EXECUTIVE SUMMARY

Implementing Advanced Magnetic Gradiometric Algorithms Within Geosofts Oasis montaj Software Platform

ESTCP Project MR-201423

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Project: MR-201612

TABLE OF CONTENTS

Page

1.0 INTRODUCTION 1
2.0 OBJECTIVES 3
3.0 TECHNOLOGY DESCRIPTION 5
4.0 PERFORMANCE 7
5.0 COST ASSESSMENT 9
6.0 IMPLEMENTATION ISSUES 11

LIST OF FIGURES

Page

Figure 1. Prototype LSG Sensor Mounted on a REMUS600 Being Deployed in the Field..... 5
Figure 2. Prototype Single Axis Gradiometer Mounted on a REMUS100..... 5
Figure 3. Examples of Various Stock Oasis Montaj Interfaces and Data Products..... 6

1.0 INTRODUCTION

The US Navy has for decades been developing passive magnetic gradiometers for use in underwater mine hunting, including sensor hardware, vehicle integration, and detection algorithm development. Currently, analyzing the data from these systems has been the purview of a small number of analysts, making the dissemination of data collected from munitions response sites problematic. As these systems get more utilization on munitions response sites, it will be important to provide additional non-Navy personnel with the capability to process and analyze the gradiometric data. Geosoft's Oasis montaj, one of the common software packages for analyzing magnetic data for remediation, does not currently possess a complete set of tools to properly analyze magnetic gradiometer data from these systems, limiting the munitions response community's ability to properly leverage data from these magnetic gradiometers as they find increased usage on underwater munitions sites.

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2.0 OBJECTIVES

The objective of this project was to create a toolbox within Geosoft's Oasis montaj software package that would allow import of raw data from these gradiometers as well as access to the robust detection algorithms developed and being used by the Navy. This will increase usability of these sensors and data products, as well as develop trust in the results being presented and provided to remedial program managers.

A selection of algorithms and software tools developed at the Naval Surface Warfare Center, Panama City Division (NSWC PCD) will be packaged and combined with tools already available within Oasis montaj to allow for magnetic gradiometric data collected from these systems to be analyzed and displayed in a manner similar to other current electromagnetic unexploded ordnance detection systems, allowing a much wider audience to analyze the data.

The toolbox will be demonstrated by using existing data collected over many years of in-water testing and validation. Intermediate data products from both the original implementation and the Oasis montaj tools will be compared to make certain individual steps in the workflow have been created correctly, while final source detection lists will be compared to verify that the overall product is generating comparable results. Only fully tested and stable tools, the primary set used to import data and generate targets lists are being implemented, as experimental tools would be more prone to failure and inconsistent results.

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3.0 TECHNOLOGY DESCRIPTION

The Laser Scalar Gradiometer (LSG) and follow-on sensors are prototype passive magnetic gradiometers designed for underwater mine countermeasures surveys, built by Polatomic Inc. in collaboration with the US Navy. The original LSG system and its successors, mounted on unmanned underwater vehicles, are capable of detecting ferrous targets such as mines and discarded munitions (see **Figure 1**).

Figure 1. Prototype LSG Sensor Mounted on a REMUS600 Being Deployed in the Field.

Figure 2. Prototype Single Axis Gradiometer Mounted on a REMUS100.

Oasis montaj (see **Figure 3**) is the industry standard for analyzing magnetic survey data. The toolbox created under this project is designed for the LSG system and will make future analysis open to a wider audience.

