ANTENNA DESIGN USING RIGOROUS HYBRID FINITE ELEMENT COMPUTATIONAL TOOLSETS

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Recent developments in computational electromagnetics have led to algorithms and associated codes which provide for full geometrical adaptability and material generality. The finite element-boundary integral (FE-BI) algorithms have been quite popular primarily due to these attributes. Their integration with fast integral algorithms and solvers such as the fast multipole method, the adaptive integral method and the fast spectral domain method has also led to the codes which have O(N) memory and CPU requirements. For example, a 200,000 unknown dense system can now be solved in minutes whereas previous solvers required several hundred minutes. These speed-ups open new possibilities for computational research and more specifically for hybrid finite element methods.

Applications that have both material modeling and large-scale requirements are particularly suited for finite element algorithms. Such applications include high density packages for compatibility and signal integrity studies, finite arrays, and multilayed antenna structures, among several possibilities. However, of particular interest is the use of the new fast algorithms within a design loop which incorporates optimization and topology tools. In this paper, we will present examples that demonstrate a successful integration of robust conformal antenna modeling with optimization algorithms (statistical and gradient based). We will present various layered artificial substrate configurations for enhancing the performance of printed antenna and array configurations. Among them, will be layered bandgap configurations to serve as frequency selective volumes, and multifunctional arrays on layered artificial dielectrics to substantial enhance their bandwidth characteristics. We will further discuss future techniques such as the homogenization design method (HDM) for designing new artificial material for electromagnetic applications. HDM has recently been used for low frequency (motor) designs, but can be equally successful for high frequency and microwave applications.

1) Commission and session topic for the paper:

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2) Statement of what new knowledge is contributed by this paper

New design techniques coupled with rigorous computational tools are presented

3) Relationship of this work to previous work.

This work extends the capability of recently developed computational tools associated with the hybrid finite element methods.