Modeling EM Wave Scattering from Tree Branches and Leaves

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Understanding the EM wave interaction with trees and forest is important for remote sensing and wireless communications. The signal transmission loss through tree canopy depends on the frequency, tree types and sizes, dielectric constant of branches and leaves, and polarization. Commonly, the branches are modeled using a finite dielectric cylinder and the leaves of evergreen trees are modeled using a spheroid. Senior et al [Radio Science, 1987] used the current on the resistive sheet and physical optics to model leaves of deciduous trees. In this paper, we will describe a new way to model a thin large leaf. The leaf is modeled using a thin dielectric layer. Using the ABCD matrix method, the reflected and transmitted waves were obtained. Then the Kirchhoff approximation was applied to calculate the scattered waves from a finite size leaf. The numerical results were compared with that of the resistive sheet approach.

Most wireless communication devices use an antenna with the broad radiation pattern. When trees are located close to a wireless device and a base-station is far away, the effect of the trees on the wireless device depends on whether the device is acting as a receiver or transmitter. The transmitted wave through trees may contain a significant amount of coherent waves if a source is located close to the random medium. On the other hand, if a receiver is located close to the random media, it may receive a large amount of incoherent waves due to its wide antenna pattern. This is called the “Shower Curtain Effect”. We will describe these two cases using the realistic tree models and simulations.