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# Design and Integration of an Energy Harvesting Vibration Absorber for Rotating System

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**Abstract :** In the last decade the demand of wireless sensors and low-power electric devices for condition monitoring in mechanical structures has been strongly increased. Networks of wireless sensors can potentially be applied in a huge variety of applications. Due to the reduction of both size and power consumption of the electric components and the increasing complexity of mechanical systems, the interest of creating dense nodes sensor networks has become very salient. Nevertheless, with the development of large sensor networks with numerous nodes, the critical problem of powering them is drawing more and more attention. Batteries are not a valid alternative for consideration regarding lifetime, size and effort in replacing them. Between possible alternative solutions for durable power sources useable in mechanical components, vibrations represent a suitable source for the amount of power required to feed a wireless sensor network. For this purpose, energy harvesting from structural vibrations has received much attention in the past few years. Suitable vibrations can be found in numerous mechanical environments including automotive moving structures, household applications, but also civil engineering structures like buildings and bridges. Similarly, a dynamic vibration absorber (DVA) is one of the most used devices to mitigate unwanted vibration of structures. This device is used to transfer the primary structural vibration to the auxiliary system. Thus, the related energy is effectively localized in the secondary less sensitive structure. Then, the additional benefit of harvesting part of the energy can be obtained by implementing dedicated components. This paper describes the design process of an energy harvesting tuned vibration absorber (EHTVA) for rotating systems using piezoelectric elements. The energy of the vibration is converted into electricity rather than dissipated. The device proposed is indeed designed to mitigate torsional vibrations as with a conventional rotational TVA, while harvesting energy as a power source for immediate use or storage. The resultant rotational multi degree of freedom (MDOF) system is initially reduced in an equivalent single degree of freedom (SDOF) system. The Den Hartog's theory is used for evaluating the optimal mechanical parameters of the initial DVA for the SDOF systems defined. The performance of the TVA is operationally assessed and the vibration reduction at the original resonance frequency is measured. Then, the design is modified for the integration of active piezoelectric patches without detuning the TVA. In order to estimate the real power generated, a complex storage circuit is implemented. A DC-DC step-down converter is connected to the device through a rectifier to return a fixed output voltage. Introducing a big capacitor, the energy stored is measured at different frequencies. Finally, the electromechanical prototype is tested and validated achieving simultaneously reduction and harvesting functions.

**Keywords :** energy harvesting, piezoelectricity, torsional vibration, vibration absorber
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