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Applications of efficient nonlinear model order reduction in computer aided vehicle structure design

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Large and detailed FEM models with nonlinearities still suffer from high computational costs, especially in the context of many-query applications such as optimisations or robustness studies with a large number of parameters. Projection-based nonlinear model order reduction (MOR) methods aim to reduce these costs by approximating the discretised degrees of freedom of the original model using a reduced-order basis (ROB).

We discuss potential applications in vehicle structural design, with special focus on crashworthiness. To this end, we first highlight particular aspects of projection-based model order reduction for explicit time integration, including stability. An important aspect for the design of automotive structures is also the typically large dimension of the original model due to a fine FE discretisation and the large number of components present in the model. This requires efficient and scalable offline and online-phase algorithms. The approach presented makes use of the POD-snapshot method [1], with special improvements made to accelerate the reduced basis computation for large FE models and a large number of snapshots. The proposed method is further equipped with a hyper reduction procedure to reduce the number of nonlinear function evaluations [2-4]. We then apply the methods to an example problem.

REFERENCES

[1] Sirovich L (1987). Turbulence and the dynamics of coherent structures, part I-III. Quarterly of Applied Mathematics, **XLV**(3), 561–571.

[2] Chaturantabut S, and Sorensen D C. Nonlinear Model Reduction via Discrete Empirical Interpolation. SIAM Journal on Scientific Computing, **32**(5), 2737–2764 (2010).

[3] Carlberg K, Bou-Mosleh C, and Farhat C (2011). Efficient non-linear model reduction via a least-squares Petrov-Galerkin projection and compressive tensor approximations. International Journal for Numerical Methods in Engineering, **86**(2), 155–181.

[4] Farhat C, Avery P, Chapman T, and Cortial J. Dimensional reduction of nonlinear finite element dynamic models with finite rotations and energy-based mesh sampling and weighting for computational efficiency. International Journal for Numerical Methods in Engineering, **98**(9), 625–662 (2014).