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Combining Computational Electromagnetics with Signal Processing Algorithms to Enhance the Performance of Imaging Devices and Antennas

by

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Abstract

Computational Electromagnetics (CEM) has made great strides over the years and has enabled us to solve very large and complex problems that were well beyond our reach only a few year ago. This has been made possible because of steady increases in computing speeds--thanks to Moor's Law--and the advent of parallelization as well as development of iterative and domain decomposition techniques. The quest as well as progress toward the solution of very large and complex problems remain unabated--CEM problems involving "billions and billions" of unknowns are being routinely solved today--and this trend is likely to continue for a long time to come.

The focus of this presentation is not on proposing yet another algorithm which would help us solve even larger problems than we can handle today, but on discussing alternate ways by which we can enhance the performance of microwave devices--such as imaging systems and lenses--by combining signal processing algorithms with CEM.

The paper will discuss several examples of performance enhancement including sub-wavelength imaging of objects that are not located in the near fields of lenses, and improving the accuracy of direction finding antenna systems with size constraints that limit their limitation if conventional DF techniques are used. Our strategy is to first use available CEM techniques to solve the forward problems efficiently and then to use these solutions in Signal Processing algorithms for the purpose of performance enhancement of microwave devices of the type mentioned above.

Biography

Raj Mittra is a Professor in the Electrical Engineering department of the Pennsylvania State University, where he is the Director of the Electromagnetic Communication Laboratory. Prior to joining Penn State he was a Professor in the Electrical and Computer Engineering at the University of Illinois in Urbana Champaign from 1957 through 1996, when he moved to his present position at the Penn State University. Currently, he is also a Professor at the University of Central Florida in Orlando, FL.

He is a Life Fellow of the IEEE, a Past-President of AP-S, and he has served as the Editor of the Transactions of the Antennas and Propagation Society. He won the Guggenheim Fellowship Award in 1965, the IEEE Centennial Medal in 1984, and the IEEE Millennium medal in 2000. Other honors include the IEEE/AP-S Distinguished Achievement Award in 2002, the Chen-To Tai Education Award in 2004 and the IEEE Electromagnetics Award in 2006, and the IEEE James H. Mulligan Award in 2011.

He has been a Visiting Professor at Oxford University, Oxford, England and at the Technical University of Denmark, Lyngby, Denmark. Until recently, he served as the North America editor of the Journal AEU. He was recently appointed a Distinguished Professor (Adjunct) at the Yun Tze University in Taiwan, and also at the Harbin Engineering University in Harbin, PRC.

Dr. Mittra specializes in the design of electromagnetic systems such as radars, satellite antennas, communication systems, microwave and millimeter wave integrated circuits and instruments for remote sensing and geophysical prospecting. His role in the design of these systems is primarily in the development of special-purpose computer programs and algorithms that are capable of solving problems that are well beyond the reach of commercially available computer codes. The Electromagnetic Communication laboratory, of which Dr. Mittra is the Director, is engaged in a number of different areas of research under the general umbrella of Electromagnetics and Communication.

He has published over 1000 technical papers and more than 30 books or book chapters on various topics related to Electromagnetics, Antennas, Microwaves and Electronic Packaging. He is one of the top highly-cited researchers in Electromagnetics, as evidenced by the Citation index compiled by Thomson Scientific, Google and others.

He has advised more than 110 Ph.D. and an equal number of M.S. thesis students over the years, and has mentored more than 60 postdocs. He also has three patents on Communication Antennas to his credit. For the last 15 years he has directed, as well as lectured in, numerous short-course on Computational Electromagnetics, Electronic packaging, Wireless Antennas, RFID, Metamaterials, etc., both nationally and internationally. He has also served on a number of government panels on antenna designs and evaluation of Computational Electromagnetics codes. Further information may be found at the website:
http://www.personal.psu.edu/rxm53/.

Dr. Mittra is a Principal Scientist and President of RM Associates, a consulting company founded in 1980, which provides services to industrial and governmental organizations, both in the U.S. and abroad.