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Full-wave Inversion and Antenna Modeling for the Characterization of Cylindrical Targets

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The reconstruction of the geometric and dielectric properties of unknown targets starting from measurements of the electromagnetic fields they scatter is essential in many different applicative areas, ranging from object detection in subsurface regions [1] to the recent developments related to biomedical and environmental engineering [2]. To obtain such information, an inverse problem should be solved, in which the unknown is represented by the characteristics of the objects. To this end, proper algorithms should be devised, specifically tuned for the measurement setup used for the inspection and for the target configuration.

A crucial part in the development of the reconstruction procedures consists in the accurate modeling of the radar antenna behavior. In most cases, ideal radiating elements are assumed, such as point-like or line-current sources. However, such models do not allow to include multiple reflections within the antenna and between the external scatterers and the antenna, which are inherently present in radar measurements. Hence, for a correct interpretation of measured data, a suitable modeling of these physical effects is fundamental. To address this problem, in [3, 4] a closed-form model able to effectively represent the antennas behavior has been developed. The approach is based on an intrinsic radar equation and on the use of Green's functions applying to the considered imaging configuration.

Up to now, such a model has been successfully used in full-wave inversion procedures involving planar layered media only. However, layered cylindrical configurations, for which closed-form Green's functions also exist, are also of high interest in many applications, like tree trunks, pipes and body parts, such as arms or neck. Consequently, in this contribution, the antenna model in [3, 4] is extended to deal with cylindrical structures through the Green's function for multi-layered cylinders with circular cross section. Moreover, a preliminary inversion procedure aimed at retrieving the geometrical and dielectric properties of the considered cylindrical objects is presented and validated.

References

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