A Fast 3-D Inverse Scattering Method for Objects in Layered Media

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Ground penetrating radar (GPR) and electromagnetic induction (EMI) are two important modalities for the detection and discrimination of landmines and unexploded ordnance. Several signal processing algorithms have been successfully developed and are widely utilized. However, current processing algorithms for these measurements are far from being satisfactory. The major difficulties with these processing arises because of the presence of the layered earth.

To improve the processing schemes, we propose a 3-D inverse scattering method to process electromagnetic induction and ground penetrating radar data for buried target detection and discrimination. Unlike the conventional signal processing schemes, this inverse scattering method is based on the full physics of wave-material interactions. This method has the capability of imaging the subsurface structure of the buried objects and their surrounding environment. Therefore, it can be a useful complement to the existing signal processing methods.

Our algorithm is based on the nonlinear inverse scattering method. It incorporates the physics of multiple wave field interactions with the buried objects as well as the layer interfaces to unravel the complex subsurface phenomena, and thus gives a clear image of the objects. To account for the reflections from the ground surface and subsurface interfaces, we incorporate a dyadic Green's function for a general multilayered medium in the inverse scattering method. A novel method is developed for the inversion so that there is no need to perform time-consuming forward iterations during the inversion. Several convincing examples will be demonstrated to show the merit of this new technique.