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Theoretical and Numerical Investigation of a Tri-Stable Nonlinear Energy Harvesting System in Rotational Motion for Low Frequency Environment

Authors : Mei Xutao, Nakano Kimihiko

Abstract : In order to enhance the energy harvesting efficiency, this paper presents a novel tri-stable energy harvesting system (TEHS), which is realized by the effect of magnetic force, in rotational motion to scavenge vibration energy. The device is meant to provide the power supply for wireless autonomous systems in low-frequency environment. The nonlinear TEHS is composed of the cantilever beam which is mounted on a rotating hub and partially covered by piezoelectric patch, a tip mass magnet in the end and two fixed magnets. A theoretical investigation using the Lagrangian formulation is derived to describe the motion of the energy harvesting system and the output voltage. Additionally, several numerical simulations were carried out to characterize the system under different external excitations and to validate its performance. The results demonstrated that TEHS owns a wide range of frequency of snap-through and high output voltage compared with the bi-stable energy harvesting system (BEHS). Moreover, some sets of experimental validations will be performed in the future work because the experimental setup is in the configuration now.

Keywords : piezoelectric beam, rotational motion, snap-through, tri-stable energy harvester
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