EE Department Seminars

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Yorgo Istefanopulos Meeting Lounge (KB 217)

Advances in Numerical Electromagnetic Modeling from Antennas to Microscopes

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Abstract
The finite-difference time-domain (FDTD) numerical method has emerged as one of the most popular approaches to solving the basic equations of electromagnetics. The FDTD method is applicable to the numerical modeling of electromagnetic phenomena in an extremely wide range of frequencies; including radio-frequency propagation at the kHz spectrum as well as infrared or visible light at nanometer-scale wavelengths. Continuing advances in computational solution capabilities also bring about a need for more advanced algorithms for non-trivial problem geometries and new theoretical tools for simulating systems that were previously not amenable to numerical modeling. In this talk, we will outline recent advances made along these lines in two distinct avenues of numerical electromagnetic research. First, we will present a summary of auxiliary methods developed for planar layered geometries.

Second, we will describe a set of algorithms, collectively called a "microscope-in-a-computer", that allow the simulation of an optical imaging system in its entirety. We will discuss the application of all of these techniques to the numerical modeling of an optical early-stage-cancer-detection system that is under development in Northwestern University. Finally, we will introduce briefly our FDTD software package ("Angora"), which features all of the advances mentioned in our talk, and will be made available in open source in the near future.

Short Bio:
Ilker R. Capoglu received his B.S. and PhD degrees from the Electrical and Electronics Engineering Department of Middle East Technical University, Ankara, Turkey in 2002, and the School of Electrical and Computer Engineering in Georgia Institute of Technology, Atlanta, GA, USA in 2007, respectively. Since 2007, he has been employed as a postdoctoral research fellow at the Biomedical Engineering Department of Northwestern University, Evanston, IL, USA. In his PhD studies, he developed theoretical and numerical techniques for handling electromagnetic wave propagation in planar layered media. During his postdoctoral appointment, he investigated theoretical and numerical aspects of the electromagnetic modeling of optical imaging systems, with direct applications to an early-stage cancer-detection scheme. He also helped create software tools for modeling the scattering of light from biological media statistically. He is the sole developer of a comprehensive numerical electromagnetics software package ("Angora") that has been funded by the National Institutes of Health (NIH) and will be made available to the public in open source in the near future. His research interests include theoretical electromagnetics, the analysis/development/optimization of numerical solution methods in electromagnetics, electromagnetic waves in multilayered and inhomogeneous media, and rigorous full-wave modeling of optical imaging systems. He has authored 11 peer-reviewed journal publications and two book chapters. He is an associate member of the International Union of Radio Science (URSI) Commission K (Electromagnetics in Biology and Medicine), and a member of the IEEE Antennas and Propagation Society.