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

HIGH-REYNOLDS FLUID-STRUCTURE SIMULATIONS USING ADAPTIVE GRID REFINEMENT AND OVERSET APPROACH FOR HYDRODYNAMIC APPLICATIONS

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Key Words: *Fluid-structure interaction, CFD, Adaptive grid refinement, overset*

Fluid Structure Interaction (FSI) problems are commonly encountered in naval architecture. During the last two decades, major numerical developments were performed and prosperous literature was published related to this topic. Two different numerical methodologies can be distinguished: numerical methods which extend classical Navier-Stokes solvers based on body-fitted meshes through an Arbitrary Lagrangian Eulerian (ALE) approach and new paradigms based on Immersed Boundary (IB, also called Embedded Boundary) where the fluid-structure interface is no more a boundary of the mesh but captured through an implicit surface, generally described by a level-set method. Even if the versatility of IB is an advantage, as it has no limitation in terms of structural deformation and body contact, body-fitted mesh approaches remain up to now the more accurate solution for high Reynolds-number configurations where the capture of the turbulent boundary layer and the accurate prediction of viscous fluid forces are crucial.
To conserve the high-Reynolds performance of ALE while approaching the versatility of IB, we propose here a numerical approach which pushes the limits of the ALE formulation, owing to the combined use of the overset grid technique and adaptive grid refinement (AGR) [1], developed in the Finite-Volume solver ISIS-CFD: overset approach with deformable external boundaries allows to handle large body deformations while keeping a high mesh quality, and AGR ensures numerical accuracy by refining the mesh not only to adapt the grid density to the flow solution but also to ensure mesh size continuity in the moving overlapping boundary.
The FSI coupling algorithm, based on an efficient two-ways partitioned approach leading at convergence to the monolithic solution, will be also presented [2]. The partitioned approach brings some advantages, such as the re-use of dedicated existing solvers for each medium, developed and maintained by experts in each field. However, stability issues can appear especially in hydrodynamics where the added-mass effect is strong. Here, the robustness of the method is obtained by a specific stabilization to handle this numerical issue [3].

REFERENCES

[1] J. Wackers, G.B. Deng, A. Leroyer, P. Queutey, M. Visonneau, Adaptive grid refinement for hydrodynamci flows. *Computers & Fluid*, Vol. **55**, pp. 85-100, 2012.
[2] M. Durand, A. Leroyer, C. Lothodé, F. Hauville, M. Visonneau, R. Floch and L. Guillaume, FSI investigation on stability of downwind sails with an automatic dynamic trimming. *Ocean Engineering*, Vol. **90**, pp. 129-139, 2014.
[3] A. Leroyer, C. Yvin, E. Guilmineau, M. Visonneau, P. Queutey, Efficient FSI codes coupling with possible large added mass effects: applications to rigid and elongated flexible bodies in the maritime field. Proceedings of Coupled Problems Conference, 2015.