A Numerical Algorithm for Transitioning from Sharp to Continuous Material Interface Representation

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There are several existing approaches to model material interfaces in fluid flow. The interface can be captured (Eulerian approach) or tracked (purely Lagrangian approach or mixed Eulerian-Lagrangian approach). In this work we employ a purely Eulerian approach in which the different phases are represented by the volume fractions. The focus of this study is the transition from a sharp representation of a material interface, to a more diffused representation whenever the interface curvature is unresolved. We consider a single velocity representation with averaged material properties in mixed cells. Within this context, we devise an algorithm that combines the interface preserver capturing method (also known as "artificial steepening" or "compressive limiter") with an interface reconstruction method (volume of fluid: VOF-PLIC). The VOF-PLIC approach reconstructs a linear interface within each cell and this interface is used to compute accurate fluxes. This representation is considered "sharp" as it keeps the interface within a single cell as opposed to most capturing methods which diffuse the interface over a many cells. In regions where the VOF-PLIC method fails, (i.e. unable to capture thin filament or dispersed phase because of lack of resolution) the method switches to the interface-preserver capturing method, which steepens the computed density gradients in order to keep the mass diffusion to a minimum. The numerical algorithm for transitioning between volume tracking and interface capturing will be presented and examples will be shown on several test cases.