הטכניון מכון טכנולוגי לישראל
TECHNION Israel Institute of Technology

Faculty of Mechanical Engineering
הפקולטה להנדסת מכונות

MECHANICAL ENGINEERING SEMINAR

Monday, January 23rd, 2023 at 14:30, D. Dan and Betty Kahn Building, Auditorium 1

(Online zoom session is available: https://technion.zoom.us/j/99613034783)

Using Insights from Human Motor Control and Robotics to Design Intuitive, Semi-Autonomous Prostheses and Exoskeletons

Nili E. Krausz, Ph.D.

Post-Doctoral Researcher, Dept. of Applied Math and Computer Science,
Weizmann Institute of Science
Email: nili.krausz@weizmann.ac.il ; Website: www.nilikrausz.com

Hosted by: Prof. Alon Wolf, Prof. Oleg Gendelman

State-of-the-art controllers for powered, multi-joint prosthetic limbs devices use kinetics, kinematics and electromyography (EMG), to predict intended changes in locomotion mode or grasp type. However, these controllers can be unintuitive, naïve, and slow. My overall research goal is to bridge the gaps between prosthetics, robotics, and neuroscience to allow for the development of a robust, reliable, and intuitive control system that will provide users with added function. In this talk I'll discuss work towards incorporating robotics-inspired approaches and insights from human motor control into prosthetic controls. Firstly, using external sensing for intent prediction can move prosthetic control from being purely reactive, to predictive and robust. During my PhD I developed, characterized, and validated algorithms using environmental data to perform intent prediction. Testing with able-bodied and amputee subjects, I showed that including external sensing decreased variability and increased repeatability across subjects and produced >99% classification accuracy for all subjects and conditions tested. Future work to include long-range sensing and state estimation can further improve the performance across subjects and conditions. Meanwhile, during my PhD I proposed an endpoint controller for a prosthetic arm, driven by sensor fusion of neural signals and filtered gaze, that can be used with inverse kinematics solvers to control multi-joint arms. During my postdoc, we've shown a possible method for how the nervous system may resolve redundancy and solve the inverse kinematics problem using basis functions, or sources. In the future, I plan to use this neurally-inspired inverse kinematics solver with my endpoint-driven approach for a more intuitive, semi-autonomous control method for prosthetic arms, and I will assess if cognitive load is reduced using this controller. Finally, I'll discuss how coupling our robotics approach with computational modeling of pathological movements could be used to estimate the required assistance for a powered exoskeleton, as well as provide insight into the neural mechanisms of movement coordination.

Nili Krausz received her BS and MS degrees in Mechanical Engineering from the University of Colorado Denver. She then completed her PhD at Northwestern University and the Shirley Ryan AbilityLab (formerly the RIC) with Dr. Levi Hargrove. In 2015-16 she was selected to do a PhD exchange in the LASA lab (with Dr. Aude Billard) at EPFL. Her postdoctoral training has been completed in the Motor Control for Humans and Robotic Systems Lab with Dr. Tamar Flash at the Weizmann Institute of Science. Her research interests include robotics and neurophysiology for rehabilitation and assistive wearable devices, with emphasis on mechanical design, shared and semi-autonomous control, computer vision, and human motor control, for improved intent recognition and human-machine interaction.

Seminars Coordinator: Assoc. Prof. Matthew Suss.