A combined HDG-PGD approach for the solution of a parameterized Oseen flow

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ABSTRACT

The increasing interest in high-order discretization techniques for CFD applications is motivated by the high accuracy that these methods provide, mainly in the simulation of transient flows due to low dispersion and dissipation errors compared to low-order methods [5]. Moreover, in industrial applications, the necessity of testing a large number of parameter settings for the same problem (e.g. material parameters, boundary conditions) leads to an unaffordable computing time. This issue can be circumvented by means of a reduced order modeling framework.

In this work a methodology that combines the high-order hybridizable discontinuous Galerkin (HDG) method and the proper generalized decomposition (PGD) is proposed for the solution of a steady Oseen flow problem. HDG was first proposed in [3] and it is a variation of the classical discontinuous Galerkin (DG) which substantially reduces the number of coupled unknowns of the discrete problem. Its main feature is the definition of all the DG unknowns as functions of a hybrid variable - that is, the trace of the solution on the skeleton of the mesh. The PGD will be utilised to construct a general solution, incorporating parameters such as the Reynolds number as extra coordinates. As discussed in [2], the PGD algorithm provides an a priori vademecum of the solution which depends on the parameters of the problem, thus its evaluation for a given set of values is computationally inexpensive. The applicability and potential of the proposed HDG-PGD methodology will be illustrated using numerical example, paying particular attention to the HDG stabilization term in the convection-dominated setting [1, 4].

REFERENCES