STW Perspectief

neuroSIPE

Newsletter (2) November 2012

General: The goal of the NeuroSIPE programme (System Identification and Parameter Estimation of Neurophysiological Systems) is to improve and develop **new diagnostic tools for neurological disorders**, through the use of closed-loop system identification techniques for the peripheral and central nervous system. Read more about the 9 projects in this newsletter and on our website www.neurosipe.nl.

STW annual congress 2012: Program leader **Frans van der Helm** has received the STW Simon Stevin Master Award of 0.5 M€ for his outstanding work on applied technical research. Frans was honored because of his numerous projects in which research institutes and companies collaborate to develop new tools and applications for rehabilitation. During his award speech he was equipped with several sensors as a kick-off of the MeMachine-project. He wore an Xsens motion-capture suit, a perspiration monitor, a heart rate monitor, an EMG system and an eye-tracker. The 3D motion data was streamed to Motek Medical's Human Body Model which was projected in real-time on a large screen above him.

Besides Frans v/d Helm also PhD student **Yusang Wu** (Beyond Pain) received an award at the STW congress. In a 2 minute pitch he convinced the audience of the relevance of this research and he received the Simon Stevin Student award of 1000 €.

On November 28th a new gait analysis laboratory will be opened with a symposium at the **Rijnlands Revalidatiecentrum.** An instrumented treadmill, the C-Mill from Forcelink, with visual and auditory cues for training and evaluation of gait patterns has been installed and will be used for gait analysis of patients and for research purposes (ROBIN project).

NeuroSIPE meets Chicago. Directly after the NeuroScience conference in New Orleans, NeuroSIPE organized a 5-day workshop in Chicago for all NeuroSIPE participants. The course was organized in cooperation with the Northwestern University, the Feinburg school of Medicine and the Rehabilitation Institute. These world leading institutes host renown groups in neuroscience, physiology and rehabilitation; all within walking distance between the sky scrapers in the city center. Every day of the workshop had a specific theme and consisted of expert lectures in the morning and lab visits in the afternoon. We were able to meet experts, share ideas in an open atmosphere and make new friends.

Project **Beyond Pain** investigates small fiber neuropathy (SFN), which is a sensory neuropathy that affects small fibers and their functions. Diabetes is known as one of the major causes of SFN. There is no good test or tool available to identify SFN in an early stage. This project aims to develop a novel method using non-contact heat stimuli and video thermography to assess small nerve fiber function and as such to realize quantitative and non-invasive diagnosis of SFN in an early stage. A thermal perturbation

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device using a medical infrared lamp has been designed. This new device is used to provoke a local vasomotor response of skin in healthy subjects and patients. Skin temperature is measured with a thermographic video-camera. The video thermography is further processed in order to obtain a comprehensive characterization of the skin temperature response. Experiments in a healthy control group is ongoing in Erasmus MC. A first patient study with CHDR in Leiden is finished and the data is being analyzed at this moment. Read more on the website

The aim of the **PaINSIGHT** project is to use a dynamical system perspective for monitoring of pain processing in the central nervous system in patients developing chronic pain. It was shown that there exists a relation between chronic pain development and (mal)function of the nociceptive system. Application of electrical stimuli using an electrode specifically designed for our purposes (see figure) is capable of selectively stimulating nociceptive related fibers. A psychophysical method is developed allowing simultaneously tracking of multiple thresholds before, during and after a painful stimulus. A first human subject study (N=30) was performed to compare existing psychophysical methods with our developed method. From that study, we found that we were able to track nociceptive thresholds over time. Moreover, we were able to detect habituation effects as well as an increase of threshold due to the painful stimulus. Applying a system approach, we have built abstract models of the forward pathway with four neuropsychological parameters. Read more on the website

