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A SPACE-TIME PGD APPROACH FOR 3D NONLINEAR PARAMETRIZED PROBLEMS

P.A. Boucard[1]*, D. Néron[1]
[1] LMT-Cachan (ENS Cachan/CNRS/PRES UniverSud Paris)
61, avenue du Président Wilson, F-94235 CACHAN CEDEX, France
boucard, neron@lmt.ens-cachan.fr

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This paper deals with the recurring question of the resolution of a problem for many different configurations. In spite of the fact that computational power has been increasing continuously, the direct treatment of such a problem often remains inaccessible. When dealing with high-fidelity models, the number of degrees of freedom can lead to systems so large that direct techniques are inapplicable. Model reduction techniques constitute an efficient way to circumvent this difficulty by seeking the solution of a problem in a reduced-order basis (ROB), whose dimension is much lower than the original vector space. A posteriori methods usually consist in defining this ROB by the decomposition of the solution of a surrogate model relevant to the initial model (see e.g. [1, 2]). A priori methods follow a different path by building progressively an approximate separated representation of the solution, without assuming any basis (see e.g. [3, 4, 5]).

This work focuses on the Proper Generalized Decomposition (PGD) which belongs to the second family. Recently, PGD was used (with different algorithms to generate the approximation) for what one calls multidimensional problems, for stochastic problems (an approach referred to as Generalized Spectral Decomposition) or to construct response surfaces of parametric problems. The technique which is presented here is based on the use of the PGD in the framework of the LATIN method and is used herein to solve elastic-viscoplastic evolution problems defined over the time-space domain. Within the LATIN framework, PGD has also been developed for multiphysics problems, and for multiscale problems. In these works, the space-time PGD consists in seeking a separated time-space representation of the unknowns and the iterative LATIN method is used to generate the approximation by successive enrichments. At a particular iteration, the ROB which has been already formed is first used to compute a reduced-order model (ROM) and find a new approximation of the solution. If the quality of this approximation is not sufficient, the ROB is enriched by determining a new functional product using a greedy algorithm.

So, the LATIN method and the PGD is an *a priori* model reduction technique which allows to build the solution of a problem at the same time than the most relevant basis to represent this solution. Then, when considering a parametric study, the reduced model generated for some previous sets of parameters is reused and enriched by the LATIN method if needed for a new set all along the parametric study [6]. The basis can be viewed as a set of modes adapted to the loadings and the physics of the phenomenon and is in our cases of small size, which enables light weight calculation.

Drastic computational cost reduction have been already observed with the LATIN method without PGD in parametric studies [7]. In this work, we will show that the PGD enables to perform parametric studies with even more low computational costs. The gain of the strategy for studying the influence of material variability will be exemplified on some 3D examples with large numbers of degrees of freedom.

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