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Adaptive Extremum-Seeking Control of Subsonic Cavity Flows¹

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Collaborative Center of Control Science, The Ohio State University — Flow over a shallow cavity produces strong pressure fluctuations that result from the coupling between flow and flow-induced acoustics in the cavity. These fluctuations could lead to strong resonant tones that could cause structural damages to the surfaces exposed to the flow. This work is focused on the development and implementation of extremum-seeking control to attenuate pressure fluctuations in subsonic cavity flows. First, a simple but effective feedback control law based on a reduced-order Galerkin model of the flow dynamics is implemented as an inner-loop controller to suppress the cavity flow fluctuations. The magnitude of the limit cycle in the closed-loop, obtained from a pair of surface pressure sensors, is employed as a performance output, and its static characteristics with respect to control parameters are identified analytically and experimentally. Then, a single-input single-output adaptive extremum-seeking scheme is applied to the closed-loop control in such a way that the control parameters can be tuned in real time towards the optimal value where the limit cycle magnitude is minimized. The extremum-seeking control is tested to verify its effectiveness under various flow conditions.

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