IEEE Ottawa Section

Extraction and Utilization of Cognitive Signals for Neural Prosthetic Applications

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admission is free

17:30 – 19:00 pm

Mackenzie Building 4359

Carleton University

Light refreshment will be served

An important question in neural prosthetics research is what parameters can be decoded from the brain and used for prosthetic control. The current aim of my lab is to elucidate the nature of cognitive signals for prosthetic applications and develop improved methods to record from cognitive areas deep in the brain. I will first review the behaviour of neurons in the parietal cortex that contain information about the goal of a reach (the location of a reach target in space). Recent experiments that suggest these neurons can also encode the goal anywhere in 3D space during imagined or executed movements will also be described. Interestingly, these neurons also encode the expected value of reward which may serve as an indicator of the motivational state of the animals. The utility of these signals for prosthetic applications is significant and their use in prosthetic control will be discussed. This utility, however, comes at a cost as most of the neurons just described lie in sulci and are hard to reach with multi-probe arrays. The large technological advancements in micromachining silicon probes to record the brain's electrical activity have made them the preferred device for neural prosthetic applications. Silicon probes are too brittle, however, to survive the journey into deep areas of the brain. We have recently developed methods to reinforce silicon probes to increase their tensile strength. To optimize the information we can extract from these areas, we are also developing processes to integrate optical biochemical sensors on these probes. Sol-gel derived xerogel thin films that encapsulate specific analyte-responsive fluorophores in their nanostructured pores will be described. As a prototype, we demonstrate direct-write patterning to create oxygen-responsive xerogel waveguide structures on the neural microelectrodes. The recording of neural biomarkers along with electrical activity could minimize the invasiveness of implants while increasing their utility for prosthetic control. They may also help provide novel methods to investigate complex brain diseases and disorders.

Sam obtained his Bachelor of Science (honours) from the University of Toronto (UT) in Physics and Math. In 1995, he joined the department of Biomedical Engineering at UT and the lab of David Tomlinson and completed his Masters modeling the translational vestibulo-ocular reflex. In 1997, he spent a year in Greece working for the European Union building web applications. In 1998, he started his PhD in the departments of Physiology and BME again with David Tomlinson. He studied the signal processing performed by the vestibular nucleus (VN) during combined linear and rotational motion. In 2001, he joined the lab of Dr. Richard Andersen at Caltech for his post-doctoral training. He headed the development of a neural prosthetic that can ultimately control arm movements in paralyzed patients. The goal of this project was to extract and decode neural signals from the parietal cortex of monkeys while they simply thought about completing a reach movement. At McGill, he plans on continuing the development of cognitive neural prosthetics with the aim of restoring natural behaviour to paralyzed patients.