Combining an FEM Domain Decomposition Method with BEM for Accurate Antenna Array Analysis

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Finite Element Method-Domain Decomposition (FEM-DD) methods have been proven very efficient and effective numerical techniques for the analysis of Maxwell's equations. Among other advantages, it suffice to stress their parallelization ability, ability to systematically couple different numerical methods into hybrid schemes, efficient exploitation of geometrical redundancies and symmetries, and relaxing meshing and adaptive meshing strategies. On the other hand, in light of the resent fast Integral Equation developments, see for example MLFMA, AIM, P-FFT, etc. Boundary Element Methods (BEM) are best suited for the fast analysis of unbounded problems.

This paper attempts to modularly couple the two approaches. The result is a very robust, accurate and efficient method for unbounded electromagnetic problem analysis. The method is extremely efficient when repeating structures are involved in the computational domain. The FEM-DD is coupled with BEM using DD concepts. In other words, the FEM-DD and BEM are viewed as another domain level in the domain decomposition. In overall this is a 2-level DD, where the inner level of the DD is the FEM-DD whereas the outer level DD is the coupled FEM-DD and BEM problem. The method is non-conforming thus it allows for maximum exploitation of geometry repetitions, local adaptation schemes and efficient structured BEM solvers. The overall method is variational and free of internal resonances. Various solutions strategies will be proposed.

New results of the coupled FEM-DD and BEM will be given. Comparisons with other methods, convergence curves and computational statistics will be presented in order to demonstrate the accuracy, efficiency and versatility of the method. Some results on real-world challenging radiation and scattering problems such as very large antenna arrays, hybrid radomes and EBGs will be presented.