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A microwave tomography based strategy for the determination of the dielectric permittivity of a lossy soil

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An accurate measurement of the dielectric permittivity of the soil is of interest in hydrology, because of relevant applicative issues as optimal irrigation, pollution monitoring so on (Lambot et al., 2004). Also in the framework of inverse scattering, a reliable detection and characterization of buried targets requires an accurate knowledge of the dielectric properties of the host medium . In (Soldovieri et al. 2008) we have introduced a strategy to retrieve the permittivity of the soil funded on a solution approach that falls in the more general class of the microwave tomography based techniques. Such a strategy exploits as data the GPR measurements at air/soil interface gathered over a buried pipe, where the only a priori information necessary for the exploitation of the approach is that the pipe is small in terms of the probing wavelength. In particular, the strategy is based on the determination of the searched dielectric permittivity as the one that when introduced in the microwave tomographic approach gives the "most focussed image" of the pipe. Compared to the method based on the shape of the diffraction hyperbolas and the nonlinear method based on the Hough Transform, such an approach has the advantage that the reliability of the diagnostics result does not rely on "single points" (or a set of few points) of the hyperbola but rather of the comprehensive overall behaviour of the radar traces. In addition, the method robust with respect to the noise thanks to the adoption of regularization schemes well assessed in linear inverse problems. The method introduced in (Soldovieri et al. 2008) was tested even in inhomogeneous soil, but only in lossless cases or in cases where

the conductivity of the soil was accurately known a-priori.

Here, we extend the method to the case that the soil is lossy when an accurate estimation of its conductivity is not available. This is the case most likely to occur in realistic situations, where a reliable estimation of the soil conductivity is customarily quite more difficult to be obtained than an estimation of the dielectric permittivity. The extension of the method to this more challenging case has required to modify some important details of the solution algorithm in (Soldovieri et al. 2008), even if the underlying ideas are the same exposed in (Soldovieri et al. 2008). In particular, for such a case, we show how the adoption of a criterion based on the support of the reconstructed spot of an electrically small buried target makes it possible to achieve a good estimate of the soil permittivity. This makes the method nearer to the applications, where usually the conductivity of the soil is unknown and even harder to be retrieved with respect to the permittivity.

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