Simulating EM Scattering from Forests by WIPL-D Code

Dragan I. Olcan[(1)], Branko M. Kolundzija [(1)], and Bojan B. Janic*[(2)]
(1) School of Electrical Engineering, University of Belgrade, SCG
(2) WIPL-D Ltd. Belgrade, SCG, http://www.wipl-d.com

Electromagnetic scattering from trees and forests plays important role in many civil and military applications. For example: mobile communications in the presence of foliage, target detections with foliage penetrating (FOPEN) radars, remote sensing of terrain etc. However, full wave 3D EM simulation of such structures requires much more RAM than it is available with standard computers, since each tree should be modeled with many dielectrics rods (for trunk and branches) and dielectric plates (for leaves). We present an efficient approach for 3D EM modeling of forests which is based on the fact that dielectric rods and plates can be substituted with metallic wires and plates with distributed loadings along them. This substitution does not affect the scattering pattern considerably, at lower frequencies. However, it significantly decreases the number of unknowns needed for simulations, i.e., it decreases the memory requirements of the used computers, and the time needed for simulations.

First we briefly describe the modeling approach for trees, and then we present examples of calculating monostatic RCS of several configurations of forests and an example of a tank positioned in a forest. We use WIPL-D Pro for all EM simulations. All presented results are calculated at the operating frequency of 100 MHz.

The replacement of dielectric rods and plates with metallic counterparts and distributed loadings along them is shown to be very accurate at lower frequencies, while its accuracy decreases at higher frequencies. Yet, the same approach can be utilized at higher frequencies if all trunks and branches that do not satisfy the inequality $a \le \frac{\lambda}{8}$ are simulated as dielectric rods and all the others as metallic counterparts with distributed loadings (a is the dielectric rod radius and λ is a wavelength at the operating frequency).

The presented numerical approach for EM simulations of trees and foliage is shown to be computationally efficient. The approach opens the possibility of rapid EM simulations of whole forests and potential targets in them.