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Design and Analysis of Vibration-Based Piezoelectric Energy Harvester
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Abstract
Despite the common use of batteries, their limitations, such as finite energy capacity and environmental concerns upon disposal, pose significant challenges. Piezoelectric energy harvesters (PEH) offer a promising solution for low-power devices, potentially reducing the necessity for battery replacement. They have emerged as a crucial technology for sustainable energy solutions and a key characteristic for engineering applications, such as sensors and actuators. This study aims to design and analyze PEH devices. A PEH with various cantilever shapes, namely, rectangular, circular, and triangular edges, has been designed with varying substrate materials (rigid, such as structural steel, and flexible, such as polyethylene terephthalate (PET)) in conjunction with piezoelectric materials, namely, lead zirconate titanate (PZT) and polyvinylidene fluoride (PVDF). Finite element modelling was conducted to analyze the output voltages harvested from PEH and its resonance frequencies. The simulation results indicated that the cantilever with rectangular edges generated the highest output voltage when combined with PZT /steel, reaching up to 1.3914V at a resonant frequency of 250 Hz, In comparison, the circular and triangular cantilevers produced lower output voltages, demonstrating the influence of cantilever shape on energy harvesting efficiency. Furthermore, the study found that using a flexible substrate like PET, while advantageous for certain applications, resulted in lower output voltages compared to rigid substrates like steel. © 2024 IEEE.

Author Keywords
Cantilever beam; Finite element modelling; Piezoelectric energy harvesters

Index Keywords
Cantilever beams, Concretes, Hydraulic structures, Mortar, Piezoelectric actuators, Piezoelectric materials, Piezoelectricity, Pressure vessels, Structural design, Vibrations (mechanical); Design and analysis, Element models, Energy-capacity, Environmental concerns, Finite element modeling, Finite energy, Low output voltage, Piezoelectric energy harvesters, PZT, Terephthalate; Nanocantilevers

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