Scattering from Non-Shallow Targets Buried Beneath Two-Dimensional Random Rough Surfaces Using the Multiple Interaction Model

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The multiple interaction approach is used with the robust Steepest Descent Fast Multipole Method (SDFMM) to compute the signature of non-shallow penetrable scatterers buried beneath 2-D random rough surfaces. The most attractive feature of the proposed model is removing the quasi-planar structure constraint of the Steepest Descent Fast Multipole Method (SDFMM) when used in analyzing non-quasi-planar scatterers. The basic idea of the multiple interaction model is to decompose certain non-quasi-planar structures into two quasi-planar scatterers where the conventional SDFMM can be applied separately to each one. The interactions between the sub-quasi-planar scatterers are calculated directly using the electromagnetic vector potentials near-field expressions. Significant reductions in the CPU time and computer memory are achieved by using the SDFMM in the model. A variety of geometries are used to test the model and their numerical results are validated with the conventional MoM.

The results show that the buried object's signature is largely due to the first interaction mechanism (i.e. ground-object-ground). However, the contribution of each additional interaction is explicitly calculated using the model. Interestingly, the contributions from repeating this mechanism become insignificant especially for lossy background soil. This conclusion depends on the physical properties of the scatterer.

The multiple interaction model successfully demonstrates the exploitation of the SDFMM robustness when applied to the multilayered rough ground where the burial depth of the underground rough layer is on the order of a wavelength.