

Flow Around a Plunging Airfoil: A Comparative Study of Immersed Boundary and Arbitrary Lagrangian-Eulerian (ALE) Methods in OpenFOAM

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Synopsis

The present study is to apply the Immersed Boundary Method (IBM) on a plunging airfoil using FOAM-Extend, a fork of the OpenFOAM open-source library and compare the aerodynamic load coefficients with the Arbitrary Lagrangian-Eulerian Method (ALE). The main interest of this study is to observe the significance of this method in capturing the moving boundary accurately since this method works on an algorithm of momentum forcing and interpolations, unlike mesh deformation in ALE. The 2D plunging airfoil is simulated with a flow of Reynolds number=100 in IBM, and the results are compared with those of the body-fitted mesh. The reduced frequency(k) of 4Hz and amplitude(h) of 0.25m is taken for the plunging motion. FOAM-Extend offers immersed boundary solvers to handle the flow problem uniquely. In this paper, the results show good agreement between these methods and justify the accurate prediction of the moving boundary by the Immersed Boundary Method. However, a detailed analysis of the immersed boundary cells and time step size is essential for the accuracy of this method.