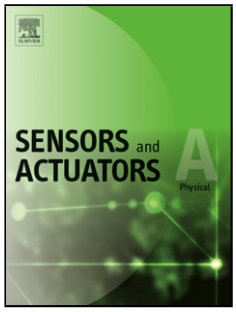

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Design and optimization of piezoelectric impact-based micro wind energy harvester for wireless sensor network

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Abstract

The purpose of the current study is to design and optimize a piezoelectric impact-based micro wind energy harvester (PIMWEH) as a power source for wireless sensor networks. First, using new PIMWEH design, numerical simulation, and experimental comparison analysis, we determined the most durable PIMWEH shape for application as a power source of WSNs. The experimental results show that the optimized PIMWEH generated 2.8 mW (RMS value) and did not crack within 40 h. Second, to supply power for sensor operation, we performed an experiment using a rectifying circuit, an AC–DC converter, and an electrical charger. The experimental results show a pure DC voltage signal of 3.3 V, and the output power was 1.0 mW (3.1 mW/cm^3). A charging energy of 0.845 J was obtained in 24 min. Third, we calculated the efficiency of the PIMWEH to evaluate its performance. Using a three-step energy conversion process (using wind turbine, PZT, and LTC3588-1), an overall PIMWEH power conversion efficiency of 3.2% was obtained. For one day, the PIMWEH could supply power that is 6263 to 25055 times the power requirement of a commercialized ZigBee transmission. In addition, transmitting signals at intervals from 3.4 to 13 s was made possible.

Keywords: Piezoelectric; wind energy harvester; durability; wireless sensor network

1. Introduction

In recent years, wireless sensor networks (WSNs) have been widely used at home, environment monitoring, healthcare, industrial monitoring, structural health monitoring, and traffic control [1-4]. However, because of the size limitation of a WSN module, a WSN battery is very limited and cannot meet the power consumption of a WSN [5]. To solve this problem, self-powered energy harvesters for WSN applications have been actively studied [6-10]. In particular, wind energy harvesters that use