ABSTRACT

In this study, a systematic development of a hybrid method of the finite different time domain method (FDTD) and the finite element time domain method (FETD) is investigated. The hybrid method is developed with a goal to combine the advantages of the two time domain methods, the efficiency in the FDTD method and the ability to use unstructured grid in the FETD method. Integral lumping of the time integration is performed on the local cubic elements at the interface of the implicit (FETD) and explicit (FDTD) regions. The issues associated with the hybrid method such as the late time instability of the scheme are also examined. In the second part, the focus of the study is on the preconditioning of the FETD matrix and adaptive mesh refinement for the FETD method. The accuracy of the solutions from the finite element method depends upon the gridding of the geometry. The solutions may require high order basis functions or a higher mesh density in some regions. Adaptive mesh refinement through the use of *a posteriori* error prediction is investigated. From the error prediction, the polynomial order refinement (*p* refinement) or the gird size refinement (*h* refinement) can be performed efficiently in regions with a user specified error criteria. However, the main issue associated with the use of hierarchical high order basis function and smaller size elements is the ill-conditioning of the finite element matrix. To overcome this issue, an application of incomplete Cholesky preconditioner is applied. During the matrix decomposition process for the incomplete Cholesky preconditioner, the use of a reordering scheme can significantly reduce the number of the matrix fill-in terms. Numerical examples will show effectiveness of the application of the preconditioner. In the last part of the dissertation, the *h* version refinement for the FETD method via the hanging variable technique will be investigated. The hanging variable technique allows elements with different refinement levels to touch while maintaining the field continuity at the interfaces. To maintain the continuity condition at the interface of different mesh levels, proper restrictions are enforced on the interface elements, known as the intermediate elements. This allows refinement in selective regions without remeshing due to bad quality of the mesh after refinement or the presence of distorted elements after mesh refinement. The restriction operators for the hanging variables will be discussed and numerical examples on *h* refinement for the FETD method will be presented.