Adaptive immersed isogeometric analysis for incompressible viscous flow problems

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ABSTRACT

Over the last decade the application of Isogeometric Analysis (IGA) to incompressible viscous flow problems has been studied extensively, which has led to the development of a range of isogeometric finite element families. While these element families have been successfully applied in a mesh conforming setting, direct application in an immersed (Isogeometric Finite Cell) setting has been demonstrated to yield local oscillations in the pressure field near cut boundaries [1]. An alternative stabilization technique that avoids the stability problem observed for inf-sup stable velocity-pressure pairs in the Isogeometric Finite Cell method was proposed in Refs. [2, 3]. This technique – referred to as skeleton-stabilized IGA – can be regarded as a high-regularity generalization of the continuous interior penalty method [4].

In Ref. [3] the Skeleton-stabilized Isogeometric Finite Cell technique was applied to the scan-based analysis of Stokes flow through a porous medium. It was demonstrated that the proposed technique can be successfully applied to determine the effective permeability of a scanned porous medium sample. In this contribution we extend the scan-based analysis in Ref. [3] with adaptive mesh refinement capabilities. A goal-oriented refinement strategy will be considered to optimally compute the effective permeability of a scanned specimen. The local mesh refinement capabilities offered by truncated hierarchical B-splines will be leveraged to optimally benefit from the decoupling of the geometry representation and the solution discretization, *i.e.*, while the geometry is resolved adequately by an advanced cut cell integration scheme, the background mesh is only refined in regions that are important to the quantity of interest. The proposed technique will be studied based on simplified benchmark cases and will be applied to a scan-based analysis of a porous medium sample.

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