Dispersion in Non-Orthogonal FDTD Meshes

I. J. Craddock and R. Nilavalan
Department of Electrical and Electronic Engineering, University of Bristol
Bristol, BS8 1UB, UK

The standard FDTD model is well-known and widely-used for full-wave electromagnetic analysis. Numerical dispersion is one of the main sources of error that degrade the accuracy of the analysis - for each structure of interest, the users of the model must attempt to generate a mesh that will avoid introducing high levels of dispersion. One of the main limitations of the traditional FDTD method is that it is restricted to structures described in orthogonal (usually Cartesian) co-ordinates. In order to model curved and angled structures, the Non-Orthogonal FDTD method may be used, however the Non-Orthogonal mesh cells introduce further dispersion into the analysis. Little information is however available on how the dispersion properties of the Non-Orthogonal FDTD algorithm vary with mesh size, mesh angle and direction of propagation - and hence it is difficult for users to make appropriate choices in their mesh generation. The aim of this contribution is to quantify the dispersion in realistic Non-Orthogonal FDTD models of microstrip structures directly through numerical simulations. A test structure is considered, discretised using a number of Non-Orthogonal mesh configurations, including single and multiple skew angles. Based on these results, recommendations are made concerning the range of cell angles for which dispersion stays within acceptable bounds. Results are compared to previously unpublished predictions from the Numerical Dispersion Relation (NDR) for the algorithm. It is shown that, although the NDR gives a guide to the algorithm dispersion under some circumstances, the Non-Orthogonal FDTD method suffers from additional dispersion effects that are not adequately described by the NDR - the origin of these effects is discussed.