Boulder Fluid and Thermal Sciences Seminar Series

Tuesday, March 14, 2017
3:30pm-4:30pm (refreshments at 3:15pm)
Bechtel Collaboratory in the Discovery Learning Center (DLC)
University of Colorado, Boulder

Uncertainty Quantification Using Low-fidelity Data

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Realistic analysis and design of multi-disciplinary engineering systems require not only a fine understanding and modeling of the underlying physics and their interactions but also recognition of intrinsic uncertainties and their influences on the quantities of interest. Uncertainty Quantification (UQ) is an emerging discipline that attempts to address the latter issue: It aims at a meaningful characterization of uncertainties from the available measurements, as well as efficient propagation of these uncertainties through the governing equations for a quantitative validation of model predictions.

The use of model reduction has become widespread as a means to reduce computational cost for UQ of PDE systems. This talk introduces a model reduction technique that exploits the low-rank structure of the stochastic solution of interest – when it exists – for fast propagation of high-dimensional uncertainties. To construct this low-rank approximation, the proposed method utilizes models with lower fidelities (hence cheaper to simulate) than the intended high-fidelity model. Using realizations of the lower fidelity solution, a set of reduced bases, and an interpolation rule are identified and applied to a small set of high-fidelity realizations to obtain the low-rank, bi-fidelity approximation, which in turn will be employed to generate statistics of the high-fidelity solution. The talk will then focus on the convergence analysis of the method and discuss a verifiable condition for the low-fidelity model to lead accurate, bi-fidelity approximation. The performance of this approach will be demonstrated on a RANS model of heat transfer in a channel with ribs.

This is a joint work with Hillary Fairbanks (CU Boulder), Jerrad Hampton (CU Boulder), and Akil Narayan (U of Utah).

Biography: Dr. Doostan's research is focused on assimilation and propagation of uncertainties in complex PDE-based models for the purpose of model validation and verification. Of particular interest to his work is the development of reduced order models for scalable solution of partial differential equations with random inputs. He is also involved in the development of efficient computational tools for large-scale statistical inverse problems. Dr. Doostan has Ph.D. and M.A. degrees from Johns Hopkins University and M.S. and B.S. degrees from Sharif University of Technology.