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Advanced Numerical Imaging Procedure Accounting for Non-Ideal Effects in GPR Scenarios

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The capability to provide fast and reliable imaging of targets and interfaces in non-accessible probed scenarios is a topic of great scientific interest, and many investigations have shown that Ground Penetrating Radar (GPR) can provide an efficient technique to conduct this kind of analysis in various applications of geophysical nature and civil engineering. In these cases, the development of an efficient and accurate imaging procedure is strongly dependent on the capability of accounting for the incident field that activates the scattering phenomenon.
In this frame, based on a suitable implementation of an electromagnetic (EM) CAD tool (CST Microwave Studio), it has been possible to accurately and efficiently model the radiation pattern of real antennas in environments typically considered in GPR surveys [1]. A typical scenario of our interest is constituted by targets hidden in a ground medium, described by certain EM parameters and probed by a movable GPR using interfacial antennas [2]. The transmitting and receiving antennas considered here are Vivaldi ones, but a wide variety of other antennas can be modeled and designed, similar to those ones available in commercial GPR systems.
Hence, an advanced version of a well-known microwave tomography approach (MTA) [3] has been implemented, both in the canonical 2D scalar case and in the more realistic 3D vectorial one. Such an approach is able to account for the real distribution of the radiated and scattered EM fields.
Comparisons of results obtained by means of a 'conventional' implementation of the MTA, where the antennas are modeled as ideal line sources, and by means of our 'advanced' approach, which instead takes into account the radiation features of the chosen antenna type, have been carried out and discussed.
Since the antenna radiation patterns are modified by the probed environment, whose EM features and the possible stratified structure usually are not exactly known, the imaging capabilities of the MTA advanced implementation have also been tested by introducing 'errors' on the knowledge of the background medium permittivity, by simulating the presence of one or more layers, and by choosing different models of the surface roughness. The impact of these issues on the performance of both the conventional procedure and the advanced one will be extensively highlighted and discussed at the conference.

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