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Towards the development of a multipurpose tool for underwater manipulation.

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***Abstract* - Every year, the use of underwater vehicles equipped with underwater manipulator arms is becoming more popular in order to perform activities that are dangerous for divers. However, for the field of marine sciences, many of the manipulator arms that currently exist are heavy, expensive and not exactly good for the tasks required by marine biologists. This paper presents a first approach towards the development of a multipurpose, modular and low-cost tool that focuses on solving the problem of collecting samples of marine organisms using underwater vehicles.**

Keywords - *underwater manipulators, marine science, sample recollection, underwater robotics*

I. INTRODUCTION AND MOTIVATIONS

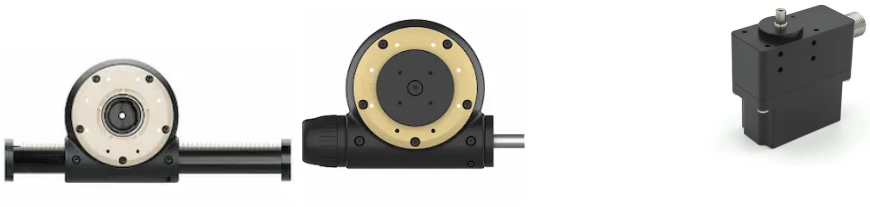
Nowadays there are a large number of underwater manipulator arms which have been used in activities with archaeological purposes, such as collecting pieces from shipwrecks, or in activities related to industry, such as manipulating valves in oil platform facilities [1]. These manipulator arms are usually large and heavy since due to the application for which they are used, manipulator arms with these characteristics are required. However, there are applications where it is not possible or necessary to use a large and heavy arm, such as aquaculture or marine sciences, where more delicate manipulation is required. There are small, low-cost AUVs that are being used in this context which need to be integrated with a small, light and sometimes touch-sensitive arm. One of the manipulators that can be used for this type of task is the Reach Alpha from Reach Robotics, however the cost is high and it is still not very versatile.

In the context of marine sciences, this tool is intended to be used to collect samples of living organisms, from algae to small fish or mollusks. Having a low-cost tool that can be integrated into a low-cost vehicle is something that has been requested by the marine science research community in recent years since it can facilitate the tasks they carry out on a daily basis [2]. In addition, there are two ongoing projects that will benefit from the development of this multipurpose tool. In the COOPERAMOS project (PID2020-115332RB-C31), cooperative bimanual robotic manipulation tasks are being carried out using Reach Bravo 7 manipulator arms from Reach Robotics installed on a G500 AUV. The proposed tool in this paper could be used as a simple support accessory to facilitate grasping with the two Reach manipulators. Moreover this tool will be used in the third prototype of an underwater vehicle of the EU Horizon 2020 El-Peacetolero (945320) project to carry a sensor as an end effector.

This led us to want to develop a low cost multipurpose tool that can be modular and adaptable according to the application that will be given to it.

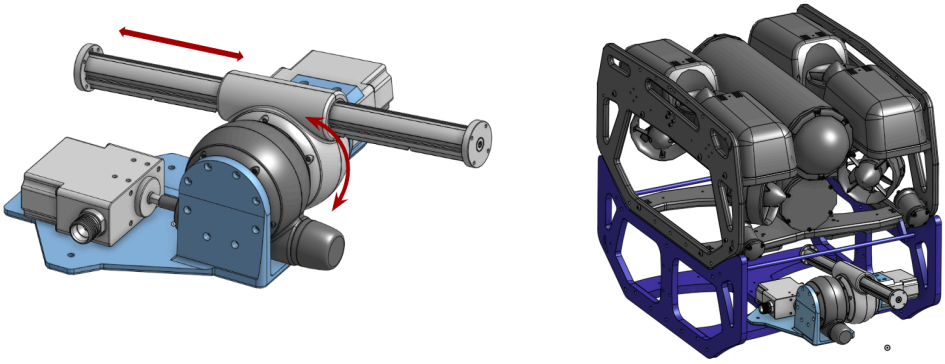
II. DEVELOPED WORK

The main challenge of this project is to design a low-cost, modular, adaptable and underwater tool thus a first prototype of this tool has been built using Igus mechanical elements (Fig. 1a) and watertight servo motors from BlueTrail engineering (Fig. 1b). A 3D model of the first prototype can be seen in Fig. 2a and an assembly showing the prototype installed in a BlueROV2 can be seen in Fig. 2b. This first prototype has 2 degrees of freedom, it weighs approximately 1kg in air and has a range of 30cm.



a) b)

Fig 1. a) IGUS Components b) SER-2020 BlueTrail Servomotors.



a) b)

Fig 2. a) 3D model of a first prototype of the multipurpose tool using SER-2020 underwater servo motors from BlueTrail engineering and Igus gear boxes. b) 3D Model of the prototype installed in a BlueROV2 underwater vehicle

III. FUTURE WORK

This effort represents the first step towards making a modular, adaptable, and low cost multipurpose tool. This first prototype remains to be tested in a BlueROV underwater vehicle. In the future an end effector will have to be designed; for this, the latest technological advances will be explored. Some of these technologies include the use of soft materials for the development of a gripper similar to the ones described in [3] for collecting samples or in [4] for manipulating living organisms. Moreover a unique user interface will also be developed so that the tool can be operated independently of the operation of the underwater vehicle.

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