MSM Meeting Abstract

**Improving Cortical Electrode Placement and Stimulation via Co-Simulation of Large-Scale Compartmental Neuronal and Multi-Resolution Admittance Method Models**

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**Abstract**

As a greater number of medical devices which function by injecting electrical current are being used to treat central nervous system disorders, it is increasingly important that an efficient method to design and evaluate arrays of stimulating and recording electrodes is developed. Electrode and array geometry, position relative to target neuron populations, stimulation waveform and pulse spectral characteristics, as well as countless properties of the target tissue all contribute to the electrical behavior and response of neural tissue. As an approach to refining intracortical electrical stimulation systems, the authors are developing a computational model of a 400 μm thick section of an in vivo rat dentate gyrus, its primary innervating fibers, and superimposed a virtual system for electrical stimulation and recording. Stimulation voltages were estimated via a specialized lumped circuital network model of the passive electrical properties of the hippocampal tissue using the Admittance Method. By this method, the authors were able to predict voltage attenuation from complex geometry electrode arrays throughout a 3-dimensional space of heterogeneous conductivity. Estimated voltages were then passed to a computer reconstruction of a region of in vivo dentate tissue including primary cell-types with unique morphologies and realistic biophysics implemented in the NEURON simulation environment. Together, these model components provide a framework from which the authors are able to predict hippocampal tissue response to electrical stimulation with arbitrary spatial and temporal complexity. Tissue responses were recorded in a range of clinically relevant stimulation amplitudes and electrode locations. The results of this work provide a promising avenue for evaluation of arrays of stimulating or recording electrodes and their placement.