Multilevel Fast Multipole Algorithm with Local and Global Interpolators

Seppo Järvenpää* and Pasi Ylä-Oijala
Department of Radio Science and Engineering, School of Electrical Engineering, Aalto University, Espoo 00076, Finland,
http://www.aalto.fi

Multilevel fast multipole algorithm (MLFMA) implementations typically utilize local interpolators. However, use of global interpolators based on trigonometric polynomials allow radiation patterns to be stored in much reduced sample sets which in best cases contain only one-eighth of the points required with local interpolators. Although the samples must be interpolated to *translation size* in order to perform the actual out-to-in translation, global interpolators still has an advantage of order two compared to local interpolators, partly due to the even distribution of sample sample points in the polar regions of the unit sphere. Also the obtainable numerical error control with global interpolators is better. On the other hand, implementing MLFMA with global interpolators in distributed computing system is difficult due to the global nature of the interpolators, since each sample of an radiation pattern is needed in the interpolation process to compute value for a new sample point. Thus there is a need for an hybrid algorithm that utilizes both type of interpolators, combining the best parts from both algorithms.

The algorithm presented in this talk utilizes local interpolators in upper levels $\ell \geq L$, and global ones in lower levels $\ell < L$. Here cube side-length is assumed to be $2^{\ell-1}\lambda$ in level ℓ. Further the proposed method allows the use of local interpolators on the sample sets used with the global interpolators, but stored in translation size (since local interpolators require oversampling). This means that the cost of out-to-in translations is halved compared to other implementations which employ only local interpolators.

In this talk we discuss the proposed algorithm, present methods to speed up the computations, namely algorithmic optimizations, parallellization and the use of SIMD instructions. Finally we show results that verify usefulness of the proposed method.