MLFMA with Local and Global Interpolators

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Multilevel fast multipole algorithm (MLFMA) has made it possible to solve large electromagnetic problems with integral equation methods due to its good scalability in terms of both memory and CPU-time. Interpolation plays a vital role in the actual implementation of MLFMA. A good interpolator should maintain accuracy while preserving the efficiency of the algorithm. Generally speaking there are two major classes of interpolators available, *local* and *global*.

Existing implementations typically utilize Legendre-Gauss quadrature in θ-direction and trapezoidal rule in φ-direction, respectively. The actual interpolation is performed with local interpolators which are based on Lagrange interpolating polynomials. One of the available advantage is the better CPU-time scalability (compared to global interpolators), and considering the fact that the current supercomputers are distributed machines with relatively slow interconnect, the local nature of such interpolators make it possible to create applications that can be run efficiently in these kind of computer systems.

Another option is to use trigonometric polynomials to expand the field patterns, and perform the required interpolations with Fast Fourier Transform (FFT). The sample points are now equidistant in both θ and φ directions, although for each θ-sample the number of points in φ-direction varies. This approach allows some advantages. For example, the required number of sample points for a given accuracy is roughly one-eighth of the sample points needed with local interpolators. Also these kind of interpolators allow simple and effective accuracy control. However, the asymptotic CPU-time cost is worse than what the local interpolators are capable of. Therefore this approach is better suited for solving medium sized problems in desktop computers where the available memory is limited.

Considering these facts it seems that it would be beneficial if both type of sample points and interpolators could be used in the same MLFMA-engine. However, to the best of our knowledge, an interpolator that would allow interpolation between both types of the discussed sample points has not yet been suggested in literature.

In this presentation a new interpolator which allows one to combine both types of existing interpolators (and related sample points) in one algorithm is introduced. It should make it possible to develop an efficient implementation for distributed computer systems with the memory savings provided by the use of global interpolators.