Finite Element Simulation and Comparison of Piezoelectric Vibration-Based Energy Harvesters with Advanced Electric Circuits

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ABSTRACT

A piezoelectric vibration-based energy harvester (PVEH) is composed of an electromechanical structure along with an energy extraction circuit. The objective of such a device is converting otherwise unused mechanical energy to electrical energy to power e.g. wireless sensors. The piezoelectric effect, used as the energy conversion principle, describes the appearance of electrical voltage when the piezoelectric material is mechanically deformed and vice versa.

In an energy harvesting application the electromechanical structure and the electrical circuit have an influence on each other. This necessitates the accurate modeling of both parts and their interactions [1]. However, until now all finite element (FE) based methods reported in literature, which are not coupled to a circuit simulation software, are limited to linear circuit elements and passive electrical interfaces. The FE based methods, which are combined with an external circuit simulation tool, consider only linear electromechanical structures or the coupling between the electromechanical structure simulation and the electric circuit simulation is not very efficient.

To overcome the mentioned drawbacks of existing FE methods for PVEH we developed a FE based approach, which can simulate nonlinear behavior of electromechanical structures as well as nonlinear and active electric circuits [2]. The influence of the circuit on the electromechanical structure is considered via the vector of external forces and an implicit time integration scheme is applied. The proposed method allows for consistent and efficient simulations of the complete possibly nonlinear PVEH using only one software tool.

REFERENCES
