A novel consistent scheme for Fluid-Structure Interaction with Immersed Boundary Method

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ABSTRACT

We present an improved consistent immersed boundary (IB) method for simulating the fluid-structure interaction (FSI) process. It is based on the rotational incremental pressure-correction projection scheme for solving the fluid equations. In the classical IB method, the immersed structure is represented by a set of Lagrangian points on which the hydrodynamic force is first evaluated and then spread to its surrounding Eulerian grid with the smoothed delta function. The force is then added to the Navier-Stokes equations for the effect of immersed structure on the flow by using an explicit scheme.

In this paper, we adopt an implicit scheme to handle this feedback procedure between fluid and structure with arbitrary structures, which provides more stability and accuracy. The numerical results are shown to be in good agreement with those obtained in previous numerical and experiments studies.

Fig.1 shows the numerical results for a cylinder immersed in the lid-driven cavity. The implicit scheme used in the present work gives much accurate non-slip boundary condition on the immersed cylinder interface and the calculation time remains the same compared to the explicit scheme.

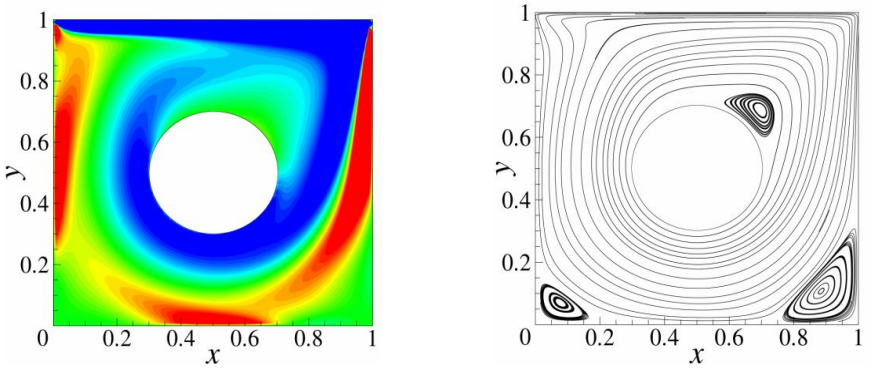

Fig 1. Vorticity and streamline of flow in the lid-driven cavity with an immersed cylinder: Re = 1000.