Broadband vibration energy harvesting based on a weakly coupled nonlinear periodic system

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Summary. In this work, a broadband vibration energy harvester based on a weakly coupled nonlinear periodic N-Dofs system is proposed. In order to enlarge the frequency bandwidth of the harvester, the multimodal property induced by the system periodicity and the nonlinear hardening and softening behaviors are functionalized.

Over the past decades, many efforts have been made to harvest energy from ambient vibrations. Various techniques for vibration energy harvesting (VEH) based on different energy conversion mechanisms have been achieved and proved their potential to enhance the output performances of the harvesters. Although the conversion's mechanisms are various and the development of harvesters is continuous, VEHs still have limitations. In fact, most devices have a narrow operating bandwidth. Consequently, their implementation is limited in real-life applications where energy prevails over a wider bandwidth. To overcome this limitation, several approaches have been proposed namely the adoption of multimodal configurations and the introduction of nonlinearity.

In the following, we are interested in the enhancement of the performances of a vibrating energy harvester based on electromagnetic transduction. The present work investigates the benefits of the multimodal approach and the introduction of the nonlinearity. The multimodal approach involves operating multiple modes in a periodic N-Dofs discrete system. This technique proves its potential to enlarge the frequency bandwidth [1,2,3]. Concerning the nonlinearity, it is used also to extend the frequency bandwidth and diverse works have shown the remarkable improvement of the bandwidth while using this method [4,5,6]. In this work, we functionalized simultaneously the nonlinear softening and hardening behaviors of different Dofs.

Numerical simulations on 5 and 10-Dofs systems have been performed to highlight the benefits of the proposed approach.

References

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