Large Scale Electromagnetic Scattering Problems Solved Using The Locally Corrected Nystrom Method and Adaptive Cross Approximation

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In this work, we investigate a fast direct solution of a linear system obtained from the Locally Corrected Nystrom Method (LCN) and the Combined Field Integral Equation (CFIE). Since LCN offers a high-order (HO) solution, it allows one to solve up to several digits of precision while greatly reducing the unknown count, thereby making it preferable to typical RWG-based Method of Moments (MoM) formulations, which typically offer only 2 or 3 digits of accuracy. Furthermore, the system matrix is compressed using Adaptive Cross Approximation (ACA), allowing us to perform a direct LU factorization that is also stored in compressed form. Typical iterative solutions, such as the Multi Level Fast Multipole Algorithm (MLFMA), may suffer from conditioning issues in multiscale discretizations as well as convergence problems when the structure has cavities or other resonant features. By using the direct factorization, we can sidestep these difficulties while quickly solving multiple excitations. Also, the LCN code uses Non-Uniform Rational B-Splines (NURBs) rather than flat cells in order to accurately represent the scattering geometry and has been demonstrated to produce high-order convergence for all regions of the problem including both near- and far-fields as well as in the surface currents. The ACA implementation is multi-GPU accelerated and has been used to solve over 1 million unknowns on a single workstation. This work combines the high-order accuracy of the LCN solution with an efficient and robust fast direct solver. Finally, each stage of the solution is error-controllable enabling one to maintain the desired accuracy throughout the process.