Combined SMS and finite-difference method for inverting a buried object location

F. Shubitidze [1], K. O'Neill[1,2], B. Barrows [2], I. Shamatava [1], J. P. Fernández [1], K. Sun [1]
[1] Thayer School of Engineering, Dartmouth College, Hanover NH, 03755 , USA
Email: Fridon.Shubitidze@dartmouth.edu
[2] USA ERDC Cold Regions Research and Engineering Laboratory, 72 Lyme Road, Hanover NH, 03755, USA

The cleanup of unexploded ordnance (UXO) is a most pressing military environmental problem that involves approximately 11 million acres of land in the USA alone and whose estimated cost is in the range of tens of billions of dollars. Mostly, this cost is driven by the digging of holes in which no UXOs are present: current inversion techniques used to identify underground UXOs produce many false alarms—due to scrap metal or other manmade or natural objects—for every real unexploded munition found. Each of these false alarms could potentially be a UXO and consequently requires a careful and costly excavation. One of the main steps in any UXO-discrimination procedure consists of determining the location and orientation of a buried object using electromagnetic-induction (EMI) data collected at some set of points above the ground. An object's EMI response is a non-linear function of its location and orientation.

The main objective of this work is to combine a surface-magnetic-source (SMS) method (surface magnetic charges or surface magnetic dipoles) and a finite-difference (FD) scheme in order to solve the buried-object-location inverse problem. After dividing the entire observation volume into subcells, the proposed technique uses measured data (at a height h) to determine SMS amplitudes at each frequency by solving a linear system of equations; these amplitudes can be used to generate a scalar magnetic potential ψ at a height $h + dz/2$, which can in turn be combined with the magnetic field H_z at h to find the magnetic field and scalar potential everywhere inside the observation volume. The algorithm will be tested using actual frequency-domain EMI data. The comparison between inverted and true locations will be presented and demonstrated.