Interface capturing in the Multifluid dynamics

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The current article is about capturing the interface in multifluid/multiphase. When one fluid separate from the other fluid or solid, we have to define the interface separating among them. Interface capturing is essential because, in multiphase, the pressure jump across the interface is directly proportional to the curvature of the interface (by Young-Laplace boundary condition).

So normally, there are two methods:

1) Interface capturing method

2) Interface tracking method.

The interface capturing method includes the Volume of Fluid (VOF), Level Set Method (LSM), Marker and Cell, Phase-field method. And the interface tracking method includes the Front track method. In the VOF or LSM methods, we separate the interface by the function. Like in LSM, the level set function is the normal distance function from the interface. So the one fluid has a positive value; others have a negative value, and the interface is defined by zero value level set function.

Whereas, in the front tracking method interface is defined by Lagrangian points. That means we actually put the marker points on the interface. And these marker points evolve by implementing the kinematic boundary condition, i.e., the velocity of the fluid on the interface in the normal direction is equal to the velocity of the interface in the normal direction (velocity of fluid.n = velocity of the interface.n, where n is normal to the interface). The main issue with the interface tracking method is the merging the breaking of the interface. So as the interface start to merge or break, normal on the marker points of the interface will give the crude results. Also, with evolving the interface, markers will get collect at some part of the interface that also creates problems. We can add or delete markers on the interface with each time step to track the interface correctly. We can redistribute the interface markers after each time steps with a specific distance to avoid such a problem. So front tracking method recommended where the interface is not changing to complex shape. But where the interface is more complex and going to merge or break with the evolution, interface capturing methods like VOF, LSM are recommended. Because these front capturing methods like VOF, LSM are defined by function for the interface. So by solving the advection equation for each time step, evolve the interface to a new position. So for capturing the complex interface evolution VOF, LSM like interface capturing methods are recommended.

So the current article is mainly focused on basic fundamental methods for accounting the interface physics. In upcoming articles, I will try to explain the LSM and front track method in more detail with some examples.