The project **Movement Diagnostic System** designs a novel system to differentiate movement disorders and to investigate pathological brain networks in movement disorders with the help of EEG and fMRI combined with EMG, accelerometry and a wrist manipulator. After two years of tackling the technological challenges of developing MR compatible equipment, we have currently started with the first recordings in patients outside the MR scanner and are making preparations for the recordings inside the MR scanner. We aim to complete 100 patient recordings by the end of 2013. Our experimental protocol targets parts of the human motor system that are likely to be involved in movement disorders. Examples of the tests are:

entrainment of hand tremor and dystonia by means of the wrist manipulator (see figure) to influence (faulty) neuronal feedback loops, auditory cueing during hand tapping to determine its influence on brain activations and motor performance, and mapping the default mode of the neuronal networks of each patient group with the help of movement measures. Read more on the website

Project **TORTICOLLIS** investigates neck stabilisation in healthy subjects and in patients suffering from cervical dystonia (also called: torticollis) a syndrome characterized by sustained involuntary muscle contractions. Three potential diagnostic methods have been developed using 1) intermuscular EMG coherence, 2) mechanical perturbation with a moving platform and 3) isometric force testing. In addition, the detailed neck model obtained from partner TNO (see figure) is used and has been extended with neuromuscular feedback. First experimental results comparing 10 patients to 9 controls show deviating surface EMG in isometric conditions, and a second test series with needle EMG is being prepared. Galvanic vestibular stimulation (GVS) was shown to elicit consistent neck motion in combination with mechanical perturbation. Read more on the website

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Project **ROBIN** investigates the role of muscles and neural reflexes in ankle joint stiffness in patients with cerebral palsy (CP) and stroke. As most movement disorders are manifest during execution of movements,

we finished a new identification method that enabled estimation of muscle and reflex stiffness for a wide range of movement tasks. CP patients were separated from healthy controls and from each other based on intrinsic and reflexive properties. Most recent results showed accurate estimation of muscle, tendon and reflexive stiffness within just a single observation of less than one minute! From small changes in treadmill velocity we also achieved in estimation of ankle joint viscoelasticity during walking. Multicenter (LUMC/VUMC) ROBIN stroke/CP cohort study starts early 2013. Read more on the website.

Unlike ROBIN, the **BATMAN** project (**B**ehavior, **A**lertness, and **T**hermoregulation: a **M**ultivariate **AN**alysis) pursues to identify the thermoregulatory system parameters from unrestrained ambulatory measurement of all inputs and outputs in the field, namely physical activity, posture, environmental light and temperature, electrocardiography, and skin temperature by means of a multi-sensor system as well as questionnaires and reaction times assessed on a PDA. These parameters will be validated against those derived under strictly controlled laboratory manipulations. Read more on the website

The **BALROOM** project focuses on human balance control. Impaired balance in elderly can result in falls which have a profound socioeconomic impact. Impaired balance can have several underlying causes, namely dysfunction of muscles, sensory systems, sensory integration and processing, neural control or a combination. At the LUMC first experiments have been performed to identify the sensitivity of the Bilateral Ankle Perturbator (BAP) to detect the use of proprioceptive information in elderly. The BAP is the first module of the BALROOM and consists of two pedals which can rotate independently around the ankle axes. Comparing the results of healthy young and elderly we concluded that healthy elderly use their proprioceptive information more compared to young. Another module of the BALROOM has been developed in collaboration with ForceLink B.V. This device (figure) perturbs the human balance mechanically at hip and shoulder level. First tests of the device in combination with the CLSIT will be performed on healthy young subjects. Read more on the website

The goal of **QDISC** is to develop a diagnostic tool as the basis for more targeted treatment for patients with chronic low back pain. To this end, we are developing methods to quantitatively assess neuromuscular control of trunk muscles and the potential determinants of motor control changes in low back pain. Tests on healthy subjects revealed that intrinsic stiffness and proprioceptive feedback dominate trunk control, while visual and vestibular feedback are less important. The first measurement on patients with low back pain have recently been performed and we are in the process of assessing differences with healthy controls. Read more on the website

The goal of the **PowerSensor** project is to develop and demonstrate methods to assess the dynamic interaction of the human hand with the environment through combined movement and force

sensing. The hardware of the 2nd kinematic glove version is finished and operational. The hardware has been built modularly such that the force sensor output can be easily integrated. The instrumentation for acquiring the signals from the fingertip capacitive 6 DoF force/moment sensorchip developed in the project has been realised and integrated with the instrumentation for the kinematic sensing. Sensor acquisition can be performed in either LabView or Matlab. Read more on the website

