MTADS Data Collection in Support of the ESTCP UXO Discrimination Study

G.R. Harbaugh*, N. Khadr†, and D.A. Steinhurst*
*Nova Research, Inc., Alexandria, VA 22308
†SAIC - ASAD, Arlington, VA 22202

Introduction

The Naval Research Laboratory (NRL) Multi-sensor Towed Array Discrimination System (MTADS) magnetometer, EM61 MkII, and GEM-3 sensor arrays were deployed to collect discrimination-quality data sets under real-world conditions as part of the Environmental Security Technology Certification Program (ESTCP) Unexploded Ordnance (UXO) Discrimination Study in the Spring of 2007. The demonstration site was located within Site 18 of the Former Camp Sibert Formerly Used Defense Site (FUDS), near Gadsden, AL. This effort was funded as part of ESTCP project MM-0533.

Based historical records, the 4.2-in mortar was the primary munitions used on the site, and therefore the item of interest for the Study. Data collection was conducted in two phases. The first phase provided information to aid in the selection of the final demonstration site and to assist in site preparation. These data were used to identify and clear a geophysical prove-out area and to determine the locations for a number of seeded UXO. Additional areas were further investigated to better characterize the site.

A series of measurements of a representative 4.2-in mortar in a pit dug in the ground were made on site with each of the three sensor arrays. These data were used to determine the range of burial depths at which the 4.2-in mortar could be detected by each of the sensor array.

Once the seed UXO items were emplaced and the GPO installed, the second phase was conducted. Fit parameters for approximately 2,000 individual anomalies from each data set were determined using physics-based models. After the submission of all data, the results from the GPO and the pit data were used to further compare the performance of each sensor array for the local geology and the 4.2-in mortar.

The collected data will be combined with several data processing methodologies from other demonstrations to test and evaluate complete UXO discrimination strategies that can be deployed against real world UXO problems.

NRL MTADS

ESTCP has supported NRL in the development of the MTADS as an efficient set of technologies for the detection and discrimination of buried UXO with the ultimate goal of more effective UXO remediation with maximum terrain adaptability.

The MTADS vehicle consists of a low-magnetic-signature vehicle capable of collecting data over large areas (up to 25 acres / day). Positions are measured in real-time using cm-level RTK GPS technology.

The MTADS magnetometer vehicle consists of a 1m x 1m EM61 MkII coils with custom MkII electronics for improved detection of smaller items at vehicular speeds. Cross-track spacing is 50 cm.

The GEM-3 (GEMTADS) array is a triangular array of 96-cm diameter GEM-3 sensors with custom electronics to increase the transmit current. Cross track spacing is 50 cm.

Platform orientation is provided for the EMI systems using a three-receiver GPS configuration and an inertial measurement unit (IMU).

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System Response to the 4.2-in Mortar

The response of the sensor to the 4.2-in mortar is used to determine an appropriate detection threshold for each sensor. The UXO Discrimination Study design set a goal depth 11x for the 4.2-in mortar diameter, or 1.7m. At this depth, the anomaly detection threshold for each sensor was set to be one-half the least-favorable predicted response at a depth of 11x. The system response for the three sensors was determined using a combination of field measurements and modeling. Data were collected on site at various depths and orientations using an example 4.2-in mortar. The peak amplitude for the 4.2-in mortar was extracted from the data from each ‘sweep’. Response curves were generated to completely bound the sensor responses at the most favorable orientation and at the least favorable orientation of the sensor / item of interest pair. The sensors travel an additional 25-33 cm above the surface. The system RMS background signal level from the GPO is also shown as a dashed line. After the demonstration was completed, the peak magnitudes for the seeded 4.2-in mortars in the GPO were also determined.

GPO Results

Data was collected over the GPO using the three sensor arrays prior to data collection in the main survey areas. These data were used to validate the performance of each sensor system and the anomaly detection methodology. The results are shown below as anomaly maps.

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Inert 4.2-in mortars and metal spheres were installed on site. Surveys were conducted twice daily to document day-to-day variability. Static platform data were also collected daily.

Item Depth (cm) Item Length (m) Item Width (m)

4.2" Al Sphere 6 N/A N/A
Shotput #1 10 N/A N/A
Shotput #2 20 N/A N/A
4.2" Mortar #1 35 29 3
4.2" Mortar #2 57 30 2

GEMTADS

EM61 MkII

Magnetometer

GEMTADS

EM61 MkII

4.2" Mortar #1

Emplaced Items

Inert 4.2-in mortars and metal spheres were installed on site. Surveys were conducted twice daily to document day-to-day variability. Static platform data were also collected daily.

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