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IMMERSED ISOGEOMETRIC ANALYSIS OF FLUID-STRUCTURE INTERATION PROBLEMS

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In the past few decades, numerous research efforts have been directed to the development of modelling and simulation techniques for Fluid-Structure Interaction (FSI) problems. An FSI problem that has attracted considerable attention is that of a viscous fluid containing fully immersed deformable solids. In the 1970's, Peskin [1] developed the Immersed Boundary (IB) method to study this kind of problems and later on this method was improved in [2]. The major advantage of the IB method is that the fluid-structure interface is tracked automatically, which removes the time consuming computations due to mesh update algorithms that are present in the arbitrary Lagrangian Eulerian technique.

In this work, we develop a new method based on applying isogeometric anlysis [3] to the immersed solid-fluid system. The fluid is governed by the Navier-Stokes equations of viscous incompressible flows and the Variational MultiScale (VMS) method is utilized in the simulations [4]. The solid is treated as a nonlinear hyperelastic solid, but other solid models could be considered. The information transfer between the fluid mesh and the solid mesh is carried out utilizing the NURBS shape functions instead of introducing a discretized Dirac delta function. The higher-order and higher continuity of the shape functions permits to deal with severe distortions in the solid mesh and improve the accuracy in the fluid resolution per degree-of-freedom. Several 3D numerical examples are compared with experimental data and other numerical methods.

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