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Data-driven nonlinear aeroelastic models of morphing wings for control[1] URBAN FASEL, ETH Zurich, NICOLA FONZI, Politecnico di Milano, STEVEN L. BRUNTON, University of Washington — Accurate and efficient aeroelastic models are important for enabling the optimization and control of morphing wings, which are characterized by highly-coupled and nonlinear interactions between the aerodynamic and structural dynamics. In this work, we leverage emerging data-driven modeling techniques to develop highly accurate and tractable reduced-order aeroelastic models that are valid over a wide range of operating conditions and are suitable for control. In particular, we develop two extensions to the dynamic mode decomposition with control (DMDc) algorithm to make it suitable for aeroelastic systems: 1) we introduce a formulation to handle algebraic equations, and 2) we develop an interpolation scheme to connect several linear DMDc models developed in different operating regimes. Thus, the innovation lies in accurately modeling the nonlinearities of the coupled aerostructural dynamics over multiple operating regimes. We demonstrate this approach on a high-fidelity model of an airborne wind energy (AWE) system, although the methods are generally applicable to any highly coupled aeroelastic system. Our proposed modeling framework results in real-time prediction and we demonstrate the enhanced model performance for model predictive control. Thus, the proposed architecture may help enable the widespread adoption of next-generation morphing wing technologies.

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