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Nonlinear Passive Shunt for Electroacoustic Absorbers Using Nonlinear Energy Sink

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Abstract : Acoustic absorber devices play an important role reducing the noise at the propagation and reception paths. An electroacoustic absorber consists of a loudspeaker coupled to an electric shunt circuit, where the membrane is playing the role of an absorber/reflector of sound. Although the use of linear shunt resistors at the transducer terminals, has shown to improve the performances of the dynamical absorbers, it is nearly efficient in a narrow frequency band. Therefore, and since nonlinear phenomena are promising for their ability to absorb the vibrations and sound on a larger frequency range, we propose to couple a nonlinear electric shunt circuit at the loudspeaker terminals. Then, the equivalent model can be described by a 2 degrees of freedom system, consisting of a primary linear oscillator describing the dynamics of the loudspeaker membrane, linearly coupled to a cubic nonlinear energy sink (NES). The system is analytically treated for the case of 1:1 resonance, using an invariant manifold approach at different time scales. The proposed methodology enables us to detect the equilibrium points and fold singularities at the first slow time scales, providing a predictive tool to design the nonlinear circuit shunt during the energy exchange process. The preliminary results are promising; a significant improvement of acoustic absorption performances are obtained.

Keywords : electroacoustic absorber, multiple-time-scale with small finite parameter, nonlinear energy sink, nonlinear passive shunt
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