Nonstandard FDTD Realization of Radiation Behaviour of Epsilon Negative Metamaterial Corner Reflector Antenna

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Abstract – **The radiation behaviour of a corner reflector antenna designed using epsilon negative (ENG) artificial wire medium is realized using nonstandard Finite Difference Time Domain (NS-FDTD) method and the results are compared with standard FDTD algorithm. High accuracy NS-FDTD algorithm which requires less iteration for convergence is for the first time implemented for metamaterial corner reflector antenna. This is achieved by extending this powerful algorithm by addressing the stability related issues in conducting media and the proposed work may find potential applications in the simulation studies of dispersive and metamaterial designs.**

I. Introduction

One of the major issues for the implementation of standard Finite Difference Time Domain (FDTD) method in structural designs related to matematerials is the requirement of large domain space which, in turn, requires high computational cost. A modified form of FDTD, named as nonstandard Finite Difference Time Domain (NS-FDTD), has proved to be highly effective in many aspects like accuracy and speed and it achieves the same result with λ/h (ratio of wavelength to grid space) = 8 which the standard one can only attain with λ/h = 1140 [1]. NS-FDTD has already been successfully implemented for dielectric medium [2] and for structures having low conductivity. Quite recently, this powerful algorithm which considerably enhances the computational efficiency is reported for a plane conducting plasma medium [3]. In this work, for the first time, we have successfully employed NS-FDTD method to analyze the radiation behaviour of a corner reflector antenna designed using conducting wires in the form of an artificial Epsilon Negative (ENG) plasma medium by considering the stability issues related to the convergence of the function used [4]. The already predicted accuracy claims of NS-FDTD is achieved in a metamedium and the results are compared with standard FDTD.

II. Formulation of the problem and Design of the Structure

For employing NS-FDTD, we have incorporated wave equation method instead of using Maxwell's equations. The absorbing wave equation given by Cole [4] is used for designing the ENG medium which made by periodic array of thin conducting wires for the proposed corner reflector antenna and is given by

$$E_z(\mathbf{x}, t+\Delta t) = E_z(\mathbf{x}, t) + (\frac{1-a}{1+a})[E_z(\mathbf{x}, t) - E_z(\mathbf{x}, t-\Delta t))] + (\frac{v^2}{1+a})D_o^2 E_z(\mathbf{x}, t) \tag{1}$$

where v^2 and a are given by

$$v^2 = \frac{1}{\sin^2(\frac{kh}{2})}[\sin^2(\frac{\omega\Delta t}{2})\cosh^2(\frac{\alpha\Delta t}{2}) - \sinh^2(\frac{\alpha\Delta t}{2})\cos^2(\frac{\omega\Delta t}{2}) + \frac{1}{2}\tanh(\alpha\Delta t)\sinh(\alpha\Delta t)\cos(\omega\Delta t)] \tag{2}$$

$$a = \tanh(\alpha\Delta t) \tag{3}$$

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