PhD Program in Bioengineering and Robotics

Curriculum Cognitive Robotics, Interaction and Rehabilitation Technologies

Research themes

1. PSYCHOPHYSICS AND NEUROPHYSIOLOGY OF TACTILE-VISUAL INTEGRATION AND INTERACTION 4
2. HUMAN-ARTIFICIAL INTERACTION SYSTEM AND TOOLS DEVELOPMENT 5

In the spirit of the doctoral School on Bioengineering and Robotics the PhD Program for the curriculum **"Cognitive Robotics, Interaction and Rehabilitation Technologies"** provides interdisciplinary training at the interface between technology and life-sciences. The general objective of the program is to form scientists and research technologists capable of working in **multidisciplinary teams** on projects where **human factors** play a crucial role in technological development and design.

The fellowships offered this year by the Istituto Italiano di Tecnologia as part of this curriculum will be assigned to the best applicants to one of the seven themes offered by three Units: i) the Robotics, Brain and Cognitive Sciences Unit (RBCS); ii) the Unit for Visually Impaired People (U-VIP), and iii) the Unit COgNiTive Architecture for Collaborative Technologies (CONTACT). Theme No. 2 will be tutored jointly with colleagues of the MaLGa - Machine Learning Genova Center (MaLGa) - Department of Informatics, Bioengineering, Robotics and System's Engineering (DIBRIS) of the University of Genova.

Interested applicants are encouraged to contact the perspective tutors and/or the Unit's PI for clarifications before submitting their application.

All IIT units involved in this curriculum are located in the "Erzelli" site of the Italian Institute of Technology and share research facilities including, beside two iCub humanoid Robots, a fully equipped motion capture room with simultaneous electromyography recording and force-platforms, a Transcranial Magnetic Stimulation Lab, an Electrophysiology Lab for EEG recording and meeting rooms.

The ideal candidates are students with a higher level university degree willing to invest extra time and effort in blending into a multidisciplinary team composed of neuroscientists,

engineers, psychologists, physicists working together to investigate brain functions and realize intelligent machines, rehabilitation protocols and advanced prosthesis.

International applications are encouraged and will receive logistic support with visa issues and relocation.

A brief description of the Units Involved and their overall objectives are given below.

RBCS Unit: Robotics, Brain and Cognitive Sciences
(Prof. Giulio Sandini – giulio.sandini@iit.it)
In RBCS we are merging top-level neuroscience research and top-level robotics research by sharing, as a fundamental scientific objective, the study of physical and social interaction in humans and machines (www.iit.it/rbcs).
The research activity is articulated in three main streams:
The study of human sensorimotor and cognitive abilities with a focus on action execution and understanding;
The implementation of sensorimotor and cognitive abilities in the humanoid robot iCub with a focus on human–robot cooperation and symbiosis;
The exploitation of assistive technologies to alleviate sensory disabilities and the implementation of robotic rehabilitation devices with a special attention on user requirements and strict clinical assessment.
A factor, common to all three streams is learning and development and, in general, the dynamics of knowledge acquisition and update.
Besides the humanoid platform iCub and the support of professional electronic and mechanical design, RBCS research facilities include haptic devices for ergonomic measures of individual and dyadic interaction, haptic devices that exploit visuo-tactile sensory substitution, binaural acoustic feedback platforms, robot rehabilitation devices for the upper limbs including the wrist. This infrastructure supports our students' research activities including the realization of ad-hoc experimental set-ups and mechatronic devices.

U-VIP: Unit for Visually Impaired People
Dr. Monica Gori – monica.gori@iit.it
The main aim of the unit is to identify spatial impairments possibly conditioning the life of children and adults with and without visual disability, with the ultimate goal to develop new technological solutions suitable since the first years of life to overcome impairments and enhance learning skills.
In particular the focus of the group is:
to investigate how integration between sensory and motor signals develops during childhood and identify solutions (technologies and rehabilitation procedures)
to enhance the sensorimotor abilities necessary to orient and move in space, to communicate, to access everyday information and, therefore, to interact in social contexts
testing and validating with human-centered techniques the devices (friendly and ergonomic) developed by considering social and clinical contexts.

