High-Order Discretizations of Flow Past Moving Obstacles using Universal Meshes

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ABSTRACT

We introduce a high-order finite element method for the simulation of fluid flow past moving obstacles in two dimensions. We discretize the fluid domain using a universal mesh [1, 2, 3]: a background mesh that conforms to the geometry of the fluid boundary at all times by perturbing a small number of nodes near the fluid boundary. The method is able to handle large deformations of the fluid domain easily, and it provides a sharp representation of the geometry of the fluid-solid interface. We show further that free surfaces can be incorporated by discretizing the free surface with a spline and enforcing the no-slip condition condition via collocation at the spline's control points. We give numerical evidence that the method achieves high-order rates of convergence when using finite elements and time integrators of the appropriate order, and we discuss theoretical results that support these observations [4].

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