THE DEPARTMENT OF ELECTRICAL & COMPUTER ENGINEERING SPEAKER SERIES

PRESENTS

A New Age of Computing: Numerical Methods for Automatically Designing Radio-Frequency and Nanophotonic Devices using Fast Simulation and Inverse Design Techniques

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LECTURE ABSTRACT

Maxwell's equations are responsible for explaining the fundamental operating principles behind much of today's technology. Unfortunately, analytical solutions to Maxwell's equations exist for only the simplest of structures and numerical simulation must be used for modeling most realistic devices such as antennas or waveguiding systems. The complexity of modern electromagnetic devices coupled with the absence of analytical solutions can make designing new devices extremely challenging. This usually results in electromagnetic structures being designed via heuristic-based approaches rather than by "first-principles", which can make the design process extremely tedious and time-consuming and furthermore may lead to suboptimal solutions, especially in scenarios with difficult design parameters or constraints. On the other hand, largely thanks to Moore's Law, computational power has increased tremendously in the last decade—even our cell phones wield more computing power today than the computers on the Apollo missions. In this talk, I will demonstrate how progress in computation coupled with advanced numerical simulation and optimization techniques can lead to algorithms capable of designing new electromagnetic devices from "scratch" given only target performance specifications and design constraints without any human assistance. The efficacy of these techniques will be shown with examples in both the radio-frequency (RF) and optical domains. We will first discuss an inverse-designed 3D-printed coupling antenna for a dielectric waveguide communication link. Next, we will move to higher frequencies, and I will introduce high-order accurate boundary integral equation methods that we have recently been developing for simulation and optimization of nanophotonic devices. I will begin by showing a few two-dimensional examples using an effective-index approximation and will conclude the talk by presenting our most recent work on optimizing 3D nanophotonic devices using a new integral equation-based fully-vectorial Maxwell solver.

SPEAKER BIOSKETCH

Dr. Constantine Sideris is an Assistant Professor of Electrical and Computer Engineering at the University of Southern California. He received the B.S., M.S., and PhD degrees with honors from the California Institute of Technology in 2010, 2011, and 2017 respectively. He was a visiting scholar at UC Berkeley's Wireless Research Center from 2013 to 2014. He was a postdoctoral scholar in the Department of Computing and Mathematical Sciences at Caltech from 2017 to 2018 working on integral equation methods for electromagnetics. His research interests include RF and millimeter-wave integrated circuits for bioelectronics and wireless communications, applied electromagnetics, and computational electromagnetics for antenna design and nanophotonics. He was a recipient of the NSF CAREER award in 2021, the AFOSR YIP award in 2020, and the Caltech Leadership Award in 2017.