Nonlinear Feedback Control and Dynamics of an Electrostatically Actuated Microbeam Filter

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abstract

This work is concerned with the modeling, nonlinear dynamic analysis and control design of an electrostatically actuated clamped-clamped microbeam filter. The model accounts for the mid-plane stretching and nonlinear form of the electrostatic force actuated along the microbeam span. A reduced-order model is constructed, using the method of multiple scales, to examine the microsystem static and dynamics behaviors. To improve the microbeam behavior, a nonlinear feedback controller is proposed. The main control objective is to make it behave like commonly known one-degree-of-freedom self-excited oscillators, such as the van der Pol and Rayleigh oscillators, which depict attractive filtering features. We present a novel control design that regulates the pass band of the fixed-fixed microbeam and derive analytical expressions that approximate the nonlinear resonance frequencies and amplitudes of the periodic solutions when the microbeam is subjected to one-point and fully-distributed feedback forces.