on a HROV to support the exploitation and management of fish farms.**

Keywords - *Sustainable aquaculture, underwater Remotely Operated Vehicles, underwater acoustic imaging*

I. INTRODUCTION

The European Union's Blue Growth Plan [1] proposes that the future of fishery resources lies in smart, sustainable, and inclusive aquaculture production, which will play an essential role in providing food for the European population. To achieve this, it is crucial to use different technological solutions that support the sustainable exploitation of aquaculture farms and ensure their viability [2].

In recent years, modernization efforts in aquaculture have focused on estimating growth, biomass [3], and physical-chemical parameters [4]. Additionally, underwater vehicles equipped with special sensors are being used to provide information on the state of the ponds of the farms [5].

This work illustrates a processing methodology that allows extracting adequate information from the data provided by a MSIS (Mechanical Scanned Imaging Sonar) sensor that performs a 360º scan by using an acoustic beam, which has a wide vertical aperture and a narrow horizontal opening and generate acoustic cross sections of the environment [5].

The proposed methodology has been used within the framework of the KTTSeaDrones Project, funded by the European Union, and lead by the University of Huelva. In this project, two Hybrid Remotely Operated Underwater Vehicles (HROVs) [5] have been used to support the exploitation and management of fish farms, where the turbidity of the water is so high that it is impossible to use traditional optical sensors to visualize the objects in the environment of the vehicle (see Fig 1 a) and Fig 2 a).

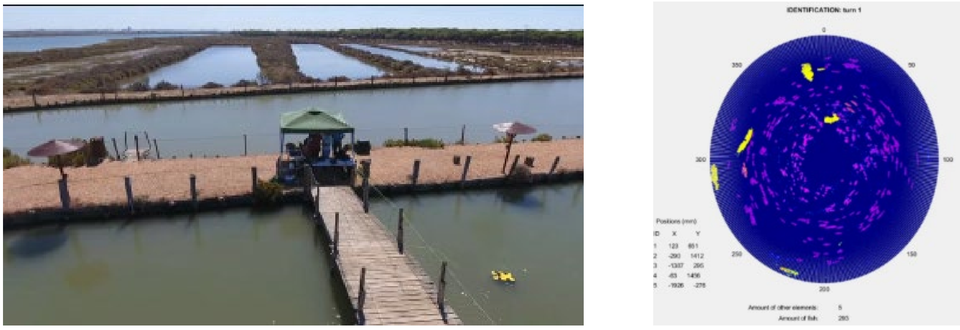
Particularly, the objective consists in using acoustic images for locating the elements that are around the HROV and that may be of interest for the exploitation of the installation. To this end, the proposed procedure makes it possible to locate the objects relative to the HROV and globally in order to create a geographic coordinates map of the bottom of the pond.

II. ACOUSTIC IMAGE PROCESSING

The data acquired by the Ping360 sonar provides information about the environment of the HROV. However, this information includes redundant data and noise that needs to be filtered to identify potential targets of interest for the farm's operators. Therefore, a processing mechanism with a series of stages has been implemented:

- Filtering of the bordering areas with the limit of the pond. At the edges of the pond, there are bounces and reflections of the signal that can lead to the identification of false objects. For this reason, a mechanism has been developed to exclude the bordering areas with the edges of the pond.
- Threshold filtering. This mechanism discards data that are the result of bounces with an intensity less than or similar to that of the signal returned by the water.
- Proximity noise filtering. Data close to the location of the HROV are discarded due to the appearance of false bounces of stochastic nature.
- Identification of elements according to the intensity of the returned echo and classified by proximity and connectivity. The data resulting from filtering represent physical elements that provide an echo signal with similar intensity and compact spatial distribution. Therefore, a processing technique based on clustering has been applied to group these elements based on their proximity and connectivity, as well as the homogeneity of the intensity of the received signal. As a result, a matrix of elements is obtained, characterized by the position of the groups' centroids, their size, and the intensity of the echo signal.

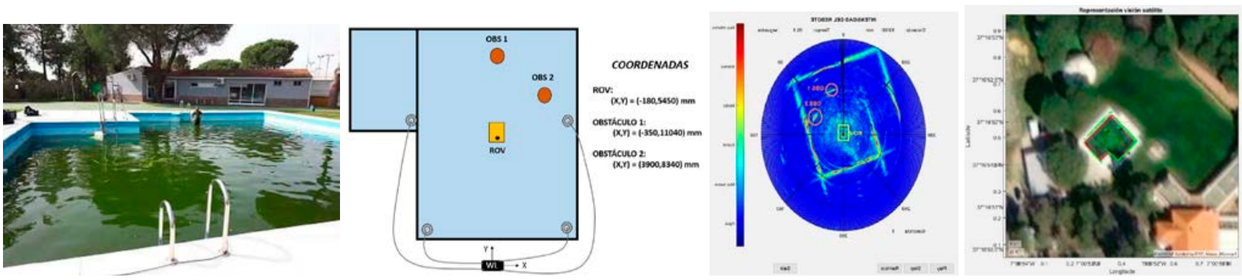
Once the processing is complete, the distances between the HROV and the centroid of each element are known, as well as the sectors where the elements are located. This information can be used to obtain the position of any of them referred to the local system of the HROV, giving the user a representation of the solid elements that surround the vehicle (see Fig 1 b).



a) b)

Fig 1. a) Natural fish farm; b) Local Map

Additionally, by incorporating a global location system into the vehicle, it is possible to carry out a geographic mapping of each of the identified elements. Fig 2 Illustrates an outdoor experiment, where several objects were located in a pool Fig 2 a). Fig 2 b) represents the setting of the experiment; Fig 2 c) shows the local map, and Fig 2 d) presents the objects represented in a geographic coordinates map.



a) b) c) d)

Fig 2. a) Outdoor pool ; b) experiment setting; c) local map; d) satellite image with the detected object.

III. CONCLUSIONS

This article illustrates a methodology for processing the information provided by a MSIS sensor in order to develop local and global maps of the bottom of a pond in a fish farm. The proposed approach has been tested in real scenarios in the context of the KTTSeaDrones Project ('Conocimiento y transferencia de tecnología sobre vehículos aéreos y acuáticos para el desarrollo transfronterizo de ciencias marinas y pesqueras 0622-KTTSEADRONES-5-E') founded by the European Regional Development Fund (FEDER) through the Interreg Program V-A España-Portugal (POCTEP) 2014-2020.

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