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Reduced Order Modelling with Applications to Inverse Problems and Uncertainty Quantification

Scientific area: Computational Solids And Structural Mechanics

In the vast majority of engineering applications, models are used for the response prediction of physical systems, as well as the assimilation of data obtained during operation. The latter is often achieved through the solution of inverse problems or the use of uncertainty quantification methods, both of which require repeated evaluations of high-fidelity models (HFM), that might render the whole process computationally infeasible.

Reduced order modelling techniques allow to substantially reduce the computational cost associated with the evaluation of such models, while offering comparable accuracy and enabling online evaluations for Digital Twin (DT) applications. Typically, they involve an offline stage, where a Reduced Order Model (ROM) is constructed based on information from the HFM, and an online stage where the ROM is deployed to make fast predictions. However, preserving the high accuracy achieved by ROMs over the range of all possible configurations of the system that might encountered in practice can be challenging and might require the use of sophisticated methods.

In this MS, recent advances in ROM techniques, as well as their application to inverse problems and uncertainty quantification will be presented. Topics of interest include, but are not limited to:

- Parametric reduced-order modelling techniques.
- Probabilistic ROMs.
- Adaptive techniques, allowing to refine ROMs online, improving their accuracy for regimes beyond the training data used.
- Combination of ROMs with optimisation techniques for the solution of inverse problems.
- Adaptation of ROMs from sparse response observations.
- Identification of ROM parameters.

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