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Experimental gust mitigation using model based feedforward and feedback control BENJAMIN HERRMANN, University of Washington, JOHANNES POHL, Technische Universitat Braunschweig, STEVEN L. BRUNTON, University of Washington, RICHARD SEMAAN, Technische Universitat Braunschweig — Wing-gust encounters arising from flight over complex terrain or adverse weather are unavoidable and cause large lift transients that may result in structural damage due to extreme loads and/or fatigue. With the potential to extend the lifetime and improve the safety of air vehicles, gust mitigation through control is challenged by sensor noise, time-delays, and short response-time requirements. In this study, we build and deploy a closed-loop controller on an airfoil equipped with an actuated trailing-edge flap in a wind tunnel experiment. The control objective is the regulation of the lift coefficient, measured in real-time along the mid-section using fast-response pressure sensors. The onset and magnitude of gust disturbances, which are generated upstream by a pitching airfoil, are fed through using a two-component cross-wire located upstream of the leading edge. Feedback and feedforward controllers are designed based on reduced-order models for the lift response to flap actuation and perturbations in the cross-wire signals identified from open-loop experiments. The combined control setup proves to be an effective strategy for lift regulation during gust encounters, rejecting disturbances, attenuating noise, and compensating for model uncertainty.

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