HiMod discretizations for parametric problems in CFD

S. Perotto*

* MOX-Department of Mathematics, Politecnico di Milano
Piazza L. da Vinci 32, I-20133, Milano
e-mail: simona.perotto@polimi.it, web page: http://www1.mate.polimi.it/∼simona

ABSTRACT

Hierarchical Model (HiMod) reduction proved to considerably contain the computational effort without giving up accuracy, when modeling, for instance, CFD dynamics characterized by a preferential direction. This goal is reached throughout a standard separation of variables smartly combined with a different numerical discretization of the main and of the transverse dynamics. Leading dynamics are generally solved by finite elements or with an IsoGeometric Analysis (HIgaMod discretization) [2, 3]. In the last case, the employment of Non Uniform Rational B-Splines (NURBS) provides a crucial tool towards CFD simulations in real geometries.
Transverse dynamics are discretized in terms of a modal basis, properly selected to include the boundary conditions assigned on the lateral surface of the computational domain.

In this communication, we focus on the parametric generalization of HiMod reduction. Indeed, the computational benefits provided by a HiMod discretization become even more significative when solving parametrized problems, such as in data assimilation, optimization or parameter estimation. To this aim, we merged HiMod reduction with standard techniques to deal with parametrized settings. In particular, we combined HiMod with the Proper Orthogonal Decomposition (POD) and with the Reduced Basis (RB) method, thus yielding the so-called HiPOD [1] and the HiRB approaches. After introducing the HiPOD and the HiRB procedures, we will numerically investigate the corresponding performances on benchmark cases.

REFERENCES

[1] D. Baroli, C.M. Cova, S. Perotto, L. Sala and A. Veneziani. Hi-POD solution of parametrized fluid dynamics problems: preliminary results. In Model Reduction of Parametrized Systems. Series: MS&A Springer, P. Benner, M. Ohlberger, A.T. Patera, G. Rozza, K. Urban Eds., Chapter **15**, pp. 235–254, 2017.

[2] S. Perotto, A survey of hierarchical model (Hi-Mod) reduction methods for elliptic problems. In Numerical Simulations of Coupled Problems in Engineering. Series: Computational Methods in Applied Sciences, Vol. **33**, Springer, S.R. Idelsohn Ed., pp. 217–241, 2014.

[3] S. Perotto, A. Reali, P. Rusconi and A. Veneziani. HIGAMod: a Hierarchical IsoGeometric Approach for MODel reduction in curved pipes. *Comput. & Fluids*, Vol. **142**, pp. 21–29, 2017.