Conception des systèmes mécaniques à absorbeurs de vibrations non-linéaire en présence d'incertitudes

Doctorant·e

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Abstract

This thesis explores the behavior of Nonlinear Energy Sinks (NES) in mechanical systems, focusing on their dynamics and the impact of uncertainties associated with system parameters. The evaluation of the vibrational performance of the systems is first carried out in a deterministic framework using the Harmonic Balance Method (HBM), which allows for determining the evolution of modal frequencies as a function of energy, through Frequency Energy Plots (FEP), as well as the Nonlinear Normal Modes (NNM). This helps to better understand the influence of NES in typical systems such as mass-spring-damper oscillators and Euler-Bernoulli beams, by analyzing the energy transfer and dissipation mechanisms in these NES-equipped systems. The study then addresses the incorporation of uncertainties via a stochastic response model. To handle the complexity of the nonlinear dynamics, an approach based on Proper Orthogonal Decomposition (POD) and Multi-Element Polynomial Chaos Expansion (MPCE) is used. This method reduces the dimensionality of the problem while representing the dynamic response of the system under uncertainty. The efficiency of this strategy is evaluated through applications to mass-spring-damper oscillators, Euler-Bernoulli beams, and rotors, starting from a fixed initial energy level for each configuration to determine the stochastic temporal responses. This research makes a significant contribution to the fields of passive vibration control and uncertainty quantification, by deepening the understanding of NES behavior and proposing advanced methodologies for the propagation of uncertainties in complex dynamic systems.