Mechanical Engineering Thesis Defense

Modeling jet-plate interactions using large eddy simulations

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Abstract

Modern aircraft propulsion systems such as the ultra high bypass ratio turbofan impose constraints on engine installation below the wing, causing jet--wing interactions. Similar interactions are encountered when a jet-powered aircraft takes off on airport runway or aircraft carrier deck. High-speed jet flow near a solid surface shows markedly different turbulence characteristics compared with free jet, including attached turbulent jet and development of non-equilibrium boundary layer downstream. Wall pressure fluctuations tend to be more unsteady and stronger, leading to increased vibration affecting aircraft cabin noise and modified jet noise radiation. Large-eddy simulation (LES) is useful to characterize turbulent jet flows over a solid surface as well as wall pressure distribution to promote physical understanding and modeling studies. In this study, LES is performed for an installed setup of a Mach 0.7 turbulent jet where the jet--plate distance is fixed at 2D where D is the nozzle-exit diameter. Unstructured-grid LES is used to validate the corresponding experiment (Meloni et al., Exp. Fluids 2019). In addition, a high-fidelity numerical database is built for further analysis and modeling. Turbulence statistics and energy spectra show that agreement with the experimental measurement for the installed case is encouraging, paving a way for future analysis and modeling.

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Zoom Link: https://asu.zoom.us/j/83048136252