IEEE KITCHENER-WATERLOO

IEEE MTT-Chapter Presentation

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"Evolutionary Computational Techniques in Novel Design of Antenna and Microwave Structures"

Abstract:

In optimization and synthesis of antenna and microwave structures for applications in communication and radars one typically deals with objective functions that are highly non-linear and have a large number of optimization parameters. In addition for many electromagnetic problems, the objective functions manifest epistatic behavior due to strong mutual coupling and other propagation effects, requiring a simultaneous optimization of the design parameters. Also, most complex electromagnetic systems have to be numerically modeled, resulting in objective functions that have no readily available derivatives. For such problems the evolutionary computational techniques can yield robust globally optimized solutions that otherwise are not possible by using traditional gradient-based local-search optimization methods. These probabilistic techniques, collectively known as Evolutionary Algorithms (EAs), try to emulate, in one way or the other, the Darwinian model of natural evolution on a computer. One can in general identify three main branches of EAs in the literature: Evolutionary Programming (EP), Evolution Strategies (ES) and Genetic Algorithms (GAs). All these algorithms are multi-agent stochastic search methods that incorporate random variation and selection. Of the three paradigms of EAs, GAs have been widely used and are well known to the electromagnetics community, whereas the application of EP in electromagnetics appeared more recently.

In this talk, we present details of various EP algorithms using Gaussian, Cauchy, Poisson, and hybrid of these mutation operators for continuous, discrete or mixed parameter optimization problems. We then present the implementation of these algorithms to constrained design of various antenna and microwave structures in microwave and millimeter-wave frequency regions. Examples include syntheses of multi-layered printed antennas, phased arrays, corrugated horn antennas, frequency selective surfaces, polarization rotation plates and dielectric filters. If time permits, a new hybrid EP-GA algorithm, which speeds up the optimization of certain electromagnetic problems, will also be presented

Biography:

Ahmad Hoorfar received his B.S.E.E. from the University of Tehran and M.S. and Ph.D. degrees in electrical engineering from the University of Colorado at Boulder in 1978 and 1984, respectively. During 1982-1984 he worked as a senior R&D engineer/project manager at Signalink Corporation, a start-up company in the area of direct broadcast satellite systems. From 1984-1986 he was a post-doctoral research associate in the Electromagnetics Laboratory at the University of Colorado. In 1986 he became a research faculty in the NSF Research Center for Microwave/Millimeter-waves Computer-Aided Design (MIMICAD) in Boulder. Since 1988 he has been with Villanova University where he is now a professor of electrical engineering, director of the Villanova's Antenna Research Laboratory, and program director of the ECE department's graduate admission and advising. He was the chair of the Antennas and Propagation/Microwave Theory and Techniques (AP/MTT) Chapter of the IEEE Philadelphia Section from 1993-1996 and was the recipient of the '1995 Chapter of the Year Award' for his leadership in chairing the AP/MTT joint Chapter Dr. Hoorfar's present research interests include electromagnetic field theory, low profile and multifunction antennas, meta-materials, numerical modeling and evolutionary computational techniques. He has published over 100 journal and conference papers in these areas.

DATE: Monday May 10, 2004

TIME: 5:00 pm

LOCATION: DC 1302, University of Waterloo Davis Centre

Invited by Prof. Safavi Naeini

Electrical & Computer Engineering Department