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Half- and Quarter-Sweeps Implementation of Finite-Difference Time-Domain Method

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ABSTRACT

The propagation, diffraction, scattering, penetration and interaction phenomena of electromagnetic waves are governed by the well known Maxwell's equations. The applications of Maxwell's equations can be found in many disciplines in science and engineering particularly in antenna design and analysis. Finite Difference Time Domain (FDTD) is a popular numerical simulation technique for solving problems related to Maxwell's equations. Recently, there is other formulation that can potentially be used to solve Maxwell's equations in source free region.. The new formulation, namely the scalar Wave-Equation Finite-Difference Time-Domain (WE-FDTD), is numerically and mathematically equivalent to the conventional FDTD. Unlike the conventional FDTD, the scalar WE-FDTD allows computing any single field component without the necessity of computing other field components. Therefore, significant savings in the computational time and memory storage can be achieved. In this paper, we presented the explicit formulation of the scalar WE-FDTD for free space wave propagation on one dimensional model problem using full-sweep, half-sweep and quarter-sweep approaches which successfully implemented for solving elliptic problems. We analyzed and compared the performance of the scalar WE-FDTD with all approaches to the conventional FDTD method in terms of the computational accuracy and simulation time. The results found that the proposed formulation significantly reduced the computational time of the method but posed less accuracy as compared to the conventional FDTD method.

Keywords: Maxwell's equation, Finite Difference Time Domain (FDTD), scalar wave-equation.