POLITECNICO DI MILANO

PhD in BIOINGEGNERIA / BIOENGINEERING - 38th cycle

THEMATIC Research Field: TECHNOLOGICAL SOLUTIONS TO PROMOTE SPORT-THERAPY IN FRAGILE PEOPLE AND CHRONIC PATIENTS

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	In Italy, there are more than 7 million elderly people, of which about 60% are women, half of whom live alone. One third of older people over 65 fall annually, a percentage that rises to 40% in over 70s. The aging of the population has also led to the inevitable increase in the incidence of chronic diseases. Every year in Italy there are at least 100,000 new hospitalizations following stroke, for a total of almost one million stroke survivors. In Italy, people with motor or cognitive disabilities are more than 3 million (5.2% of the population - ISTAT 2019); physical disabilities, although more frequent in the elderly, are transversal to age. Being able to live an active life is essential to maintain psycho-physical-social well-being. The majority of frail or disabled people do not participate in motor activity fearing the risk of injury, pain associated with training and the inadequacy of their abilities with respect to the group, as well as objective difficulties in using standard sports equipment. The development of technological solutions and adequate and personalized tools responds to the need to break down physical, cultural and social barriers, in the promotion of active life as a prevention for fragile people, elderly and people with chronic diseases and disabilities, who may need, even more than healthy people, to perform some level of physical training. This Phd project starts from this motivation and aims at the design of technological solutions to promote Sport-

	Therapy for elderly, fragile people, and people with physical disability. In particular, the focus will be on the design of a recumbent electric-assisted trike which integrates Functional Electrical Stimulation (FES) of lower limb muscles to strengthen the training and add to the exercise the typical peripheral benefits of FES, such as increase of muscle tone, improvement of cardiopulmonary fitness and lower limb circulation, decrease of bone mineral loss. Finally, FES enhances cortical and spinal plasticity, thus favoring motor re-learning, mainly in case of neurological patients (e.g. stroke patients, people with incomplete Spinal Cord Injury). This project will be carried out within the Activ-e^3 (Everyone, Everywhere, Everyday) project, funded by Cariplo Foundation and Lombardy Region (CUG: C13C21000200005).
Methods and techniques that will be developed and used to carry out the research	The PhD student will design for the first time a hybrid FES-electric assisted recumbent trike suitable to be used for outdoor sport activities by fragile people and people with chronic diseases. The Phd student will develop a trike which integrates: - An electric motor for assisting pedaling, - A neuromuscular electrical stimulator to allow the stimulation of at least 8 muscle groups of the lower limb, - The residual capability of the subject, - Sensors to measure the pedaling performance and to estimate muscle fatigue so as to adapt the control system and to personalize the training (e.g. pedaling power, surface EMG sensors, heart frequency, etc). A cooperative control system will be designed in order to modulate FES and motor contributions and maximize at the same time the volitional contribution of the subject. The main objective is to minimize the motor contribution, following an assist-as-needed paradigm. An easy-of-use interface will be developed, as well as a self-calibration procedure, in order to favor the use by non-expert users. Longitudinal pilot studies will be designed to quantitatively evaluate the usability, the acceptance and the safety of the hybrid trike in selected groups of people (e.g. elderly

	>75 years old, elderly at high fall risk, and chronic patients). The effect of such a training on quality of life, physical and mental well-being and physiological parameters will be also evaluated. The PhD student will be involved in the design of these studies, in the collection of quantitative data and in the data analysis, in collaboration with the clinical partners. This research activity will be carried out mostly at Lecco Campus of Politecnico di Milano.
Educational objectives	We provide doctoral candidates with high-level scientific training, fostering and refining research and problem-solving abilities by focusing on both theoretical and experimental skills. A PhD in Bioengineering will be able to layout, draft, and carry-on original research, by leading a research group or working in a team.
Job opportunities	National and international academic and non-academic institutions and organizations, engaged in innovation, research and technical development; high-tech SMEs, government departments.
Composition of the research group	3 Full Professors 1 Associated Professors 2 Assistant Professors 8 PhD Students
Name of the research directors	PROF. EMILIA AMBROSINI, PROF. ALESSANDRA PEDROCCHI

Contacts
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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	625.0 €
By number of months	6

Additional information: educational activity, teaching assistantship, computer availability, desk availability, any other information
The PhD student will attend specific PhD courses at Politecnico di Milano according to his/her personal study plan; He/she will be able to attend summer schools and will have the opportunity to disseminate his/her research results in international conferences; The PhD student will assist in teaching by giving practical and lab lessons and by tutoring of BSc and MSc students developing their thesis work. The PhD student will have personal desk in the Politecnico and will be equipped with a personal computer, in addition he/she will have access to the Lab facilities and instrumentation.