NEUROPROTHETICS

Session co-chairs: Justin Williams, University of Wisconsin, Tim Denison, Medtronic

The brain has always been attractive to engineers. Neurons and their connections, like tiny circuit elements, process and transmit information in a dramatic way that is intimately curious to researchers in the computer science and engineering fields. Neurons are amazing computational devices capable of both robust response to widely varied inputs and adaptability to changing conditions. Our most advanced computing systems are still dwarfed by the computational power of the human brain. Even small groups of neurons are capable of intricate interactions that produce basic mechanisms of learning and memory, highly parallel processing and exquisite sensing capabilities.

Science has made great strides in the past few decades toward uncovering the basic principles underlying the brain's ability to receive sensation and control movement. These discoveries, along with revolutionary advances in computing power and microelectronics technology, have led to an emerging view that neural prosthetics, or electronic interfaces with the brain for restoration or augmentation of physiological function, may one day be possible. While the creation of a "six million dollar man" may still be far into the future, neural prostheses are rapidly becoming real potential treatments for a broad range of patients with injury or disease of the nervous system.

This session will focus on the types of engineering technology that we use to interface with the nervous system. This includes technology for stimulating the nervous system for restoration of sensory function as well as methods for extracting motor intention from the brain for use in artificial prostheses. In addition, we will also consider how lessons learned from how the nervous system processes information can also be applied to circuit design—both for prosthetics and consumer circuits in general.

The speakers in this session represent both academia and industry. Clinical studies will be presented that span both basic research and commercial applications. Finally, emerging technologies that combine genetic and optical approaches will be presented to give a glimpse into the state of the art in neural interfacing technology.

The talk by Weiland will cover the historical use of electrical stimulation of the nervous system and then focus on recent clinical development of retinal implants to restore sight, he will also give a brief overview on the emerging field of optogenetics. Leuthardt will then discuss the use of neural recording devices to extract motor command signals for use in communication aids and brain machine interfaces for disabled populations. Finally, Sarpeshkar will present new paradigms of "neuromorphic" processing, how we can learn from the brain's amazing processing properties, and how that can be applied in next generation applications like cochlear prosthesis.