ICORR Workshops

Implementation of impairment based rehabilitation robotics	Friday 13:45 - 15:45
Jules Dewald, Northwestern University, Chicago Jacob MacPherson, Northwestern University, Chicago Arno Stienen, University of Twente, The Netherlands Ana Maria Acosta, Northwestern University, Chicago	HPH, G1
Organizers: Jules Dewald, Northwestern University, Chicago, USA Ana Maria Acosta, Northwestern University, Chicago, USA	

Objective

This workshop will demonstrate the ideal attributes of various robotic technologies necessary for the quantification of motor impairments, such as stereotypical muscle synergies, spasticity and paralysis, that appear following stroke-induced brain injury. Deeper understanding of how these impairments impact movement will be shown to lead to the successful development of novel robot-mediated interventions. The discussion will include how impairment-based robotic interventions differ from conventional rehabilitation not only in quantitative control and level of intensity, but in the fundamental approach or strategy employed to achieve functional gains. Furthermore, considerations for successful transition to clinical practice will be highlighted including methods to increase acceptance by the therapist and patient such as merging entertainment with impairment-based rehabilitation robotics through the implementation of virtual gaming environments.

Motor Intention and Sensory Feedbacks in Rehabilitation	Friday 13:45 - 15:45
Koji Ito, Ritsumeikan University Rieko Osu, ATR Yasuharu Koike, Tokyo Institute of Technology Etienne Burdet, Imperial College London Pietro G. Morasso, Italian Institute of Technology	HPH, G2
Organizers: Koji Ito, Research Organization of Science and Engineering, Ritsumeikan University, Japan Kiyoshi Nagai, Department of Robotics, College of Science and Engineering, Ritsumeikan University, Japan	

Objective

Functional injuries in motor control are induced by various causes, such as stroke, traffic accidents, etc. Especially, stroke is a leading cause of adult disability. Though many rehabilitation methods are proposed for motor recovery, motor learning underlying the acquisition of motor skills is considered as a basic principle for functional recovery. It is then known that proprioceptive feedbacks to the somatosensory area reinforce the motor control in the damaged area and its surroundings. Specifically, synchronous activation of neurons along the motor and sensory pathways is essential to facilitate the synaptic reconnection.

The objectives of this workshop are to discuss the following topics related to motor intention and sensory feedbacks in rehabilitation.

- Novel methods detecting motor intention by EEG, EMG, NIRS etc.
- Proprioceptive sensory feedbacks by FES (Functional Electrical Stimulation), haptic interfaces of robots, and variable compliance/impedance robotic devices.

Intended Audience

The workshop is open to all the delegates.

Clinical insights for rehabilitation engineers	Friday 13:45 - 18:15
Jane Burridge, University of Southampton (UK) Peter Feys, Hasselt University & PHL (BE) Annick Timmermans, Adelante Centre of Expertise in Rehabilitation (NL) Gerdienke Prange, Roessingh Research & Development Research Institute (NL) Ann-Marie Hughes, University of Southampton (UK)	HPV, G5
Organizers: Jane Burridge & Ann-Marie Hughes, University of Southampton, UK Peter Feys, Hasselt University & PHL, Belgium Annick Timmermans, Adelante Centre of Expertise in Rehabilitation, The Netherlands Gerdienke Prange, Roessingh Research & Development Research Institute, The Netherlands	

Objective

This workshop aims to bridge the gap between robot designers and robot users. It addresses the question 'how do we design robots that will be used in clinical practice for different types of impairments?' Robotic devices are increasingly sophisticated and have many applications in supporting neuro-rehabilitation. Recent evidence from neurophysiological research and clinical studies has influenced rehabilitation robotic interventions for the arm, providing valuable knowledge about how to apply technology-based therapy for people with neurological disorders, such as stroke and multiple sclerosis. However, clinical use of such devices remains limited. Should the robots have to be re-designed?

The workshop will provide a comprehensive view from neurophysiology to users' needs and expectations. It will involve the audience in a lively debate stimulated by video presentations of patient case studies.

Intended Audience

The intended audience is primarily designers, engineers, and developers of arm rehabilitation technologies for neurological patients. The session will also be of interest to therapists, researchers, medical practitioners, neurophysiologists etc. involved in the application of rehabilitation robotics in clinical practice, as well as to any people interested in this field of study from a professional or personal background.

Physiological Principles of Locomotion required for Robot Design	Friday 13:45 - 18:15
Volker Dietz, University of Zurich Gregoire Courtine, University of Zurich Alexander König, ETH Zurich Rüdiger Rupp, Universitätsklinik Heidelberg Hartmut Geyer, Carnegie Mellon University Erin Vasudevan, Moss Rehabilitation Research Institute Jacques Duysens, KULeuven Renaud Ronsse, UCLouvain Jonas Buchli, Italian Institute of Technology	HPV, G4
Organizers: Volker Dietz, University of Zurich, Switzerland Alexander König, ETH Zurich, Switzerland Heike Vallery, ETH Zurich, Switzerland Renaud Ronsse, UCLouvain, Belgium	

Objective
This workshop aims at transferring physiological knowledge on the principles underlying neuro-plasticity after CNS damage in animals and humans to the efficient design of rehabilitation robotics and prosthetics. We will describe experiments in which neuroscientific knowledge has already been transferred into pre-clinical and clinical robots, and will provide neuroscience-based guidelines to design novel gait rehabilitation robots and prostheses. Collectively, the presented results will define a conceptual and practical framework to elaborate novel robotic systems that have the potential to further enhance the efficacy of robotically assisted neuro-rehabilitation to improve function after neurological impairments. A point of discussion will be the combination of the advantages from both sensory feedback and feed-forward controllers in rehabilitation robotics and prosthetics designs, as established by control theory principles.

