GROUND PENETRATING RADAR MEASUREMENTS: APPLICATIONS TO SYNTHETIC DATA GENERATION AND TARGET CHARACTERIZATION

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1. INTRODUCTION

Ground penetrating radar (GPR) is widely studied for detection of landmines and mine-like targets; GPR is particularly useful for detecting minimum metal mines which are harder to detect using traditional metal detection devices alone. In order to expand the phenomenology for GPR, careful measurements of homogeneous and heterogeneous soils with and without targets (landmine simulants and metal objects) are performed in a controlled environment. These measurements will aid in the development of models for soil response beyond the initial air-ground interface. Such explicit models for soil will increase the effectiveness of algorithms designed to discriminate between returns from targets and from naturally occurring geologic materials and interfaces. Furthermore, careful measurement of soil characteristics will enable comparison and refinement of models of soil with embedded targets developed in electromagnetic simulations (using finite-difference time-domain codes (FDTD), e.g.).

Virginia Tech, through a cooperative research and development agreement with US Army RDECOM CERDEC Night Vision and Electronic Sensors Directorate, is pursuing a simulation effort to enhance the understanding of propagation effects caused by the environment in which landmines are emplaced [1,2]. After simulating propagation and developing an accurate model of the antennas being used, a measurement effort began to study propagation effects in various (layered) media with and without targets.

2. MEASUREMENT APPROACH

The measurements are made in a sandbox (175.26 cm wide by 237.49 cm long by 96.52 cm tall with sand 73.66 cm deep) using an Agilent Technologies Network Analyzer, 8753ES, and 3 Archimedean spiral antennas (left and right-hand circular polarization). The sandbox has a single receiving antenna buried in the sand, same sense circular polarization as the top, transmitting antenna; there is a second receiving antenna (opposite sense) at the top adjacent to the transmitting antenna. The experimental setup is intended to characterize the transmission, dispersion and reflection properties of the various materials layered between the two sets of antennas. In initial measurements, the bottom antenna is buried in sand flush with the air so that the transmission channel can be characterized with no materials in the path. Subsequent measurements are made with single layers of varying depths of sand, soil or gravel. Additional measurements are then made with buried targets (a 2" steel ball and a TS-50 minimum metal landmine stimulant). Finally, measurements are made with layers of different materials (sand above gravel, sand above soil, soil above gravel, etc.) in order to characterize the effects with and without targets in the time domain, frequency domain, and using time-frequency analyses to determine what features can be isolated, and therefore extracted to better identify and characterize the targets (metal or plastic).

3. MODEL APPLICATIONS

The results of these measurements will be used to validate simulation results from electromagnetics modeling codes (XFDTD and FEKO). Previous work has demonstrated 2-D and combined 2 and 3-D modeling of the layered media without targets [3, 4]. The intent of this work is to extend those previous models to include the (metal) target in the layers of environmental material (soils).

4. ACKNOWLEDGMENTS

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5. REFERENCES

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