HigaPOD: Recent Developments for Parameter-Dependent Problems in Hemodynamics

Yves A.B.C. Barbosa† **and Simona Perotto**†

†Politecnico of Milano
MOX - Department of Mathematics
Piazza Leonardo da Vinci 32, I-20133 Milano, Italy
e-mail: {yvesantonio.brandes,simona.perotto}@polimi.it

ABSTRACT

In the field of hemodynamics, numerical models have evolved to account for the demands in speed and accuracy of modern diagnostic medicine. Methods have incorporated different reduction techniques to perform, with the same level of precision, the computation of solution of partial differential equations in the constraints of time and computation power available in most diagnostics center.

In this context, we studied Hierarchical Model Reduction techniques combined with Isogeometric Analysis (HigaMOD), a technique recently developed in [1]. HigaMod is a reduction procedure used to downscale models when the phenomenon at hand presents a preferential direction of flow, e.g., when modelling the blood flow in arteries. The method showed a significant improvement in reducing the computational cost and simulation time, while providing enough information to analyze the problem at hand.

In this presentation we focus on HigaPOD, a method that combines the advantages of HigaMod with the benefits characterizing the Proper Orthogonal Decomposition (POD). This allows us to further speed-up the computation of a HigaMod approximation in a parametric context. HigaPOD approach has been also properly extended to a nonlinear context by resorting to (discrete) empirical interpolation algorithms.

We have recently extended the application of HigaPOD to the solution of the Stokes problem [2]. In particular, we merge this technique with an ad-hoc reconstruction procedure to recover patient-specific geometries from Magnetic Resonance Imaging (MRI) and Computerized Tomography (CT) scan information, in order to assess the effectiveness of hierarchically reduced methods in real-life applications. The results obtained, even though preliminary, are promising and show the actual capabilities of HigaMod with respect to conventional numerical approaches.

REFERENCES

[1] S. Perotto, A. Reali, P. Rusconi, and A. Veneziani. *HIGAMod: A Hierarchical IsoGeometric Approach for MODel reduction in curved pipes.* Computers & Fluids, Vol. **142**, 21-29 (2017).

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