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Simulation-Based Optimization of a Non-Uniform Piezoelectric Energy Harvester with Stack Boundary

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Abstract : This research presents an analytical model for the development of an energy harvester with piezoelectric rings stacked at the boundary of the structure based on the Adomian decomposition method. The model is applied to geometrically non-uniform beams to derive the steady-state dynamic response of the structure subjected to base motion excitation and efficiently harvest the subsequent vibrational energy. The in-plane polarization of the piezoelectric rings is employed to enhance the electrical power output. A parametric study for the proposed energy harvester with various design parameters is done to prepare the dataset required for optimization. Finally, simulation-based optimization technique helps to find the optimum structural design with maximum efficiency. To solve the optimization problem, an artificial neural network is first trained to replace the simulation model, and then, a genetic algorithm is employed to find the optimized design variables. Higher geometrical non-uniformity and length of the beam lowers the structure natural frequency and generates a larger power output.

Keywords : piezoelectricity, energy harvesting, simulation-based optimization, artificial neural network, genetic algorithm
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