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Large-eddy simulation of flow over a multi-element airfoil[1]
DONGHYUN YOU, Department of Mechanical Engineering, Carnegie Mellon University — An accurate prediction of turbulent flow over a multiple element high-lift airfoil configuration remains a challenge to computational fluid dynamics. Maximum lift, drag, and pitching moment are difficult to accurately predict especially in the presence of flow separation on one or more of the airfoil elements. In this study, we investigate turbulent flow over a MD30P30N high-lift configuration using large-eddy simulation. The MD30P30N configuration consists of three elements: a slat, a main airfoil, and a flap. Four different attack angles, 16°, 19°, 21°, and 24°, are considered while deflection angles of the slat and flap are fixed to 30°. The Reynolds number is 9×10^6 based on the mounted-wing chord-length and freestream velocity. Simulation results obtained on a 54 million-element mesh agree well with experimental data in terms of pressure distribution, velocity profiles, and transition location. A grid sensitivity study is performed to identify the resolution effects on the prediction of flow transition, wakes, and turbulent boundary layers. Accurate prediction of laminar-to-turbulence transition on the slat surface and downstream evolution of the slat wake is found to be crucial for the global accuracy of the simulation.

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