CONTACT Unit: COgNiTive Architecture for Collaborative Technologies
Dr. Alessandra Sciutti – alessandra.sciutti@iit.it

The aim of this unit is to overcome the limitations of current human-machine co-working, where often machines and humans just work in the same space, to obtain a novel form of collaboration, in which the two partners can actually perform joint actions, establish mutual understanding and achieve real cooperation. To this aim, it is crucial to endow robots with the same degree of predictivity and intuition that characterizes humans, enabling them to understand and adapt to the other's feelings, goals and needs. To achieve this goal, we focus on the investigation of the human perceptual, motor, and cognitive skills supporting efficient interaction. In particular, we also exploit robots as unique measurement tools for the systematic study of social interaction. The research is conducted within the framework of the ERC StG project wHiSPER – Investigating Human Shared Perception with Robots.

The research activity is articulated into two main streams

The investigation of the mechanisms supporting mutual understanding in human-human and human-robot interaction, with a focus on identifying the minimal verbal and non-verbal signals necessary to enable intuitive communication;

The implementation on the iCub humanoid robot platform of the derived models, to validate the theories, and bring forward a new generation of adaptive technologies, able to support and assist non-expert users.

1. Psychophysics and Neurophysiology of Tactile-Visual Integration and interaction

Tutor: Dr. Monica Gori

Institute: IIT (Istituto Italiano di Tecnologia)

Research Unit: Unit for Visually Impaired People
https://www.iit.it/it/linee/unit-for-visually-impaired-people

The goal of the project is to study the multisensory integration and visual-tactile interaction of motion. The PhD will be involved in doing Psychophysical and EEG experiments. Unit for Visually Impaired People (IIT) is looking for a PhD in the field of informatics and artificial intelligence.

The goal of the project is to understand brain principles behind early interactions of vision and touch:

- The study of perceptual mechanisms of sensory integration.
- Improvement of methods and tools for interaction study.

Requirements:
The PhD student will be involved in doing psychophysics, neurophysiology measures and analysis, application of mathematical modelling and programming. A background in neuroscience or experimental psychology is required. Programming skills are also desired.

Contacts: Monica.gori@iit.it
https://www.iit.it/it/research/lines/unit-for-visually-impaired-people

2. Human-Artificial Interaction System And Tools Development

Tutor: Dr. Monica Gori

Institute: IIT (Istituto Italiano di Tecnologia)

Research Unit: Unit for Visually Impaired People

https://www.iit.it/it/linee/unit-for-visually-impaired-people

The Unit for Visually Impaired People (IIT) is looking for a Ph.D. candidate with an M.Sc. in artificial intelligence, computer science, computer engineering, robotic engineering, biomedical engineering, or related fields. The candidate will contribute to developing new technologies for individual state modelling in an ecological urban context.

The Unit for Visually Impaired People (U-VIP) Research line is coordinated by Monica Gori, who has extensive experience in the field of psychophysics for multisensory processing, and that has been working for over twenty years on the perceptual and motor correlates of many pathologies, among which blindness, deafness, dyslexia, psychiatric disorders, multiple sclerosis, in childhood and in adulthood.
The research focuses on the quantitative characterization of individuals to develop and validate user-centered urban technologies for inclusive engagement.
The candidate will work in a challenging and international environment using science to develop new technological solutions with a concrete impact on society.

Specifically, the goal of the Ph.D. project is to investigate the mechanisms underpinning the (inter- and intra-) individual variability in motor and perceptual abilities in humans, developing new methods to characterize this variability.

The Ph.D. student will design experiments concerning the assessment of perceptual and motor human abilities by studying/applying statistics and machine learning approaches (in particular, supervised learning, learning with partial feedback, and reinforcement learning) to quantify the subject's individual characteristics and will develop new applications/ technological solutions to extract the information of interest.

Requirements:
An M.Sc. in artificial intelligence, computer science, computer engineering, robotic engineering, biomedical engineering, or related fields.

Knowledge of Python (strongly preferred for machine learning), R, and MATLAB environments.
Contacts: Monica.gori@iit.it

https://www.iit.it/it/research/lines/unit-for-visually-impaired-people