Research and Innovation Conference

Biomechanics & Technology for Research

PROGRAM

Introduction by Track Chair	**Nick Stergiou,** *Director of Nebraska Biomechanics Core Facility*
1:30-1:55	**Natasa Kyvelidou** "Infant Postural Control: New insights for diagnosis and treatment of motor disorders"
1:55-2:20	**Shing-Jye Chen** "Biotechnology in Stairs Negotiation"
2:20-2:45	**Max Kurz** "Assessment of Pathological Gait Based on Insights from Walking Robots"
Break 2:45-3:10	
3:10-3:30	**Mukul Mukherjee** "Virtual Reality Technology in Human Locomotion"
3:30-3:55	**Ka-Chun Siu** "Simulation for Advanced Robotic Surgical Technology"
3:55-4:15	**Leslie Decker** "Smart Wireless Insoles for Gait Monitoring and Fall Prevention in the Elderly: the Gait-O-Gram™"
4:15-4:30	**Sara Myers** "Applications in Biomechanics for Research: PAD and MS projects"

ABSTRACTS

"Infant Postural Control: New insights for diagnosis and treatment of motor disorders"

In our previous funded work we were able to identify sensitive and reliable techniques to evaluate the development of sitting postural control in typically developing infants and in infants with cerebral palsy (CP). Using these techniques, we identified a physical therapy intervention that successfully improved sitting posture in infants with CP. This foundation has strategically positioned us to now investigate the efficacy of additional innovative intervention for children with moderate to severe CP, a group of children who have been neglected in previous intervention studies. Such intervention is the paradigm of adding stochastic noise to the support surface to improve postural responses, a method being used successfully in adults with decreased postural control. In addition, we are currently pursuing to build a Balance-o-Gram biomedical device and custom clinical assessment software for the detection of early balance impairments during sitting development in infancy. This biomedical device will allow clinicians access to the latest mathematical nonlinear analysis for the early detection of neuromuscular health.

"Biotechnology in Stairs Negotiation"

Stairs negotiation is one of the most common activities of daily life. Climbing stairs has imposed great muscular challenges not only on lower limbs of a human body, but also on upper limbs while gripping handrails to prevent from falling. To prevent the falls on stairs, there is a need for the development of biotechnological measurements in handrails of stairs that can be used to clinically assess handrail forces needed for maintaining balance during stair climbing and the biomedical technologies of stairs being used for rehabilitation in patients who have lower limb pathologies. To directly measure handrail forces, a mechanical design of a four-step stairway and rails were constructed so that the gripping handrail forces and lower limb biomechanics were able to be quantified while negotiating the stairs.

"Assessment of Pathological Gait Based on Insights from Walking Robots"

The pathological gait patterns seen in individuals with Parkinson's disease and cerebral palsy are often less efficient and more susceptible to falls. Management of these movement deficiencies has an impact on the overall cost of health care. There is a need for the development of better biomedical technologies that can be used to clinically assess the mechanisms behind these movement deficiencies, and the efficacy of the current medicine being used for the management of gait pathologies. Engineering analysis from walking robots and physics-based models can be used to predict what biomechanical factors influence the mechanical efficiency and stability of the walking pattern. This presentation will provide insight on how we are applying these engineering innovations for the clinical assessment of pathological gait.

"Virtual Reality Technology in Human locomotion"

Virtual Reality technology allows the user to interact with a computer-simulated environment. When used in conjunction with locomotion, it provides perception of self motion. Such perception can be manipulated to produce variations in locomotion patterns. Human gait patterns are remarkably adaptive however, sensorimotor abnormalities after diseases like stroke make such adaptations difficult to achieve. VR technology provides us an excellent opportunity to influence abnormal gait patterns by providing a perception of self motion through simulation. In this presentation, a series of experimental results will be discussed which probe the interaction of VR environments with human locomotion.

"Simulation for advanced Robotic Surgical Technology"

Virtual reality (VR) environments have been developed to improve training for conventional laparoscopic surgery. Verbal training and subjective skill assessments by expert surgeons are also commonly used to train and evaluate surgeons on the da Vinci™ Surgical System (Intuitive Surgical, Inc.). We have implemented a formal training program in conjunction with a VR simulation which can provide residents with an ideal learning experience for robot-assisted surgical techniques in a risk-free environment. Our simulated VR also provides a subjective and quantitative approach to evaluate and improve surgical performance and efficacy. Fidelity and complexity of the VR should be the focus in developing training program for the next generation of robot-assisted surgeons. We are currently designing a new VR training simulator for robotic surgery, which will be portable, low cost and easy to control.

