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Adaptive Mesh Refinement for Multi-Material Volume-Tacking Computation with Moment-of-Fluid Method

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ABSTRACT

A novel adaptive mesh refinement (AMR) strategy based on Moment-of-fluid (MOF) method for volume-tracking evolving interface computation is presented. Moment-of-fluid method is a new interface reconstruction and volume advection method using volume fraction as well as material centroid. The mesh refinement is performed based on the error indicator, the deviation of the actual centroid obtained by interface reconstruction from the reference centroid given by moment advection process. Using the AMR-MOF method, the accuracy of volume-tracking computation with evolving interfaces is improved significantly compared to other published results. By compact nature of the AMR-MOF method, the mesh refinement is confined only at the cells with interface without propagating to the neighbors. By using the centroid error indicator detecting high curvature region, the refinement is prioritized for the cells with high curvature interface to the cells with low curvature interface. The effectiveness and efficiency of AMR-MOF method is demonstrated with classical test problems, such as Zalesak's disk and reversible vortex problem. The comparison with previously published results for these problems shows the superior accuracy of the AMR-MOF method over other methods. In addition, two new test cases with severe deformation rates are introduced, namely droplet deformation and $\mathcal{S}$-shape deformation problems, for further demonstrating the capabilities of the AMR-MOF method. Extension to multi-material ($n_{mat} > 2$) cases will also be presented.

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