UXO Discrimination in Cases with Overlapping Signatures

Background:
Buried unexploded ordnance (UXO) constitutes a major environmental problem for the Department of Defense. Currently, cleanup methods are notably inefficient and expensive because sensors produce many false alarms. Many studies have been pursued in recent years in an attempt to better discriminate UXO from omnipresent clutter, and some progress has been made and demonstrated at various test sites. However, these test sites fail to include the most daunting aspect of real world UXO remediation sites, namely the likely proximity of a number of UXO and also the density of clutter, with its tendency to overwhelm discrimination schemes based on isolated targets. When situations can be handled where signatures of a number of targets overlap, significant progress in the area of subsurface UXO remote sensing and discrimination will be made.

Objective:
This project will perform basic research to develop an understanding of the physics and consequent sensor responses for three problems involving clusters of metallic targets: (1) two or three UXO-sized objects; (2) many small non-UXO items with a total volume of metal that could be the same as a single UXO; and (3) a single UXO-sized object amidst or beneath a distribution of smaller fragments. The objective of the research is to identify characteristic signature patterns over broad frequency bands in both ground penetrating radar (GPR) and electromagnetic induction (EMI) sensing and to isolate the spatial patterns of those frequency signatures.

Summary of Process/Technology:
A central innovation in this project is the combination of information from both GPR and EMI sensors to classify unseen target clusters. Each technology will exploit ultra-wideband frequency ranges and positional diversity in the data. The latter refers to locating the sensor at an array of spots around a presumed cluster location in order to get views from a variety of different angles. New analytical and numerical solutions will be used to analyze the signal behavior of multiple targets under diverse angular and frequency conditions. In EMI, tractable analytical and approximate analytical solutions will be developed further and tested for elongated and flattened shapes of both magnetic and non-magnetic materials. These will be used further to produce solutions for structured random distributions of small targets, for a few large objects near one another, and for the screening problem. Numerical solutions will look at more diverse geometries. These will be used to understand what to expect in terms of shifts in scattered field eigenvalues, as a function of direction, frequency, and position, for different target arrangements. Ultimately, the processing systems suggested by these analyses will be tested in "half blind" field tests under controlled settings.

Benefit:
Use of newly developed, efficient computer techniques should allow an understanding of the interaction between location and geometry of arbitrary, multiple objects under diverse viewing angles. The use of these analytical results to fashion better processing of field data should reduce false alarm rates without increasing detection failures. It should also foster more reliable detection of UXO amidst clutter. These advances are crucial for real world sites, where most of the costs of cleanup are associated with non-UXO items.

Accomplishments:
This project began in FY 2002. Accomplishments will be noted upon completion of the project.

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