Topology optimization of Permanent Magnet and Coils in Electromagnetic Vibration Energy Harvesters

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Abstract

The electromagnetic vibration harvesters are designed using the topology optimization approach. The energy harvesters designed herein are composed of permanent magnets and pick-up coils. The geometry of permanent magnets and coils in the harvesters are simultaneously designed using topology optimization. The optimization is performed in two-dimensional axisymmetric model of the harvester. The optimization objective is set as to maximize the root-mean-square value of the output voltage. The output voltage is calculated by differentiating the flux linkage with respect to time, that is, the Faraday's induction law. The flux linkage is computed by the integration of the magnetic vector potential in the coil area. The magnetic vector potential is obtained by solving the Maxwell's equation using finite element analysis. To apply the gradient-based optimization algorithm, the analytical sensitivity of the objective function is derived using the adjoint variable method. The proposed topology optimization approach finds the optimal geometries of the permanent magnet and pick-up coils maximizing the output voltage of the harvester.

Keywords: Topology optimization, Electromagnetic energy harvesters, Permanent magnet, pick-up coils