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Retrieval of Shape Characteristics for Buried Objects with GPR Monitoring

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Information retrieval on the location and the geometrical features (dimensions and shape) of buried objects is of fundamental importance in geosciences areas involving environmental protection, mine clearance, archaeological investigations, space and planetary exploration, and so forth. Among the different non-invasive sensing techniques usually employed to achieve this kind of information, those based on ground-penetrating-radar (GPR) instruments are well-established and suitable to the mentioned purposes [1].

In this context, our interest in the present work is specifically focused on testing the potential performance of typical GPR instruments by means of appropriate data processing. It will be shown in particular to what extent the use of a suitable "microwave tomographic approach" [2] is able to furnish a shape estimation of the targets, possibly recognizing different kinds of canonical geometries, even having reduced cross sections and in critical conditions, where the scatterer size is comparable with resolution limits imposed by the usual measurement configurations.

Our study starts by obtaining the typical "direct" information from the GPR techniques that is the scattered field in subsurface environments under the form of radargrams. In order to get a wide variety of scenarios for the operating conditions, this goal is achieved by means of two different and independent approaches [3]. One approach is based on direct measurements through an experimental laboratory setup: commercial GPR instruments (typically bistatic configurations operating around 1 GHz frequency range) are used to collect radargram profiles by investigating an artificial basin filled of liquid and/or granular materials (sand, etc.), in which targets (having different constitutive parameters, shape, and dimensions) can be buried. The other approach is based on numerical GPR simulations by means of a commercial CAD electromagnetic tool (CST), whose suitable implementation and data processing allow us to retrieve results again in the form of radargrams for the scattering features of arbitrarily-composed subsurfaces.

Once these types of "direct" (measured and/or simulated) radargram data are obtained, the "inverse" problem is then handled, based on a Born approximation to linearize the scattering problem. The targets are represented in terms of anomalies ("contrast function") of dielectric permittivity and conductivity with respect to the properties of a background environment. The analysis of the relevant results for the spatial distribution of the magnitude of the contrast function shows that, in various even-challenging practical cases, this kind of approach is able to properly locate buried objects, also identifying the relevant shape features.

[1] D. J. Daniels (Ed.), Ground penetrating radar. IEE Press, 2004.

[2] E. Pettinelli, A. Di Matteo, E. Mattei, L. Crocco, F. Soldovieri, J. D. Redman, and A. P. Annan, "GPR response from buried pipes: measurement on field site and tomographic reconstructions," IEEE Trans. Geosci. Remote Sensing, vol. 47, pp. 2639-2645, Aug. 2009.

[3] G. Valerio, A. Galli, P. M. Barone, S. E. Lauro, E. Mattei, and E. Pettinelli, "GPR detectability of rocks in a Martian-like shallow subsoil: a numerical approach," Planet. Space Sci., 10 pp., doi: 10.1016/j.pss.2011.12.003, 2011.