Multi-Modal Inverse Scattering for Detection and Classification Of General Concealed Targets:

Landmines, Targets Under Trees, Underground Facilities

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Research Overview

• Sensing of landmines, targets under trees and underground structures are very distinct missions, although they fall under the general problem of sensing concealed targets in the presence of a complex, stochastic environment

• Rather than focusing on one of these areas, we exploit their inter-relationships to investigate the general concealed-target problem

• Particular examples will be investigated by connecting members of the MURI to appropriate members of the user community (e.g. landmines: Army Countermine Office, Ft. Belvoir, VA)

• Undertake a multi-modal (multi-sensor) approach to effect inversion, with insights from the evolving inversion used to refine/optimize the inter- and intra-sensor parameters

• Will exploit the fact that future (and current) DoD systems will rely increasingly on autonomous vehicles (e.g. multiple robots, UAVs and UUVs that can be positioned to optimize the sensor platform as the inversion is undertaken)
Multi-Modal Inversion of General Targets Embedded In Arbitrary Stochastic Layered Media

General Adaptive Algorithms and Phenomenological Insights

Landmines

Underground Structures

Concealed Ground Structures

Application-Specific Questions/Issues
Multiple UAV Sensor Platforms
Flight Paths and Sensor Parameters
Refined as Inversion Undertaken

Multiple Robotic Sensor Platforms
Robot Positions & Sensor Parameters
Refined as Inversion Undertaken

Concealed Ground Target
Landmines

Conduit/Tunnel
Underground Facility
Multiple Sensors

Multi-Sensor Physics-Based Constrained RDOF

Phenomenology from Forward Models

Direct Inversion

Reverse-Time Migration

General Nonlinear Inversion

Statistical Inversion

Adaptive Coarse-to-Fine Pruning

Adaptive HMM
Multi-sensor mutual information
Multi-sensor, adaptive Bayesian

Optimize Intra-Sensor Parameters
Optimize Inter-Sensor Parameters

Inversion Confidence

High

Inversion complete

Phenomenology from Forward Models
Workshop Series on Adaptive Multi-Modal Inversion

Workshop I: August 14, 2003; Stanford University

Workshop II: July 1-3, 2004; University of Minnesota (IMA)

Workshop III: During week of August 1, 2005; Georgia Tech