UIC UNIVERSITY OF ILLINOIS AT CHICAGO Department of Electrical and Computer Engineering
COLLEGE OF ENGINEERING

University of Illinois at Chicago, Electrical and Computer Engineering Department

Computational Electromagnetics Enables Personalized Medicine: A Case Study in Transcranial Magnetic Stimulation

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Online seminar available at

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Meeting ID: 752 292 9507
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Host: Prof. Danilo Erricolo, derric1@uic.edu

Abstract

As we enter the era of personalized medicine, electromagnetic and wireless performance has become increasingly important to the control and functionality of implantable devices, imaging modalities, and non-invasive stimulation techniques. I describe a framework for coil design and uncertainty quantification for next-generation transcranial magnetic stimulation (TMS), a noninvasive brain stimulation technique used for research and clinical applications. The framework designs coils that double the precision of spatial targeting (focality) of existing TMS coils. This is the first significant advancement in the depth-focality trade-off of TMS coils since the introduction of the standard figure-of-eight coil three decades ago, and likely represents the fundamental physical limit. Moreover, the framework quantifies uncertainty in TMS induced electric fields due to system setup and patient variability, and it identifies key parameters that affect targeting. Results show that coil position is a key contributor to TMS variability, supporting the need for more precise neuro-navigation devices. Finally, I will present a novel general-purpose electromagnetics solver that can be used for a wide range of applications like TMS, MRI imaging modalities, negative permittivity plasmas, and near-zero/low permittivity metamaterials. This solver uses a novel integral equation formulation that, unlike other solvers, does not exhibit high/negative permittivity and low-frequency breakdowns.

BIOGRAPHY

Luis J. Gomez is a Post-doctoral associate at the Department of Psychiatry & Behavioral Sciences in Duke University Medical School at Durham, NC, USA, where he is developing optimization and computational techniques for use in improving non-invasive brain stimulation procedures. Previously, he was at the Radiation Laboratory, University of Michigan, Ann Arbor, MI, USA, where he developed fast-integral equation methods for analyzing scattering by highly-heterogeneous media and inverse scattering methods. Dr. Gomez was a recipient of the National Science Foundation Graduate Fellowship in 2008, and a National Institutes of Health BRAIN initiative K99/R00 advanced post-doctoral career transition award in 2019.