Increasing the Autonomy Levels for Underwater Intervention Missions by Using Learning and Probabilistic Techniques

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Abstract. This paper represents research in progress in autonomous manipulation for underwater intervention missions within the context of the GRASPER project. This project focuses on developing manipulation skills for an Autonomous Underwater Vehicle (AUV). Current research in underwater robotics intends to increase autonomy for all kinds of robotic intervention operations that require physical interaction. Very few underwater systems have the capacity to carry out intervention without any kind of umbilical cables for tele-operating the actions. This article aims to investigate new approaches to follow with the aforementioned challenges, with the inclusion of learning and probabilistic techniques to increase the autonomy levels of an underwater manipulation system. With this goal, a collaboration research action has been established between the IRS-Lab at UJI (Spain), as experts in the underwater robotic manipulation domain, and the Institute of Systems and Robotics from University of Coimbra (Portugal), experts in learning by interaction within a robotic manipulation context.

Keywords: Underwater Autonomous Intervention, Bayesian Learning, Dynamic Bayesian Network, UWSim underwater realistic simulator.

1 Introduction

This paper discuss the research in progress, under development by UJI-ISR cooperation action, in the context of autonomous underwater intervention missions. Current research in the underwater robotics intends to increase autonomy for all kinds of robotic intervention operations requiring physical interaction. Despite the fact that autonomous robotic intervention on land remains in development and with some valuable achievements, the current state-of-the-art in underwater intervention missions is currently in a very primitive stage where the majority of the systems are tele-operated by an expert user. This paper addresses this challenge through research that stills under development, within the context of a project, funded by the Spanish Ministry, titled GRASPER. GRASPER

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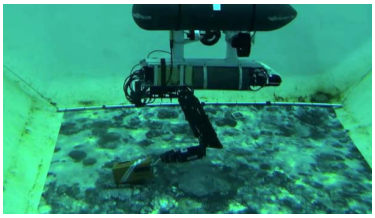

(a) search and recovery of an object of interest (e.g. a "black-box mockup" from a crashed airplane).

(b) the intervention of an underwater panel in a permanent observatory.

Fig. 1. TRITON Spanish coordinated project proposed scenarios

(under the responsibility of University of Jaume-I, UJI, and addressing the problem of the "Autonomous Manipulation") represents only a sub-project inside a Spanish Coordinated Project, entitled: TRITON[1], "Multisensory Based Underwater Intervention through Cooperative Marine Robots", which includes two other sub-projects: COMAROB ("Cooperative Robotics", under the responsibility of University of Girona, UdG), and VISUAL2 ("Multisensorial Perception", under the responsibility of University of Balearic Islands, UIB). In summary, TRITON is a marine robotics research project focused on the development of intervention technologies really close to the real needs of the final user and, as such, it can facilitate the potential technological transfer of its results. The project proposes two scenarios to test the concept, and to demonstrate the developed capabilities: (1, Figure 1a) the search and recovery of an object of interest (e.g. a "black-box mockup" from a crashed airplane), and (2, Figure 1b) the intervention of an underwater panel in a permanent observatory.

The specific objectives for GRASPER are the following:

(a) To develop the user interface and simulation capabilities needed for TRITON.
(b) To generate all the mechatronics and sensor improvements to succeed in the autonomous manipulation requirements.
(c) To develop new planning and control strategies, making use of range and visual information, finally leading to visual free floating manipulation.

This paper highlights the potential benefits of including a new approach based on the "learning by demonstration" paradigm, in order to increase autonomy in the required grasping and manipulation skills. Because initially the experimental validation will be carried out in virtual reality (i.e. by using the 3D simulator UWSim [1] described below), some contributions are expected in the aforementioned objectives (a) and (c).

[1] Multisensory Based Underwater Intervention through Cooperative Marine Robots (TRITON), available: `http://www.irs.uji.es/triton/`