Mechanical and Industrial Engineering -College of Engineering-Sultan Qaboos University

Vibration-Based Energy Harvester Designs with Impact Oscillators

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Abstract

Harvesting energy from ambient vibration opens the way of powering small-scale systems without the need of battery replacements. Many studies having been conducted considering the use of this new technology as it is considered a clean energy source. This thesis starts with an exploration and comparison approach on the use of electromagnetic, piezoelectric and hybrid transduction types in noncontinuous system to harvest vibration through as well as the effect of adding an impact oscillator into the main harvester system on the harvested power and frequency bandwidth. It was observed that adding single or double impact oscillator into piezoelectric or electromagnetic harvester resulted in widening the frequency harvesting bandwidth of the vibration-based harvester. The effect of having duale impact oscillator combing both previous types into one harvester produced the optimum frequency range that can be harvested compared to the other forementioned types. Adding nonlinearity into system stiffness and impact oscillator was also examined. Having such nonlinear effect helped in relatively widening of the harvesting bandwidth of the harvester as compared the linear case. Moving to continuous system represented by the cantilever beam and choosing to have just electromagnetic transducer to harvest vibration, it was concluded that the usage of impactoscillators in a nonlinear electro-magnetic cantilever, the harvested power simulation results indicate a spectrum of resonant frequencies of the vibrating cantilever beam that extends beyond its basic natural frequency. Moreover, as the nonlinearity of both the impact oscillators forces and the magnetic flux is increased, the harvested power of the enhanced system shows wider bands in its respective frequency response. Using FEA, it was clear that considering two magnets in repulsion generates higher values mainly due to the strong nonlinear transient magnetic flux, resulting into few times more power as compared to the case of considering only one magnet in the system.