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Proceedigns

Development of an Artificial Vision System for Underwater Vehicles †

Cristian Méndez Sanmartín * and Moisés Bautista Briceño

Integrated Group for Engineering Research (GII), University of A Coruña, Campus de Esteiro, 15403 Ferrol, Spain
* Correspondence: cristian.mendez@udc.es; Tel.: +34-881-013-866

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Abstract: Beyond certain depth there is no light, supposing the main obstacle in the use of optical systems beneath the water. Therefore, the underwater vision system developed is composed of a set of underwater lights which allow the system to work properly and the cameras. These are integrated with the navigation system through the Robot Operating System (ROS) framework, which handles the acquisition and processing of information to be used as support for the navigation and which is also essential for its use in reconnaissance missions.

Keywords: Autonomous Underwater Vehicle (AUV); autonomous navigation; artificial vision; Robot Operating System (ROS)

1. Introduction

Marine activities have experienced a considerable increment in the last few years due to the increasing energy demand in renewable energy resources, with offshore wind farms leading, and it is expected to keep growing. Therefore, the number of offshore structures is rising, and they are moving further from shore. The goal of these power plants is to get to the more constant offshore winds leading to improvements in efficiency and the reduction of the impact in land [1] (pp. 47–48).

Nevertheless, this power plants must operate in harsh environments with very adverse weather conditions so, regular inspection, maintenance and repair tasks (IMR) are required and they become difficult, expensive and risky, and, above all, they are traditionally executed by professional divers. Much research in the marine field is devoted to reducing the costs and minimizing the risks for the workers in their tasks, in addition to overcoming certain physical limitations that preclude specific human operations. However, the tendency is to go deeper in the ocean and some areas become inaccessible for a diver. At the same time, underwater activities carried out by human require much time due to the large extensions of seabed that that must be covered. In these scenarios, the efforts are focused on reducing the costs and minimizing the risks for the workers on their tasks [2].

The logical path to follow in this field resides in the evolution from Remotely Operated Vehicles (ROV) towards Autonomous Underwater Vehicles (AUV). However, there are still some technical challenges related to this conversion, such as underwater communications, power supply, autonomy, autonomous navigation and localization, among others. Related to this field, the Integrated Group for Engineering Research (GII) is taking steps towards constructing an AUV by carrying out modifications over its own ROV. The current state of work includes tasks such as the integration of the acoustic communications system and the robotic arm, the development of the data acquisition and security system, the programming of the intelligence onboard and the development of the artificial vision system, which is the theme addressed in this paper.

2. System Development

Due to the submarine does not have much space in its containers and in underwater environments we have power limitations due to the battery capacity, the developing system must be compact, low-power, accurate and accessible to be installed. Currently, this system is composed of a Raspberry Pi 3, with an installed image of Ubuntu 16.04 (Xenial) Mate for ARM with ROS Kinetic Kame, and a Low-Light HD USB Camera from Blue Robotics.

The mentioned Raspberry Pi assumes the role of being the data acquisition node and through the ROS OpenCV camera driver [3] and using the cv_bridge package, we are able to deal with the camera information and the images taken in OpenCV format in order to publish them in a topic with the ROS image message format as it is seen at the Figure 1. This proceeding helps us to retrieve the image from the ROS image message format and convert it to OpenCV format with any other device used as subscriber, as long as it is being connected to the ROS network [4].

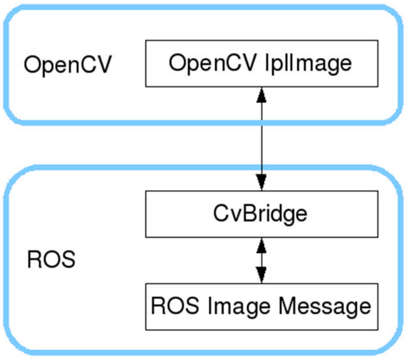
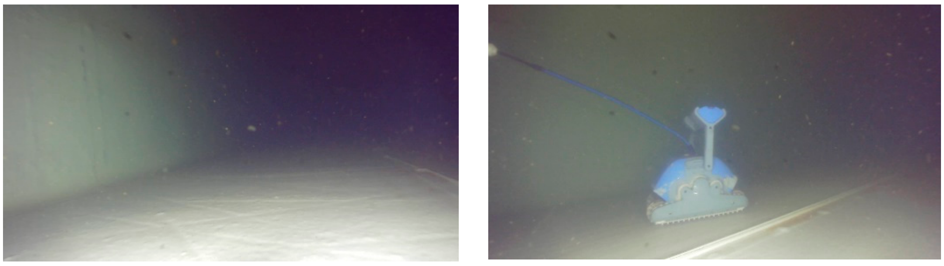


Figure 1. Cv_bridge package operation scheme for image information transfer.

The results obtained with the current hardware lead us to a publication rate of 15 messages per second, which is enough due to underwater systems are quite slow, but it must be revised for future implementations. The results of the vision system can be seen below in the Figure 2.



(**a**) (**b**)

Figure 2. Images taken with the vision system of the Kai submarine in the hydrodynamic test channel: (**a**) Bottom of the ship model basin; (**b**) Process of cleaning up the ship model basin.

3. Challenges and Future Work

There is still much work in progress needed to be addressed. For instance, the first point we must work on is the hardware replacement challenge. We need to use more powerful hardware to manage dynamically more than one camera with better framerate and where we could run stereo vision algorithms.

The second challenge and the most difficult is the development and implementation of a data fusion algorithm with which we could combine the image obtained from the cameras and the image provided through an image sonar.

Finally, we need to run more tests in order to use this merged image to improve navigation in order to be a little step closer towards an AUV and implement other functionalities such as artificial recognition.

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