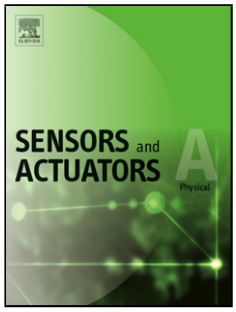

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Author: D. Alghisi S. Dalola M. Ferrari V. Ferrari

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Triaxial Ball-Impact Piezoelectric Converter for Autonomous Sensors Exploiting Energy Harvesting from Vibrations and Human Motion

D. Alghisi [1*], S. Dalola [1], M. Ferrari [1, 2], and V. Ferrari [1, 2]

[1] Department of Information Engineering, University of Brescia,

via Branze 38, 25123 - Brescia, Italy

[2] INO-CNR,

via Branze 45, 25123 - Brescia, Italy

*Corresponding author. Tel.: +39 030 3715938 Fax: +39 030 380014

E-mail address: d.alghisi001@unibs.it

Abstract

A piezoelectric converter for energy harvesting composed of a rigid ball enclosed among six piezoelectric diaphragms arranged in a cube-shaped structure is presented. When the converter is excited by mechanical vibrations, the ball repeatedly bounces and hits one or more diaphragms, implementing the impact technique in a multi-degree-of-freedom configuration. The structure is isotropic thus the converter is effective irrespective of the vibration orientation. The converter is particularly suitable for energy harvesting from low-frequency random vibrations, such as those provided by human motion. The triaxial ball-impact piezoelectric converter was designed, built and experimentally characterized in the laboratory, and then tied to the ankle of a person and tested during physical activity. While the person is running at 7 km/h, a peak instantaneous power of up to 16 mW is provided by each of the six piezoelectric diaphragms, while the average power is significantly lower. The converter was coupled to a tailored power management circuit which intermittently powers a battery-less wearable temperature sensor module. In about 260 s of walking at 2 km/h, an energy of 1.4 mJ is extracted, stored into a 1-mF capacitor, and used to power the