Embedded Boundary Methods (EBMs) [1] for the solution of Computational Fluid Dynamics (CFD) and Fluid-Structure Interaction (FSI) problems are typically formulated in the Eulerian setting, which makes them more attractive than Chimera and Arbitrary Lagrangian-Eulerian methods when the structure undergoes large structural motions and/or deformations. In the presence of viscous flows however, they necessitate Adaptive Mesh Refinement (AMR) because unlike Chimera and ALE methods, they do not track boundary layers [2]. In general, AMR gives rise to non-conforming mesh configurations that can complicate the semi-discretization process. This is the case when this process is carried out using the popular vertex-based finite volume method and dual cells. Perhaps for this reason, most of the literature on AMR in the context of EBMs and the FV method has focused so far on cell-centered schemes, where the treatment of non-conforming mesh configurations is straightforward [1]. Specifically, most if not all local refinement strategies developed in this context generate “hanging” nodes in the refined mesh that can be easily dealt with using cell-centered but not vertex-based methods. In the latter case, flux assembly after a mesh refinement step becomes a problematic issue, due to presence of dual cells. This talk proposes a simple approach for resolving this issue by appropriately managing the construction of dual cells past each refinement step. The talk will recall the motivations for EBMs and vertex-based FV methods, explain the aforementioned AMR issue that arises in their context, present a method for resolving it, and illustrate this method with the application of the EBM known as FIVER (Finite Volume method with Exact two-phase Riemann solvers) [3, 4] to various examples including the prediction of the aerodynamic performance of a Formula 1 car.

REFERENCES


