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Post-doc/Graduate Student/Resident/Research Scientist Poster Presentation

Title:
Antiferromagnetic Auto-oscillators as Artificial Neurons: A Platform for Neuromorphic Computing and Physiological Modeling

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Abstract
The nervous system provides necessary electrical impulses and connectivity to sustain life. A foundational understanding of biological neural network function could prove instrumental for refined clinical applications and treatments. We have developed an artificial neuron using antiferromagnetic (AFM) auto-oscillators to produce ultra-fast voltage spikes as a response to external stimulation [1]. AFM neurons have many features closely resembling biological neurons, including response latency, refractory periods, inhibition, etc. to simulate biologically realistic artificial neural networks and physiological reflexes.

AFM neurons consist of nanometer-sized AFM materials mounted on platinum [1]. Electrical current flowing through the platinum elicits rotations of AFM magnetization to generate a voltage spike, much like a biological action potential. We have developed a mathematical differential equation model describing the voltage spike, and a simulation software to integrate such equations to display AFM neuron interconnectivity.

Our computer simulations dynamically model the withdrawal reflex arc [2]. The withdrawal reflex arc is a neural network comprising five parts: sensory neurons, interneurons, motor neurons, the spinal cord, and the brain. All of these were modeled with an AFM neural network. Our results demonstrate two things: firstly, AFM neurons are capable of accurately modeling the functionality of the withdrawal reflex. Secondly, this study develops a platform to perform further studies of neural circuitry.

Dynamic modeling of biological neural circuitry with AFM neurons can propel neurological research toward prospective improvements in treatment for neurodegenerative diseases and ailments of organ systems, ultimately elevating the efficacy and quality of healthcare.

[1] Bradley, Hannah, et al. “Artificial neurons based on antiferromagnetic auto-oscillators as a platform for neuromorphic computing.” AIP Advances 13.1 (2023): 015206.[2] Derderian, Celena, and Prasanna Tadi. “Physiology, withdrawal response.” StatPearls Publishing, 2021.

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