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[Plenary Talk]
From Green and Sommerfeld to Takahasi and Mori: recent developments in Computational Electromagnetics

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Abstract

Since their introduction in the seventies, microstrip antennas have become one of the most popular and successful type of antenna. Nowadays, the original printed microstrip patch antenna has evolved into a very general class of planar antennas, used in frequencies from 100 MHz to 100 GHz, where thin metallizations (patches, ground planes, slots) occupy the interfaces of a multilayered dielectric substrate, with eventual metallic probes and/or via-holes possibly connecting the different interfaces.

The most successful computational model for these antennas is provided by an integral equation formulation, where the associated Green's functions are originally expressed as Sommerfeld integrals (SIs). Currently, some of the most popular commercial Computational ElectroMagnetics software codes are directly based on this strategy. Hence, the robust and accurate evaluation of Sommerfeld integrals is of paramount relevance, since any improvement in their calculation will directly result in faster and more accurate software tools.

This paper reviews two of the most successful algorithms that have recently been applied to the numerical evaluation of these Sommerfeld integrals: the Weighted Averages (WA) algorithm and the Double Exponential (DE) quadrature. Although their use by the Antennas&Propagation community is quite recent, both algorithms are solidly rooted on well established numerical mathematics. Weighted Averages can be considered as an adaptation of the classic Euler transformation, while the Double Exponential quadrature was introduced in 1974 by two Japanese mathematicians, Takahasi and Mori.

Together, WA and DE combine to provide a numerical evaluation of Sommerfeld integrals of unprecedented quality. This paper will provide a historical perspective of both algorithms together with numerical results showing their practical interest, which clearly go far beyond the Sommerfeld integrals' realm.

About the speaker

Juan R. Mosig was born in Cadiz, Spain. He received the Electrical Engineer degree from the Universidad Politecnica de Madrid, Madrid, Spain, in 1973, and the Ph.D. degree from the Ecole Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland, in 1983. Since 1991, he has been a Professor in the Laboratory of Electromagnetics and Acoustics (LEMA) at EPFL and its Director since 2000. He has held scientific appointments with the Rochester Institute of Technology, Rochester, NY, USA; the Syracuse University, Syracuse, NY, USA; the University of Colorado at Boulder, USA; University of Rennes, Rennes, France; University of Nice, Nice, France, the Technical University of Denmark, Lyngby, Danemark.

Dr. Mosig has been a member of the Swiss Federal Commission for Space Applications, the Chairman of the EPFL Space Center, the Director of the Electrical Engineering Section at EPFL and a Vice-Dean of the Humanities and Social Sciences College at EPFL.

He has authored four chapters in books on microstrip antennas and circuits and over 150 reviewed papers. His research interests include electromagnetic theory, numerical methods, and planar antennas.

Dr. Mosig is a Fellow of IEEE (1999). He has been the Swiss Delegate for European COST Antenna Actions since the 1980's and the Chair for the two last Actions 284 and IC0603 ASSIST (2003–2011).

During 2004-7 he was Vice-Coordinator of the European FP6 Network of Excellence ACE, that enabled the EuCAP Conference series. He has also served as member of the Board in the Coordination Actions ARTIC (FP6) and CARE (FP7) and as Transnational Delegate in the IEEE APS AdCom. Currently, he is also Associate Editor of the IEEE AP Magazine.

He is a founding member and Chair of the European Association on Antennas and Propagation (EurAAP) and he also chairs the EuCAP Conference series and its Steering Committee.