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Nonlinear Inversion of Multifrequency GPR Data in Tomographic Configurations

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The accurate tomographic reconstruction of structures starting from Ground Penetrating Radar (GPR) data is useful in many real-world scenarios, ranging from the characterization of buried regions to the inspection of tree trunks. Unfortunately, the practical application of advanced inverse-scattering methods requires an accurate modeling of the GPR system, and in particular of the antenna and antenna-medium interactions [1]. In this work, the combination of an advanced antenna modelling technique with a nonlinear multifrequency inversion method is investigated from an experimental point of view. The GPR measurements, acquired with a lightweight radar system prototype in different configurations, are processed with a hybrid reconstruction approach that aims at combining the benefits of qualitative processing and quantitative inversion techniques [2]. The reconstruction of cylindrical targets buried in a sand box and in free space are considered, evaluating the influence of the antenna and its modelling on the inversion. Results are promising and allow to draw indications about the applicability of the proposed method to GPR configurations.

[1] A. De Coster and S. Lambot, “Full-wave removal of internal antenna effects and antenna-medium interactions for improved ground-penetrating radar imaging,” IEEE Transactions on Geoscience and Remote Sensing, 2019.

[2] F. Boero et al., “Microwave tomography for the inspection of wood materials: imaging system and experimental results,” IEEE Transactions on Microwave Theory and Techniques, vol. 66, no. 7, pp. 3497–3510, Jul. 2018.