Fast Algorithm to Determine Successive Scattering of Two Dielectric Cylinders in the Near Field of Each Other

Ronald J. Hooker* and Roger H. Lang
Department of Electrical and Computer Engineering, The George Washington University, Washington, DC 20052, http://www.gwu.edu

Mechanisms of electromagnetic scattering within a vegetative canopy layer continue to be of interest to the remote sensing community. In this paper, we investigate successive scattering from tree branches by determining the scattered field from one branch to another. The goal is to verify the validity of an analytical model that will provide an accurate and computationally efficient solution suitable for use in a canopy simulation model. Such applications require these types of calculations for a large number of scatterers, making solutions by numerical methods unacceptably slow. Our approach promises faster results relative to traditional moment methods.

We consider a physical arrangement where the branches may be arbitrarily oriented with respect to each other. Moreover, the arrangement allows the branches to be in close proximity to each other to account for near field interaction for wavelengths of interest. The formulation is fully dyadic to handle arbitrary incident and scattered wave polarizations.

Formulation of the successive scattering problem begins as a three-dimensional vector integral in the spatial domain. The branches are described as finite dielectric circular cylinders. Fourier transform methods are then applied to transform the spatial integral to the wave vector domain in spectral spherical variables. The vector integral is evaluated by first employing Cauchy's theorem to the integral over the magnitude variable, leaving a two-dimensional integral over the spectral angular variables between the cylinders. Care must be taken in evaluating the remaining integral, as poles lead to line singularities in the integration domain.

Results are first presented for a single cylinder vector field problem to illustrate the technique and verify the approach. Results and conclusions are then presented for the case of a two-cylinder arrangement assuming a thin cylinder approximation. The work results in a model suitable for evaluating scattering cross sections in a vegetation model.