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Detecting a subsurface cylinder by a Time Reversal MUSIC like method

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In this contribution the problem of imaging a buried homogeneous circular cylinder is dealt with for a two-dimensional scalar geometry. Though the addressed geometry is extremely simple as compared to real world scenarios, it can be considered of interest for a classical GPR civil engineering applicative context: that is the subsurface prospecting of urban area in order to detect and locate buried utilities.

A large body of methods for subsurface imaging have been presented in literature [1], ranging from migration algorithms to non-linear inverse scattering approaches. More recently, also spectral estimation methods, which benefit from sub-array data arrangement, have been proposed and compared in [2].Here a Time Reversal MUSIC (TRM) like method is employed.

TRM has been initially conceived to detect point-like scatterers and then generalized to the case of extended scatterers [3]. In the latter case, no a priori information about the scatterers is exploited. However, utilities often can be schematized as circular cylinders. Here, we develop a TRM variant which use this information to properly tailor the steering vector while implementing TRM. Accordingly, instead of a spatial map [3], the imaging procedure returns the scatterer's parameters such as its center position, radius and dielectric permittivity.

The study is developed by numerical simulations. First the free-space case is considered in order to more easily introduce the idea and the problem mathematical structure. Then the analysis is extended to the half-space case. In both situations a FDTD forward solver is used to generate the synthetic data. As usual in TRM, a multi-view/multi-static single-frequency configuration is considered and emphasis is put on the role played by the number of available sensors.

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