Curvilinear Non-Uniform Meshing: A Memory Reduction Technique for MoM Systems

Stephen J. Leifer and Robert J. Burkholder*
The Ohio State University Dept. of Electrical and Computer Eng.
ElectroScience Lab, 1320 Kinnear Road, Columbus, OH, 43212.
Phone 614-292-4597, E-mail rjb@esl.eng.ohio-state.edu

The Method of Moments (MoM) is a widely accepted solution to EM scattering. While accurate, MoM systems are computationally expensive and require large amounts of CPU time and memory. This paper presents three methods to reduce the memory requirements in MoM systems.

Many MoM approaches use flat triangular patches or flat quadrilateral patches to represent a scattering object. Flat meshes require a high discretization for any surface with an electrically small radius of curvature; this creates more unknowns, increasing the computational requirements. This is why curvilinear basis functions are often desired to solve MoM problems. Not only do curvilinear basis functions yield a more accurate representation of an object's geometry, they can also reduce the number of necessary facets when compared to flat patches. This paper presents a simple method in the construction of these basis functions. Triangular quadratic patches are used in this paper; however, the same approach can be applied on bi-quadratic quadrilateral patches. Three-dimensional curved patches are mapped into parametric space using Largrangian interpolation polynomials. After the mapping, simple rooftop functions are constructed and mapped back into three-dimensional space. Numerical examples are presented which compare the memory and accuracy of flat basis functions to curvilinear basis functions.

Next, we will show that non-uniform meshing can reduce the number of unknowns while sacrificing little in accuracy. Throughout the literature most objects are represented with near uniform meshes; we have illustrated that electrically smooth regions can have coarse meshing and with the fine meshing reserved for discontinuities and sharp edges. Combining non-uniform meshing with curvilinear basis functions can greatly reduce the number of unknowns by a significant amount.

Finally, the rooftop functions may be superimposed with linear phase functions so that the quadratic patches can be made much larger, even larger than a wavelength. The linear phase functions must be known *a priori*, by using ray tracing or the asymptotic phasefront extraction (APEx) method (D. H. Kwon, R. J. Burkholder and P. H. Pathak, *IEEE Trans. Antennas Propagat.,* 49, 4, 583-591, 2001). Numerical results will be presented to verify each of the above approaches.