Modeling of smart vibration-based energy harvesters based on the PGD method

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ABSTRACT

In recent years, energy harvesting (EH) devices are becoming an alternative to provide energy in many different low-powered applications. Among the several energy harvesting mechanisms, the vibration-based approach seems to be the most suitable one for engineering structures subject to continuous ambiental vibration. Particularly, the piezoelectric energy conversion is a very versatile option able to harvest energy from different ambiental sources. Most piezoelectric EH devices designs are based on cantilever beams, including unimorph, bimorph and functionally graded piezoelectric material (FGPM) beams configurations. The conventional approach to evaluate the performance of these devices is the use of simplified models (single degree of freedom systems, beam theory, etc.) or numerical techniques such as the finite element (FE) method.

In order to reduce the computational cost without losing accuracy in the solution, the proper generalized decomposition (PGD) method [1] is used herein as a reduction model. The coupled problem variables are decomposed into space, frequency and electrical load as in [2]. In this approach, the field variables are written as a sum of products of unidimensional functions of spatial coordinates x and z (beam axis and thickness directions respectively), frequency ω and electric load R. The main objective of this work is to develop a parametric comparative study of different laminates configurations for energy harvesting purposes to validate the proposed method. Several numerical test are analysed under different excitation frequencies and electrical loads.

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