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3D simulation of flapping flags in a viscous fluid flow WEI-XI HUANG, HYUNG JIN SUNG, KAIST, FLOW CONTROL LAB TEAM — The flapping of flags is commonplace in everyday life, but includes extremely complicate dynamics. The flag exerts inertial and elastic forces on the fluid, while the fluid acts on the flag through pressure and viscosity. The study of flapping dynamics is helpful to improve some industrial applications such as paper production, and to understand biological processes like fish swimming. Recently, several interesting studies of flapping dynamics have been carried out, including theoretical, experimental and numerical works. However, most numerical simulations were 2D and few 3D simulations can be found in the literature. In the present study, we develop a numerical solver for 3D simulation of flapping flags in a viscous fluid flow by using the immersed boundary method. The flag motion equation is derived using the variational derivative of the deformation energy and solved on a Lagrangian grid. On the other hand, the fluid motion equation is discretized on an Eulerian grid and solved by the fractional step method. An additional momentum forcing is formulated from the flag motion equation and acts as the interaction force between the flag and its surrounding fluid. The symmetry property is investigated by accounting for the boundary conditions and the shear force term. The effects of physical parameters on the flapping frequency are studied and the bistability of flapping is discussed. Flow field is visualized and vertical structures are identified.

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