12. MOVEMENT REHABILITATION

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MEDICAL REHABILITATION ACTIVITY OF THE LABORATORY

Research in the Movement Rehabilitation Laboratory deals with the questions how the nervous system interacts with parts of the body and the environment to produce well coordinated movements like cyclic limb movements or reaching movements as reaching and transporting and object held in the hand. How external forces, resistances, practice, learning or fatigue does effect movement execution? How the central nervous system chooses particular solutions for a motor task that has theoretically an infinity of different solutions. Based on measured movements, we aim to reveal the contributions of muscle properties, limb geometry and neural activation in the control of limb movements.

Applying an ultrasound based movement analyzing system (ZEBRIS, Ivry, Germany) we record kinematic parameters of human movements. We place ultrasound emitting markers on anatomical landmarks of the body and record their position as function of time during human movements. Simultaneously we record muscle activities applying surface electromyograms (EMG) and we study muscle synergies.

Fig. 1 *Cycling arm movements of an able bodied participant while muscle activities (EMG) and kinematic variables are measured.*

We measure and analyze multi-joint movements in able-bodied individuals and our aim is to apply our research in medical rehabilitation for people with movement disorders.

The goal of our research in the laboratory is to use biomedical engineering methods and biomechanics to investigate and understand how humans use and control their movements. The main motivation is to improve abilities (e.g. limb movements) of people who partly lost their motor and sensory functions. Beside basic research our aim is to reactivate paralyzed muscles and to restore lost motor functions for people who suffered accidents or neurological disorders as stroke, spinal cord jury or other neural based movement dysfunctions.

Based on measured and averaged kinematic parameters and muscle activities (Electromyograms) of able bodied people we define muscle activity patterns that can be applied for controlling functional electrical muscle stimulation (FES) for people with paralysed limbs. FES is a technique to generate muscle activities by transferring electrical signals to muscles via electrodes to evoke limb movements. In cooperation with the National Institute for Medical Rehabilitation and the the University of Physical Education we trained 26 spinal cord injured patients whose lower limbs were paralyzed to perform lower limb cycling movements on a recumbent bike (ergometer) using their own muscles. Otherwise these people would not be able to generate active muscle forces.

A general interest of the laboratory is human-machine interface. This includes functional electrical stimulation, when an artificial device sends the control signals to muscles. Another field of human-machine interface is the use of bioelectrical signals recorded from the human body for controlling movements of external objects. We study how information can be changed between the human body and artificial instruments. Our research can be applied in neuromorphic control of prosthetic devices designed for paralysed patients (neuroprostheses).

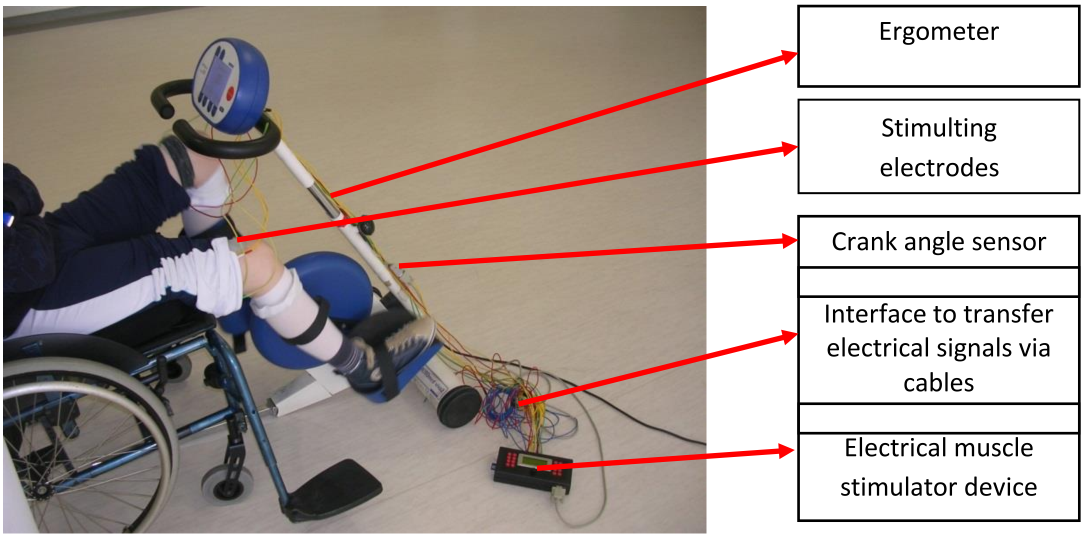

Fig. 2 *Training set up as paralyzed patients are cycling on an ergometer in the National Institute for Medical Rehabilitation using an 8 channel electrical stimulator device developed at the Pázmány Péter Catholic University.*

SOME STEPS TOWARD DESIGN OF AN ARM PROSTHESIS

Measurement and analysis of wrist movements with inertial and biopotential sensors were integrated based on commercially available inertial sensor systems. In addition to hardware considerations current sensor fusion algorithms were compared on the basis of implementation complexity hardware requirements and effectiveness to support the design decision s in the proof of concept implementation.

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