An Arbitrary Lagrangian Eulerian (ALE) Framework for the Numerical Simulation of Multiphase Flow Problems

Cagatay GUVENTURK[1,a)] and Mehmet SAHIN[1,b)]

[1]Faculty of Aeronautics and Astronautics, Astronautical Engineering Department, Istanbul Technical University, Maslak, Istanbul, 34469, TURKEY

[a)]Author: cagatay.guventurk@gmail.com

[b)]Corresponding/Presenting author: msahin.ae00@gtalumni.org

ABSTRACT

An Arbitrary Lagrangian Eulerian (ALE) framework which combines the advantages of both pure Lagrangian and pure Eulerian methods is presented to solve incompressible multiphase flow problems. The incompressible Navier-Stokes equations are discretized using the side-centered unstructured finite volume method [1] where the velocity vector components are defined at the mid-point of each cell face, while the pressure term is defined at element centroids. The pressure field is treated to be discontinuous across the interface with the discontinuous treatment of density and viscosity. The computational mesh is also deformed due to the motion of interface by solving the linear elasticity equations. The surface tension term at the interface is computed by using different approaches. In addition, the several different discretizations of interface boundary conditions are investigated. Furthermore, a special attention is given to satisfy the both local and global discrete geometric conservation law (DGCL) in order to conserve the total mass at machine precision [2]. The method is validated by simulating the classical benchmark problem of a single rising bubble in a viscous fluid due to buoyancy. The results of numerical simulations are found out to be in a good agreement with the earlier results in the literature. The mass of the bubble is conserved and discontinous pressure field is obtained in order to avoid errors due to the incompressibility condition in the vicinity of the interface where the density and viscosity jump occurs.

Keywords: Multiphase, Arbitrary Lagrangian Eulerian (ALE), Unstructured finite volume, Discontinuous interface, Rising bubble.

References

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