Analysis of Transient Scattering from Multiregion Bodies Using the Plane Wave Time Domain Algorithm

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Integral equation based methods for time domain scattering analysis are computationally intensive with a cost scaling of $\mathcal{O}(N_t N_s^2)$, where N_s represents the number of surface unknowns modeling the current on the body, and N_t denotes the number of time steps in the analysis. The PWTD algorithm considerably alleviates this cost, and has been used in accelerating the analysis of scattering and radiation from perfect electrically conducting (B. Shanker, A. A. Ergin and E. Michielssen, *Proceedings of IEEE Antennas and Propagation Society International Symposium*, **2**, 1342-1345, 1999) and penetrable bodies (B. Shanker, A. A. Ergin, and E. Michielssen, *J. Opt. Soc. Am. A*, **19**, 716-726, 2003).

In this paper, a novel time domain integral equation technique for analyzing transient scattering from arbitrarily shaped bodies that comprise of different regions will be presented. These regions could be conducting or penetrable. In each region, the time domain Stratton-Chu integral equations are reduced to a set of matrix equations by (i) expanding currents in space and time in terms of Rao-Wilton-Glisson and approximate prolate spheroidal basis functions, respectively, and (ii) by Galerkin testing in space and point matching in time. Our earlier efforts in analyzing this problem suffered from two deficiencies: (i) Despite being implicit, the procedure was unstable for several geometries, (ii) when it was stable, it often was inaccurate as the degree of implicitness increased. Recent work has shown that use of bandlimited functions for representing temporal variation considerably alleviates this problem when analyzing scattering from PEC objects (D. S. Weile, N. W. Chen, B. Shanker and E. Michielssen, *Proceedings of IEEE Antennas and Propagation Society International Symposium*, 162-165, 2002). This paper extends the proposed scheme to multiply connected domains. Boundary conditions between regions are enforced using the algorithm proposed by Medgyesi-Mitschang *et. al.* (L. N. Medgyesi-Mitschang, J. M. Putnam, and M. B. Gedera, *J. Opt. Soc. Am. A*, **11**, 1383-1398, 1994). The set of equations thus obtained is solved using a MOT scheme that is augmented with the PWTD algorithm. To implement the latter, multiple trees and interaction lists are necessary (one for each region) as the wave speed is different in each domain. The proposed technique has been applied to the analysis of scattering from electrically large bodies. Details of the method and numerical results that demonstrate its efficiency will be presented.