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Electromagnetic Wave Scattering from Two Nearby Objects Buried Under Random Rough Surface Using the SDFMM: Subsurface Sensing Applications

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In anti-personnel mine detection applications, explosive objects buried under ground with rough soil surface could be surrounded by different clutter objects such as rocks, roots, sticks, metallic nails, vegetation, etc. Target discrimination between the AP mine and any sort of object clutter is necessary to minimize false alarms.

In this work, we present the analysis of the electromagnetic wave scattered from two objects buried under a 2-D random rough surface. These two buried objects could both be perfect electric conductors (PEC), one plastic object and one PEC, or two plastic objects. The random height variation of the rough ground is assumed to have Gaussian probability density function and the surface autocorrelation function is assumed Gaussian as well. A carefully tapered Gaussian beam is assumed for incident waves.

The integral equation-based fast algorithm, the Steepest Descent Fast Multipole Method (SDFMM), will be implemented in this work to calculate the electric and magnetic surface currents on the soil/ground interface and the multiple objects. The great advantage of the SDFMM lies in its $O(N)$ computational complexity versus the $O(N^2)$ for the Method of Moment (MOM) to solve N linear system of equations using an iterative solver. The SDFMM was originally developed at UIUC.

In our previous work, we used the SDFMM to analyze the near electric field scattered from single plastic object buried under the rough ground. The rough ground surface was the only source of clutter in the surrounding environment. Here, we are adding another source of clutter that is the proximity of an un-explosive object to the AP mine. The effect of the proximity and orientation of clutter object on target signature will be investigated here. Our objective is to understand the physics behind the mechanism of scattering from these two buried objects and hence to be able to discriminate between the explosive target and the clutter object.