PhD in Mechanical Engineering

Research Title: Development of innovative actuation and unconventional kinematics for a rehabilitative upper limb exoskeleton

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Context of the research activity	The use of robotics in clinical settings can provide repeatability and intensity to the rehabilitation protocols. Compared to conventional manipulators, which interact with human operators at the end-effector, exoskeletons allow distributed physical interaction with the whole limb. The complexity of such physical human-robot interaction (pHRI) requires a deep understanding of biomechanics and human anatomy. Several upper-limb exoskeletons have been recently developed, but their clinical effects have been poorly studied up to now. The candidate will be required to implement these solutions working in collaboration with the FLOAT upper limb exoskeleton team. FLOAT has been developed at Rehab Technologies (IIT) in collaboration with the National Institute for Insurance against Accidents at Work (INAIL). FLOAT was designed to promote and accelerate the motor and functional recovery of the shoulder joint complex following post-traumatic or post-surgical injuries. The aim of this project is to design and implement innovative advanced mechatronic solutions for the rehabilitation of the upper limb with a specific focus on the shoulder complex and the elbow joint. The main goal is to implement a revised version of the FLOAT device with a specific focus on bio-inspired kinematic chains to increase the manipulability and compliance of the device. The successful candidate will work with a rapid prototyping approach to test and iterate solutions in tight collaboration with clinical partners. Several solutions will be studied, including but not limited to: novel kinematic chains, custom-made highly integrated and performing actuators, and bio-inspired

	mechanical solutions to combine performance, engagement and usability of the device. The candidate will also investigate state of the art control algorithms to better exploit the designed mechatronic solutions. An additional goal of this project is to enrich the rehabilitation experience taking advantage of under-actuated, lightweight, remotely supplied devices to further reduce the size of the exoskeleton and favor a greater usability of the robot.

Objectives	1. Study of unconventional actuating solutions to optimize the mechanical performances of the exoskeleton in terms of weight, size and power generation. 2. The main goal of this research activity will be focused on the implementation of a revised version of the FLOAT device. 3. Investigation and analysis of novel and bio-inspired kinematic chains to increase device manipulability and compliance. 4. Exploration of under-actuated and remotely supplied devices to increase the exoskeleton functionalities without affecting the wearability and usability of the system.

Skills and competencies for the development of the activity	• Mechanical, Mechatronic Engineering or related degrees; • CAD; • Mechanical and actuation design; • Matlab & Simulink; • Rapid Prototyping;