CALIFORNIA STATE SCIENCE FAIR
2009 PROJECT SUMMARY

Name(s)

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Project Number

S0212

Project Title

Putting the Squeeze on Energy Harvesting: Piezoelectric Power Scavengers

Abstract

Objectives/Goals

A growing demand for clean, efficient, low-cost powering systems favors development of mechanical to electrical energy conversion technologies. A currently untapped source, the energy dissipated as crowds walk through busy public spaces, could be captured with piezoelectric elements embedded in flooring tiles. This experiment addressed the optimal internal configuration of these tiles, hypothesizing that mounting the piezo elements in a concave position, to allow them to stretch with tensile strain when stepped on, would result in higher voltage production than would be obtained by simply compressing the piezoelectric material with a direct strike.

Methods/Materials

A hinged wooden apparatus was built to strike a piezoelectric element with an experimentally controllable force, with resulting electrical output recorded on a scope meter. Voltage magnitude was studied as variations were made in the height from which each strike was delivered, surface area of the strike point, and curvature of the thin platform on which the piezo element sat.

Results

Piezoelectric behavior was evident in all configurations tested, giving voltage readings between 100 volts and 258 volts. Increases in height from which a piezo element was struck, and surface area of strike point, both improved output. More interesting from a design standpoint, the platform which forced a piezo element to stretch into a concave shape when struck, inducing tensile strain, resulted in an average production of 21 volts of additional power compared to using a flat platform, on which the element only experienced compressive strain.

Conclusions/Discussion

Manipulation of the character of the force delivered in the test apparatus produced voltages supporting the hypothesis that tension, induced by stressing the element into a concave shape, increases the magnitude of the piezoelectric effect compared to using simple compression. Improved energy output from a piezoelectric flooring tile would therefore be expected with a piezo element mounted over a slight concave gap, allowing it to stretch under the applied force of footsteps. Since fine cracking was noted in the ceramic elements used in this experiment, further testing with higher tensile-strength polymer elements should be considered.

Summary Statement

A mechanical/electrical energy conversion apparatus shows waste energy reclaimed from walking can be optimized by positioning piezoelectric scavengers in flooring such that steps induce tensile, not compressive, strain in piezo elements.

Help Received

Steven A. Press, Director of Data Center Facilities, Kaiser Permanente, loaned me the scope meter used in this experiment.