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# Non-destructive Testing of Multi-Layer Structures with a Newton-type Inversion Method

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In principle, the dielectric reconstruction of structures with a multi-layer configuration can have several practical implications. Layered scenarios are indeed present in a quite large number of circumstances, from geophysical inspections [1] to road pavements evaluation [2]. In all these contexts, the ground-penetrating radar (GPR) is a valuable instrument to acquire the back-scattered electromagnetic signals arising from buried targets and discontinuities. However, starting from GPR data, the retrieval of geometric and dielectric properties of such structures is not a straightforward task and is frequently left to operator's interpretation skills or accomplished in qualitative ways. Conversely, the possibility of an accurate characterization of the dielectric properties of objects buried in multi-layer environments may represent a further step toward their automated recognition and classification. The main obstacle in this direction is the need to resolve an ill-posed nonlinear inverse scattering problem, which requires advanced processing techniques with proper regularization capabilities. In free-space and half-space configurations, promising results have been obtained by adopting Newton-type inversion methods in Banach spaces, in particular with multi-frequency formulations [3]. This kind of technique is extended in order to reconstruct targets in three-layer scenarios. Such an extension includes changes in the kernels of the adopted integral operators, which reflect in an increased complexity of the relationship between scattered-field data and target properties. Initial numerical simulations are proposed to validate the inversion procedure and evaluate its performance in a fully controlled environment.

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