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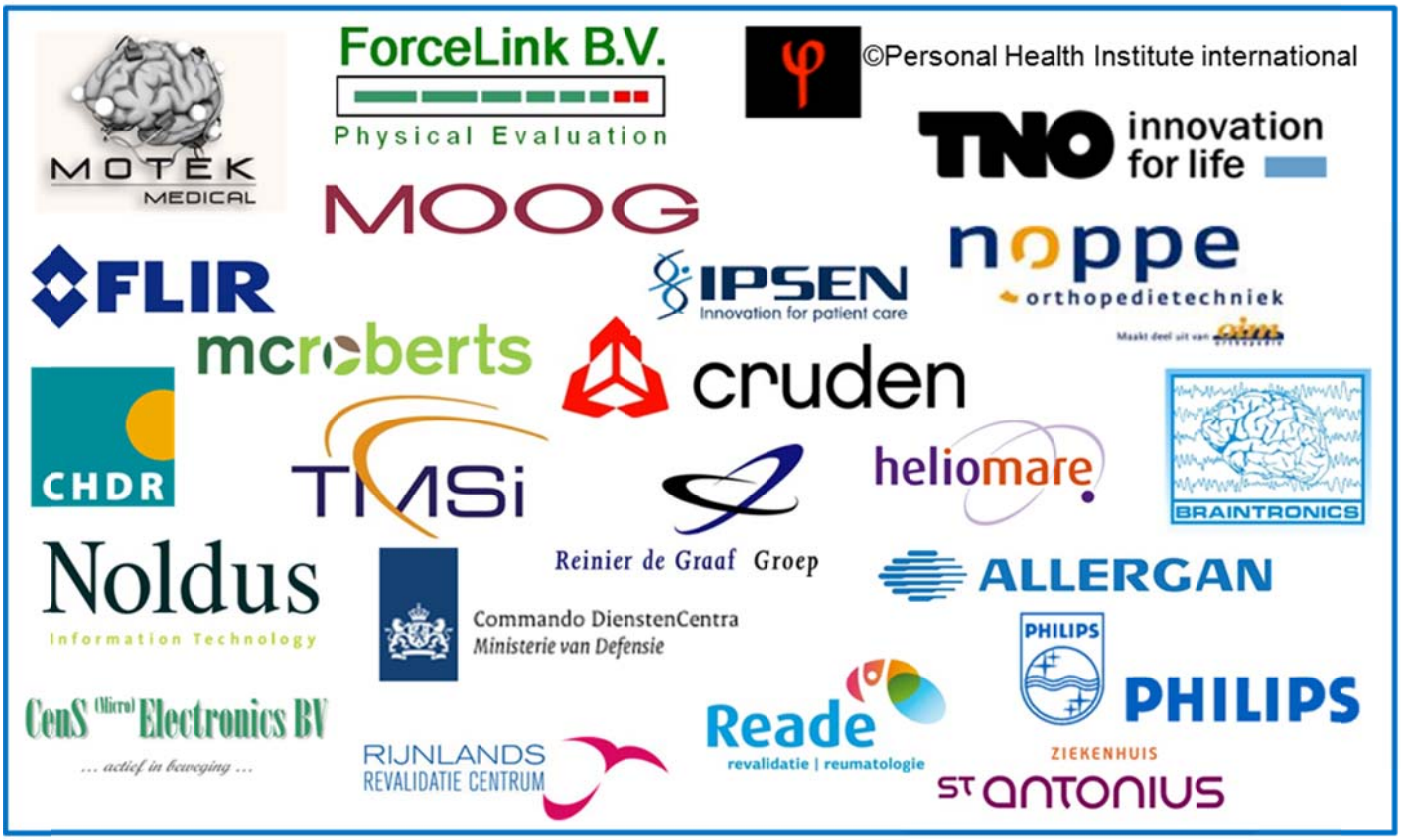

Enabling new technology

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