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Piezoelectric Actuators Mode of Vibration Influence on Energy Harvesting Applications.

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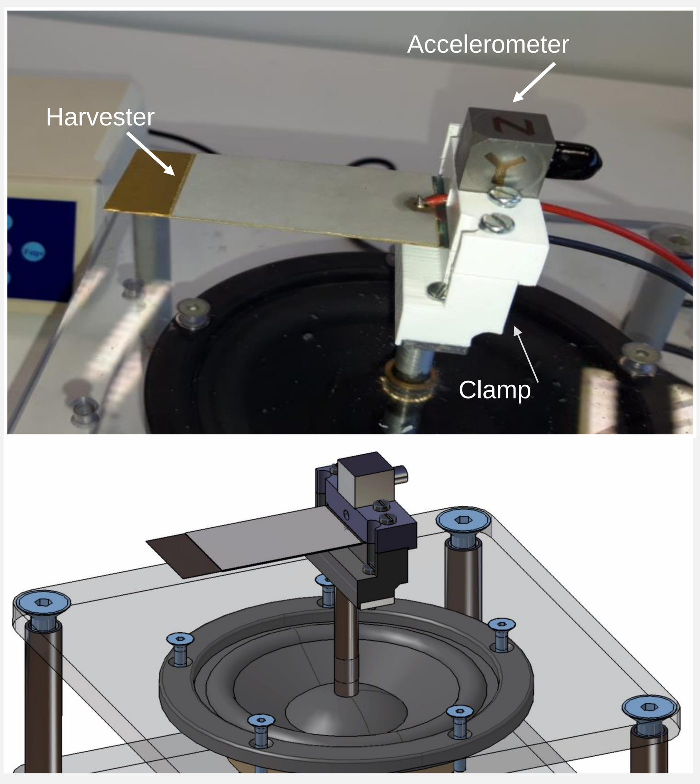
Motivation and Goals

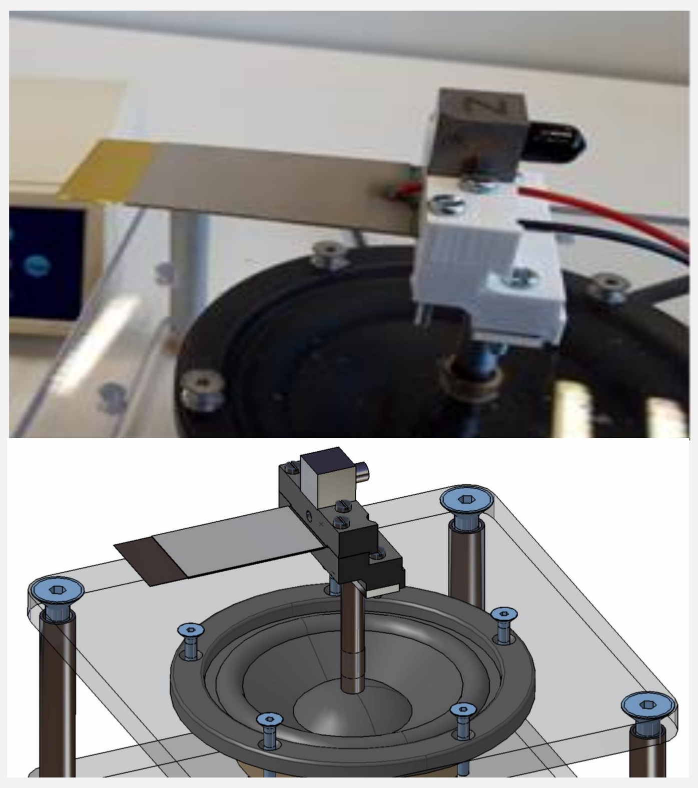
In the framework of the Industry 4.0, there is a great demand to provide sustainable and efficient self-powering solutions for small IoT sensing and communication electronic devices. However, the design of electrical power systems based on energy harvesting, entails the need to develop highly efficient solutions in energy extraction. For this reason, the authors have focused on the study of mechanical vibrations, demonstrating that the optimization of energy extraction must start from the optimization of the mechanical deformation of the harvester.

Experimental Procedure

The piezoelectric harvester manufactured perform the tests is a specimen composed of two PZT sheets of PIC 255 material in a bimorph configuration with a brass interlayer. The electrical configuration selected is the series, due to its higher power scavenging potential.
To analyze the influence on the vibration modes due to the clamping system in the amount of energy harvesting, two clamping setups have been designed to modify the center of gravity in the system. The first one, C1, has been designed to achieve a distribution of vibrations coming from excitation source centered on the OZ axis. The second one, C2, has been designed to modified the center of gravity following the literature examples.



