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FLUID-STRUCTURE INTERACTION ANALYSIS WITH ISOGEOMETRICALLY ENRICHED FINITE ELEMENTS

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In this study, we investigate the influence of an isogeometric enrichment approach for fluid-structure interaction (FSI) applications. The approach has demonstrated significant merits for fluid flow [2, 3] and heat transfer[4] applications. Here, we present a numerical strategy capable of locally blending IGA within a finite element mesh representation, composed of classical Lagrange finite elements. This is achieved by exploiting the dual character of isogeometrically enriched elements [1], whose one face is enriched with a matching NURBS representation of the localized IGA mesh element while the opposite face offers the classical Lagrange representation. Hence, the enriched elements act as interfacing elements between IGA and classical mesh descriptions. Adopting this methodology leads to the localized IGA zone enrichment approach, where it is possible to model major part of the bulk domain with efficient but less accurate Lagrange finite elements, while IGA is performed only at regions where it may be critically beneficial.

In this context, a FSI solver capable of analyzing solid bodies undergoing large deformations due to acting fluid forces is developed. Consistently stabilized Petrov-Galerkin formulation expressed in arbitrary Lagrange-Eulerian finite element framwork is used for modeling the laminar fluid flow, while the Galerkin finite element method is used to numerically solve the hyperelastic solid governing equations. The fluid and the solid mechanics formulations are set up in a monolithic solution environment, where the dynamic system is evolved using the generalized α-time integrator. The merits of the proposed approach are identified through robust convergence analysis of several FSI benchmark examples of two- and three-dimensional nature and comparison with other well established solution approaches namely, the classical finite element method, the isogeometric surface enrichment approach and the full scale IGA. The proposed zone enrichment approach is observed to yield IGA comparable solutions — that are significantly improved than the classical or the surface enriched approach — without resorting to full scale IGA.

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