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Comparison of pulse and SFCW GPR in time, frequency and wavelet domain

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Ground penetrating radar (GPR) systems operating in the time- or frequency domain are two fundamentally different concepts, pursuing the same objective: non-invasive characterization of the subsurface. The aim of this study is to compare the performance of these two GPR systems in the time, frequency and wavelet domain. The time domain GPR investigated is the Utilityscan DF. This is a ground coupled GPR with a digital dual-frequency antenna (300 and 800 MHz). The Geoscope GS3F and VX1213 antenna array from 3DRadar is the frequency domain GPR used in this comparison. It is an air coupled stepped frequency continuous wave (SFCW) GPR with a frequency bandwidth from 200 MHz to 3000 MHz. Using data from several test sites of various soil types, the data is evaluated in the time domain, the frequency domain and the wavelet domain. Each of these domains contains specific information regarding the data quality.
Presenting the data in the time domain, allows visualizing the subsurface reflections. This makes it visible how strong the data is affected by internal interference, ringing and other noise. To compensate for the attenuation of the signal in time, automatic gain control is applied. The maximum of this gain function indicates the time where the signal is attenuated completely and noise becomes more dominant, corresponding with the maximal penetration depth of the different GPR systems. In the frequency domain, the data allows to investigate which frequencies contain most valuable information and which ones are affected by noise. Finally, by performing a wavelet transformation the data is transformed to the time-frequency domain. Due to frequency dependent attenuation of electromagnetic signals in the soil, low frequencies will be more dominant in deeper layers, and high frequencies will not be present anymore. This is determining for the range resolution of the data throughout the traveltime of the signal.

This work is a contribution to COST Action TU1208 "Civil Engineering Applications of Ground Penetrating Radar".