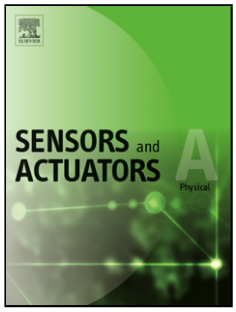

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Design of a nonlinear energy harvester based on high static low dynamic stiffness for low frequency random vibrations

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Abstract

Most of the vibration sources, which could be used for energy harvesting, are vertical and very low frequency (*e.g.* human movement, vehicle transportation, etc...). Under those conditions and while considering the size constraints, usual vibration energy harvesters (VEHs) underperform due to the combined effect of gravity, mechanical damping and the necessity to be tuned to very low frequencies. In order to overcome these limitations, the concept of *High Static Low Dynamic* (HSLD) stiffness is proposed and validated for VEHs. To do so, a theoretical study is performed to optimize the electromagnetic structure and design a folded-beam suspension of the moving mass allowing a low mechanical damping. This leads to the design of an original VEH, which is experimentally characterized under harmonic and white noise excitations. Compared to the literature, it demonstrated high performances with up to 41.3 $mWcm^{-3}g^{-2}$ of normalized harvested power at an operating low frequency of 5.3 Hz.

Keywords:
Vibration Energy Harvesting, High Static Low Dynamic Stiffness, Random Vibrations, Electromagnetic

1. Introduction

The Internet of Things (IoT) is a term used to describe a cluster of technologies enabling machine to machine (M2M) communication and machine to human interactions through the Internet [1]. One of these technologies is the autonomous wireless sensors which can be scattered in unfriendly environments leading to communication, electronic or mechanical issues. Power supply is one of the main concerns; due to their limited lifespan and/or their inability to withstand extreme temperatures, usual batteries are sometimes unable to satisfy the sensor specifications. A promising solution is to take advantage of the ambient energy surrounding the sensor: energy harvesting. Among the various exploitable sources [2], this study focuses on the mechanical energy of vibrations.

Vibration energy harvesting aims to turn mechanical vibration into usable electrical power. Most of the vibration energy harvesters can be classified according to their trans-

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