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Early detection of thermoacoustic instability in a swirl-stabilized turbulent combustor using a noise-induced dynamical system and a deep neural network

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Abstract

We experimentally attempt to detect a precursor of thermoacoustic instability in a swirl-stabilized turbulent combustor using a stochastic van der Pol oscillator and a deep neural network. Stochastic van der Pol oscillator is a low-order model representing the dynamic behavior of acoustic pressure fluctuations during thermoacoustic instability. We estimate the linear growth rate as the bifurcation parameter of the van der Pol oscillator, identifying the system parameters of the stochastic van der Pol oscillator for steady state tests. The time series, which are generated from the optimized van der Pol oscillators are used as the training data of the deep neural network. The trained deep neural network can appropriately detect a precursor of thermoacoustic instability.

Keywords: Swirl-stabilized turbulent combustor, Thermoacoustic instability, Low-order model, Deep neural network