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FINITE ELEMENT ADAPTIVITY IN PROBABILISTIC MODEL UPDATING

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This paper presents an automated approach to control the quality of finite element structural dynamic models where some parameters are unknown a-priori but may be updated from data. The ultimate goal of the research is to explore how the uncertainty of the problem must guide the adaptivity strategy and its required accuracy. For instance avoiding unnecessary computational cost if the data is uncertain or maximizing the effect of local refinement of some engineering quantities of interest once the most likely parameters have been computed.

These quantities of interest are calculated as the product between an influence function and the residual [1], which allows localization. Consequently, the finite element(FE) error is estimated with a simple implicit a-posteriori error estimation based on the residual and p refinement. Examples of this kind of estimators can be found at [2].

At each mesh refinement step a stopping criterion for the stochastic analysis [3] must be defined. The maximum distance between the cumulative distribution functions(CDF) of the coarse and estimated fine meshes is a good indicator on how big the finite element error is with respect to the actual level of uncertainty. Some choices to evaluate the CDF include Markov chain Monte Carlo algorithms (or its variants), kernel density estimation or mixture of Gaussian functions.

Once the uncertainty is small enough, all unassembled sample information in the posterior must be transferred to the spatial domain and localised to optimize the next mesh refinement. The two analysed options for spatial localisation are a) using directly the expectation of nodal contributions to a quantity of interest and b) counting the number of samples that indicate each single element to be refined.

In order to speed up the computations, polynomial chaos [4] can be used to approximate the parameter response surface. This approximation produces yet another source of error which needs to be controlled. By nature this error is integrated across all the parameter domain. The required Hermite polynomial order can be controlled independently through a validation sample set. Alternatively, localization in the parameter domain could be achieved through extra localised sample points and additional local basis functions.

Comparative convergence analysis and cost efficiency ratios will be included in the results section leading to conclusions about the advantages of this approach.

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