Large-Scale High-Order 3D Electromagnetic Analysis with Locally Corrected Nystrom Discretization of Combined Field Integral Equation

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Today’s design for Electromagnetic Compatibility (EMC) requires accurate prediction of highly isolated antennas mounted on an electrically large platforms such as ships, aircrafts, and vehicles. A modern aircraft features over 50 antennas many of which are operating simultaneously at different frequencies ranging from 30MHz to tens of GHz. Such antennas are mounted on different parts of the aircraft and produce interference with each other. The latter reduces signal to noise ratio in the channels, range of the radars, and create various other detrimental effects. Prediction of such interference which may be at the levels of -60dB and lower with the accuracy of 1% puts very stringent accuracy requirement (5 digits and higher) on the electromagnetic modeling tools used for such EMC design and verification. When the accuracy requirement of 5 digits is imposed on resolution of the electromagnetic fields throughout electrically large 3D model exceeding 500 wavelengths in size it becomes nearly impossible to reach such solutions with classical low order methods such as Rao-Wilton-Glisson (RWG) Method of Moments (MoM). In this work we present higher order EM modelling framework capable of satisfying both requirements of high accuracy and large model sizes. The approach is based on the Locally Corrected Nystrom (LCN) discretization of the Combined Field Integral Equation. The high accuracy representation of the model geometry is enabled through Non-Uniform-Rational-B-Splines (NURBS) description of the piece wise surfaces forming the model. The error-controlled LCN formulation accelerated with error-controlled Multilevel Fast Multipole Algorithm (MLFMA) formulation allows to achieve *O(h^p)* error behavior in antenna coupling prediction as well as the calculation of RCS and antenna radiation patterns, *h* being the size of the mesh elements and p the order of polynomial approximations within each element. The algorithm is in-core parallelized for distributed memory compute clusters with all of its stages establishing *O(N/P)* memory and CPU time scaling maintained with high efficiency for large-scale calculations, *N* being the number of unknowns and *P* the number of CPUs (I. Jeffrey, et.al., *IEEE Mag. Antennas Propag*, **3**, 2013, pp. 294-308).