Modeling Clutter from Random Rough Ground for GPR Subsurface Sensing Applications

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Scattering of electromagnetic waves from two-dimensional penetrable rough surfaces (3-D scattering) with different characteristics will be presented here. The integral equation-based fast algorithm, Steepest Descent Fast Multipole Method, will be used to analyze this intensive computational problem. The objective is to investigate the scattering phenomena of electromagnetic waves from typical Bosnian, Puerto Rican, and A. P. Hill soils. Soil moisture level, frequency band and surface roughness parameters are considered major factors that affect the scattered fields. For example, the range of volume moisture level in a typical Bosnian soil will be chosen from 3.8 to 25.3% for a frequency range 600 Mhz–2 Ghz. Thus the relative dielectric constant will range approximately from 3 to 10 and from 0.04 to 1.3 for the real and imaginary parts, respectively. As well known, for larger soil water content, the relative dielectric constant becomes larger, and as a result the problem becomes more computationally expensive. Different soil samples from Puerto Rican clay loam and A. P. Hill, Firing Point will be used in this work as well. The rough surface is characterized with Gaussian statistics for the random heights and also for the auto-correlation function. The roughness parameters (root mean square height and correlation length) are chosen to be in the moderate roughness range for the current application. For example, the root mean square height will range from 0.1 to 0.2 wavelength and the correlation length will range from 0.5 to 1.5 wavelength. The scattered near field E-patterns of an incident Gaussian beam will be calculated at different locations above the dielectric interface. The receiver locations are chosen to simulate GPR measurement protocols. Moreover, the transmitted E-patterns will be computed at locations below the rough dielectric interface.

The goal of this paper is to fully understand the effect of different soil properties on the scattering phenomena as an a *priori* phase of investigating scattering from buried mines under the same types of soil.