Stabilised Finite Element Methods vs LES modelling for fluid-strucure interaction with anisotropic adaptive meshing

E. Hachem and T. Coupez

Ecole des Mines de Paris, Centre de Mise en Forme des Matériaux (CEMEF), UMR CNRS 7635
Address: 1 rue Claude Daunesse, Sophia-Antipolis, France
e-mail: elie.hachem@mines-paristech.fr
Web page: http://www.cemef.mines-paristech.fr/staff/elie-hachem

Abstract

This paper presents a stabilised finite element method for the solution of incompressible multiphase flow problems in three dimensions using an immersed volume method with anisotropic adaptive meshing [1]. A recently developed stabilised finite element solver which draws upon features of solving general fluid-structure interactions is presented. The proposed method is developed in the context of the monolithic formulation. Such strategy gives rise to an extra stress tensor in the Navier-Stokes equations coming from the presence of the structure (e.g. rigid or elastic) in the fluid. The distinctive feature of the Variational MultiScale approach is not only the decomposition for both the velocity and the pressure fields into coarse/resolved scales and fine/unresolved scales but also the possible efficient enrichment of the extra constraint [2]. This choice of decomposition is shown to be favorable for simulating multiphase flows at high Reynolds number [3].

We assess the behaviour and accuracy of the proposed formulation coupled to the levelset method approximation in the simulation of 2D and 3D time-dependent numerical examples such as: the water waves propagations, vortex shedding behind an obstacle, conjugate heat transfer inside industrial furnaces and the rigid bodies motion in incompressible flows. Results are compared with the literature and show that the present implementation is able to exhibit good stability and accuracy properties.

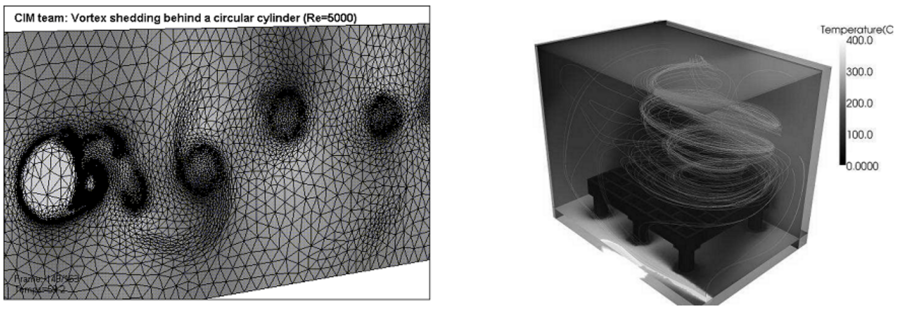

Figure 1: Dynamic anisotropic mesh adaptation for vortex shedding behind a rigid obstacle (left). Turbulent heat transfer inside an industrial furnace (right)

References

[1] T. Coupez, *Metric construction by length distribution tensor and edge based error for anisotropic adaptive meshing*, submitted to J. Comp. Phys. (2010)

[2] S. Feghali, E. Hachem and T. Coupez, *Monolithic stabilized finite element method for rigid body motions in the incompressible Navier-Stokes flow*, submitted to Er. Journ. of Comp. Mech.(2010)

[3] E. Hachem, B. Rivaux, T. Kloczko, H. Digonnet and T. Coupez, *Stabilized finite element method for incompressible flows with high Reynolds number*, J. Comp. Phys. **224** (2010), 8643–8665.