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Multi-illumination and multi-view GPR measurements for Through-the-Wall radar imaging

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The use of Ground Penetrating Radar (GPR) as a non-destructive technique for the localization and imaging of buried targets is nowadays widely used in the fields of civil engineering, archeology, and geology. In traditional GPR applications, the transmitting antenna is placed in air, whereas targets are embedded in a background of different permittivity, which may be given by a soil or a construction material. However, the GPR architecture can be also applied to the case of targets located in air but hidden from the illumination field radiated by the transmitting antenna by a dielectric discontinuity, as in the case of the Through-the-Wall (TW) radar applications, where targets inside a building interior must be localized and imaged [1]. In this work, a commercial GPR equipment is employed to perform an experimental campaign on a TW scene, where two targets of different reflectivity, i.e., a metallic cylinder and a wooden bar, are located behind a masonry wall in a laboratory environment. To increase the information on the scattered fields, the scanning of the transmitting and receiving antennas is performed in a fully multi-bistatic manner, through a multi-view and multi-illumination mode, along a horizontal line parallel to the wall, and keeping the antennas in direct contact with it. The transmitting antenna is a transducer emitting a pulsed signal, with frequency centered at 1 GHz. The imaging of the buried targets has been performed through a novel two-step inverse-scattering technique, that is based on a regularization scheme developed in the framework of variable exponent Lebesgue spaces [2], [3]. In particular, the norm exponent function is directly built from the available data through an initial processing of the data, based on a beamforming approach or on a truncated singular value decomposition (TSVD) technique [4]. The whole frequency spectrum of the measured data is exploited, as the scattered field from the pulsed signals is extracted on a set of frequencies through a Fast Fourier Transform. The proposed approach, applied to the measured data, shows good reconstruction capabilities and a reduction of artifacts.

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