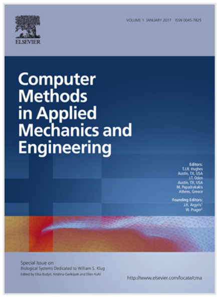
Accepted Manuscript



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PII: S0045-7825(16)30227-4
DOI: http://dx.doi.org/10.1016/j.cma.2017.01.007
Reference: CMA 11292

To appear in: *Comput. Methods Appl. Mech. Engrg.*

Received date: 20 April 2016
Accepted date: 4 January 2017

Please cite this article as: Z. Hu, D. Ao, S. Mahadevan, Calibration experimental design considering field response and model uncertainty, *Comput. Methods Appl. Mech. Engrg.* (2017), http://dx.doi.org/10.1016/j.cma.2017.01.007

Calibration Experimental Design Considering Field Response and Model Uncertainty

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Abstract

Calibration experiment design optimization (CEDO) seeks to identify the optimal values of experimental inputs in order to maximize the obtained information within testing budget constraints. Current CEDO methods only consider observation errors and focus on problems with low-dimensional response variables. This paper proposes a new robust CEDO model for Bayesian calibration with field response and incorporates various sources of model uncertainty such as surrogate model uncertainty, numerical discretization error, and model discrepancy, into CEDO. Since sampling-based methods to estimate the posterior distributions and thus compute the objective function (information gain) are computationally expensive, this paper develops an analytical method to estimate the objective function while accounting for model uncertainty during this process. Based on the evaluation of objective function, a global sensitivity analysis (GSA)-based method is proposed to check the quality of surrogate models used in CEDO, guide the training and improvement of the surrogate models, and thus reduce the effect of surrogate model uncertainty on CEDO. The optimal experimental input settings are obtained using the efficient global optimization (EGO) method. A nonlinear analytical example and a heat transfer example are used to illustrate the effectiveness of the proposed approach.

Keywords: Model calibration; Bayesian approach; Kullback-Leibler (K-L) divergence; Optimization; Experimental Design; Sensitivity Analysis;

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