Study of an electromechanical absorber while the main structure present a $1:3$ internal resonance

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Abstract. Study of the dynamics of an electromechanical nonlinear vibrating system is carried out. It is composed of a nonlinear beam patched with a piezoelectric material linked to a circuit with a cubic nonlinearity. Complexified form of system equations are treated with a time multiple scale method, in order to detect the fast and slow dynamics. The different dynamical scenarios are presented.

Introduction

This work takes interest in an electromechanical absorber linked to a main structure presenting a $1:3$ internal resonance. Analytical and experimental [1, 2] results showed that particular positions of the piezoelectric material on the beam allow the creation of a $1:3$ internal resonance between the second and third mode of the system. A nonlinear circuit is used to improve the vibration mitigation of the main structure. Such a nonlinear circuit has been tried for piezoelectric materials [3, 4]. The complexified form of system equations [5] are treated by a multiple scale approach, to identify the system response at different scale of time.

Results and discussion

Let us condense the model of the composite structure to a three degree of freedom system with variables as: r_2, r_3 and Q. r_2 and r_3 are the second and third mode of the main system and Q is the electrical charge inside the piezoelectric material. The three-dimensional SIM of the system in terms of N_1, N_2, N_3 standing for the amplitudes or r_2, r_3 and Q, respectively can be traced (see Fig. 1). Results obtained by direct numerical integration of system equations are included in Fig. 1 showing the non periodic response with repeated bifurcations between stable zones of SIM. An analysis is carried out to verify the stability of the periodic solutions. Different dynamic are spotted this way, as quasi-periodic regimes. Frequency response fonction can also be

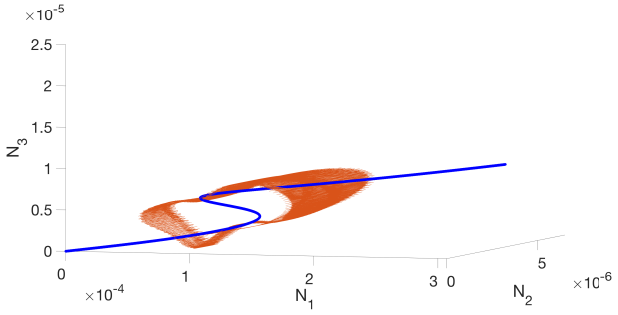

Figure 1: Three dimensional Slow Invariant Manifold (blue line) with its numerical integration (red line). The system presenting a modulated response.

traced for the nonlinear circuit and compared with a resonant circuit, allowing to choose which circuit allow a better vibration mitigation. Tracing the frequency response functions allowed to predict isola that are verified by numerical integration.

Other nonlinear circuit can be considered for vibration mitigation purposes with piezoelectric materials, as Synchronized Switching Damping circuits[6]. Experimental verifications could also be interesting, playing on the electrical parameters to trigger particular behavior as modulated responses or creation of isola.

References

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