Fast and Accurate Computation of the Field Radiated by an Antenna Installed on a Large Structure Using Hybridization between MoM and MLFMM

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For an antenna installed on a large structure, radiated far field can be computed accurately by using surface integral equations. If the structure is electrically too large for a direct solution of the linear problem, then fast solvers are needed, for example MLFMM or ACA-based matrix compression solvers. MLFMM involves an iterative solver, then it could seem appropriate when the number of sources is small (one or few antennas), but the convergence is highly penalized by the necessity of mesh refinement in the vicinity of the antenna. Moreover, for this kind of problem, the electromagnetic field dynamic range is very high; therefore the iterative solution threshold, which is needed to reach a desired accuracy for the radiated far field, is much lower than for a RCS computation, and difficult to specify a priori. On the other hand, matrix compression solvers are usually not optimal for a small number of sources, and they need much more computing resources for very large problems.

A hybridization method is used to optimally benefit of both MLFMM solvers and direct solvers (or matrix compression solvers if needed). This method is implemented in the in-house SPECTRE code of Dassault Aviation. First a “vicinity model” is defined, in order to get the radiated near field around the antenna, taking into account only a small part of the structure but avoiding undesired scattering. This first problem can be solved by a direct solver or a matrix compression solver. In a second step, the computed near fields of the first problem are used as sources in a global problem, taking into account the whole large structure. This second problem is solved using MLFMM.

This method is illustrated by its application to a test case of ISAE 2014 EM Workshop: “antenna with dielectric obstacle set on a launcher”. The comparison with results obtained with purely MLFMM and ACA-based computations show that hybridization allows combining accuracy with a better computational efficiency.