Enhanced detectability of underground objects using an interference-resistant GPR method

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Abstract

Ground penetrating radar (GPR) is often used in various non-destructive geophysical methods for monitoring underground structures. However, the inspection depth of conventional GPRs is limited to few meters. For deep objects, the propagation losses results in an extremely weak signal at the receiving antenna, and the presence of a large number of small reflectors in the soil layers gives rise to a strong background noise in the signal spectrum. Hence, the signal-to-noise ratio (SNR) is very low. Here, we present the orthogonal scanning GPR method aimed at improving the SNR and the lateral resolution of the GPRs when used for detection of underground rectilinear objects. This method is based on orthogonal scanning for evaluation of the soil anisotropy, and the pattern recognition theory. We also present a method for increasing the reflectivity of narrow underground objects detected by GPR. This can improve both the detection depth and the horizontal resolution. The main idea behind the method is to use two transmitting antennas operating in anti-phase in order to produce a "crescent" shape radiation pattern, so that the desired signal is significantly enhanced. Theoretical analysis and calculations corresponding to real cases show that the proposed method can improve the GPR's SNR by several orders of magnitude. It is clearly shown that this method performs well even in cases that the signal is well below the noise level.