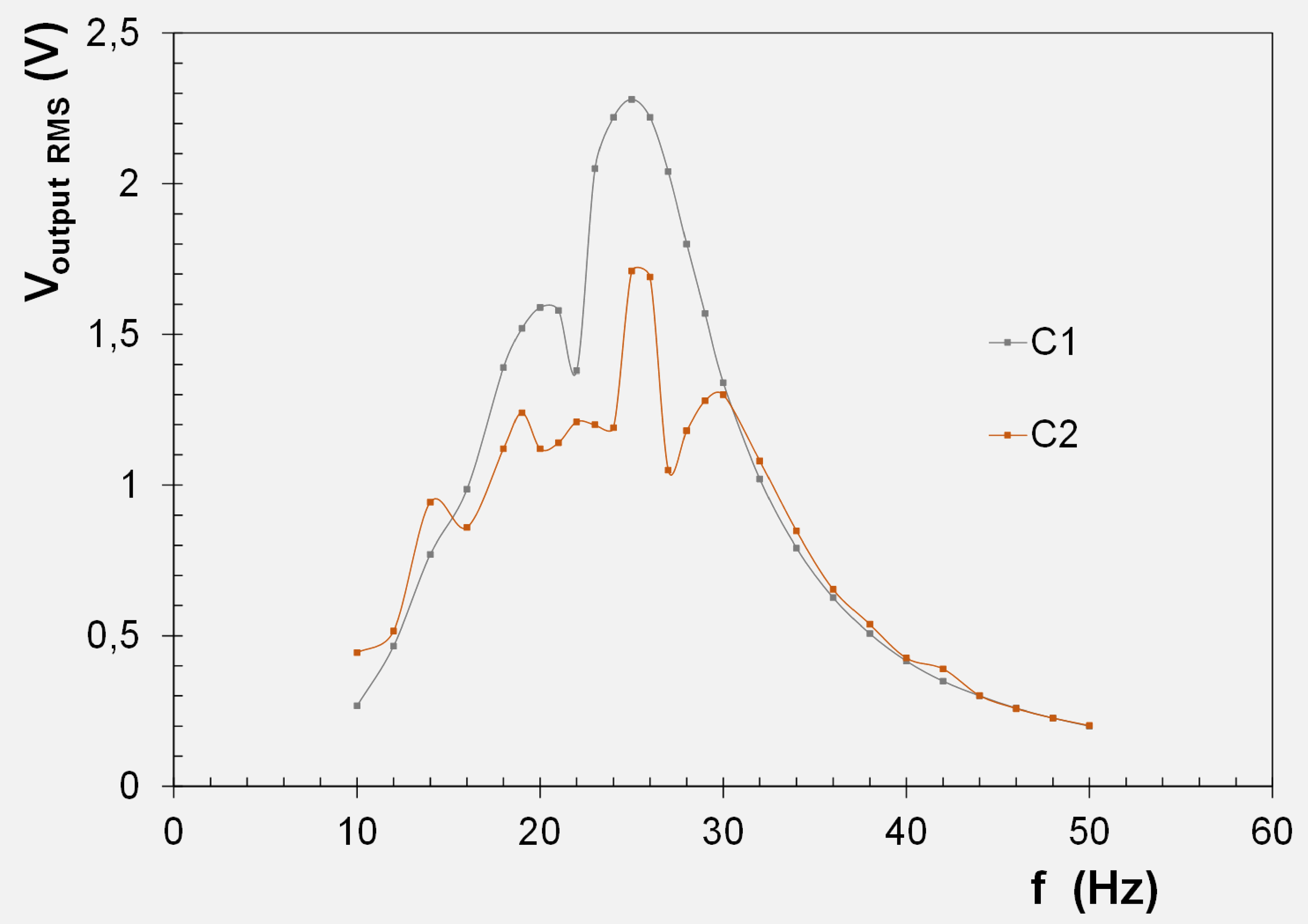
Clamping system of bimorph piezoelectric harvester C1: distribution of vibrations coming from excitation source centred on the OZ axis (scheme and real setup).



Clamping system of bimorph piezoelectric harvester C2: centre of gravity off-centre of the OZ axis of the vibration source (scheme and real setup).

Results

A Smart Material excitation shaker has been used to generate the vibrational excitation of the bimorph piezoelectric harvester. The frequencies range used was from 10 Hz to 50 Hz, and the RMS voltage output has been measured in open circuit configuration. The results obtained show minimal differences at lower frequencies, from 10 Hz to 17 Hz, in the V_{output} RMS behavior between both configurations, C1 and C2, as well as, at high tested frequencies, from 32 Hz to 50 Hz. Nevertheless, the behavior changes drastically at the resonation frequencies, between 17 Hz and 32 Hz, where the maximum energy is harvested. An increasing of the V_{output}, RMS is observed in the C1 configuration achieving an increased of the 25% than C2, indicating the great influence of clamping system in the energy harvested.



V_{output}, RMS vs frequency for C1 and C2 configurations.

Conclusions

In energy harvesting application designs, it is especially important to pay attention to the performance of the full system to take advantage of all the available energy and to maximize their efficiency on energy scavenging. This work has been demonstrated the great influence of the clamping system of the experimental setup to achieve the maximum energy collection from the surrounding environment in vibrational applications. Allowing the system to increase up to the 25% of usable voltage when the clamping system is centered with the vibrational source in the OZ axis.

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