"Smart Wireless Insoles for Gait Monitoring and Fall Prevention in the Elderly: the Gait-O-Gram™"

Gait variability, as it can be measured from temporal parameters such as stance and step times, can assist in better understanding the mechanisms underlying decline in motor function. Over four years of development, The Nebraska Biomechanics Core Facility designed and built the wireless Gait-O-Gram™ (GOG) for this purpose. The GOG monitors the temporal step parameters and the variability of these parameters in conditions outside of the laboratory for long periods of time. The purpose of this study is to present the design and the validation of our device. Our immediate future work will focus on turning this device into a new miniaturized system, in which the force sensitive sensors, as well as

the microprocessor will be entirely embedded in the shoe insoles. While this work is continuing to be developed, it offers a practical and low cost biotechnology of objectively monitoring gait variability and as a result shows great promise as a future contributor to clinical gait analysis. For instance, the GOG is intended to become part of the existing comprehensive fall risk assessment for preventing falls among the elderly. The patent pending GOG has already attracted venture capital interest. We hope that, in the near future, the GOG will be commercialized as it gains wide acceptance in clinical settings. This work was supported by funds from the Nebraska Research Initiative.

"Applications in Biomechanics for Research: PAD and MS projects"

Gait analysis procedures are commonly used to assess mobility problems and treatment efficacy in clinical populations. We are currently using biomechanical gait analysis to evaluate patients with Peripheral Arterial Disease and patients with Multiple Sclerosis (MS). Peripheral Arterial Disease (PAD) is a condition causing impaired mobility; occurring disproportionately in the geriatric population. MS is a progressive, debilitating, neurological disease resulting in varying symptoms such as sensory disturbances, trunk and limb parasthesias, and severe fatigue. Biomechanical analysis provides an objective basis for evaluation, treatment and rehabilitation of the patients' physical function. There is a need for gait analysis procedures that allow clinicians to meaningfully assess the functional status of patients. We are designing methods and products that extend our current research work, including development of software and devices that can be applied to multiple mobility disorders; with the potential for broad application to multiple patient populations. Through these projects, PAD and MS patients will serve as models to implement novel gait analysis procedures in clinical settings.

SPEAKER BIOS

Natasa Kyvelidou received her BS degree in Exercise Science from the Aristotle University of Thessaloniki, Greece in 2002 and her MS in Exercise Science from the University of Nebraska at Omaha in 2006. She is pursuing a PhD in Biomechanics and Motor Development from the University of Nebraska Medical Center, through the Medical Sciences Interdepartmental Area-Department of Pediatrics program. Her research interests include postural control in pediatric and pathologic populations.

Shing-Jye Chen earned his PhD from the University of Oregon in 2005. Then, he came to the University of Nebraska at Omaha and taught during the first year as a teaching instructor. He is currently an assistant professor at the UNO and a co-director of the HPER Biomechanics Laboratory. His research focuses on biomechanical gait analysis in the patients who had intermittent claudication and in the elderly fallers whose lower limb biomechanics are challenged during stair negation.

Max J. Kurz earned his PhD from the University of Nebraska. Previously he was an assistant professor at the University of Houston where his research group focused on the movement disabilities seen in individuals with Parkinson's disease. He is currently an assistant professor at the University of Nebraska Medical Center's Munroe-Meyer Institute for Genetics and Rehabilitation. He is responsible for the clinical analysis of patients with gait pathologies, and his current research is directed toward overcoming the walking disabilities seen in children with cerebral palsy.

Mukul Mukherjee is a postdoctoral research associate in the Nebraska Biomechanics Core Facility at the University of Nebraska at Omaha. He obtained his PhD in Rehabilitation Sciences from the Kansas University Medical Center and his Bachelor's degree in Physical Therapy from the Delhi University. His research interests include stroke rehabilitation and utilizing virtual reality technology and robotics for studying human movements in healthy and pathological populations.

Ka-Chun Siu is currently a Post-Doctoral Research Scientist at the Nebraska Biomechanics Core Facility, University of Nebraska at Omaha and the project coordinator of the robot-assisted surgery educational program at the Center for Advanced Surgical Technology, University of Nebraska Medical Center. Dr. Siu obtained his BS in Physical Therapy from the Kaohsiung Medical University, School of Rehabilitation Medicine in Taiwan in 1999 and received his PhD in motor control and learning at the University of Oregon in the Department of Human Physiology. His research interests include motor control, motor learning and robotic surgery.

Leslie Decker conducted her undergraduate studies in Evry Val-d'Essonne, France, which led to a Bachelor of Science in Exercise Science. She pursued her graduate work at the University of Pierre & Marie Curie, Paris VI, France, where she obtained her Master of Science in Physiology and Biomechanics of Human Movement. She received a Postgraduate Diploma in Applied Biostatistics in Clinical Research and Epidemiology at the Faculty of Medicine Henry Warembourg, Lille, France. During her doctoral thesis, she developed interest in using statistical shape analysis to quantify motor patterns in human walking and running. She was awarded her Ph.D. degree in Biomechanics from the University of Pierre & Marie Curie in 2006. Her doctoral work was the stepping stone for her postdoctoral training at the University of Nebraska at Omaha. Her current research aims to address what gives rise to the gait unsteadiness in elderly fallers and elucidate the potential utility of gait variability measures to assist in the development of new therapeutic strategies.

Sara Myers received her BS degree in Exercise Science from the University of Nebraska at Omaha in 2004 and her MS in Exercise Science from the University of Nebraska at Omaha in 2007. She is pursuing a PhD in Biomechanics and Motor Control from the University of Nebraska Medical Center, through the Medical Sciences Interdepartmental Area-Department of Surgery program. Her research interests include gait analysis, specifically in aging and pathological populations.