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EVALUATION OF COMBINED GROUND PENETRATING AND THROUGH-THE-WALL SURVEILLANCE UWB TECHNOLOGY

V. E. Ivashchuk, V. P. Prakhorenko, A. A. Pitertsov, F. J. Yasovskiy
Transient Technologies LLC, Kyiv, Ukraine, National Aviation University, Kyiv, Ukraine

Abstract

This work investigates the possible identification of underground targets using GPR around 300 MHz. For this test, the site was chosen where various unknown objects were buried previously. Depth, location, shape, and the material of cover, in targets were known before experiment. In addition, the same device with different software for signal processing has been tested as a TWS for detecting human movement behind a thick wall [1].

Principles and Performance Characteristics of the Device

Technical data:

- Antenna frequency: 300 MHz
- Antenna to Digital Converter range: 10 cm
- Dynamic range: at least 120 dB
- Measuring rate: up to 50 frames per second
- Survey window: 60, 100, 133, 166 Hz
- Maximum number of channels per trace: 1000
- Trace stacking number: up to 128
- Depth of scanning: up to 3 m (determined by soil properties)
- Scatter resolution: better than 3 m
- Operating modes: point selection, continuous, measuring wheel
- File size of a single profile: up to 2 GB
- Interface: USB
- Dimensions (L x W x H): 610 x 312 x 170 mm
- Weight: 8.4 kg

Some features of this device are:

- Antennas design: all GPR antennas are arranged together into a single cable, which is connected to computer via USB communication cable
- Spectrum processing (equalization, calibration): provides accuracy improvement especially in cluttered environment
- Increased dynamic range: owing to digital stacking of received signals
- Real time signal pre-processing

Description of the Proving Ground

As an experimental test site to investigate the possibilities of modern GPR, the area reserved for the construction of ground heated wall (shown). There were various underground objects and communications at that site, such as a cable, an underground concrete pit for waste water, sewage pipes, access gate pipes, electric cables, and various metal objects buried.

Depth and shape of all the objects were well known a priori; there were appropriate photographic data in general during construction. The aim of the study is to assess the capacity to identify objects with the help of modern technology GPR.

Results of GPR Function Implementation

Fig. 1. GPR and study area

Fig. 2. Reinforced well during construction

Fig. 3. Vertical scan profile. Rectangle situated reinforced location well

Fig. 4. View from above. Horizontal section from the depth of water surface

Fig. 5. 3D recovered well images

Fig. 6. Vertical scan profile of the collector discharge allocated extended location

Fig. 7. A drainage collector in a pit, filled with concrete blocks and covered with pebbles and metal grids, where wastewater are discharged

Fig. 8. Vertical scan profile of the metal pipe. Circle situated reinforced pipe.

Conclusions

Modern methods of signal processing in conjunction with the development of UWB technology can detect the presence of underground objects and communications, but there is ambiguity in their operation. Items should be marked to develop methods and systems of object identification that is a very difficult task. Sometimes a two-dimensional view of data in the diagram is not enough for decision making. Visualization of maximum 2D to 3D view of information in the graphs as has been shown in the paper.

Similar UWB technology can be adopted for both GPR and TWS applications.

REFERENCES

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2. V. E. Ivashchuk, V. P. Prakhorenko, A. A. Pitertsov, and F. J. Yasovskiy, "Through-the-wall UWB technology for detecting human movement behind a thick wall," *Proceedings of SPIE*, vol. 8440, pp. 844001, 2012.

Example of TWS Function Implementation

The test of the system as TWS was done in the building using the plastered brick wall of about one meter thickness. A man was sitting on the chair, making different kinds of movements, namely:

- test 1: leaving his hand from side to side;
- test 2: bending his body from side to side;
- test 3: just breathing, keeping the body in the stable position.

The results of the experiment are presented in [2]. Signal processing detected changes of reflection due to the motion of the object under observation. Very strong changes were observed for test 1 and test 2. Comparison levels but still detectable changes were observed in case of test 3.

