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Reduced-order Model Based Feedback Control of Cavity Flows[1]

M. SAMIMY, M. DEBIASI, E. CARABALLO, J. LITTLE, A. SERRANI, X. YUAN, Gas Dynamics and Turbulence Laboratory, Collaborative Center of Control Science, The Ohio State University — The focus of this work is on the development of reduced-order model based feedback control of low- to mid-subsonic cavity flows. A reduced-order model was developed via Proper Orthogonal Decomposition using particle imaging velocimetry (PIV) in conjunction with the Galerkin projection of the governing equations - simplified Navier-Stokes - onto the resulting spatial eigenfunctions. The stochastic estimation method was used for real-time estimation of the model time coefficients from simultaneous PIV and dynamic surface pressure measurements. The reduced-order model was linearized around the equilibrium point and a linear-quadratic optimal controller was designed and implemented in the experiments. The actuator was a compression driver type and its output was channeled through a one millimeter slit spanning the entire width of the cavity leading edge. Promising results show that the controller is capable of reducing the cavity flow resonance at Mach 0.3 flow, for which the model was specifically derived, and also at other flows near the design Mach number.

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M. Samimy
Gas Dynamics and Turbulence Laboratory
Collaborative Center of Control Science, The Ohio State University

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