The 18th International Conference on Finite Elements in Flow Problems (FEF2015)
16-18 March 2015, Taipei, Taiwan

FRACTION DIRECT-FORCING IMMERSED-BOUNDARY METHOD WITH SUBGRID ENRICHMENT

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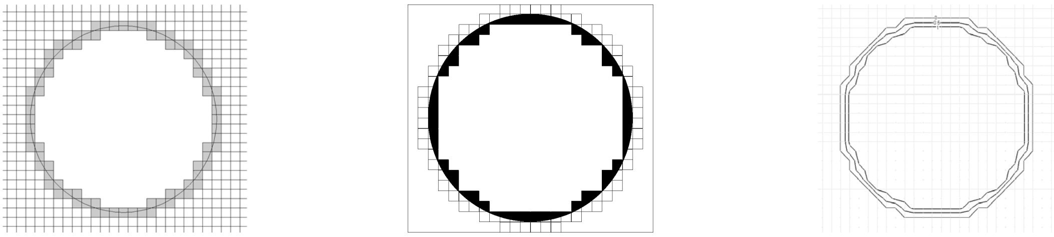
Key Words: *Immersed Boundary, Direct Forcing, Fraction Function, Subgrid, Interpolation.*

A direct-forcing immersed-boundary (IB) is often used to investigate soild-fluid interaction problems. In [1], a very efficient direct-forcing immersed-boundary (IB) pressure correction method is developed to study many-particle soild-fluid interaction problems. The method uses a uniform mesh to solve Navier–Stokes equations, and instead of distributing Lagrangian points around the solid surface, a fraction function φ is defined on the flow Eulerian grids to distinguish the solid (φ=1) and the liquid (φ=0) phases. Smooth transition is enforced by adopting a user-specified linear function ($0<\varphi<1$) across the solid-liquid interface which inevitably makes it of finite thickness. The fluid-solid interaction force F can be obtained via straightforward summation of the gradient of pressure and tangential stress on the Eulerian nodes with $0<\varphi<1$. Hence, how accurately the interface is captured becomes essential in this scheme.

This work proposes to use a subgrid system in the primary interface cell to locate true solid boundary to finer interface cells (Fig. 1). Flow information can then be interpolated more precisely from adjacent Eulerian grids to achieve more accurate force calculation. The scheme is evaluated the accuracy in two problems with uniform flow over a fixed cylinder and a symmetric cambered airfoil at different angles of attack at Re=1000 and 2000.



(a) (b) (c)

Fig. 1. (a) The shaded cells present a cylinder in a uniform Cartesian grid; (b) contour of the volume fraction function across the interface cells with subgrid; (c) contour of the volume fraction function across the interface cells without subgrid.

REFERENCES

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