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A SNAPSHOT-FREE PROPER ORTHOGONAL DECOMPOSITION METHOD FOR TIME-DEPENDENT PROBLEMS

Carlos Sandino[1]*, José V. Aguado[2] and Francisco Chinesta[3]

[1 2] ICI - High Performance Computing Institute, Ecole Centrale de Nantes, ESI GROUP Chair, 1 Rue de la Noë, BP 92101, F-44321 Nantes cedex 3, France, E-mail: [1] Carlos.Sandino@ec-nantes.fr [2]Jose.Aguado-Lopez@ec-nantes.fr

[3] PIMM, ENSAM ParisTech, ESI GROUP Chair on Advanced Modeling and Simulation of Manufacturing Processes, 151 Boulevard de l'Hôpital, F-75013 Paris, France.
E-mail: Francisco.Chinesta@ensam.edu

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The standard Proper Orthogonal Decomposition (POD) is an *a posteriori*-based approach that builds a reduced basis by previously carrying out simulations for different snapshots using a full-order solver. This technique is widely used and involves a significant decrease of the computational cost. Nevertheless, if the sampling is not fine enough, the associated reduced basis will not be able to properly span the entire solution subspace. In the context of reduced basis methods, error estimators have been developed in order to carry out an accurate sampling, but this matter still represents a challenging issue, especially for parametric problems. In this regard, the Proper Generalized Decomposition (PGD) [1] propose an alternative approach, an *a priori* model order reduction method that builds a tensor subspace by setting up an optimization problem, not requiring a prior solution of the problem.

Nevertheless, when considering non-symmetric algebraic configuration problems, the PGD presents several limitations in terms of convergence. In order to alleviate this issue, several techniques have been proposed using alternative strategies based on residual minimization [2], a Petrov-Galerkin approach [3] or ideal residual minimization [4], among others.

In this study, a snapshot-free new technique is proposed for the solution of time-dependent partial differential equations. In order to avoid the computation of snapshots required by POD techniques, an auxiliary symmetrized PGD is solved in order to create a reduced basis. This PGD approach can also consider parametric problems. Then, the obtained basis is employed to implement the POD. Thus, this hybrid POD/PGD-based approach ensures better results in terms of convergence while remaining an *a priori* technique for building separated representations.

REFERENCES

[1] F. Chinesta, R. Keunings, A. Leygue. *The Proper Generalized Decomposition for advanced numerical simulations. A primer.* Springerbriefs, Springer, 2013.
[2] Falcó, A. and Nouy, A. (2011). A Proper Generalized Decomposition for the solution of elliptic problems in abstract form by using a functional Eckart-Young approach. J. Math. Anal. Appl., 376:469–480.
[3] A. Nouy. A priori model reduction through Proper Generalized Decomposition for solving time-dependent partial differential equations. Comput Methods Appl Mech Eng. 199, 1603-1626. (2010).
[4] M. Billaud-Friess, A. Nouy, O. Zahm. A tensor approximation method based on ideal minimal residual formulations for the solution of high-dimensional problems. Esaim Math Model Numer Anal, 48 (6), pp. 1777-1806, 2014.