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

A NITSCHE FINITE ELEMENT METHOD FOR THE NAVIER-STOKES EQUATIONS WITH SLIP CONDITIONS ON CONFORMING INTERNAL INTERFACES

Van-Dang Nguyen[1], Johan Jansson[1], Thomas Frachon[1], N. Cem Degirmenci[2], Johan Hoffman[1]

[1] KTH Royal Institute of Technology
[2] BCAM - The Basque Center for Applied Mathematics, Spain

Key words: *Nitsche finite element method, fluid-structure interaction, slip conditions, conforming meshes, internal interfaces*

Slip velocity boundary conditions (BCs) can be used to simulate the effect of turbulent boundary layers in fluid-rigid body interaction models [1] and have been applied successfully in many applications in aerodynamics. To prescribe the slip boundary conditions we need to enforce the continuity of the velocity normal to the fluid-rigid body interface, while allowing a jump in the tangential velocities. Our aim is to extend this work to fluid-structure interaction (FSI) to allow for some important phenomena such as bending and vibration. A unified continuum fluid-structure interaction model [2] was developed to simulate flexible structures but with no slip boundary conditions imposed implicitly through the model. Here we investigate an extended finite element method [3] which allows for imposing slip boundary conditions over the internal fluid-structure interface. In the following figure we show preliminary results for inviscid flow past a rigid structure with no-slip BCs (left figure) and slip BCs (right figure) imposed at the internal interface. Only slip BCs can be used to describe the Euler flow correctly.

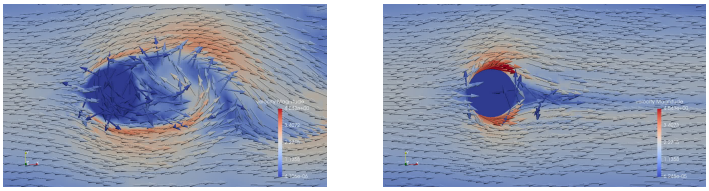

Figure: Euler flow approximated by a stabilized finite element method, with no slip (left) and slip (right) boundary conditions.

REFERENCES

[1] J. Hoffman, J. Jansson, N. Jansson, R. Vilela De Abreu, Towards a parameter-free method for high Reynolds number turbulent flow simulation based on adaptive finite element approximation, Comput. Meth. Appl. Mech. Engrg., Vol.288, pp.60-74, 2015.

[2] J. Hoffman, J. Jansson, and M. Stöckli, Unified continuum modeling of fluid-structure interaction, Math. Models Methods Appl. Sci. 21, 491 (2011).

[3] Wadbro, E., Zahedi, S., Kreiss, G. et al, A uniformly well-conditioned, unfitted Nitsche method for interface problems, Bit Numer Math, Vol.53, pp.791-820, 2013.