Higher-Order Large-Domain MoM-PO Solution to EFIE-MFIE

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Traditional method of moments (MoM) analysis is inherently limited to electrically small and moderately large electromagnetic structures, because its computation costs (in terms of memory and CPU time) increase rapidly with an increase in electrical size of the problem. Modern wireless systems, on the other hand, often involve electrically very large metallic surfaces, that span many wavelengths and may posses arbitrary curvature. Frequently, major parts of these surfaces are smooth and surface currents flowing over them exhibit slow spatial variations. Therefore, one strategy to substantially reduce the computation costs in MoM at high frequencies is based on a hybridization with asymptotic techniques, such as the physical optics (PO), for electrically very large smooth parts of the structure with slowly space-varying currents.

This paper presents our novel higher-order, large-domain hybrid MoM-PO technique for analysis of arbitrary perfectly conducting structures. In general, the higher-order or large-domain MoM approach utilizes higher order expansion functions defined in electrically relatively large elements (e.g., [1]). Theoretical foundation of the hybrid technique is a system of coupled surface integral equations, with an electric field integral equation (EFIE) in the exact (MoM) part of the structure under consideration and a magnetic field integral equation (MFIE) in the asymptotic part of the structure [2]. The new method represents a generalization and extension of the higher order Galerkin-type MoM, which is referred to as a double-higher-order method because it combines higher order geometrical modeling and higher order current modeling. In the MoM-PO solution, all the surfaces in the system, in both the MoM- and PO-regions, are modeled by electrically large generalized curvilinear quadrilaterals of arbitrary geometrical orders (large domains). Different higher order divergence-conforming basis and testing functions are used in the MoM- and PO-regions of the structure, in order to maximize the overall accuracy and efficiency of the hybrid method in practical applications. In the MoM-region, basis functions are higher order hierarchical polynomials of the parametric coordinates over generalized quadrilaterals that automatically satisfy continuity boundary conditions for the current components normal to the quadrilateral edges shared by adjacent elements in the model (divergence conformity) and the same functions are used for testing (Galerkin technique). In the PO-region, basis functions are higher order divergence-conforming interpolatory polynomials based on modified Chebyshev polynomials of parametric coordinates and the testing procedure is a modified point-matching technique at the interpolation points of the basis functions.

Due to its PO extension, the new hybrid higher order MoM-PO method is much more efficient in analysis of large metallic structures than its pure MoM counterpart. Due to its truly higher order, large-domain nature in both MoM- and PO-regions, on the other hand, the new hybrid method is much more efficient than the low-order, small-domain MoM-PO techniques (e.g., [2]). These features of the new method will be demonstrated on characteristic realistic examples.

REFERENCES

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