Finite Element Reduced Order Model of a Piezoelectric Energy Harvester

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ABSTRACT

In the last few years, piezoelectric materials have been widely used for vibration energy harvesting due to its efficiency for converting mechanical energy into electrical one. Various approaches have been appeared in the literature for modeling the electromechanical coupling of a piezoelectric harvester in order to predict its electromechanical responses. The present paper presents a finite element modeling of a bimorph piezoelectric cantilever beam which is composed of an elastic substrate covered by two piezoceramic layers. The generated electricity is due to the vibration of the host structure. As well as, the main goal is to propose a reduced order model to predict the output responses of the harvester and to improve simulation efficiency with a low computation cost. In fact, the reduced order model is based on a normal mode expansion using the eigenmodes of the structure. In this paper, the electromechanical problem is projected on a truncated eigenvectors basis for short-circuited piezoelectric layers. Furthermore, a case study of a bimorph piezoelectric energy harvester is presented and analyzed. Through this example, the effect of the basis truncate on the electromechanical outputs is discussed in term of computation error and time required. Results show that for an optimal truncated basis, the reduced order model enables true system level simulation, reduces the calculation cost and preserves the accuracy of the output responses of the harvester.

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