MECHANICAL ENGINEERING STUDENT SEMINAR

Thursday, October 20 2022 at 13:00, **Hybrid:** D. Dan and Betty Kahn Building, Auditorium 1. **Or** https://technion.zoom.us/j/91025916188

Personalized haptic systems for able-bodied and prosthetic hand users

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The human hand is an astounding apparatus with an extremely elaborate kinematic and sensing capabilities. Most of what we do with our hands relies on tactile feedback perceived through mechanoreceptors in our skin. While the mechanisms behind other human senses such as sight and hearing are well understood and even though touch has been the subject of numerous studies there are still many unknowns. Correspondingly, while visual and auditory feedback devices provide immersive experiences, cutaneous feedback devices are typically limited in the range of sensations they provide. Similarly, commercial prosthetic hands suffer from high rejection rates due to many reasons, but among which are lack of degrees of freedom, age of first fitting, weight, and lack of sensory feedback.

In this research we present two haptic interfaces, one designed to be used by able-bodied user and one integrated in a low-cost prosthetic hand. The devices development was based on grasping experiments in which both kinetic and kinematic data was collected for 31 subjects that grasped multiple objects. The data was used to study the micro properties that make human grasping subject specific.

The device designed for able bodied is a High resolution UX for Geometric objects (HUGO). HUGO's design is bio-inspired and was designed by reverse engineering the mechanoreceptors in the human hand. HUGO triggers the mechanoreceptors sensitive to pressure, low-frequency vibrations, and high-frequency vibrations, enabling to experience touch of any surface "in-the-wild". The device is based on a parallel manipulator and a pin-array, that operate simultaneously at 200Hz and emulate coarse and fine geometrical features, respectively. The decomposition into coarse and fine features, alongside the high operation frequency, enable simulation of high-resolution virtual surfaces. This was corroborated in experiments on real-world surfaces using a quantitative recognition test and a usability questionnaire.

The haptic interface for prosthetic hand users was integrated in a low-cost, motorized, 3D printed hand design for below and above wrist amputations. The design includes the addition of a mechatronic sensory feedback interface capable of measuring grip force and providing feedback in a modality-matched approach. The hand design and feedback interface were validated in a set of experiments using an adapter for able-bodied users. Moreover, we developed a concept and present preliminary results for a fully automated fitting and manufacturing pipeline for personalized low-cost prosthetic hands. The entire design and pipeline are shared online and are freely available for anyone to use.

Note: the seminar will be given in Hebrew

Seminars Coordinator: Assoc. Prof. Matthew Suss.