Geophysical Research Abstracts
Vol. 18, EGU2016-10685, 2016
EGU General Assembly 2016

Numerical study of the coupling of two identification methods - thermal and electromagnetic - for the reconstruction of inclusions in thick walls

Nicolas Le Touz (1,2), Jean Dumoulin (1,2), and Francesco Soldovieri (3)

(1) French institute of science and technology for transport, development and networks (IFSTTAR), Components & Systems (COSYS), Bouguenais, France (jean.dumoulin@ifsttar.fr), (2) INRIA/IRISA, I4S Team, Campus de Beaulieu, F-35042 Rennes, France, (3) CNR, IREA, 328 Via Diocleziano, 80124 Naples, Italy

In this numerical study we present an approach allowing introducing a priori information in an identification method of internal thermal properties field for a thick wall using infrared thermography measurements. This method is based on a coupling with an electromagnetic reconstructing method which data are obtained from measurements of Ground Penetrating Radar (GPR) ([1], [2]). This new method aims at improving the accuracy of reconstructions performed by using only the thermal reconstruction method under quasi-periodic natural solicitation ([3], [4]).
Indeed, these thermal reconstructions, without a priori information, have the disadvantage of being performed on the entire studied wall. Through the intake of information from GPR, it becomes possible to focus on the internal zones that may contain defects. These areas are obtained by defining subdomains around remarkable points identified with the GPR reconstruction and considered as belonging to a discontinuity.
For thermal reconstruction without providing a priori information, we need to minimize a functional equal to a quadratic residue issued from the difference between the measurements and the results of the direct model. By defining search fields around these potential defects, and thus by forcing the thermal parameters further thereof, we provide information to the data to reconstruct. The minimization of the functional is then modified through the contribution of these constraints. We do not seek only to minimize a residue, but to minimize the overall residue and constraints, what changes the direction followed by the optimization algorithm in the space of thermal parameters to reconstruct.
Providing a priori information may then allow to obtain reconstruction with higher residues but whose thermal parameters are better estimated, whether for locating potential defects or for the reconstructed values of these parameters.
In particular, it is the case for air defects or more generally for defects having a thermal effusivity ratio much greater than one by reference to the effusivity of the wall. For these types of defects, located at different depths and different thicknesses, it has been shown that the coupling of the two reconstructions led to a reconstruction of better quality that the use of only one of the two methods, either on a qualitative term (the position of the defect and its shape) or quantitative (thermal parameters reconstructed). In particular, the variation of thermal parameters in the vicinity of defects occurs on a much smaller distance when using a priori information, enabling better estimate the discontinuity caused by the presence of the defect.
References :
[1] Brouns, J., Développement d'outils numériques pour l'audit énergétique des bâtiments, PhD thesis, Université Paris-Est, SIE, 2014
[2] Nassiopoulos, A., Bourquin, F., On-site building walls characterization, Numerical Heat Transfer, Part A : Applications, 63(3) :179 :200, 2013
[3] Soldovieri, F., Solimene, R., Lo Monte, L., M. Bavusi, Loperte, A., Sparse reconstruction from GPR data with applications to radar detection, IEEE transactions on instrumentation and measurement, Vol. 60, 3, 2011
[4] Persico, R., Introduction to Ground Penetrating Radar, IEEE Press, Wiley, 2014