Characterization of acoustic damper’s response to combined harmonic and stochastic forcing for gas turbine application

Description:
In gas turbine combustion chambers, thermo-acoustic coupling may occur and yield significantly high amplitude pressure oscillations, which reduce the structural parts lifetime. In order to better prevent such behavior, one can implement acoustic resonators in the combustion chamber in order to enhance the system dissipation. The frequency response of these dampers must be well understood in order to abate pulsations as efficiently as possible. Linear analysis is generally used in the first acoustic-design step. It is nevertheless important to pay attention to the nonlinearities of the resonators’ response, which might yield actual behavior which is far from the one being predicted using linear description. Another important phenomenon to consider is the additive forcing due to turbulent combustion noise. Indeed the ratio between harmonic and stochastic forcing amplitudes plays a crucial role in the damper’s dynamic response.

Objective:
The objective of this Master Thesis project is to investigate the following system describing a nonlinear oscillator submitted to external harmonic and random forcing:

\[ \ddot{x} + |d + \delta x| \dot{x} + \omega(1 + f(y))x = B \cos(\Omega t) + \xi(t) \]

\[ \dot{y} = x \]

where \( f(y) \) is a nonlinear function (see sketch) and \( \xi \) a Gaussian white noise.

Prerequisites:
Strong analytical skills and initiative, having followed the course Nonlinear Dynamics, MATLAB

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