School of Mathematical and Statistical Sciences
Arizona State University

M E M O R A N D U M

DATE: June 23, 2022

TO: Faculty and Students

FROM: Professor(s) James Abbas Sharon Crook
Chair/Co-Chairs of Morteza Rouhani
Defense for the PhD in Applied Mathematics
Committee Members Carl Gardner
Rosalind Sadleir
Steven Baer

DEFENSE ANNOUNCEMENT

Candidate: Morteza Rouhani

Defense Date: 07/11/2022

Defense Time: 9:15 AM

Virtual Meeting Link: https://asu.zoom.us/j/86241786362?pwd=3rZtVGmFdANQb5mNnpfS9yaShxaFwx.1 Password: 071122

Title: Model-based investigations of peripheral nerve stimulation using longitudinal intrafascicular electrodes.

Please share this information with colleagues and other students, especially those studying in similar fields. Faculty and students are encouraged to attend. The defending candidate will give a 40 minute talk, after which the committee members will ask questions. There may be time for questions from those in attendance. But, guests are primarily invited to attend as observers and will be excused when the committee begins its deliberations or if the committee wishes to question the candidate privately.

ABSTRACT
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ABSTRACT

Electrical stimulation of the human peripheral nervous system can be a powerful tool to treat various medical conditions and provide insight into nervous system processes. One important challenge for many applications is to selectively activate neurons that have the desired effect while avoiding activation of neurons that produce side-effects. To stimulate peripheral fibers, the longitudinal intrafascicular electrode (LIFE) is designed to target small groups of fibers inside the fascicle using low-amplitude pulses and are well-suited for chronic use. This work is directed at gaining a better understanding of the ability to use intrafascicular stimulation with LIFEs to selectively activate small groups of neurons within a fascicle.

A hybrid workflow was developed to simulate: 1) the production/propagation of the electric field induced by the stimulation pulse, and 2) the effect of the electric field on fiber activation (recruitment). To create efficient and robust strategies for selective recruitment of axons, recognizing the effect of each parameter on their recruitment and activation pattern is essential. Thus, using this hybrid workflow, the effects of various factors such as fascicular anatomy, electrode parameters, and stimulation pulse parameters on recruitment have been characterized, and the sensitivity of the recruitment patterns to these parameters have been explored.

Results demonstrated the potential advantages of specific stimulation strategies and the sensitivity of recruitment patterns to electrode placement and tissue properties. For example, we demonstrated: the significant effect of endoneurium conductivities on threshold levels; that a configuration with a LIFE as a local ground can be used to deselect its surrounding axons; the advantages of changing the delay between pulses in dual monopolar stimulation in targeting different axons clusters and increasing the activation frequency of some axons; how monopolar and bipolar configurations can be used to enhance spatial selectivity; and that changing the delay between pulses in dual monopolar stimulation can alter recruitment patterns and increase the activation frequency of some axons. In summary, this work forms the foundation for the development of stimulation strategies to enhance the selectivity that can be achieved with intrafascicular stimulation.