



PhD in BIOINGEGNERIA / BIOENGINEERING - 37th cycle

THEMATIC Research Field: ADVANCED CONTROL STRATEGIES FOR LOWER LIMB EXOSKELETONS & STRATEGIE AVANZATE DI CONTROLLO PER ESOSCHELETRI DI ARTO INFERIORE

Monthly net income of PhDscholarship (max 36 months)

€ 1250.0

In case of a change of the welfare rates during the three-year period, the amount could be modified.

Context of the research activity

Motivation and objectives of the research in this field

Spinal cord injury is a critical condition which often leads to permanent disability, permanent use of wheelchair and several secondary clinical complications. In most cases, repetitive and task-oriented movements of the impaired limbs can prevent complications such as muscle atrophy and osteoporosis. In this scenario, lower-limb exoskeletons can be a valid tool for rehabilitation. Motivated by this, researchers have been developing a vast range of robotics exoskeletons for spinal cord injury patients. The current leading products are ReWalk, Ekso and Indego. Traditional designs of lower-limb exoskeleton present two degrees of freedom in each leg to obtain the flexion-extension of the knee and hip joints, which are generally actuated by electric motors. Some recent lower-limb exoskeletons, as well as WalkOnSuit, Mina 2020 and Project March showed promising new design concepts with 6 or 8 degrees of freedom for each leg (hip, knee and ankle). In the context of rehabilitation, additional degrees of freedom open new scenarios: indeed, a more articulated system can perform a wider range of movements. Moreover, from a robotic point of view, more articulated exoskeletons leave wide margins to implement novel and advanced control strategies. The aforementioned characteristics would enhance not only the usability and effectiveness of the device, but also its safety. The main objective of this PhD is to develop new control strategies to enhance our existing system and to



	<p>respond to the growing needs of clinicians. In this scenario, the candidate will work in a multidisciplinary team of engineers, researchers and physiotherapists.</p> <p><i>1. Control Strategies for rehabilitation purposes</i> This research work will aim at developing new software for our lower limb exoskeletons in order to enhance their walking capabilities. Among the different research studies that will be derived from literature studies, one of the PhD activities will be to study the human gait characteristics, determine the biomechanical and physiological rules, and then define and implement advanced control strategies biologically inspired.</p> <p><i>2. Innovative behaviors</i> The lower-limb exoskeleton capabilities to react at particular conditions (i.e. falling) or to adapt at the different environments without an intervention from external actor(s) are still open points. In the research context, one of the objectives of this PhD is to develop methods and strategies to increase the safety and security of the device and to adapt to the environment more effectively. The successful candidate will have access to our lower limb exoskeletons named Twin, and an exhaustive range of mechatronics equipment to facilitate the development activities. Moreover, the candidate will have the opportunity to work in an international environment with a transfer technology mindset.</p>
Methods and techniques that will be developed and used to carry out the research	<p>The candidate will be mainly involved on the research activities of our lower limb exoskeleton in the Rehab Technologies IIT-INAIL Lab of the Istituto Italiano di Tecnologia, Genova. The research activities will be carried out with a team of robotic, computer and mechatronic engineers. The development of the control strategies will be integrated in the real-time system through C and C++ programming languages.</p>
Educational objectives	<ul style="list-style-type: none"> - To learn scientific research methods in mechatronics, robotics and computer science - To grow as a scientist in a T&T team - To improve scientific dissemination skills



Job opportunities	<ul style="list-style-type: none"> - Robotic and medical companies - R&D and start-up - Universities and research centres
Composition of the research group	1 Full Professors 2 Associated Professors 2 Assistant Professors 0 PhD Students
Name of the research directors	ELENA DE MOMI

Contacts	
<i>Stefano Maludrottu (IIT)</i> <i>stefano.maludrottu@iit.it</i> <i>Elena de Momi (POLIMI)</i> <i>elena.demomi@polimi.it</i>	

Additional support - Financial aid per PhD student per year (gross amount)	
Housing - Foreign Students	--
Housing - Out-of-town residents (more than 80Km out of Milano)	--

Scholarship Increase for a period abroad	
Amount monthly	564.01 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
IIT will provide a desk, a personal laptop and if necessary a desktop PC to the candidate during the whole PhD period