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Direct and sampling-based flutter solution methods in the SU2 solver

N. Simiriotis[1] and R. Palacios[2]

[1]Research Associate, Imperial College London, Department of Aeronautics, London SW7 2AZ United Kingdom, n.simiriotis@imperial.ac.uk

[2] Professor of Computational Aeroelasticity, Imperial College London, Department of Aeronautics,London, SW7 2AZ, United Kingdom r.palacios@imperial.ac.uk

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The current standard for flutter prediction on full-aircraft models are techniques based on potential flow aerodynamics and CFD-based system identification methods. In problems such as flutter, where the periodic steady-state is of primary interest, frequency-based methods can be used as an alternative to accelerate the solution process. Frequency-domain simulations seek the periodic solution directly. These highly efficient methods are applicable to systems of high complexity and can be used to track flutter instabilities across the flight envelope. Frequency-domain flutter prediction is typically based on the harmonic balance (HB) method [1]. The flutter prediction framework developed here is based on the work of Li & Ekici [2]. When searching for a flutter condition, both the flutter frequency ω_F and velocity V_F are unknown a priori. Thus, additional constraints are added to the solution process in order to treat (ω_F, V_F) as independent variables of the problem. Their values are updated at every aeroelastic iteration for the complete system to converge to a unique solution. This is achieved by minimizing a figure of merit, based here on the structural residual. This contribution deals with the development of a dedicated aeroelastic framework in the open-source SU2 suite [3], a state-of-the-art RANS-based multiphysics solver. A previous HB implementation has been extended to treat arbitrarily deforming surfaces. Reduced order structural equations of motion are built based on the input modal description, and then solved with a native implementation. Dedicated interpolation schemes have been employed to transfer data across the fluid-structure interface. The flutter prediction method will be demonstrated for 2D and 3D configurations in the transonic regime, and will be shown to be accurate and robust with respect to the initial conditions. Finally, a comparison will be made between direct flutter prediction and system identification through linear CFD-based Generalized Aerodynamic Forces (GAFs) computed in the frequency-domain.

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