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Reduced Order Unsteady Aerodynamic Model of a Rigid Aerofoil in Gust Encounters

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Abstract

Predicting gust loads using computational fluid dynamics is prohibitively expensive and unrealistic for parametric searches. This work presents the development, implementation, and demonstration of a reduced order model which balances accuracy and speed. The model builds on a proper orthogonal decomposition representation of the linearised time–domain equations and achieves a further reduction in size through a balanced truncation. The novelty of the work lies in the mechanism to introduce any arbitrary gust shape within the reduced order model framework. The methodology combines an analytical formulation, loosely based on the Küssner function, and a numerical approach to identify, or optimise, the unknown parameters of the analytical ansatz. A model problem is investigated for various gust shapes for incompressible and transonic flows. It is found that: (i) the generation of the reduced order model is equivalent to about two steady–state analyses;

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