Subsurface Sensing of Targets Buried Beneath 2-D Multilayered Random Rough Surfaces: Use of the Steepest Descent Fast Multipole Method

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The scattering of electromagnetic waves from a penetrable shallow target buried beneath 2-D multilayered random rough surfaces will be presented. There are several applications for this work, e.g. detection of anti-personnel mines, anti-tank mines, water and/or gas pipes, location of underground water, etc. In reality, these targets are buried under the Earth's surface, which is a randomly rough interface and also is not simply composed of a single layer, but is a multilayered media. The closer the real environment is incorporated into the electromagnetic model, the more accurate and practical inferences can be gained from the numerical results. Without modeling the multiple ground layers, many targets *cannot be detected*. One unobtrusive way these buried targets can be detected is by bombarding the Earth's surface with electromagnetic waves, and comparing the scattered signature of the ground alone with that of the ground with the buried target.

A rigorous electromagnetic model based on the equivalence theorem and the method of moments (MoM) is developed to analyze this 3-D scattering problem. Three layers are considered in this work; air, dry-soil and wet-soil. The penetrable target is buried between the air/dry-soil interface and the dry/wet-soil interface. The Steepest Descent Fast Multipole Method (SDFMM) is implemented to significantly accelerate the computations of the unknown electric and magnetic surface currents. The effect of the lossy underground rough layer (wet soil) on the target signature will be investigated. Moreover, images based on the scattered electric fields for the buried target will be presented.