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Identification of thermal properties distribution in building wall using infrared thermography

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In the construction sector, most of the measurements carried out from IR camera devices are exploited in a qualitative way (e.g. observation of thermal bridges). However, unless a quantitative analysis is realized, it is not possible to assess the impact of the observed phenomena. Most of research efforts and proposed solutions to identify quantified thermal properties (e.g. U-values) have to be completed, adapted to the built environment and validated in experimental and real conditions to allow quantified assessment of materials thermal properties thanks to IR camera devices [1]. We still need several steps in terms of scientific and technical developments for such technological progress. The H2020 European Built2Spec research project (http://built2spec-project.eu/) aims at giving highlights on that.

Heat transfer through the walls are generally model by 1D heat equation in the wall depth. The built is composed by a multilayer domain representing the construction process. In this context, the thermal parameters of the wall are piecewise constant space functions. We propose a methodology to recover the vector of the wall thermal properties (conductivity and capacity) from boundary measurements obtained from an IR camera. It formulates as an inverse problem where the unknown are sought as minimizers of a cost function evaluating the gap between the measures and the model response. This optimization problem is non linear, and we solve it with the Levenberg-Marquardt algorithm coupled with the conjugate gradient method [2-3]. To shorten the time of the identification process, we use the adjoint method coming from the control theory [4]. This method fasten the gradient computation by solving an associated model, named the adjoint model.
We study the ability of the procedure to reconstruct internal wall constitution from different environmental conditions. Furthermore, we propose a controlled experimental test to evaluate the method in laboratory conditions.

References
[1] L. Ibos, J-P. Monchau, V. Feuillet, Y. Candau, A comparative study of in-situ measurement methods of a building wall thermal resistance using infrared thermography, in Proc. SPIE 9534, Twelfth International Conference on Quality Control by Artificial Vision 2015, 95341I (April 30, 2015); doi:10.1117/12.2185126
[2] Nassiopoulos, A., Bourquin, F., On-site building walls characterization, Numerical Heat Transfer, Part A : Applications, 63(3) :179 :200, 2013
[3] J. Brouns, Développement d'outils numériques pour l'audit énergétique des bâtiments, PhD thesis, Université Paris-Est, SIE, 2014
[4] J.-L. Lions, Contrôle optimal de systèmes gouvernés par des équations aux dérivées partielles. Book, Dunod editor, 1968.