

## MULTI-WAVEFORM VIDEO IMPULSE RADAR FOR LANDMINE DETECTION

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One of the challenging applications of Time-Domain Electromagnetics and UWB technology is detection of surface-laid and shallow buried targets such as antipersonnel landmines. Such application requires deep understanding of interaction of ultra-short pulses with different objects and principally new (in comparison with conventional radar) design of the system. Together with essential improvements of such hardware specifications as down- and cross-range resolution, sensitivity, stability, etc., this specific application requires a principally new ability to classify and identify detected targets. To meet these requirements we have developed a multi-waveform full-polarimetric system with essentially increased (comparing to conventional GPR) bandwidth.

The design of the radar is based on our analysis of different GPR scenarios. Trying to satisfy technical demands we developed a GPR system, which comprises a pulse generator section, a multi-static antenna system, a four-channel signal conditioner, a five-channel sampling converter and a remote control PC. The radar operates at the pulse repetition rate of 254kHz (all channels sample simultaneously). The operational bandwidth of the radar (measured via external calibration of the radar) covers an interval from 260MHz till 2220MHz for the 0.8ns generator and an interval from 790MHz till 3040MHz for the 0.5ns generator (on 10dB level). The linear dynamic range of the receiver is of about 69dB (with averaging over 128 signals).

The principal novelty of the radar performance lies in its multi-waveform nature. The radar transmits and receives quasi-simultaneously different waveforms corresponding to different transmitted polarizations and different pulse generators. To implement this multi-waveform feature the stroboscopic nature of the sampling scope is used. It allows toggling of both pulse generators and both transmit polarizations within an A-scan (a single measured waveform). Comparison with the signals measured with a constant operating generator shows a good agreement between both types of the measurements. Polarization and generators toggling prevents a necessity of multiple scans over the same area, which is of large practical value for demining.

The system has been tested at the test facility for landmine detection systems located at TNO-FEL, The Hague. The measurements have been done over the sandy lane (in two conditions: dry and wet) and over the grass lane. Analysis of the recorded data has shown that the dynamic range of the radar is sufficient for detecting all antipersonnel mines laid in the lanes in all tested types of soils. Comparison of the data measured with two different generators over the same lane does not confirm the belief that larger bandwidth of the signal necessarily leads to a better detection of the mines in inhomogeneous soil. Processing of the recorded data resulted in high-resolution full-polarimetric images of the subsurface. These images have been successfully used for classification of detected targets by shape, impulse response and polarimetric features. As a result of classification, drastic reduction of the false alarm rate has been achieved.