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GRASPING AND MANIPULATION FOR MARINE SAMPLE COLLECTION

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN BIOROBOTICS

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Abstract

Remotely operated vehicles (ROV) were designed keeping in mind heavy industrial tasks, and then become widely employed in research, in particular to collect marine specimens. Retrieving an intact delicate sample requires high dexterity, and consequently considerable time during campaigns whose duration is limited by the high cost and weather conditions. Shared autonomy might relieve operator's workload and improve the collection process through partial automation of these procedures.

Since the literature concerning marine sampling procedures with ROV is scarce, we designed a targeted questionnaire addressed to marine field researchers, ROV pilots, and designers. From the results of the interviews, we built a taxonomy of the actions performed in marine organisms sampling. In the meanwhile, we reviewed the existing underwater end-effectors, in order to integrate the taxonomy with the abilities enabled by the available technology. The review provided insights on the actions which are already (or not yet) covered by the existing marine grippers, allowing us to identify recent scientific and technological challenges. Among those, we identified the soft texture and deformability properties of several organisms as a relevant challenge for manipulation. We decided to follow a human-inspired approach for the design of a high-level manipulation strategy decisional algorithm: consequently, a human study concerning human manipulation grasp strategy for deformable objects was performed. Envisioning a test phase, a testbench teleoperation scenario on shore was developed, which gives us the possibility to test our algorithms also with participants who are novices to teleoperation.

The investigated structures serve as fundamental building blocks toward the integration of a shared-autonomy teleoperation system which assists during marine organism sampling reducing ROV pilots' workload while keeping the operator in the loop, which is a relevant feature in such an unstructured environment.