A local XFEM method for the simulation of multi-fluid flows using the Particle Level Set method

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ABSTRACT

The simulation of immiscible two-phase flows on Eulerian meshes requires the use of special techniques to guarantee a sharp definition of the evolving fluid interface. This work describes the combination of two distinct technologies with the goal of improving the accuracy of the target simulations. First of all, a spatial enrichment[1] is employed to improve the approximation properties of the Eulerian mesh. This is done by injecting into the solution space new features to make it able to correctly resolve the solution in the vicinity of the moving interface. Then, the Lagrangian Particle Level Set (PLS) method[2] is employed to keep trace of the evolving solution and to improve the mass conservation properties of the resulting method. While the local enrichment can be understood in the general context of the XFEM, we employ an element-local variant, which allows preserving the matrix graph, and hence highly improving the computational efficiency. Basically, at each cut element the pressure field is enriched at the element level and then condensed prior to the assembly. Although no enrichment for the velocity field is considered, numerical results show that the method perfectly works for the physical problems dominated by gravitational forces. Numerical results suggest that, at least for tetrahedral meshes, the inclusion of PLS to overcome the mass gain/loss is crucial in examples undergoing large deformations of the interface. Our results compare well with those obtained with standard XFEM using hexahedral meshes. And in some cases are superior in determining the interface evolution.

REFERENCES

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