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Taking into account uncertainties in non-linear dynamical systems with nonlinear energy sinks (NES)

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Abstract:

We will study the dynamics of a linear principal system, which is weakly coupled to a nonlinear attachment. This nonlinearity of the accessory allows it to resonate with any of the linearized modes of the principal system, allowing us to have a passive and irreversible energy transfer from the principal system to the NES.

An interesting feature of linear systems with essentially nonlinear attachments is the possibility of resonance capture cascades, meaning that nonlinear attachments can be designed to resonate and extract energy from an a priori specified set of modes of a nonlinear structure. As a result, even when the forcing conditions are simple as periodic, the system response can be quasi-periodic.

The objective of this study is to study the absorption of energy when uncertainties are considered in the coupling parameters between the principal system and the NES. Hence, we will propose and compare the accuracy and efficiency of different uncertainty quantification strategies based on Polynomial Chaos and Proper Orthogonal Decomposition. While it is well known -and prove- that the use of Polynomial Chaos has severe shortcomings for dynamical systems, we will demonstrate that new proposals allow to obtain accurate results with good efficiency, even in the non-linear and particularly difficult context of NES.

Keywords: dynamical system, nonlinear energy sink, uncertainty propagation, polynomial chaos, proper orthogonal decomposition.