Special issue dedicated to the 75$^{\text{th}}$ birthday of Raj MITTRA

From Engineering Electromagnetics Towards Electromagnetic Engineering: *Issues, Challenges, and Applications*

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1. Introduction

Nowadays, electromagnetics (EM) is everywhere! Although the contents of the two basic EM lectures – Field Theory and Wave Theory – have stayed almost unchanged for the last couple of decades we have witnessed the transformation from engineering EM to EM engineering for some time. Therefore, addressing technical challenges posed by electrical, electronics, communication, and computer system complexities requires a broad range of innovative, multi-disciplinary analytical and computational skills that are not adequately covered in conventional EM engineering curricula. EM engineering community, therefore, must be prepared to adapt to frequent shifts in technological priorities and rapid scientific advances, followed by rapid advances in technologies. Universities and educational institutions have been actively engaged in efforts to design curricula for teaching the necessary skills to a computer-weaned generation of students, with access to the internet and consequent globalization of information. Physics-based modeling, observation-based parameterization, and computer-based simulations are the key issues of these challenges. The reader may find some details of these discussions in [1-5].

Triggered by these facts and after a brief discussion with Kemal Leblebicioğlu, editor-in-chief of ELEKTRIK, we decided to bring these issues forward in ELEKTRIK Journal. I decided to take over the guest editorial of this special issue and chose the motto "*From engineering EM towards EM engineering*" as the title. The motto belongs to my close friend, colleague Prof. Dr. Anton Tijhuis from University of Eindhoven, The Netherlands, but I liked it very much since nothing else can better reflect the transformation in electromagnetics.

This special issue is dedicated to the 75^{th} birthday of Raj Mittra for his pioneering work in, and outstanding contributions to the international electromagnetic community. Its focus is complex electromagnetic problems and novel approaches in the context of EM engineering. With this special issue, I aimed to honor a well-known scientist, bring international experts together in a Turkish journal and elevate its prestige, and, finally emphasize the transformation from engineering EM towards EM engineering.

Dr. Raj Mittra

Raj Mittra is Professor in the Electrical Engineering department of the Pennsylvania State University. He is also the Director of the Electromagnetic Communication Laboratory, which is affiliated with the Communication and Space Sciences Laboratory of the EE Department. Prior to joining Penn State he was a Professor in Electrical and Computer Engineering at the University of Illinois in Urbana Champaign. 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, the IEEE Millennium medal in 2000, the IEEE/AP-S Distinguished Achievement Award in 2002, the AP-S Chen-To Tai Distinguished Educator Award in 2004 and the IEEE Electromagnetics Award in 2006. He has been a Visiting Professor at Oxford University, Oxford, England and at the Technical University of Denmark, Lyngby, Denmark. He has also served as the North American editor of the journal AEÜ.

His professional interests include the areas of Communication Antenna Design, RF circuits, computational electromagnetics, electromagnetic modeling and simulation of electronic packages, EMC analysis, radar scattering, frequency selective surfaces, microwave and millimeter wave integrated circuits, and satellite antennas.

He has published over 900 journal and symposium papers and more than 40 books or book chapters on various topics related to electromagnetics, antennas, microwaves and electronic packaging. He also has three patents on communication antennas to his credit. He has supervised nearly 90 Ph.D. theses, 90 M.S. theses, and has mentored more than 50 postdocs and Visiting scholars. He has directed, as well as lectured in, numerous short courses on Computational Electromagnetics, Electronic Packaging, Wireless antennas and Metamaterials, both nationally and internationally.

Dr. Mittra has had long and strong collaboration with the Turkish EM Society. He has had many visits to Turkey, especially to Istanbul and Ankara and has given many interesting seminars, lectures and short courses. The last visit, as far as I remember was in September 2006 to Gebze for EWS 2006 ***IVth International Workshop on Electromagnetic Wave Scattering***. It was then when I invited him to be the honorary guest of this special issue. He has many Turkish students, post docs and scientific visitors. Among the others I should mention Prof. Dr. Mustafa Kuzuoğlu and Dr. Özlem Özgün from Middle East Technical University, Prof. Dr. İrşadi Aksun from Koç University, Assoc. Prof. Dr. Funda Akleman from Istanbul Technical University, and Assist. Prof. Dr. Gölge Öğücü from Gaziantep University.

