

GPR Evaluation Test for Humanitarian Demining in Cambodia

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1. GPR for Humanitarian Demining

In order to improve the efficiency of the demining operations, discrimination of landmines and metal fragments by Ground Penetration Radar (GPR) is believed to be one of the most promising sensors. It can decrease the False Alarm Rate (FAR) in detection of landmines, and can directly reduce the cost of humanitarian demining. For a hand-held system, a sensor has to be compact. However, due to very strong clutter from the ground surface and inhomogeneous soil to GPR, combined use of GPR with metal detector is more common approach. This kind of sensor is named “Dual sensor” for humanitarian demining. Only a few dual sensor systems including Mine Hounds (UK and Germany) (Doheny et. al. 2005), HSTAMIDS (USA) (Daniels et.al., 2005) and ALIS (Japan) are now available for humanitarian demining in commercial basis as of 2009. Our research group at Tohoku University, Japan has been developing this dual sensor system, namely, Advanced Landmine Imaging System (ALIS) since 2002.

2. Hand-Held GPR System

The most unique feature of ALIS is its sensor tracking function. During the operation, the sensor operator can observe the metal detector response image together with a picture of the ground surface on a display. Signal processing and imaging of GPR data is quite common in GPR survey, however, it was not possible in conventional hand-held GPR and dual sensors, because the trajectory of the sensor is unpredictable in a handheld system. ALIS uses a CCD camera fixed on the handle of the sensor head for the sensor tracking. The CCD camera captures images of the ground surface, and the relative movement on the ground surface is calculated by cross-correlation algorithm, and the sensor position can be tracked. Fig.2 shows an example of the tracked sensor position. The dots indicate the positions, where ALIS acquired the data of GPR, metal detector and the sensor position.

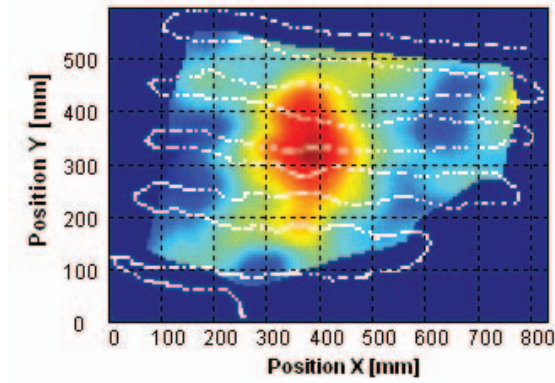


Fig.1 Sensor head trajectory plotted on a reconstructed image of a land mine (MPN-2)

At first, all the acquired data set was relocated on a regular grid points. Interpolation algorithm is used for this process. After the relocation of the data sets, metal detector signal can directly be displayed in a horizontal image as shown in Fig.1. 3-D GPR image is reconstructed by the diffraction stack migration algorithm. A migrated GPR data gives 3-D reconstructed subsurface image.

3. Evaluation Tests in Mine Affected Courtiers

After a half-year tests in Croatia, where ALIS has been used in real mine fields for Quality Control, 2 sets of ALIS were introduced to Cambodia in spring 2009. The first trial of ALIS in real mine fields has started in May 2009 near Siem Reap, Cambodia. In the operation in July 2009, ALIS detected 1193 buried objects, and found 8 ante-personnel mine PMN-2. Examples of GPR profiles in Fig.1 is one of the data acquired in this campaign.

4. Conclusion

ALIS evaluation test have been conducted in Cambodia. We are planning to continue this test in 2010.

ACKNOWLEDGMENTS

This work was supported by JSPS Grant-in-Aid for Scientific Research (S) 18106008 and by JST. ALIS test in Croatia was supported by CROMAC and CROMAC-CTDT. We are especially grateful to Oto Jungwirth, Nikola Pavkovic, Tomislav V. Blaskovic Vondracek, Tomislav Ban, Nikola Gambiroza, Stjepan Knez and Hirvoje Stipetic.

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Motoyuki Sato (S'79-M'80-SM'02-F'10) received the B.E., M.E degrees, and Dr. Eng. degree in information engineering from the Tohoku University, Sendai, Japan, in 1980, 1982 and 1985, respectively. Since 1997 he is a professor at Tohoku University and a distinguished professor of Tohoku University since 2007, and he is the Director of Center for Northeast Asian Studies, Tohoku University since 2009. From 1988 to 1989, he was a visiting researcher at the Federal German Institute for Geoscience and Natural Resources (BGR) in Hannover, Germany. His current interests include transient electromagnetics and antennas, radar polarimetry, ground penetrating radar (GPR), borehole radar, electromagnetic induction sensing, interferometric and polarimetric SAR. He has conducted the development of GPR sensors for humanitarian demining, and his sensor ALIS which is a hand-held dual sensor, has detected more than 30 mines in mine fields in Cambodia since May 2009. He is a visiting Professor at Jilin University, China, Delft University of Technology, The Netherlands, and Mongolian University of Science and Technology. Dr. Sato is a member of the GRSS AdCom (2006-) where he is responsible for specialty symposia and Asian issues. He is an associate editor of IEEE GRSS Newsletter, and a guest editor of the special issue of GPR2006 in Transactions on Geoscience and Remote Sensing. He was the chair of the IEEE GRSS Japan Chapter (2006-2007). He was appointed as the general chair of IGARSS2011 to be held in Sendai, Japan.