Research leads to sensor breakthrough, promises safer structures

June 5 2014

UH Mānoa Department of Civil and Environmental Engineering Professor David Ma and Graduate Student Hui Zhang have achieved a long-sought technical breakthrough by proving an efficient method of harvesting mechanical energy to power autonomous sensor networks. Their research findings appear in the prestigious *Applied Physics Letters* of the American Institute of Physics.

Large-scale wireless sensor networks are extremely useful in monitoring the behavior of both natural and engineered systems. For example, sensors placed in a body of water can help monitor its quality and fitness for human consumption and safe recreation. "The monitoring of the structural health of buildings, dams and bridges helps to avert sudden and catastrophic failures by providing warning signals associated with progressive deterioration as it occurs over time," explained Department Chair and Professor C.S. Papacostas.

To be able to sense the characteristics being measured and to transmit the data they collect to central locations, these sensor networks require a power source that is superior to the cumbersome and often infeasible practice of installing and replacing batteries in the field.

One of the ways to accomplish this autonomous operation is to harvest mechanical vibrations, such as the vibration of bridges resulting from the passage of vehicles, and internally convert them into electricity, which can in turn power the sensors.

Early approaches to this kind of energy harvesting concentrated on the design of the devices to match the dominant frequency of the system being measured. But, because most systems vibrate at a series of frequencies, targeting only one of them missed the rest, thus limiting the effectiveness of the device. The alternate approach was to design devices capable of responding to different frequencies but not simultaneously. It turns out that, due to "non-linearities," these "passive" responses could not be simply added together to yield significantly improved results. What was needed was a method that responded actively to multiple frequencies.

Ma and Zhang developed a theoretical model and a prototype physical device capable of actively harvesting much more energy than the traditional passive schemes. In doing so, they established a paradigm shift that has opened doors to new research applications. The next step is to fully test the concept.

Provided by University of Hawaii at Manoa

Citation: Research leads to sensor breakthrough, promises safer structures (2014, June 5) retrieved 5 May 2024 from https://phys.org/news/2014-06-sensor-breakthrough-safer.html