Nyström Discretization of an Augmented Combined Field Integral Equation with Static Charge Extraction

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The electric field integral equation (EFIE) and the magnetic field integral equation (MFIE) suffer from a spurious interior resonance problem for closed structures. The linear combination of the two equations can remedy this issue, and the resulting formulation is referred as the combined field integral equation (CFIE). Due to its incorporation of the EFIE, the CFIE inherits a low-frequency breakdown problem. This breakdown is manifest through a poorly conditioned system matrix and poor accuracy for some problems. The CFIE also exhibits mesh instability due to the hypersingular EFIE.

The AEFIEnH-S is a recently developed EFIE-based formulation that eliminates the low-frequency (LF) breakdown of the EFIE as well as its mesh instability. The AEFIEnH-S is composed of the augmented electric field integral equation (AEFIE) and a constraint on the normal component of the magnetic field (nH) with static charge extraction (SCE). It is discretized using the method of moments (MoM) with Rao-Wilton-Glisson (RWG) source functions and Chen-Wilton/Buffa-Chrisansen (CW/BC) test functions. The discrete system is stable and accurate as the frequency is reduced for closed, open, and multi-scale multiply connected geometries. It only relies on diagonal preconditioning, it does not require a Helmholtz decomposition, and it does not incorporate a frequency scaling of the unknowns. The resultant system matrix is square, since rows corresponding to the EFIE and the normal magnetic field constraint are added together. Moreover, the charge neutrality constraint is still used.

In this work, a new CFIE based formulation will be presented for modeling electromagnetic scattering from perfect electrical conductors (PECs). The MFIE and a constraint on the normal component of the electric field (nE) are added in the AEFIEnH-S system to form an ACFIEn-S system, ACFIEn-S= alpha(EFIE/eta+nH)+(1-alpha)(MFIE+nE/eta) and alpha is between 0 and 1. The continuity equation is used to relate the current and charge unknowns. The resulting system is discretized using the high order Nyström scheme. In addition to benefiting from the advantages of the CFIE, the formulation employs the same SCE procedure previously used with the AEFIEnH-S. This eliminates all nontrivial nullspaces for multiply connected geometries at LF without requiring the imposition of auxiliary loop constraints. The possibility of eliminating the charge neutrality constraint will also be discussed during the talk.