High Density Electromyography (HDEMG)

Background: The primary method of signal acquisition for prosthesis control utilizes electromyography (EMG), the electrical signals generated by the muscles during their contraction. Most commonly 1 or 2 EMG electrodes are placed over antagonist muscles on the residual limbs of amputee patients to record bulk muscle movements. Recently, machine learning based methods have become commercially available that rely on an average of 8 sensors to acquire more detailed features of muscle movement patterns that occur in the residual limb. However, EMG signals are relatively noisy, and the 8 channels still provide only limited access to the underlying control information.

HDEMG electrodes consist of a high number of EMG electrodes (generally between 32 and 256) placed in a tightly spaced fashion. This allows for more detailed reconstruction of muscle movements to the level of individual motor unit activity and electrical signal propagation through the body of the muscles. The challenge in the design of such a system comes from the need of the electrodes to maintain a robust and continuous contact with the surface of the skin.

Goal of the project: The primary aim of the project is to develop an HDEMG electrode system that maintains stable contact with the skin and provides a continuous stream of low-noise signals. This can be achieved by using flexible electronics and special materials combined with ingenious engineering solutions. A student assigned to this project will familiarize themselves with the existing body of research and the preliminary work completed in the lab. Once aquatinted with the background, the student will begin the implementation of various engineering solutions involving electronic hardware assembly, fabrication and testing. Publication of methods and results in an appropriate scientific journal is an ideal endpoint.

Benefits to the student: The opportunity to get hands on experience in the development of cutting edge sensory electronic and signal processing systems, conducting experiments with human subjects in the relevant patient population, and the potential for journal publication. In addition, this project is funded by NIH, and will be jointly carried out with collaborators at Infinite Biomedical Technologies, giving the student startup/small company collaboration and translational research experience.

Background:

- *Experience in instrumentation:* the student must have previously participated in a project that involved hardware development, including experience in soldering fine electronics, debugging electronic components, and a fundamental understanding circuitry design.
- *Intermediate coding skills in Matlab and/or Python:* testing the sensor system requires interfacing with software components. Modifying, debugging and using these components requires a fundamental understanding of the programming languages. The student must have prior experience coding in both Matlab and Python with experience beyond class assignments for at least one.
- *Self-motivation and the ability to conduct independent work:* We invite students motivated by R&D challenges, focus on the problem laid out and bring to completion (design to prototype to data to publication). Student should take (or have taken) relevant courses, e.g. electronics/sensors/instrumentation and then apply the learned basic training to practical problem solving. New ideas and independent work are highly encouraged and valued in the lab.

Expectations: Motivation to translate the technology for amputee needs. Publication and/or patenting of the original work is a must.