Design and Optimization of a Hybrid Piezoelectric–Electromagnetic Energy Harvesting System for Mechanical Energy Conversion

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This project's purpose is to explore a novel hybrid energy harvesting model that uses two kinds of sustainable harvesting that tap into unused energy in the world, piezoelectric and electromagnetic. This project aimed to see if the hybrid energy harvester model could consistently produce more voltage in comparison to harvesters that use only one mechanism. Three prototypes were designed and built: a piezoelectric model, using a flexible ruler to provide oscillating motion and piezo discs, an electromagnetic model, using copper wire wound into a coil and neodymium magnets, and a hybrid model, incorporating both methods and materials into a single system. The results revealed that the hybrid model performed better in consistency and voltage than the others, producing approximately 133% to 200% more voltage than the other models. These findings show that hybrid models could be a possible solution in the future for sustainable energy. Capturing unharnessed energy using a hybrid model helps create more voltage consistently, making a piezoelectric and electromagnetic hybrid energy harvester a viable solution for using unharnessed energy sustainably. Merely proving that the hybrid model worked best wasn't the ultimate goal of this project. Using this newly acquired data, a prototype was designed (using CAD software) to capture mechanical energy from footsteps and tested using weights. Whenever pressure was applied to the prototype, the mechanical energy and pressure would be converted to voltage through piezoelectric and electromagnetic induction processes. The first version of the prototype performed well, but a second version was designed with the use of a rack and pinion and a 3:1 gear ratio to fully optimize the limited amount of mechanical pressure applied.

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