A High-Order Method of Moments Formulation for Composite Bodies Solved with Adaptive Cross Approximation

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Typical Method of Moments (MoM) solutions use traditional RWG basis functions to represent surface currents for electrically large scatterers. Oftentimes, this results in an unknown count that greatly exceeds computational resources either in memory or runtime. In these cases, various strategies may be used such as changing the mesh, applying fast solvers, or using hardware acceleration. Here, we present a Combined Field Integral Equation (CFIE) and Poggio-Miller-Chew-Harrington-Wu-Tsai (PMCHWT) based MoM formulation for composite body scatterers that utilizes a set of hierarchical basis functions as well as a fast direct solver to reduce the unknown count and decrease memory requirements while increasing solution speed.

The hierarchical basis functions (Graglia, Peterson, and Andriulli, IEEE Trans. Ant. and Prop., v59, March 2011) are complete up to Nedelec order p = 1.5 and are built on top of the RWG basis enabling one to transition from an RWG-only code to one using a high-order basis relatively easily. Since a high-order vector basis better represents the surface currents on the scatterer, it results in much fewer unknowns than a lower-order approach.

Furthermore, due to the N^3 scaling of MoM codes, fast solvers must be used to reduce runtime and memory requirements. In this work, we compress the system matrix using Adaptive Cross Approximation (ACA). From this we may factorize and solve the linear system in compressed form. Scattering problems generally require the solution for many excitations, so this approach is preferable to iterative solvers since a direct solution must be performed only once while an iterative solution must be done for each excitation. Also, direct solvers avoid many of the conditioning problems found in iterative solvers for meshes with multi-scale features. Finally, for composite body problems, care must be taken when junctions are present. We will give an overview of their implementation and show results for various geometries.