A Practitioner's View of Time Domain Integral Equations for Electromagnetics

Daniel S. Weile
Department of Electrical and Computer Engineering
University of Delaware

For nearly five decades, great strides have been made in the solution of Maxwell's Equations on digital computers. Methods based directly on the solution of differential equations have been popular in both the time and frequency domains, and frequency domain integral equation methods have been successfully applied to the design of antennas, the modeling of radar cross section, and the analysis of metamaterials.

Despite this track record, the solution of time domain integral equations using the time domain boundary element method (TDBEM) has been fraught with difficulty. Early implementations would become numerically unstable unpredictably, and even when they did work they were notoriously slow and inaccurate. Recent research has illuminated the causes of the instability, and given rise to accurate and efficient TDBEM solvers for the first time. In retrospect, the primary cause of TDBEM instability appears to be inaccurate integration in matrix kernel computation.

In this presentation, we will cover modern methods of TDBEM implementation that eschew instability. In particular, methods that solve the matrix kernel integration problem by sidestepping explicit shadow region boundary computations will be emphasized. A history of the topic and areas for further study will also be discussed.