Brain-Computer Interfaces for communication and control	Friday 16:15 - 18:15
Rupert Ortner, g.tec Guger Technologies Nathan Evans, Laboratory of Cognitive Neuroscience, École Polytechnique Fédérale de Lausanne Robert Leeb, Chair in Non-Invasive Brain-Machine Interface, École Polytechnique Fédérale de Lausanne	HPH, G2
Organizer: Rupert Ortner, g.tec Guger Technologies, Austria	

Objective
An EEG based Brain-Computer Interface (BCI) measures and analyzes the electrical brain activity (electroencephalogram, EEG) in order to convert the EEG into control commands. These commands are used to control external devices like wheelchairs or robots, spelling applications or smart environment like smart homes. BCIs are based - depending on the type of application - on slow cortical potentials, EEG oscillations in the alpha and beta band, the P300 response or steady-state visual evoked potentials (SSVEP). For example, BCI systems based on slow cortical potentials or oscillatory EEG components with 1-5 degrees of freedom were realized up to now. However, high information transfer rates were reached based on 2 degrees of freedom as otherwise the accuracy of the BCI systems dropped down. SSVEP based systems allow selecting up to 48 different targets and are limited by the number of distinct frequency responses that can be analyzed in the EEG. With P300 response based BCIs users can select commands from a rather large command set reliably. Recent advances in usability and reliability of BCI systems made it possible to demonstrate its usefulness for persons with disabilities without significant training effort. In this session different approaches based on demonstrators shall be introduced and vividly discussed.

Intended Audience
People working in the area of brain-machine interface, neuro-rehabilitation, working with handicapped people, innovative human computer interaction.

Motor skill learning and neuro-rehabilitation	Friday 16:15 - 18:15
Vittorio Sanguineti, University of Genoa and Italian Institute of Technology (ITALY) Herbert Heuer, IfADo - Leibniz Research Centre for Working Environment and Human Factors (GERMANY) Etienne Burdet, Imperial College, London (UNITED KINGDOM) Roberto Colombo, Fondazione 'Salvatore Maugeri', Pavia (ITALY) Dejan Popovic, Aalborg University, Aalborg (DENMARK) and University of Belgrade (SERBIA) Ander Ramos, Eberhard-Karls-Universitat, Tübingen (GERMANY)	HPH, G1
Organizers: Vittorio Sanguineti, University of Genoa and Italian Institute of Technology, Italy Etienne Burdet, Imperial College of Science, Technology and Medicine, UK	

Objective
In recent years, motor learning theories and experiments have been used as a tool to investigate neurorehabilitation. In fact, neuro-rehabilitation can be analyzed as a particular form of motor skill learning.

Studying how humans acquire novel motor skills (and how robots can be used to facilitate such learning) may suggest or test neurorehabilitation therapies and novel ways to use robots for rehabilitation. For example, it has been suggested that the acquisition of a novel motor skill can be facilitated by allowing trainees to experiment the correct movements (the 'guidance' hypothesis), possibly using robots. However, guidance seems effective for some tasks but not for others. In addition, guidance may result in a reduced voluntary contribution, which may be detrimental to learning (the slacking effect).

And, after all, is guidance the only way robots could facilitate the acquisition of a motor skill? The effect of guidance and its opposite, lateral destabilisation, as well as other control strategies, have been experienced and analyzed by the speakers and other groups, and enabled to derive efficient strategies for neurorehabilitation.

The proposed workshop builds on the results of the EU-FP7 project HUMOUR, and has the following specific objectives:
- To provide an overview of the major theoretical issues in motor skill learning: guidance hypothesis, slacking, force field learning, role of redundancy
- To discuss how robots can facilitate the acquisition of a novel motor skill
- To discuss how robots could support the transfer of a motor skill from an expert to a naïve performer, and to support the acquisition of cooperative behaviors

The workshop will include tutorials, case studies and video demonstrations. The speakers are using robots and control theory, as well as psychophysical experiments, with healthy and impaired subjects, to investigate novel rehabilitation strategies.
At the end of the workshop, participants will be able to:
- Design an appropriate scheme of assistance for a specific motor task.
- Develop schemes for regulation of assistance, specifically aimed at preventing the slacking effect.
- Define appropriate performance measures for those particular tasks.

Intended Audience
Robot-therapy experts willing to identify novel and more principled approaches, based on knowledge of the mechanisms of motor skill learning.