MLFMA Analysis of Wave Interaction with Multiple Trees: Validation of Ray Codes Used in Wireless Propagation

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The multi-level fast multipole algorithm (MLFMA) is employed to analyze wave interaction from a large number of tree-like structures situated above a lossy half space (soil). A scalable MLFMA formulation is implemented. In one case all of the scatterers (trees) are analyzed simultaneously on a set of networked computers. In the other formulation wave interaction between the trees is analyzed iteratively, and each tree is analyzed separately on its on computer node. In the latter case multiple scattering is handled via inter-computer communication. The relative efficacy of these two scalable implementations is discussed, with regard to CPU and RAM requirements.

The MLFMA software is then used to analyze wireless propagation in a small forest, for validation of ray codes. This analysis allows consideration of a ray and MLFMA for identical scattering environments, thereby allowing calibration of the ray model. This direct comparison of a rigorous (MLFMA) and approximate (ray) analysis should be compared with previous comparisons of ray results to measured data, for which the exact scattering environment is rarely known exactly. Also note that for validation of the ray model, the rigorous model must be valid at high frequencies, thereby motivating MLFMA vis-à-vis the relatively low-frequency method of moments. We consider various approximations in the ray model, for example the number of inter-target interactions retained, the number of diffraction terms retained, and the inclusion of curved-body diffraction terms. Several example results and comparisons are presented.