Acceleration of Stochastic Boundary Inverse Problem

Jan Havelka, Jan Sýkora
Czech Technical University in Prague
jan.havelka.1@fsv.cvt.cz, jan.sykora.1@fsv.cvt.cz

Abstract

In this contribution we investigate the possibility of recovering material heterogeneity inside a test sample merely from the boundary measurements. Such methods are used in medical imaging (electrical impedance tomography), material science, geophysics and/or the preservation of historical structures, etc. In particular, our intention is focused on civil engineering problems described by a non-stationary heat balance equation with two material parameters/fields, i.e. thermal conductivity and specific heat capacity. Here, we present novel methodology employing the combination of introducing spatial variability, i.e. random fields, and Bayesian inference as a method utilized in the identification process. The exhaustive numerical calculations are accelerated by polynomial chaos expansion-based surrogate model. The proposed approach is computationally verified for various loading scenarios, solver setups and material field distributions.

References

1. D. S. Holder. Electrical Impedance Tomography: Methods, History and Applications. Taylor & Francis, 2004.
2. A. Kirsch. An Introduction to the Mathematical Theory of Inverse Problems. Springer-Verlag New York, 2011.
3. J. Sylvester and G. Uhlmann. A Global Uniqueness Theorem for an Inverse Boundary Value Problem. Annals of Mathematics, 125(1) (2011), 153-169.
4. A. Kučerová and J. Sýkora and B. Rosić and H. G. Matthies. Acceleration of uncertainty updating in the description of transport processes in heterogeneous materials. Journal of Computational and Applied Mathematics, 236(18) (2012), 4862-4872.
5. A. Allers and F. Santosa. Stability and resolution analysis of a linearized problem in electrical impedance tomography. Inverse problems, 7(4) (1991), 515.
6. G. Strang and G. J. Fix . An Analysis of the Finite Element Method. Prentice-hall Englewood Cliffs (1973).
7. M. Cheney and D. Isaacson and J. C. Newell and S. Simske and J. Goble. NOSER: An algorithm for solving the inverse conductivity problem. International Journal of Imaging Systems and Technology, 2(2) (1990), 66–75 .