Università degli Studi di Pavia

Computational Mechanics & Advanced Materials Group - DICAr

SEMINAR

An approach for feasible Uncertainty Quantification of complex real world problems - exemplified for problems in Biomechanics

In this lecture we present an efficient uncertainty quantification scheme that is able to deal with complex and large-scale problems. The uncertainty quantification framework is based on multi-fidelity sampling and Bayesian formulations. The key feature of the presented method is the ability to rigorously exploit and incorporate information from an approximate, low fidelity model. Most importantly, response statistics of the corresponding high fidelity model can be computed accurately even if the low fidelity model provides only a very poor approximation. The approach merely requires that the low fidelity model and the corresponding high fidelity model share a similar stochastic structure, i.e., dependence on the random input. This results in a tremendous flexibility in choice of the approximate model. The flexibility and capabilities of the framework are demonstrated by performing uncertainty quantification on some challenging biomechanics problems.

In simulation of cardiovascular processes and diseases patient-specific model parameters, such as constitutive properties, are usually not easy to obtain. Instead of using population mean values to perform patient-specific simulations, thereby neglecting the inter- and intra-patient variations present in these parameters, these uncertainties have to be considered in the computational assessment. However, due to limited computational resources and several shortcomings of traditional uncertainty quantification approaches, parametric uncertainties, modeled as random fields, have not yet been considered in patient-specific, nonlinear, large-scale, and complex biomechanical applications.

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