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Civil Engineering Applications of Ground Penetrating Radar Recent Advances @ the ELEDIA Research Center

Marco Salucci, Lorenza Tenuti, Cristina Nardin, Giacomo Oliveri, Federico Viani, Paolo Rocca, and Andrea Massa

ELEDIA Research Center@DISI, University of Trento, Trento, Italy (andrea.massa@unitn.it)

The application of non-destructive testing and evaluation (NDT/NDE) methodologies in civil engineering has raised a growing interest during the last years because of its potential impact in several different scenarios. As a consequence, Ground Penetrating Radar (GPR) technologies have been widely adopted as an instrument for the inspection of the structural stability of buildings and for the detection of cracks and voids. In this framework, the development and validation of GPR algorithms and methodologies represents one of the most active research areas within the ELEDIA Research Center of the University of Trento. More in detail, great efforts have been devoted towards the development of inversion techniques based on the integration of deterministic and stochastic search algorithms with multi-focusing strategies. These approaches proved to be effective in mitigating the effects of both nonlinearity and ill-posedness of microwave imaging problems, which represent the well-known issues arising in GPR inverse scattering formulations. More in detail, a regularized multi-resolution approach based on the Inexact Newton Method (INM) has been recently applied to subsurface prospecting, showing a remarkable advantage over a single-resolution implementation [1]. Moreover, the use of multi-frequency or frequency-hopping strategies to exploit the information coming from GPR data collected in time domain and transformed into its frequency components has been proposed as well. In this framework, the effectiveness of the multi-resolution multi-frequency techniques has been proven on synthetic data generated with numerical models such as GprMax [2]. The application of inversion algorithms based on Bayesian Compressive Sampling (BCS) [3][4] to GPR is currently under investigation, as well, in order to exploit their capability to provide satisfactory reconstructions in presence of single and multiple sparse scatterers [3][4]. Furthermore, multi-scaling approaches exploiting level-set-based optimization have been developed for the qualitative reconstruction of multiple and disconnected homogeneous scatterers [5]. Finally, the real-time detection and classification of subsurface scatterers has been investigated by means of learning-by-examples (LBE) techniques, such as Support Vector Machines (SVM) [6].

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