2. Papers in This Issue

The first paper belongs to Mustafa Kuzuoğlu from Middle East Technical University (Ankara/Turkey), a long lasting friend and collaborator of Dr. Mittra. Dr. Kuzuoğlu, in his paper entitled "My Collaboration with Raj Mittra: Contributions to the Theory of Perfectly Matched Layers" summarizes his collaboration with Dr. Mittra during the last decade or so. Dr. Kuzuoğlu met Dr. Mittra back in 1995 when he visited University of Illinois with a one-year NATO research grant. Since then, they have had a mutually

beneficial, productive, highly emotional collaboration and friendship. Dr. Kuzuoğlu concludes by saying how proud/honored he feels by the opportunity of working and knowing Dr. Mittra.

Anton G. Tijhuis, Martijn C. Van Beurden, Bastiaan P. de Hon and Hubregt J. Visser from Faculty of Electrical Engineering, Eindhoven University of Technology (the Netherlands) propose a two-stage approach for using computational electromagnetics in antenna engineering in their paper entitled "From Engineering Electromagnetics to Electromagnetic Engineering: Using Computational Electromagnetics for Synthesis Problems". They first use stochastic optimization techniques in combination with approximate models, and then combine line-search techniques with full-wave modeling. Although the paper reports a work in progress there is an interesting, illustrative example.

In the paper entitled "A Summary of Recent Developments on Metamaterial-based and Metamaterial-inspired Efficient Electrically Small Antennas", Aycan Erentok from Technical University of Denmark, and Richard W. Ziolkowski from University of Arizona (USA) summarize their recent research efforts to realize efficient electrically small antenna (EESA) systems based on ideal analytical and numerical metamaterial-based antenna systems, and physically realized metamaterial-inspired antenna designs. They also present measurement results to confirm their numerical performance predictions. Their theoretical and numerical studies on the radiation and resonance behaviors of the proposed metamaterial-based EESA systems, as well as efforts to conceptualize structures which might be used to build them have led to the discovery of several realizable metamaterial-inspired EESA systems.

Atacan Yağbasan, Celal Alp Tunç, Vakur B. Ertürk, and Ayhan Altıntaş from Bilkent University (Ankara/Turkey) and Raj Mittra from Pennsylvania State University (USA) present an integral equation (IE) based solution procedure for the rigorous analysis of scattering from terrain profiles in their paper "Use of Characteristic Basis Function Method for Scattering from Terrain Profiles". The procedure uses characteristic basis function method (CBFM), which is hybridized with the forward-backward method (FBM), to reduce the storage requirements of the resultant Method of Moments (MoM) impedance matrix as well as to accelerate the solution procedure. They also supply numerical results in the form of induced current and scattered field are presented to assess the accuracy and efficiency of the solution procedure.

The paper "The Characteristic Basis Function Method (CBFM): a numerically efficient strategy for solving large electromagnetic scattering problems" by Eugenio Lucente, Gianluigi Tiberi, Agostino Monorchio, and Giuliano Manara from University of Pisa (Italy) and Raj Mittra from Pennsylvania State University (USA) describe a numerically efficient strategy for solving large electromagnetic scattering problems. The authors term their novel approach as the Characteristic Basis Function Method (CBFM). The CBFM is based on utilizing Characteristic Basic Functions that include a relatively large number of conventional subdomains discretized by using triangular or rectangular patches. These Characteristic Basic Functions can be derived either analytically or numerically (i.e., from PO or MoM solutions). They demonstrate the accuracy and time efficiency of the CBFM for several representative scattering problems via some numerical tests.

Perfectly Matched Layers (PML) are the most effective absorbing boundary terminations in Finite-Difference Time-Domain (FDTD) and Finite-Element-Method (FEM) applications. In their paper entitled "Recent Advances in Perfectly Matched Layers in Finite Element Applications", Ozlem Ozgun and Mustafa Kuzuoglu from Middle East Technical University (Ankara/Turkey) present a comparative evaluation of two novel and practical PML implementations to the problem of mesh truncation in the finite element method (FEM) with the features of simplicity and flexibility. After overviewing the theoretical bases of these methods, they present a few numerical results in the context of two- and three-dimensional electromagnetic radiation/scattering problems.

