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GPR imaging via multi-frequency Linear Sampling Method

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The Ground Penetrating Radar technique (GPR) is constantly used in geophysics and civil engineering to provide effective and high-precision imaging of underground structures and for buried objects detection. And still needs development as shown by the recent (2013) start of the COST Action TU1208 entitled “Civil Engineering Application of Ground Penetrating Radar”; Therefore, it is very interesting to improve the GPR performance for estimating the target location, size and shape. The migration techniques are the traditional GPR imaging approaches. They are able to derive relatively high-resolution images but its capability of shape reconstruction is limited. Iterative inverse scattering methods based on the solution of a nonlinear minimization problem are commonly applied because of high accuracy. However, this kind of approaches requires forward solver for an iterative minimization scheme, which is extremely complex and computational expensive for GPR application. In addition, the iterative scheme may suffer from the presence of false solution (local minima) affecting the reconstruction validity.

Other kind of inverse scattering approaches are qualitative methods. The Linear Sampling Method (LSM) is considered in this framework. LSM can reconstruct the geometrical features of both dielectric and metallic targets with few a priori information. Furthermore, LSM is very effective in terms of computational requirement, it allows of realizing real time reconstructions, which is very attractive in GPR surveys. Several successful examples are available in the literature concerning the GPR imaging via LSM by supposing the antennas as perfect point sources, so that the antenna pattern is not considered.

In this work, the feasibility and reliability of LSM for GPR application are firstly investigated in 2D situation. The synthetic multi-frequency and multi-static data is obtained by 2D Method of Moments (MoM). The feasibility of using LSM for GPR application is studied for a 2D electromagnetic problem. Preliminary results are presented in the simplified configuration of obstacles in free space taking into account the limited data aspect of a GPR configuration. The next step will be to consider the use of non-ideal sources and the possible influence of the antenna radiation pattern onto the results. The extension of the approach to the 3D case will be dealt with and the confrontation with laboratory controlled experimentation is under investigation.