The Method of Auxiliary Sources (MAS) for Three Dimensional Time Domain Scattering Analysis

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In recent years, Time Domain Integral Equation (TDIE) method for scattering analysis has received much attention and is believed to be in a mature stage, although a few problems concerning stability and accuracy still remain. The most widely used scheme is to discretize the scatterer with triangular patches and perform Marching-On-in-Time (MOT) with RWG basis function in space and linear interpolation in time. In this scheme, basis functions for space and time are decoupled to avoid time-consuming space-time integrations and the retarded time is accounted for only approximately. There are papers dealing with aforementioned problems but their approaches sacrifice computational complexities.

The Method of Auxiliary Sources (MAS) (D. I. Kaklamani and H. T. Anastassiu, "Aspects of the Method of Auxiliary Sources (MAS) in Computational Electromagnetics," *IEEE Antennas and Propagation Magazine*, vol. 44, no. 3, pp. 48-64, Jun. 2002) is a variation of the standard Surface Integral Equation (SIE) technique and has been used successfully for frequency domain analysis. Unlike the SIE technique, where equivalent distributed sources are situated at the scatterer surface, discrete impulsive sources (auxiliary sources) located inside the scatterer are adopted for MAS in PEC scattering analysis. These discrete impulsive sources simulate the fields outside the scatterer accurately once the solution is obtained. Because of these sources, all the source integrals in SIE can be replaced by summations in MAS. Therefore MAS is computationally very efficient and simple to implement. But, there has been little effort to apply MAS in time domain. As far as we know, only two dimensional problem has been investigated (G. G. Bit-Babik et. al., "The Method of Auxiliary Sources for Investigation of Pulse Scattering in Time Domain", *DIPED-98 Proceedings*, pp. 11-14, 2-5 Nov. 1998).

In this paper, MAS for three dimensional time domain scattering analysis is presented for the first time. MAS in time domain inherits all the advantages of MAS in frequency domain. Moreover, due to the use of spatially impulsive sources, decoupling of the basis functions for space and time is already done and the retarded time is accounted for exactly. Because various kinds of numerical error affect the stability and accuracy of the time domain solution, this feature is very important which means removal of one source of numerical error. In other words, solutions from MAS in time domain can be more accurate and stable than those from the standard SIE technique in time domain.

We used implicit scheme for time marching and linear interpolation in time. And to handle the interior resonance problem, we adopted combined source solution, since combined field integral equation technique is not directly applicable to MAS formulation.

Details of the method and the results will be discussed.