EVALUATION OF PIEZO-ELECTRIC ENERGY HARVESTING FROM ROTATING ENVIRONMENTS

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ABSTRACT

The desire to reduce power consumption of current integrated circuits has led design engineers to focus on harvesting energy from free ambient sources such as vibrations. The energy harvested this way can eliminate the need for battery replacement, particularly, in low-energy remote sensing and wireless devices.

We present an energy harvester device subjected to a rotation state. Example applications include shafts connected to motors, axles, propellers, fans, and wheels or tires. The device proposed consists of a spring/mass system represented by a cantilever beam with an attached piezoelectric wafer. A mathematical model of a composite cantilever beam mounted on the inner part of a rotating hub will be presented. This model will provide us with a relationship between the mechanical stress, the deflection experienced by the beam, and the rotary speed of the reference hub. The model is then integrated with the electrical circuit equations. Altogether, they are expected to model the piezoelectricity behavior of the rotating cantilever beam to obtain the induced voltage and power from the piezoelectric transducer. With the resulting equations, the objective is to investigate the effect of rotation speed on the performance of the harvesting mechanism. The validation of the analytical model is performed by fabricating a prototype of our proposed device and conducting a full experimental study.

The numerical results are shown to be in good agreement with the experimental data as far as the frequency response is concerned.