6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

AN IMMERSED BOUNDARY FINITE ELEMENT METHOD FOR FLUID-STRUCTURE INTERACTION AND OTHER APPLICATIONS

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Keywords: *Immersed Boundary, Finite Element Method, Nitsche's Method, Ghost Penalty*

We present a finite element method which is formulated on a Cartesian b-spline grid with hierarchical refinement and uses Nitsches method for the imposition of Dirichlet conditions at immersed boundaries. Following the work by Hansbo, Burman and co-workers [1], the stabilisation of cut elements is achieved by the employment of ghost penalty terms at the relevant inter-element boundaries, which we adopt to the higher order b-spline basis functions. We discuss strategies for cut element integration. A Laplace benchmark problem is used to demonstrate that the stabilisation is effective and that the methodology retains the expected order of accuracy [2]. Further applications include the Navier Stokes equations, fluid-structure interaction [3] and our recent work on the isothermal Navier-Stokes-Korteweg equations. In terms of an industrial application, we show that the methodology allows for the accurate simulation of the dynamic behaviour of hydraulic devices used in the control system of combustion engines. Such problems typically involve a wide range of length scales and often crucially depend on the resolution of fluid flow through narrow gaps.

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