Development of Dual sensor for Humanitarian Demining and its evaluation test in Cambodia

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Dual sensor is gathering interest as a new technology for landmine detection. However, the method of combining two sensors must still be developed. Most of the conventional dual sensor systems use a metal detector as a primary sensor, and if the metal detector detects anomaly, GPR is used for confirmation. However, both the system alarms only by audio sound, and rich experience is required for better operation. We are developing a dual sensor system, namely, Advanced Landmine Imaging System (ALIS). ALIS uses a novel technique of tracking the sensor position into a combined MD and GPR sensors, even though it can be scanned by hand by deminers. On the contrary, ALIS can provide 3-D GPR image and it will help to understand the subsurface conditions much better than the conventional audio signal. It leads to the higher efficiency of detection of buried landmines. At the beginning, ALIS used an impulse radar system, and now it was replaced by a stepped-frequency GPR by using a compact vector network analyzer (VNA). We have tested ALIS in various conditions, including in test sites in mine affected country such as Afghanistan and Croatia. In this paper, we introduce the performance of ALIS, and its evaluation test results

ALIS uses a GPR system, which is a stepped-frequency radar by using a VNA(Vector Network Analyzer). The VNA is developed by Tohoku University under support from Japanese Science and Technology Agency (JST). It is small, approximately 30 20 8 cm, and light weight, less than 1.7 kg without battery, but it has almost the same performance as the conventional commercial VNA especially for the sweep speed and the measurement accuracy. The system is designed to be used by two operators. A sensor operator carries a backpack, which includes the GPR unit and metal detector controller. The weight of the backpack is about 5 kg. During the operation, the sensor operator can observe the metal detector response image together with a picture of the ground surface displayed on a tablet PC in real-time. Thus, the area, which shows a high metal detector response, can be scanned thoroughly. The GPR antennas and CCD camera are attached to a metal detector, and the weight is about 2 kg. he other operator controls the data acquisition software on the other PC. The PC and backpack are connected by cables having a length of 5 m, hence the PC operator can keep a safe distance to the searching area. All the instruments in this system can work with a 12 V battery. MIL-D1 metal detector (CEIA, Italy) is used as a base metal detector, which is most commonly used in Afghanistan. The data sampling is repeatedly done. When the data is acquired, the position of the sensor is calculated from a CCD picture.

The GPR data acquired with the sensor position information is processed after the scanning the ALIS sensor over the area of about 1m by 1m. 3-D GPR image is reconstructed by Kirchhoff migration algorithm. The migrated GPR data gives 3-D reconstructed subsurface image. However, we normally use only horizontal slice image (C-scan) as shown in Fig.8(b) for data interpretation. This is due to too much clutter in 3-D image and from many trials, detection of buried landmine image in the horizontal slice is most reliable.

After laboratory tests, we have conducted field evaluation test of ALIS in several different locations. During October to December in 2006, ALIS was evaluated by CMAC (Cambodia Mine Action Center),and local deminers tested ALIS after training. We could find very results by this test.