FINITE DIFFERENCE TIME DOMAIN (FDTD) MODELLING OF GROUND PENETRATING RADAR PULSE ENERGY FOR LOCATING BURIAL SITES

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Introduction

Analysis of the finite difference time domain (FDTD) numerical simulation of ground penetrating radar (GPR) measurement for locating burial sites is described in this paper. Effective, efficient and reliable interpretation of GPR field data obtained from clandestine sites are very crucial in forensic investigations. The main goal of the study is the prediction of the change in the interaction of the electromagnetic incident on the change on buried bodies with time.

Materials and method

The finite-difference time-domain (FDTD) method is used to discretize the partial differential equations for time stepping of the electromagnetic fields. FDTD was adopted for this study because the approach gives broadband output from a single execution of the program and also the excellent scaling performance of the method as the problem size grows. The modeling and simulation were performed using gprMAX authored by Antonis Giannopoulos of University of Edinburgh, UK. Model parameters were selected based on available information from literature and established physical properties of the media. All these information were supplied into the programme via input text files and subsequently, the model and the simulation were generated.

The field measurements were conducted with a 500MHz, 250MHz, and 100MHz central frequency antennae GPR system manufactured by Mala Geoscience incorporation. Constant offset survey technique along established profile on the ground surface where the cadaver was buried was used for the field data measurement. Basic data processing such as time gain, DC-shift and de-wow were performed on both the simulated and field real data. Precautionary measures were taken for the choice of the data processing in order not to distort the data and obliterate the accompany information. Sequel to the processing, qualitative interpretation were made on the processed data and appropriate inferences were deduced.

Results

Generated model from the input parameters is shown in figure 1. It consist of four layers, the pit and the organic body. In order to make the situation more realistic, some disturbances were added.

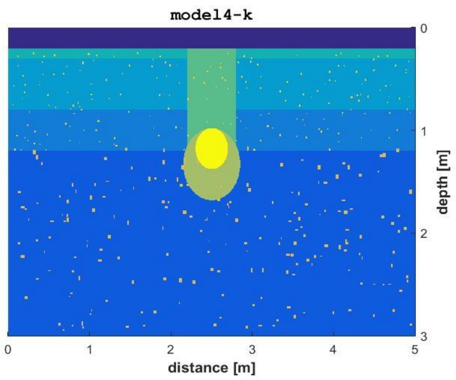

Figure 1. *Model of multilayer subsurface with organic body.*

Comparison of the FDTD numerical simulation and the observed field measurement show that there is similarity in signal amplitude response of the two approaches as shown in figure 2.

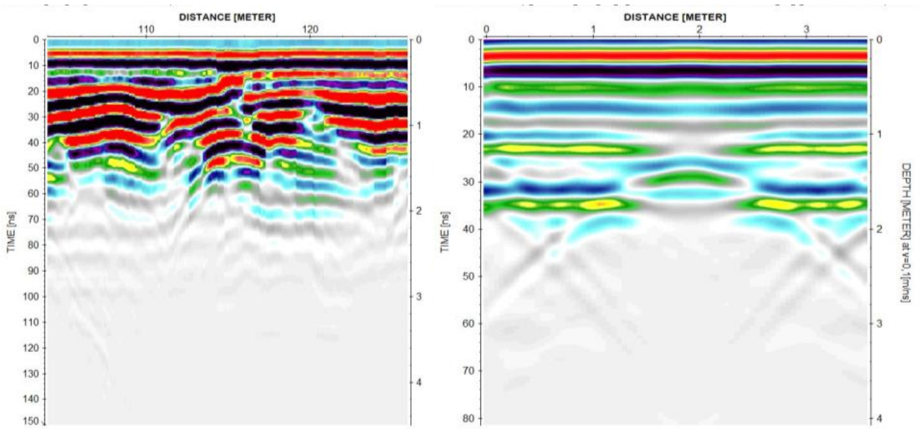

Figure 2. *Comparison of field measurements (left) and model results (right) for 100MHz frequency antenna.*

Variation of the mathematical simulation parameters also significantly improved the similarity in response suggesting that the numerical simulation is very useful at predicting the responses of buried body to incident electromagnetic pulse energy over time. Of particular interest is the correlation of simulated (synthetic) and field (real) echograms for frequency 100 MHz figure 1. Responses from both echograms depicts the target was intercepted at same time (approximately 25 ns).

Conclusions

The results have demonstrated that FDTD modeling is an important tool for enhancing the reliability of GPR data interpretation particularly for forensic study. It follows that modeling and simulation of GPR signals response over controlled buried body with reference to time may predict what results may be obtained in clandestine sites for forensic investigations. Stakeholders in criminal investigations, history and archeology may find such information useful.

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References

gprMAX authored by Antonis Giannopoulos of University of Edinburgh, UK.