REPPERGER RESEARCH INTERN PROGRAM

RESEARCH PROJECT #: AFRL-RHD-24-06

Modeling Neural Action Potential Response to IR Stimulation

PROJECT DESCRIPTION: Infrared exposure can functionally impact the electrochemical activity of neuronal networks resulting in stimulation or inhibition of action potential. The fundamental mechanics of the neuron's response are not fully understood and effect optimization is an active area of research. Experimental approaches to study these effects have limitations due to the complex nature of the interaction and difficulty in making direct and repeatable measurements. Modeling can be a useful tool for hypothesis testing, so previous efforts worked to combine laser-tissue thermal modeling with temperature dependent neuronal action potential modeling to create an end-to-end analysis tool. This project will investigate refining that model using experimental data and evaluating the model's parameter sensitivity and predictive uncertainty. This will also be an opportunity to apply recent developments in physics-informed neural networks that show promising results in predicting the outcome of the heat equation with a laser source. A machine learning model that predicts neural response given a set of input laser parameters with quantified uncertainty will be tested along with the physics-level model results. Student interns will gain skills in utilizing a finite-volume heat equation solver, high performance computing, briefing to diverse audience (i.e. skills, education, rank), and understanding neural inhibition/stimulation modeling.

ACADEMIC LEVEL: Undergraduate; Doctoral; Masters

DISCIPLINE NEEDED:

- Biomedical Engineering
- Neuroscience
- Biomolecular Engineering

RESEARCH LOCATION: JBSA-Fort Sam Houston, San Antonio, Texas

RESEARCH MENTOR: Chad Oian, MS
Mechanical Engineering, University of Texas at San Antonio, 2017

Chad Oian is a research engineer in the Air Force Research Laboratory's Optical Radiation Bioeffects Branch (711 HPW/RHDO). He has worked as a computational physics and simulation researcher for 8 years on the Bioeffects Division's modeling and simulation team. He transitioned to civil service through the Palace Acquire program in 2018 after completing a M.S. in mechanical engineering focusing on continuum mechanics modeling of laser-induced neuronal inhibition. His other research areas include laser safety tool development, vision effects modeling, and expanding multi-physics capabilities in the area of directed energy bioeffects.
Photo courtesy of the U.S. Air Force Research Laboratory.

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