Titolo: roBotic undErwater Autonomous Social Team for cooperative manipulation and IntelligencE (BEASTIE)

Codice Progetto: 2022FZJ7MR

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Coordinatore nazionale: Consiglio Nazionale delle Ricerche

Partner-Unità di ricerca: Università degli Studi di Padova, Università degli Studi di ROMA "La Sapienza".

Università degli Studi di Firenze

CUP: C53D23000410006

Bando: PRIN 2022 - Decreto Direttoriale n. 104 del 02-02-2022

Durata: 28/09/2023 – 27/09/2025 (24 mesi)

Budget totale progetto: 228.147 €

Budget UNIPD: 55.737,00 €

Abstract del Progetto: The BEASTIE project aims at pursuing a new, disruptive concept in underwater soft manipulation for a wide range of applications.

The BEASTIE concept eliminates the constraints given by cooperation of multiple physical kinematic chains focusing on the issue of controlling a morphing multi-body supra-manipulator constituted by single-link agents connected through virtual links.

The manipulation capability will be pursued by a team of small floating robots, endowed with 6 DoF-motion skills in water, able to communicate and cooperate together to accomplish the desired task. Each robot will be constituted by a very simple soft gripperand a body, equipped with suitable actuators and sensors to support its 6 DoFs motion in the underwater space (complete attitude control), with no kinematic chains or joints in-between. The robot body will be able to: i) reach the target object; ii) suitably orientthe gripper to allow grasping and manipulation of objects placed in the whole 3d space, i.e. not only laying on the seabed but also on rocks, cliffs or inside small underwater caves.

A hybrid layered approach will be adopted integrating, in a complementary way, distributed impedance control for grasping, Belief Space Planning for collective movement of the agents and Deep Learning for control optimization and object recognition.

The gripper will have a camera in the palm, and will be built with soft materials to gain compliance in order to guarantee the preservation of fragile samplings. Softness will also improve grasping stability by adapting the grippers of the different robots during the cooperative manipulation task.

Research about smart materials will develop innovative coatings to gain high performance in robot motion and, at the same time, optimize the energy management onboard.

The team will constitute a morphing multi-body supra-manipulator in which the links among the single agents will not be physical but only virtual (through information exchanges). Given the short range in which the different robots will operate, the possibility to adopt faster electromagnetic communication among close agents will be investigated.

Cooperation will be enhanced by a social behavior skill that will allow robots to predict their companions' behavior to be robust to unexpected events and failures, developing a sort of collective intelligence. The real deployment and validation of cooperative/social

models is still an open challenge. This project aims to leverage the design and development of a social model that it is inspired to human-human and human-robot interaction to enhance the technical reliability of the proposed system as well as to optimize the performance of the system

With its analogies with collective manipulation and transport strategy for large and heavy objects typical of ant colonies and the capability of "flying" (in water) in all the directions of motion, the BEASTIE project paves the way to further investigations in bio-inspired robotics.

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