Neural Engineering Group

Fall 2018 Journal Club

Friday, October 5 at 2 pm in CDI 4.352

Safe Direct Current Neural Implant

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Abstract: Safe Direct Current Stimulation (SDCS) technology holds the promise for the creation of a new class of neural implants that could expand our ability to interact with the human nervous system. Pacemakers, cochlear implants, and essentially all other chronically implanted neuroelectronic prostheses rely on charge-balanced, biphasic pulses to excite neural or muscular activity without driving electrochemical reactions that would otherwise liberate toxic substances at the metal electrode-saline interface. While these devices are effective at stimulating the target neurons, inhibition of neural activity and further expansion into alternate modes of neural control have been more challenging. Many neurologic deficits, such as balance disorders, inability to control micturition, tinnitus, chronic pain, psychiatric disorders, and epilepsy could benefit from a neural implant capable more extensive control of neural activity. In contrast to the brief biphasic stimulus pulse used to evoke an action potential in a target neuron, ionic direct current (iDC) delivered by an extracellular electrode has a graded effect on its membrane potential. As the result, iDC is capable of increasing or decreasing the probability of action potential generation. Excitation delivered this way results in an increase in neural activity that maintains its natural stochastic firing properties. In addition to being able to increase, decrease, or altogether block spiking behavior, this neuromodulation mechanism can control the speed of action potential propagation, modulate sensitivity to synaptic input, and in principle alter synaptic weights in a neural network by modulating spike timing dependent plasticity.

I will address our latest efforts toward developing the SDCS implant capable of delivering iDC to neural targets and the application of this new technology for the treatment of chronic peripheral pain and for the treatment of the vestibular balance disorders.