DIVERGENCE-FREE EXTENDED HYBRIDIZABLE DISCONTINUOUS GALERKIN METHOD (X-HDG) FOR LAMINAR INCOMPRESSIBLE TWO-PHASE FLOW

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In the last decades, there has been a considerable attention towards high-order accurate numerical methods for Computational Fluid Dynamics (CFD) applications within the research community. The reason is that the current commercial and industrial CFD codes based on Finite Volume Method (FVM), which are at best second-order accurate, are not efficient enough for some complex problems such as vortex-dominated flows. An example of future interest is the incompressible two-phase (air-water) viscous flow simulation around a maneuvering ship.

When it comes to research in high-order schemes for CFD, the Hybridizable Discontinuous Galerkin (HDG) Finite Element Method (FEM) is very popular [1]. It has some interesting properties such as being locally conservative, stable for convection-dominated problems, and highly parallelizable.

In the aforementioned unsteady example, a fixed unfitted mesh is to be used and the interface is allowed to cut through some elements of the mesh. For this, the concepts of extended FEM (X-FEM) [2] are adopted within the framework of HDG method which results in the so-called extended HDG (X-HDG) method. The X-HDG method allows for a high-order approximation of discontinuous solutions across the interface within the cut elements. This research was influenced by the combination of X-FEM with standard DG method in [3]. A divergence-free X-HDG method is presented for the laminar incompressible two-phase flow.

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