Model-Based, Robust Methods for UXO Discrimination from Time and Frequency Domain EMI

Unexploded Ordnance
UX-1379

Background:

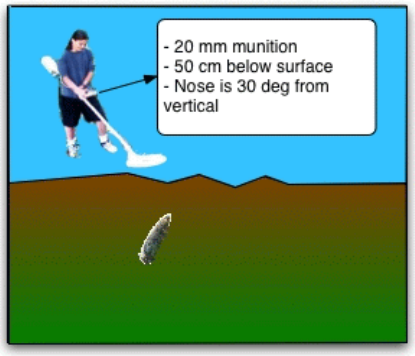
The safe and cost-effective remediation of military sites containing buried unexploded ordnance (UXO), non-hazardous scrap, and other clutter requires that objects posing a threat be distinguished from those which do not and that those classified as dangerous be characterized in terms of size, shape, object type, and location prior to their removal. Cost-effective, time-efficient, and accurate solutions to this problem of UXO discrimination are of central importance to the Department of Defense (DoD) under the Base Realignment and Closure Program and the Defense Environmental Restoration Program, both of which seek to remediate large tracts of land formerly used by the DoD and transition them to the public. Northeastern University (NU) addressed this problem in the SERDP SEED project UX-1217. Physics-based signal processing methods were developed to distinguish clutter objects from UXO and to classify the type of ordnance. In addition, computationally tractable techniques were developed to account for uncertainties in the object-sensor's position and orientation. Preliminary results using field data indicated the viability of the prototype algorithms.

Objective:

The objective of this project is to complete and transition the work begun in the SEED project UX-1217. Specific objectives include: (1) refine and enhance the NU-developed UXO discrimination signal processing algorithms; (2) develop a library of UXO time and frequency domain signatures; and (3) validate the algorithms using laboratory training data and field data collected in sufficient detail to be of use for the models and algorithms of interest.

Process/Technology Description:

With NU as the lead, the objectives will be carried out by a multidisciplinary team. NU and Alphatech Inc. will address algorithm development issues of target sensor orientation and positional uncertainties using the methods developed under UX-1217. Calibration target data for the signature library and field data will be collected by two state-of-the-art frequency and time domain electromagnetic induction (EMI) sensors. The Geophex Ltd. GEM-3 sensor will collect frequency domain data while the Johns Hopkins University Applied Physics Laboratory (JHU/APL) electromagnetic target discriminator (ETD) sensor will collect time domain data. In collaboration with Alphatech Inc., the team will leverage ongoing work under SERDP project UX-1311 to generate high quality synthetic data to test the range of efficacy of the semi-empirical dipole models and inversion codes developed under UX-1217. Previous efforts indicated that the UXO data collections were of limited value for model development, verification, and algorithmic testing due to limited spatial sampling and the collection of limited frequencies or time gates of target signatures. In collaboration with Geophex Ltd. and JHU/APL, the researchers will collect "gold standard" data sets for algorithm training, model validation, and algorithm testing and evaluation. Detailed test plans utilizing the unique character of each sensor will be developed to optimize data collection for algorithm development. These data sets will provide for the comprehensive and conclusive analysis of the project team's methods and those under development by other SERDP investigators.



Improving the Characterization of Buried Objects

Expected Benefits:

Development of data-validated, model-based methods for the extraction of information regarding the type, location, and orientation of buried targets will improve the team's ability to correctly classify objects that should be excavated from those that can remain in the ground, thereby reducing the cost of remediating contaminated land. A related outcome will be the synthesis and validation of a model-based theory to provide the analytical tools for determining the amount of data as a function of space, time, and frequency, required to meet given processing requirements such as estimation accuracy, false alarm rates, and probabilities of correct classification or to determine that these requirements cannot be met. Finally, a key part of this effort is the collection and processing of a comprehensive database of sensor data for the purposes of algorithm training, algorithm testing, and model validation. (Anticipated Project Completion - FY 2007)

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