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Proper orthogonal decomposition (POD) combined with hierarchical tensor approximation (HTA) in the context of uncertain parameters

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The evaluation of robustness and reliability of realistic structures in the presence of polymorphic uncertainty involves numerical simulations with a very high number of degrees-of-freedom, as well as a high number of parameters. Some of these parameters are certain in the way that they are a priori known. However, most of the parameters are uncertain, since they are based on incomplete information or imprecise measurements. To account for this uncertainty it is necessary to observe the high dimensional parameterspace. Therefore, a huge amount of simulation is required. In this context a method of model order reduction is used to reduce the cost of each simulation.

In the present contribution, the POD [1] is chosen for this purpose. In order to get accurate results by means of the POD method it is essential to find proper projection matrices. The goal of the present contribution is to significantly improve the accuracy and efficiency of the existing POD method by developing adaptive projection matrices during the simulation.

A moderate number of quantities of interest can be found in most technical problems. This could be for example the maximum displacement or the maximum stress in a deformed object. For several uncertain parameters the number of possible combinations of different parameters can be very high. The HTA [2] is a very good candidate to overcome this issue. The HTA needs several precalculations which can be speeded up by combining it with the POD method. In the next step the HTA can be used for uncertainty quantifications. This includes the calculation of the average, maximum and minimum value of the quantity of interest.

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