Hi-Mod reduction for incompressible flows

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ABSTRACT

Hierarchical Model (Hi-Mod) reduction provides a practical way to generate surrogate models suited to describe phenomena with a dominant dynamics even though locally featuring relevant transverse components. This is, for instance, the case of modeling blood flow in arteries in the presence of vascular diseases, such as stenotic or aneurysmal vessels.

The driving idea of a HiMod reduction consists in differentiating the discretization of the dominant and of the transverse dynamics, according to a separation of variables. The mainstream is, in general, discretized via classical finite elements or an isogeometric approach to include the possible bending of the arterial centerline [2, 4]. Transverse dynamics are described via a modal basis, according to a Fourier expansion. This distinct management of main and secondary dynamics leads to replace the full model with a system of coupled one-dimensional models, whose coefficients keep trace of the effect of the transverse dynamics. Additionally, the number of transverse modes can be locally (and automatically) tuned along the mainstream, according to the meaningfulness of the transverse information [3]. In more detail, relatively few modes are expected to capture the transverse dynamics with an overall reduction of computational costs with respect to the full model.

In this presentation, after introducing the basics for a HiMod reduction, we focus on the most recent advances of such an approach, by showing a first application of HiMod to the blood flow modeling in a patient-specific stenotic coronary [1].

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