A simple state-space approach for the investigation of non-normal effects in thermoacoustic systems

Abstract:
A low-order, state-space modeling approach for thermoacoustic systems has been developed, which is based on present and past values of nodal characteristic wave amplitudes. The method allows to simulate the time evolution of the system state, but also the efficient computation of the (pseudo-)spectrum of the evolution operator. It is demonstrated by comparison with a frequency-domain “network model” that eigenmodes and asymptotic linear stability are predicted correctly. The influence of various model parameters (downstream reflection coefficient, temperature ratio across the heat source, magnitude and spread of heat source time delays) on transient growth of perturbation energy is explored. Furthermore, it is shown how frequency-dependent boundary impedances can be modeled through FIR or IIR filters. The discussion in the present paper is limited to simple test cases, but the approach can be generalized to systems with non-trivial topology.

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