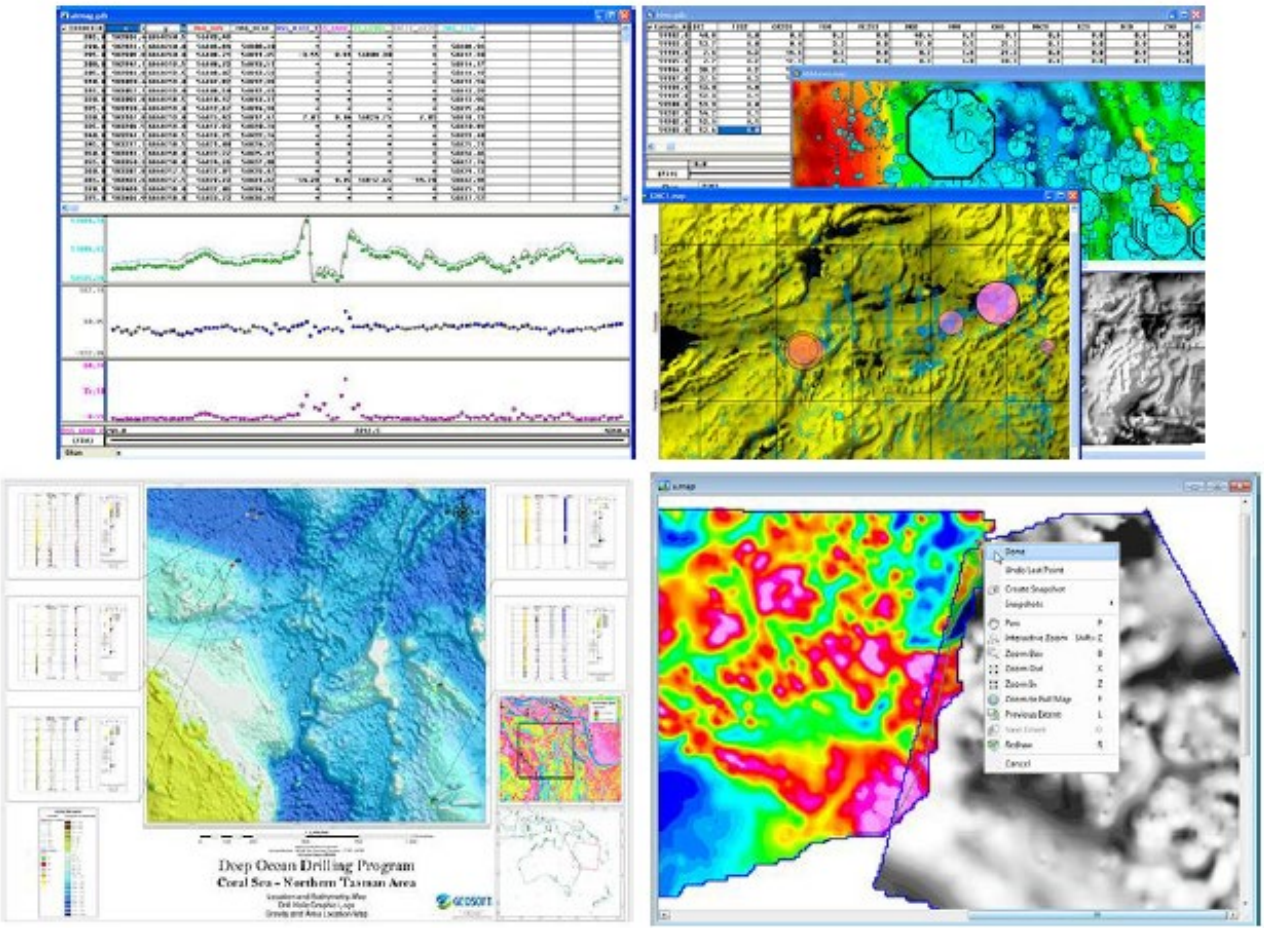

Figure 3. Examples of Various Stock Oasis Montaj Interfaces and Data Products.

4.0 PERFORMANCE

The Navy's ability to detect underwater ferrous items of interest with high confidence has been repeatedly demonstrated during testing over the last 20 years and so the focus of this project was ensuring that the new implementation generates comparable results. Comparing the original algorithm implementation to the Oasis montaj toolbox has shown that they both yield quantitatively very similar results, which is the primary metric of success. The similarity was determined to be 95.54% for anomalies clearly distinguishable from background noise and 90.46% similar for all anomalies. The comparative analysis encompassed almost 100 datasets from 5 unique work products (2013 Fort Story, 2016 Dahlgren, 2016 Panama City, 2017 Dahlgren, 2017 San Diego), each with varying degrees of complexity.

The new software tools developed for this project will be available to the community, similar to other unexploded ordnance tools created in partnership with the Department of Defense (DoD), so software costs will be low. These tools developed under ESTCP project # MM-0131 (2009), are currently available free of charge to Geosoft users from the US Unexploded Ordnance (UXO) community, comprising US government employees, UXO contractors, and regulators working for the DoD on UXO projects.

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5.0 COST ASSESSMENT

Magnetic gradiometers mounted to Unmanned Underwater Vehicles (UUV) can operate in locations inaccessible to standard tow body setups and in many cases closer to the bottom, allowing for increased discrimination of targets. In addition, high accuracy dipole detection algorithms further reduce false alarms. In total, the combined benefit of these technology solutions is to reduce survey time and the number of contacts requiring follow-up remediation, resulting in long term cost savings. However, it is true that the cost of such sensors and vehicle hardware is high, albeit comparable to other survey equipment already in use. The cost of conducting a survey with this type of hardware is also comparable to other underwater survey methodologies, which is understood to be more expensive than land-based surveys.

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6.0 IMPLEMENTATION ISSUES

There are two main requirements to implement the technology under the current configuration:

- ***Software requirements*** – Geosoft's Oasis montaj (v9.4 as of June 2018) and the implemented Magnetic Gradiometric Algorithms (MAGMA) toolbox once it is publicly released with the next version.
- ***Hardware requirements*** – The primary technology requirement is a 3-channel gradiometer, specifically the LSG from Polatomic Inc. and a REMUS600 UUV.

The software is not considered a true limitation as everyone in the industry has access to a Geosoft license for DoD deliverable requirements and the MAGMA toolbox has no extra cost.

The true limitation is the access to the hardware, not due to pubic availability but due to significant capital costs. However, the MAGMA toolbox can be used on datasets acquired by the Navy and provided to the contractor. Future interests for the project include modifying the toolbox for standardizing import formats and increasing geometric flexibilities to leverage a wider array of commercially available systems (e.g. Polatomic magnetic sensors, Geometrics G882 Array) in order to remove all implementation issues observed under the current configuration.