LOW FREQUENCY VIBRATION-BASED MEMS PIEZOELECTRIC ENERGY HARVESTER

ABSTRACT

Providing a green, virtually infinite alternative power source to traditional energy sources will significantly expand applications for WSNs and other technologies. The use of piezoelectric materials to capitalize on the ambient vibrations surrounding a system is one method that has seen a dramatic rise in the use for power harvesting. Most of the works found in literature are different in their structures and vibration frequencies, and only few of them have focused on power harvesting under both low frequency and acceleration applications. In order to meet the requirements of power optimization, three analytical models of different structures were proposed through the methodology of this research. Finally, a proposed design of a 5-element uni-morph cantilever-based array MEMS piezoelectric energy harvester for low frequency is being considered. Ambient vibration frequencies surrounding the harvester normally ranged less than 200 Hz, whereas the maximum extracted power was inversely proportional to the excitation frequency as found in the literature. Throughout this study, an ambient vibration-based MEMS piezoelectric energy harvester has been modeled and designed for low frequency applications; the harvested power and voltage were 1.8 μWatts and 190 mV respectively for a single cantilever element at excitation frequency of 70.2 Hz, while the designed 5-element cantilever based energy harvester extracted up to 6.8 μWatts and 0.4 volts at excitation frequency band of 67 to 70 Hz under acceleration amplitude of 1.3g, yielding power density of 264.2 μWatts/cm^3.