A new approach for multiphase modelling with moving objects

Georgios K. Karpouzas[1] and Eugene de Villiers[2]

{g.karpouzas, e.devilliers}@engys.com

[1,2]Engys Ltd. - London SW18 3SX, UK

In this paper, new method for modelling multiphase applications with arbitrary solid body motion is presented. The method is derived from the original Generalized Internal Boundary (GIB) approach that was implemented for single phase flows [2, 3, 4].

While there are several well-known approaches to model solid body motion, they all suffer from one or more serious drawbacks. Examples of such approaches include:

- mesh deformation plus periodic remeshing and mapping: high computational cost, volumetric interpolation
- over-set grids: high computational cost, mass conservation issues, difficulty in collision modelling.

The GIB method was developed to circumvent these issues and more: it allows for the generalized and selective injection of arbitrary boundary conditions at arbitrary locations in the interior or exterior of the grid. Since the method uses a localized mesh deformation along with face-based source injection it admits complete freedom in terms of boundary motion magnitude and character. Further, since the mapping from one instance of the GIB to the next depends on local deformation and surface-based interpolation (Arbitrary Mesh Interface (AMI)), the cost is substantially lower than is common for more traditional methods.

Although the GIB was implemented work directly at the level of finite volume operations, this does not apply to multiphase solvers that use a custom solution layer in the form of the explicit MULES algorithm. In this paper, the GIB method is extended by adding support for the additional Finite-Volume operators (MULES, CMULES). Three applications leveraging the new technology are presented:

a) Viscous fluid injection from a moving injector for foam molding applications (Figure 1)
b) Fuel-Sloshing with directional dynamically closing/opening valves
c) Falling object interaction with liquid using 6DoF motion

Figure 1 . Results of a multiphase application using the GIB method. Black and grey colours represent regions with two different (Black - high viscous fluid, grey - air). Yellow area represents a moving inlet boundary, which injects high viscous fluid in the domain and is modelled using the GIB method.

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