Spatial-spectral Hybrid Method in Calculation of Capacitances and Inductances of Ring Conductors in a Stratified Medium

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In addition to generic numerical integration equation methods in electromagnetics, there is also a need for simplier algorithms for some basic geometries. These algorithms may be used as efficient and accurate models for some RF-components, for example, or they may served as benchmarks for more generic algorithms. An example of such algorithms is the one presented earlier by the authors [1]. The paper treats the calculation of the capacitances and inductances of the system of thin ring conductors in a stratified medium. These parameters were found by solving the surface charge and current distributions on the rings by using Galerkin method and the spectral method. The present work generalises the above algorithm for thick ring conductors.

The spectral method utilising an integral transform in the transverse plane is commonly used in the analysis of planar structures in a stratified medium. This is because the solution of the Green's function is more straightforward in the spectral domain. However, if the coupling integrals between the basis functions are to be evaluated in the spatial domain, the tedious inverse transform of the spectral Green's function must be carried out for every integration point. Another solution is to calculate the coupling integrals in the spectral domain. Unfortunately, the infinity integrals which arise are also laborious due to the highly oscillating and slowly decaying integrands. The so-called spatial-spectral hybrid method exploits the benefits of the pure spectral method but avoids the most troublesome integrals. In the method the Green's function and the coupling integrals are divided into two parts. The first part of the Green's function includes the primary point source and the first reflections from the interfaces of the medium, found from the image theory. The corresponding parts of the coupling integrals are evaluated in the spatial domain. The rest of the Green's function and the corresponding parts of the coupling integrals are calculated in the spectral domain. Although the integrands are oscillating like in the pure spectral method, they decay exponentially because the asymptotic part of the spectral Green's function is contained in the first part evaluated in the spatial domain.

The unknown surface charge and current distributions on the faces of the conducting rings are estimated as superpositions of entire-domain basis functions. Each of the basis functions includes the correct edge behaviour and together they constitute a complete and quickly converging expansion for the distributions. The integral transforms of the basis functions needed in the method are found in analytic form.

REFERENCES

1. Dufva, T. J., and J. C.-E. Sten, "Quasi-static variational analysis of planar spiral conductors," *Journal of Electromagnetic Waves and Applications*, Vol. 16, No. 7, 957–976, 2002.