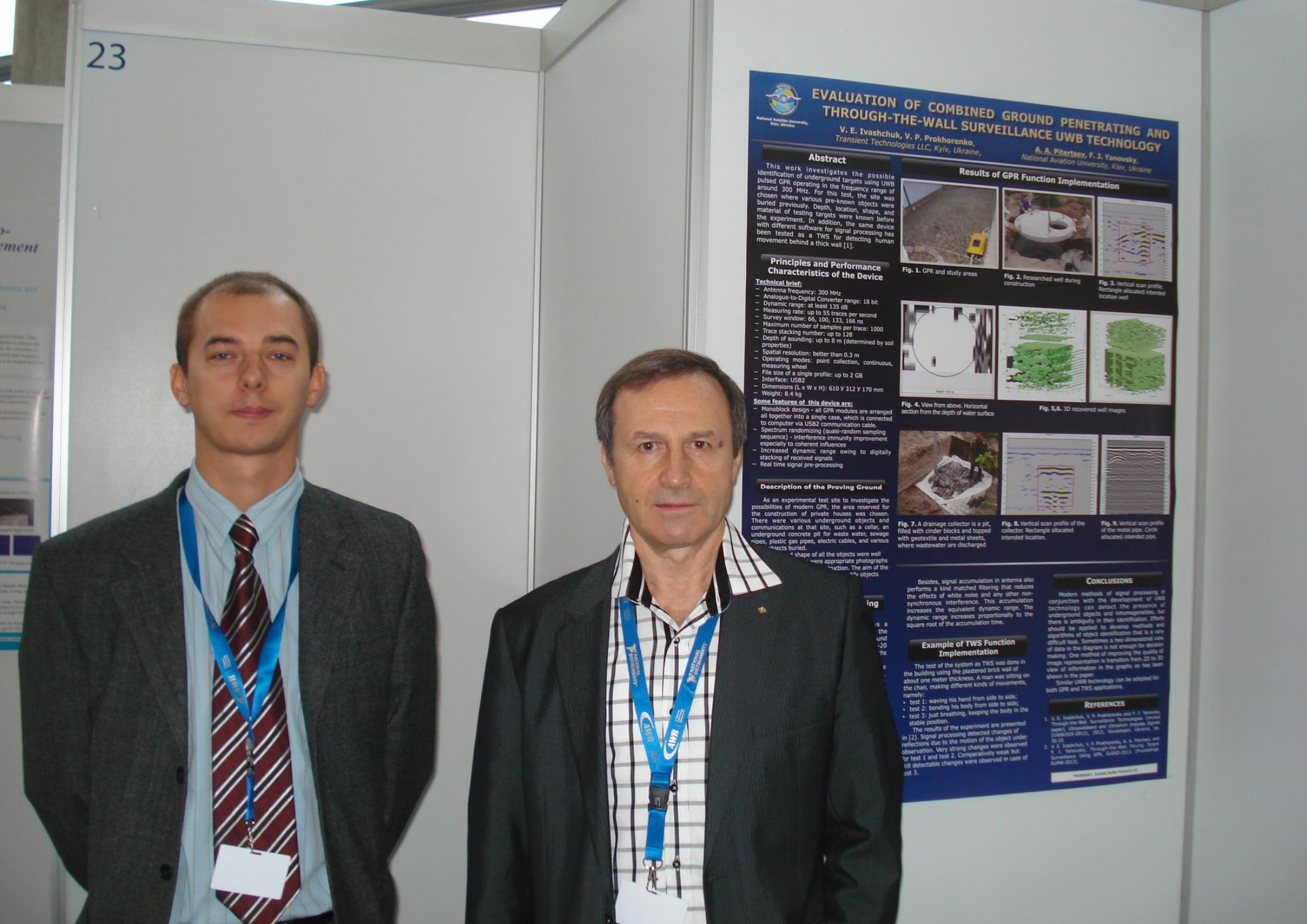
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EVALUATION OF COMBINED GROUND PENETRATING AND THROUGH-THE-WALL SURVEILLANCE UWB TECHNOLOGY
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Abstract
This work investigates the possible identification of underground targets using UWB pulsed GPR operating in the frequency range of around 300 MHz. For this test, the site was chosen where various pre-known objects were buried previously. Depth, location, shape, and material of testing targets were known before the 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 brief:
– Antenna frequency: 300 MHz
– Analogue-to-Digital Converter range: 18 bit
– Dynamic range: at least 135 dB
– Measuring rate: up to 55 traces per second
– Survey window: 66, 100, 133, 166 ns
– Maximum number of samples per trace: 1000
– Trace stacking number: up to 128
– Depth of sounding: up to 8 m (determined by soil properties)
– Spatial resolution: better than 0.3 m
– Operating modes: point collection, continuous, measuring wheel
– File size of a single profile: up to 2 GB
– Interface: USB2
– Dimensions (L x W x H): 610 y 312 y 170 mm
– Weight: 8.4 kg
Some features of this device are:
– Monoblock design - all GPR modules are arranged all together into a single case, which is connected to computer via USB2 communication cable.
– Spectrum randomizing (quasi-random sampling sequence) - interference immunity improvement especially to coherent influences
– Increased dynamic range owing to digitally 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 private houses was chosen. There were various underground objects and communications at that site, such as a cellar, an underground concrete pit for waste water, sewage pipes, plastic gas pipes, electric cables, and various objects buried.
Results of GPR Function Implementation
Fig. 1. GPR and study areas
Fig. 2. Researched well during construction
Fig. 3. Vertical scan profile. Rectangle allocated intended location well
Fig. 4. View from above. Horizontal section from the depth of water surface
Fig. 5,6. 3D recovered well images
Fig. 7. A drainage collector is a pit, filled with cinder blocks and topped with geotextile and metal sheets, where wastewater are discharged
Fig. 8. Vertical scan profile of the collector. Rectangle allocated intended location.
Fig. 9. Vertical scan profile of the metal pipe. Circle allocated intended pipe.
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: waving 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 reflections due to the motion of the object under observation. Very strong changes were observed for test 1 and test 2. Comparatively weak but still detectable changes were observed in case of test 3.
Conclusions
Modern methods of signal processing in conjunction with the development of UWB technology can detect the presence of underground objects and inhomogeneities, but there is ambiguity in their identification. Efforts should be applied to develop methods and algorithms 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. One method of improving the quality of image representation is transition from 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