Erdem Ofli from Schmid & Partner Engineering AG (SPEAG) (Switzerland), and Chung-Huan Li, Nicolas Chavannes, Niels Kuster from IT'IS Foundation, ETH Zurich (Switzerland) present an interesting paper entitled "Analysis and Optimization of Mobile Phone Antenna Radiation Performance in the Presence of Head and Hand Phantoms" in which they discuss mobile phone - human interaction to enlighten society on the issue of public concern related to possible adverse health effects of mobile phones. They show that numerical methods and enhanced FDTD tools are suitable techniques for supporting engineers in the analysis, design and optimization of transmitters in real-world usage conditions by using a commercial clam shell phone CAD model to numerically investigate the effect of a hand phantom on mobile phone antenna radiation performance. Their simulation results show that the grip of the hand phantom is the most important parameter regarding to antenna performance. They also perform optimization using Genetic Algorithms enhanced parameterization and hardware accelerated FDTD.

The paper entitled "Dual-Band Split-Ring Antenna Designs for GSM/WLAN Applications" is prepared by S. Cumhur Başaran from Akdeniz University (Antalya/Turkey) and Yunus E. Erdemli from Kocaeli University (Turkey). They propose novel split-ring antennas (SRAs) for WLAN (2.4/5.2 GHz) and GSM (900/1800MHz) applications which provide about 2% impedance-bandwidth without a need for additional matching networks. They use the finite-element method based full-wave simulators for the analysis and design of the proposed microstrip antennas.

Funda Akleman from İstanbul Technical University (Turkey), and Levent Sevgi from Doğuş University (İstanbul/Turkey) discuss rectangular and cylindrical representations of finite-difference time-domain (FDTD) method over characteristic tests and comparisons in their paper entitled "Comparison of Rectangular and Cylindrical FDTD representations on a Ring Resonator Problem". They use both rectangular- and cylindrical-FDTD models of a ring resonator which they choose as a canonical structure. They calibrate their models and codes against analytical exact solution derived in terms of cylindrical Bessel functions. They also show that rectangular-FDTD with periodic boundary condition, where the computation domain is reduced, can also be applied in modeling circular structures.

Acknowledgment

I express my deep gratitude to Prof. Raj Mittra for accepting my invitation and being the honorary guest of the special issue. I would like to thank specifically to Prof. Mustafa Kuzuoğlu, who is a close collaborator and sincere friend of Dr. Mittra, for his efforts and contributions. I would also like to thank all contributing authors, the reviewers, and especially Prof. Kemal Leblebicioglu, editor-in-chief of ELEKTRIK who extended his kind invitation. Last, but by no means least, I express my appreciation to Mr. Adnan Bahadır, acting head of the Publication Department of Scientific Journals of TUBITAK, Miss Gülnihal Ergen, journal administrator, and Mr. Dale Allen Ross, English editor, for their efforts during the preparation of the Issue for publication.

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Engineering Electromagnetic Fields Stuart M. Wentworth.Â Engineering Electromagnetic Fields Stuart M. Wentworth. Original Title. Fundamentals of Electromagnetics with Engineering Applications. Copyright. Â© Â© All Rights Reserved. Available Formats. PDF or read online from Scribd. Share this document. Share or Embed Document. From engineering electromagnetics towards electromagnetic engineering: Issues, chalanges, and applications - Preface. January 2008. Turkish Journal of Electrical Engineering and Computer Sciences 16(1):I-V. Authors: Levent Sevgi.Â A conventional electromagnetic engineer is concerned with a range of product specific issues, whereas EMC engineers are concerned with all possible external electromagnetic influences on the environment. Issues related to EMC- BEM engineering has been addressed on various platforms by experts for the last couple of years [1][2][3][4][5][6][7][8][9][10] [11][12][13][14]. Chapter 1: Introduction to Electromagnetics and Electromagnetic Fields. 1.1 Review of foundations. 1.1.1 Introduction.Â Electrical engineering has delivered four â€œmiraclesâ€ â€” sets of phenomena that could each be considered true magic prior to their development. The first of these to impress humanity was the electrical phenomenon of lightning, often believed to be a tool of heaven, and the less powerful magnetic force that caused lodestones to point north.Â This text neglects relativistic issues introduced when mass approaches the velocity of light or is converted to or from energy, and therefore we have conservation of mass: the total mass m within a closed envelope remains constant.