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Title:
"Handling Slender/Thin Geometries with Sharp Edges in Sharp Interface Immersed Boundary Approach"

Abstract:
Immersed boundary framework offers a viable alternative to traditional body conformal computational models in simulating flow past arbitrarily complex geometries. Over the years various immersed boundary formulations have been proposed which can be broadly classified into two approaches namely 'diffuse' and 'sharp' interface. As the name suggests, diffuse interface impose boundary conditions not at their exact interface boundary but within a localized region around them. Sharp interface on the other hand overcomes this either by reconstructing the solution field near the surface (as in Ghost Cell method) such that the boundary conditions are imposed exactly at the surface or by reconstituting the boundary intercept cells into a non-rectangular control volume (Cut Cells) on which conservation laws are ensured. A major issue with these class of approaches is its inconsistent handling of sharp edges in slender/thin bodies (as in flat plate, trailing edge of an airfoil). With the Cut Cell approach, sharp edges lead to generation of arbitrarily small cells, complex cut cell topologies. Enforcing conservation laws for such cells give rise to numerical stability issues. In case of solution reconstruction algorithms, the nature of difficulty in handling sharp edges is twofold: One, due to inconsistent tagging of Eulerian nodes. Another difficulty is insufficient number of points to maintain the order of accuracy of flux calculations. Several strategies have been proposed to address these issues. In case of cut cells, cell merging, cell clustering, hybrid of ghost cell and cut cell algorithms are proposed to maintain mass

conservation. In case of solution reconstruction schemes, approaches like Adaptive Mesh Refinements (AMR) are proposed. These strategies are highly complex both in terms of their formulation and implementation. In this talk, a simple and robust set of procedures for efficiently handling the sharp edges will be presented. Capability of the algorithm is demonstrated successfully through a case study of dynamic stall in oscillating airfoil.

Keywords: Sharp Interface, Immersed Boundary Method, Dynamic Stall, Sharp edges

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