

A Novel Implementation of Mur's Absorbing Boundary Condition in Finite-Difference Time Domain Technique

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Abstract: In this work, a novel implementation of Mur's second order absorbing boundary condition for the split-field method in the finite-difference time-domain (FDTD) method is presented. In many electromagnetic problems, one needs to obtain the response from a system in an "open" environment, or in other words a structure that is situated in free space, such as a scatterer or radiator. However, due to the limitations of the computational resources, the computational domain in FDTD must be limited in size and suitable absorbing boundary conditions (ABC) on the outer perimeter of the domain must be applied to numerically approximate the effects of an unbounded space. Mur's second order ABC and its further extension played an important role in the FDTD technique before the Perfectly Matched Layer (PML) ABC was introduced. In many applications, when the PML ABC is not easy and convenient to construct or fast design is needed, Mur's second order ABC is a good alternative approach. When modeling periodic structures, such as frequency selective surfaces (FSS), electromagnetic band gap (EBG) structures, or antenna arrays, Maxwell's equations are needed to be transformed, modified, and discretized by using split fields. Due to the modified Maxwell's equations, the usual Mur's ABC procedures cannot be directly applied to simulate unbounded domain. A novel way to implement Mur's second order ABC is needed in this case. In many electromagnetic applications, which require a parametric optimization, Mur's ABC could be efficient and sufficient for quicker design. If more accurate results are needed, PML ABC can be used with final parameters obtained from the Mur solution. Based on our studies of Mur's first order, Mur's second order, and PML ABC, we found that the PML ABC needs more than 50% computational resource and more than 2 times of the computational time for the same problem than the other ABCs.