A Proper Generalized Decomposition (PGD) approach with inertia relief for the solution of unconstrained parametric static problems

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ABSTRACT

The static analysis of unconstrained structures is of major importance to the automotive industry. This analysis cannot be performed by means of conventional static analysis, due to the singularity of the stiffness matrix. Imposing dummy constraints in order to make a free-body system statically determinate leads to unrealistic reaction forces and, as a consequence, an incorrect distribution of the internal stresses. The inertia relief approach [1] solves this issue by counteracting the applied loads by a set of rigid body accelerations. The latter provide body forces which are distributed over the structure in such a way that the total sum of the applied forces on the structure is zero and the static analysis can be performed.

During early stages of a new car project in which design and technical development coexist, exterior and interior design ongoing work continuously concerns car body structure and its technical response. Changing material or geometrical parameters likely results in a variation of the static and dynamic global stiffness of the structure. Trying to perform an accurate and fast evaluation of material and geometrical parameters for each of these loops is still today a challenging problem, due to the large amount of configurations to be tested and the high cost of each simulation involved.

This work proposes the implementation of the inertia relief approach in a Proper Generalized Decomposition (PGD) framework, known as a method to solve high-dimensional boundary value problems. The so-called PGD Least-Squares approximation [2] is considered to obtain explicit parametric solutions of the problem with reduced storage requirements while keeping accuracy. The final goal of this project is to devise a computational tool which can guide the designer in the decision making, so that the impact of certain design parameters on the global response of the structure can be effectively considered already in the preliminary steps.

REFERENCES

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