عنوان مقاله:

Distributed-parameter Dynamic Modeling and Bifurcation Analysis of a Trapezoidal Piezomagnetoelastic Energy Harvester

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خلاصه مقاله:

In this paper, the effect of the bimorph profile on the nonlinear dynamic behavior and performance of a vibratory piezomagnetoelastic energy harvester is investigated. The proposed model is composed of upper and lower piezoelectric layers on a trapezoidal cantilever beam with one attached tip magnet as well as two external magnets. The magnetic field of two external magnets generates magnetic forces and moment on the tip magnet. The bimorph structure is considered as a distributed-parameter system, and the external forces are obtained by analyzing the magnetic field of the external magnets. Equations of motion are obtained using electromagnetic Lagrange equations based on the generalized Hamilton principle and the Euler-Bernoulli beam theory. The proposed model for the bimorph and magnetic forces is validated by previously published experimental results. In order to compare the nonlinear behavior of the rectangular and trapezoidal beam profiles, the bifurcation diagrams are depicted for various control parameters such as the separation distances of the magnets, beam root width, and beam tip width. Verification of the bifurcation diagrams is performed by the phase plane portraits and Poincare maps. Also, the harvested power level is compared for different profiles of the bimorph. Moreover, the simultaneous effects of exciting frequency and bifurcation parameters on the system performance are investigated by the waterfall diagrams. The obtained results show that the trapezoidal beam profile with a lower tip width has higher performance than the rectangular beam. In trapezoidal beam profiles, the subharmonic and chaotic motions have relatively higher output powers than periodic motions.

کلمات کلیدی:

Energy harvesting, Piezoelectric layers, Trapezoidal beam, Magnetic field, Chaotic