Chair of Computational Modeling and Simulation
TUM School of Engineering and Design
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Modeling:
Mathematics:
Programming:
Science:

Software Lab:

Model Order Reduction for Uncertainty Quantification

Description

Uncertainty quantification enhances the reliability and credibility of models and predictions, which is essential for informed decision-making and effective risk management across science and engineering. Typical Monte Carlo based methods are based on multiple model evaluations to assess this uncertainty[1]. Especially for complex models, generating numerous system evaluations is not feasible or too expensive. Model reduction addresses this problem by identifying dominant subspaces and constructing surrogate models to approximate the behavior of the full model in a low-dimensional, cost-effective manner.
The goal of this project is to implement model order reduction with an existing finite element library in the context of stationary (time-invariant) finite element analysis. The students first have to get familiar with the specific finite element tool and use the tool to implement a Monte Carlo-based stochastic forward analysis for specific finite element problems. Afterwards they should implement a simple model order reduction approach called proper orthogonal decomposition[2] and compare the results obtained using the reduced model with the results of the full model. Finally, the reduced model can be used to quantify the uncertainty to assess the reliability of the structure.

Task

- Get familiar with sfepy library for finite element analysis
- Implement Monte Carlo method within the sfepy library
- Implement model order reduction approach with sfepy library
- Compare reduced order model with full model in the context of structural reliability

Supervisor

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References

[1] Papaioannou, I., Papdimitrou, C., Straub, D. “Sequential Importance Sampling for Structural Reliability Analysis”, Structural Safety, 2016.
[2] Liang, Y. C. “Proper Orthogonal Decomposition and its Applications – Part 1: Theory”, Journal of Sound and Vibration, 2002.