Geophysical Research Abstracts
Vol. 13, EGU2011-7260, 2011
EGU General Assembly 2011


# Detection and characterization of buried layers from holographic GPR data

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Non-invasive diagnostic techniques like the Ground Penetrating Radar play an important role in civil engineering, given their capability of providing information on the inner status of man-made structures in a fast and non-destructive way. In the framework of GPR, wherein the diagnostics is performed by exploiting the interactions among probing electromagnetic waves and hidden objects, an open challenge is to provide detailed and real time information on agents affecting the stability and the conservation state of the structure, such as presence of water infiltrations, mould layers or fractures and air gaps. Obviously, the goal is not only to detect an anomaly but also to give a characterization of it in terms of size and electromagnetic features.
This communication deals with the problem of imaging buried interfaces by means of a holographic GPR configuration, that is by taking as input data the intensity of the signal arising from the interference of a reference signal with the one reflected by the structure under test. The problem is formulated by schematizing the investigated structure as a one-dimensional layered media. The electromagnetic features of the first layer are supposed to be known, while its thickness can be known or not. The second layer is modeled as a half space, whose electromagnetic features have to be retrieved from the intensity data sets. The probing signal is a normally incident wave, schematized as a plane wave or a Gaussian beam.
Aim of this communication is twofold.
First of all, with respect to both the considered incident fields, some constrains to ensure the detectability of the buried interface are traced by comparing the intensity of the signal measured in presence of the buried interface with that of the signal arising when no hidden interface is present. Moreover, since the field reflected by a layered media probed by means of a Gaussian mode is not known in a closed form, but expressed through a series involving a non finite number of terms, some indications on the actual number of terms to be taken into account are given.
The second aim concerns the imaging strategy, i.e. the characterization of an unknown buried interface from intensity data. Such a goal, which involves the solution of a non linear and ill-posed inverse problem is pursued by exploiting a genetic algorithm. Such an inversion strategy is indeed feasible, owing to the reduced number of unknowns to be retrieved, that indeed are the real and imaginary parts of the complex permittivity of the buried half-space and, possibly, the thickness of the intermediate layer of known electromagnetic features.
Numerical examples assessing the reconstruction capabilities of the adopted strategy will be provided at the conference.

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n° 225663 Joint Call FP7-ICT-SEC-2007-1