Closed-Form Green's Functions in Cylindrically Stratified Media for Method of Moments Applications

S. Karan, V. B. Ertürk and A. Altintas
Dept. of Electrical and Electronics Engineering, Bilkent University, TR-06800, Bilkent, Ankara, Turkey
e-mail: vakur@ee.bilkent.edu.tr, Tel:++90-312-290 3154, Fax: ++90-312-266 4192

Many military and commercial applications require microstrip antennas and/or arrays, or other types of printed structures that conform to the host platform due to aerodynamic constraints, reduced radar cross section compared to antennas and arrays on planar platforms, wider scan range and aesthetic reasons. Therefore, rigorous analysis of such structures becomes important. However, as the number of layers deposited on the host platform increase, rigorous investigation of these structures becomes more difficult. Although the method of moments (MoM) based solutions are widely used for the rigorous analysis of planar layered printed structures, available tools for their curved counterparts are limited, and may suffer from the efficiency and accuracy problems. Among the curved geometries, cylindrical ones are one of the most important types since they may sufficiently model the geometry of many complicated applications. Besides, they may be treated as the canonical geometries, whose solutions are regarded as the building blocks toward the development of analysis tools for arbitrarily convex curved bodies.

The efficiency and accuracy of the MoM based solutions strongly depend on the evaluation of the Green's function representation (both in spatial and spectral domains), which is the kernel of the integral equation. Therefore, the use of closed-form Green's function representations in conjunction with the MoM has been a good candidate in the design and rigorous analysis of many printed antennas/arrays and other geometries embedded in an arbitrary layer of a cylindrically stratified media. Therefore, in this paper closed-form Green's function representations in cylindrically stratified media are developed to be used in conjunction with MoM applications. The Green's function for cylindrically stratified media involves a summation over n, which represents the cylindrical eigenmodes, and a Fourier integral with respect to k_z on the complex k_z plane. As the first step, the summation over n is efficiently and accurately evaluated for all possible field and source points. Note that this summation is very slowly convergent when both the field and source points lie on the same interface, which is the case for all MoM applications. Therefore, several techniques are performed to sum the cylindrical eigenmodes efficiently ad accurately. Once the summation over n is performed, the discrete complex image method (DCIM) is applied to the k_z integral to obtain closed-form solutions with the help of generalized pencil of function (GPOF) method. Unlike the previous works on this subject, when the field and source points lie on the same interface and when $\phi = \phi'$, an accurate expression for the closed-form Green's function representation is obtained in this paper.

Numerical examples will be presented in the form of mutual coupling between arbitrarily oriented current modes for all previously problematic cases. Moreover, the current distribution on several printed geometries as well as the input impedance of microstrip antennas will be presented.