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Design and Optimization of Small Rotational Piezoelectric Wind Energy Harvesters for Different Load Types and Working Conditions

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Abstract

In the future, smart devices are expected to operate autonomously and will be self-powering, self-sensing utilizing ambient sources. With the enormous development in low-power sensors, a self-contained electrical system will be used in practical applications. At the same time, many studies have demonstrated that vibrational energy could be present in the ambient environment. In particular, the vibrational energy produced by combining the mechanical structure and wind energy has been paid more attention recently because wind flow provides a constant source of mechanical energy and this energy can be easily harvested.

This talk will introduce several different small rotational piezoelectric wind energy harvesters which have been designed in recent years. Firstly, a piezoelectric bimorph cantilever polygon with horizontal shaft has been designed and impact-induced resonance proposed to enable effective excitation of the piezoelectric cantilevers' vibration modes and obtain optimum deformation, which enhances the mechanical/ electrical energy transformation to improve the output power. And then a vertical shaft wind energy harvester has been proposed as an optimized version of the former one. This vertical shaft Darrieus-type windmill may rotate easily in any wind direction and will have a higher mechanical to electrical energy conversion efficiency. The followed design is a bending rod piezoelectric energy harvester, which is deliberately designed for the extremely high wind speed situation. These small scale piezoelectric wind energy harvesters have been designed, optimized and tested. The output power goes from hundreds microwatts to hundreds milliwatts for different designs. The generated electricity can be stored in a supercapacitor and be used to power small electronic devices or wireless sensor nodes placed in remote locations.