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Efficient CFD Simulation Process for Aeroacoustic Driven Design

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Abstract:

The transport industries face a continuing demand from customers and regulators to improve the acoustic performance of their products: reduce noise heard by passengers and passersby; avoid exciting structural modes. In both the aerospace and automotive areas, flow-induced noise makes a significant contribution, leading to the desire to understand and optimize it through the use of simulation.

Historically, the need for time-consuming, computationally expensive transient simulations has limited the application of CFD in the field of acoustics. In this paper are described efficient simulation processes that, in some instances, remove the requirement for transient analyses, or significantly reduce the total process time through intelligent pre-processing.

We will outline this process and provide both automotive and aerospace industrial examples, including analyses of highly complex geometries found in real life. Section 2 describes a modeling hierarchy which includes steady-state, transient and frequency-based time-periodic methodologies. Section 3 contains four popular classes of application spread across the transportation sectors: - Airframe noise simulation of a complex nose landing gear; - Aeroacoustics of avionic cooling rack in an Airbus cockpit; - Automotive sunroof buffeting with structural impedance; - Fan noise signature in the presence of gusts.

For these case studies, the main focus is the prediction of aeroacoustic noise sources. The propagation of noise to the far-field is not considered here, though some qualifying comments are made in section 2.4.

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