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A Kirchhoff based reconstruction algorithm for the multimonostatic configuration

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Detection, localization and shape reconstruction of buried objects is one of the most widespread application field of Ground Penetrating Radar (GPR) diagnostics. However, one of the crucial factors limiting the use of GPR consists in the need to resort to the "interpretation" of the raw data, possible only under significant a priori information and a good expertise of the end-user. Thus, the need arises to develop microwave tomography algorithms, based on more refined electromagnetic scattering model, able to mitigate the effect of uncertainties on the scenario and noise on data. When the domains to be investigated are large in terms of the probing wavelength and the buried objects are not small with respect to it, it is convenient to adopt reconstruction algorithms based on linear models of the electromagnetic scattering. The Kirchhoff approximation is useful when strong scattering from metallic objects is investigated and allows shape reconstruction of illuminated side of the object. The unknown contour is searched as the "support" of a distribution, which is the actual unknown of a linear integral relationship connecting it to the scattered field data [1]. The determination of the unknown support is achieved by a two-step procedure: first a regularized inversion of the integral relation by the Truncated Singular Value Decomposition (TSVD) is performed. Then, the locus of the points where the retrieved version of the distribution is larger than a threshold identifies the searched support [2].

The analysis can be extended to multimonostatic measurement configuration typical of GPR applications by resorting to stationary phase approximation. Accordingly the object points contributing to the scattered field in each observation point belong to the parts of the illuminated side of the contour that are located around the geometrical

optics reflection point.

A similar linear approximation holds also for penetrable dielectric objects with permittivity very different from the one of the host medium. For a one-dimensional scattering geometry [3] interfaces embedded in dielectric host media have been reconstructed by a two-step procedure similar to the above case. In this paper we extend to dielectric media the shape reconstruction algorithm based on Kirchoff approximation and discuss the features of the resulting images, when applied to multimonostatic measurement geometry.

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