SEMINAR NOTICE

Preston M. Green Department of Electrical and Systems Engineering

MULTISCALE ELECTROMAGNETIC MODELING OF UTERINE CONTRACTIONS

PhD Preliminary Research Examination

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Abstract: The mechanisms of uterine contractions during pregnancy are still poorly understood, which makes it difficult to predict the onset of labor and thus forecast the preterm deliveries. Preterm birth can cause serious health problems to newborns as well as large financial burden to the society. Currently, there are various techniques, such as electromyography (EMG) and magnetomyography (MMG), for measuring the external electromagnetic activities associated with uterine contractions. There is no widely accepted method, however, to estimate the electrical currents in the uterus, or predict labor based on these measurements.

To address this problem, we develop a multiscale forward electromagnetic model of uterine contractions during pregnancy jointly at the cellular, tissue, and organ levels. We consider the generalized FitzHugh-Nagumo (FHN) equations for modeling both plateau-type and bursting-type transmembrane potentials in each myocyte (uterus' cell). We apply a bidomain approach to model the transmembrane potential propagation across the myometrium, whose anisotropic nature is incorporated by designing a random fiber orientation model. We introduce a realistic four-compartment volume conductor geometry, for which the uterus geometry is modeled based on magnetic resonance images of a pregnant woman. We assume that the abdomen follows the shape of the SQUID Array for Reproductive Assessment (SARA) device when the woman leans against it. We also replicate the true sensor positions and orientations to obtain accurate readings from our model as measured by the SARA device. Numerical examples are presented to demonstrate that our model is able to reproduce the characteristics of transmembrane potentials and is flexible to mimic the limited-propagation magnetic signature during the emergence and decay of a uterine contraction by varying the model configurations. Our next goal will be to solve the inverse problem using our forward model and MMG measurements.

DATE:	Monday, November 7, 2016
TIME:	3:10 p.m.
PLACE:	Green Hall, Room 0120

Thesis advisor:
Dr. Arye Nehorai

This seminar is in partial fulfillment
of the Doctor of Philosophy degree

Washington University in St. Louis
SCHOOL OF ENGINEERING & APPLIED SCIENCE