Geophysical Research Abstracts
Vol. 16, EGU2014-13874, 2014
EGU General Assembly 2014

Full 3D Microwave Tomography enhanced GPR surveys: a case study

Ilaria Catapano (1), Francesco Soldovieri (1), Antonio Affinito (1), and Johannes Hugenschmidt (2)
(1) Istituto per il Rilevamento Elettromagnetico dell'Ambiente, Consiglio Nazionale delle Ricerche, Napoli, Italy (catapano.i@irea.cnr.it), (2) Rapperswil University of Applied Science, 8640 Rapperswil Switzerland

Ground Penetrating Radar (GPR) systems are well assessed non-invasive diagnostic tools capable of providing high resolution images of the inner structure of the probed spatial region. Owing to this capability, GPR systems are nowadays more and more considered in the frame of civil engineering surveys since they may give information on constructive details as well as on the aging and risk factors affecting the healthiness of an infrastructure. In this frame, accurate, reliable and easily interpretable images of the probed scenarios are mandatory in order to support the management of maintenance works and assure the safety of structures. Such a requirement motivates the use of different and sophisticated data processing approaches in order to compare more than one image of the same scene, thus improving the reliability and objectiveness of the GPR survey results.

Among GPR data processing procedures, Microwave Tomography approaches based on the Born approximation face the imaging as the solution of a linear inverse problem, which is solved by using the Truncated Singular Value Decomposition as a regularized inversion scheme [1]. So far, an approach exploiting a 2D scalar model of the scattering phenomenon have been adopted to process GPR data gathered along a single scan. In this case, 3D images are obtained by interpolating 2D reconstructions (this is referred commonly as pseudo 3D imaging). Such an imaging approach have provided valuable results in several real cases dealing with not only surveys for civil engineering but also archeological prospection, subservice monitoring, security surveys and so on [1-4].

These encouraging results have motivated the development of a full 3D Microwave Tomography approach capable of accounting for the vectorial nature of the wave propagation. The reconstruction capabilities of this novel approach have been assessed mainly against experimental data collected in laboratory controlled conditions. The obtained results corroborate that, the use of a full 3D scattering model allows an improved estimation of the objects shape and size with respect to pseudo 3D imaging [5].

In this communication, the performance offered by the full 3D imaging approach is investigated by using a dataset from infrastructure inspection. Since the collapse of a car park in Switzerland killing 7 firemen, "punching", where a pile remains upright but the ceiling carried by the pile falls down, is considered a serious problem The 3D tomography approach was applied to a dataset acquired in a car park in the vicinity of piles. Such datasets can be used for an assessment of the safety of such structures and can therefore be considered as relevant test cases for innovative data processing and inversion strategies.

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