Application of PML absorbing boundaries in the SPR method

Pedro Pinho
Instituto Superior de Engenharia de Lisboa, Portugal
E-mail: ppinho@deetc.isel.ipl.pt

Paulo J. S. G. Ferreira , José Rocha Pereira
Universidade de Aveiro, Portugal
E-mail: pjf@ieeta.pt, jrp@det.ua.pt

Sônia M. Gomes, Andrielber S. Oliveira, Anamaria Gomide
Universidade Estadual de Campinas, SP, Brazil
E-mail: soniag@ime.unicamp.br, andriel@ime.unicamp.br anamaria@ic.unicamp.br

Margarete O. Domingues
Instituto Nacional de Pesquisas Espaciais, São José dos Campos, SP, Brazil
E-mail: mo.domingues@lac.impe.br

ABSTRACT

The Finite-Difference Time-Domain (FDTD) method has been widely employed for the analysis and modelling of several structures and in the study of indoor and outdoor electromagnetic wave propagation [1]. However, its main advantages namely, simplicity and versatility, are obtained at the expense of significant computational resources. In particular, the simulation of realistic geometries may require a large simulation time. Recently, several variants have been proposed to improve the performance of Yee's original FDTD method. In this direction, we consider the Sparse Point Representation (SPR) method for the discretization of Maxwell's equations, which is a high order finite difference scheme combined with an interpolating wavelet adaptive strategy. The wavelet coefficients, defined in terms of local interpolation errors, can be regarded as indicators of the local smoothness of the fields. A thresholding procedure leads to grids that are sparse and non-uniformly spread: coarser in smooth regions and finer close to irregularities. This scheme provides a dynamically adapted grid with improved resolution in comparison to conventional time-domain schemes [2].

In previous simulations, we have used the SPR method to study the propagation of electromagnetic waves in homogeneous media. The main purpose of the present paper is to describe new developments concerning the inclusion of absorbing boundary conditions of Berenger perfectly matched layer (PML) type [1]. Illustrative numerical simulations of TE mode electromagnetic waves show that the solutions produced by the updated adaptive code and by the finite difference scheme in an uniform grid are in good agreement. The adaptive grid in the presence of the PML medium produces perturbations that are proportional to the threshold parameter.

References

[1] A. Taflove and S. C. Hagness, *Computational Electrodynamics: The Finite-Difference Time-Domain Method*, Norwood, MA, 2005.

[2] P. Pinho, M. O. Domingues, P. J. S. G. Ferreira, S. M. Gomes, A. Gomide and J. R. Pereira, *Interpolating wavelets and adaptive finite difference schemes for solving Maxwell's equations: the effects of gridding.* IEEE Transactions in Magnetics 43(3), pp. 1013-1022, Mar. 2007.