Early Development of Computational Electromagnetics-A Perspective

ECE Distinguished Lecture

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Abstract It may be said that computational electromagnetics (CEM) began in earnest around the mid-1960s, spurred by the simultaneous emergence of available mainframe computers and the increasing need for antenna modeling capabilities to support such diverse sectors as rural TV reception, commercial and space communications, and defense. Harrington's seminal method of moments (MoM) works appeared in the late 1960s, and not only unified the various problem discretization approaches, but also solidified surface integral equations as the formulation-of-choice for the numerical solution of problems in unbounded homogeneous media. Yet to be developed, however, was a fundamental understanding of best modeling practices, capabilities, and limitations. Some solutions for scattering by perfect electric conducting (PEC) 3-D Bodies of Revolution had been obtained in the mid-1960s by reducing them to the solution of a series of independent 1-D problems. But for most researchers in the early 1970s, computer speeds and memory continued to limit gaining the needed experience and knowledge to solving and detailed study of simple 1-D, perfect electric conductor (PEC) geometries such as wires and infinite cylinders. By the late 70s, however, several studies on modeling scattering by rectangular plates (and the mathematically dual problem of penetration of rectangular apertures in infinite ground planes) had appeared in the literature. These problems convincingly demonstrated the necessity of using an offset grid to accurately model surface charges and orthogonal surface current components. Notably, similar offset charge, current, and field component arrangements are also suggested by projecting the Yee lattice (revived by Taflove in 1975 for use in his FDTD approach) onto a rectangular plate or aperture. In the late 70's, our research group embarked on an ambitious program to develop methods for solving integral equations on a triangular surface mesh because of its geometrical flexibility, well known to the finite element method (FEM) community in modeling mechanical and acoustical problems. Many of those application areas originally dealt only with scalar field quantities, however—problems that shed little light on how to represent surface vector field quantities. The development of the so-called RWG bases for representing surface currents on triangular meshes was finally achieved, however, by carefully considering and extending equivalent concepts from rectangular to triangular meshes. Though the approach was initially developed and applied to the electric field integral equation (EFIE), the approach could also be used for the MFIE, its magnetic field counterpart. Subsequent work also extended or generalized the approach to the CFIE, to dielectrics, and even to time domain problems. Later studies treated low frequency breakdown, dual meshes, volume integral equations, and higher order modeling of geometries and surface current representations.

Bio Donald R. Wilton received the B.S., M.S., and Ph.D. degrees in Electrical Engineering from the University of Illinois, Urbana-Champaign, in 1964, 1966, and 1970, respectively. From 1965 to 1968 he was with Hughes Aircraft Co., Fullerton, CA, engaged in the analysis and design of phased array antennas. From 1969 to 1970, he pursued the Ph.D. under a Hughes Doctoral Fellowship. From 1970–1983 he was with the Department of Electrical Engineering, University of Mississippi, and was a Visiting Professor at Syracuse University during the academic year 1978–1979. He was with the University of Houston from 1983 until 2012, retiring as Professor Emeritus in the Department of Electrical and Computer Engineering. During the 2004-2005 academic year he was a visiting professor at the Polytechnic of Turin, Italy, Sandia National Laboratories, and the University of Washington. His primary research area is computational electromagnetics, and he has published, lectured, and consulted extensively in this area.

Dr. Wilton is a member of the National Academy of Engineering, a Life Fellow of the IEEE, and received the IEEE Third Millennium Medal. He has served the IEEE Antennas and Propagation Society as an Associate Editor of the Transactions on Antennas and Propagation, as a Distinguished National Lecturer, and as a member of its Administrative Committee. Dr. Wilton is also a member of Commissions B and E of the International Radio Science Union (URSI), and has held several offices in Commission B, including Commission Chair. Dr. Wilton received the Applied Computational Electromagnetics Society (ACES) inaugural Computational Electromagnetic Award in 2013, the IEEE Antenna and Propagation Society's inaugural Harrington-Mittra Award in Computational Electromagnetics in 2014, and the 2015 IEEE Electromagnetics Award.

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