Improvements to the Numerical Computation of the Evanescent Part in Broadband MLFMA

Seppo Järvenpää* and Henrik Wallén
Aalto University, Department of Radio Science and Engineering, Finland

Broadband multilevel fast multipole method can be used to accelerate numerical solution of large scale field problems with integral equations. By definition, broadband methods overcome the low-frequency breakdown from which the Rokhlin translator suffers, and so they work for all mesh densities, cube sizes and frequencies. One way to implement such an algorithm is to employ plane wave expansions with the Rokhlin translator on the super-wavelength levels, and multipole series in the sub-wavelength part.

In this presentation such an approach is considered. Unfortunately the out-to-in -translation for the multipole series is not of diagonal form, and therefore a more effective alternative in the sub-wavelength part is considered here, namely the translator based on the spectral representation of the Green's function (L.J. Jiang and W.C. Chew, Microw. Opt. Techn. Lett., Vol. 40, No. 2, 117-122, 2004), concentrating particularly on the more challenging evanescent part.

We propose a reduction of the number of the samples in the φ-direction, leading to savings of up to several tens of percents depending on the level and chosen accuracy. However, conversion of the multipole series coefficients of the outgoing field to the six plane wave sample sets used in out-to-in -translation (and naturally back to the incoming field coefficients) still remains a challenging operation, even with the advanced methods available (I. Bogaert, D. Pissoort and F. Olyslager, J. Comput. Phys., 227, 557-573, 2007). We propose an improved process for this particular task which is based on the following observation: One can consider the series that needs to be computed for each θ-sample as a trigonometric polynomial respect to φ, and since the sample points are equidistant in φ, one can employ FFT, at least partially, to compute the values of the sum in an effective way. We demonstrate that the proposed improvements do not jeopardize the accuracy of the method with a simple numerical example.