5 Techs Harvesting Energy from Tiny Motions

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Pavegen

Floors, fabrics, sheets and bridges turn everyday human activities into power.

By Alyssa Danigelis

The low-power energy harvesting idea has teased us for years. Engineers and materials scientists looking at bustling city sidewalks, packed gyms and well-traveled bridges saw potential for all that movement to be converted into useful electricity.

So where is all the tech? Self-powered environmental sensors are still undergoing testing. Energy-harvesting tiles remain a novelty. And some of the most promising developments haven't left the lab yet.

Harnessing energy from movement involves numerous challenges, explained Peter Harrop, chairman for the UK-based market research firm IDTechEx in a recent Energy Harvesting Journal op-ed. "Vibration harvesting is a niche business and suppliers struggle to profitably attract more than millions of dollars of business yearly," he wrote.

Many devices have to compete against long-lasting batteries. Cost, size and standardization are additional hurdles. Academics love piezoelectric crystals, but they have issues with reliability and performance, Harrop noted. He did point out that new approaches are showing promise, though. Shifting the focus to vibration harvesting could lead to more effective and widely applicable products. Here's a look at five developments in the field that are making waves.

Floor Tiles

The UK-based startup Pavegen has become synonymous with energy-harvesting floor tiles. Since the company was founded in 2009, their tech has showed up on the dance floor, in hallways, at transit hubs and underneath runners' feet at the finish line.

Each smart tile can produce small amounts of power from footsteps. The weight vertically displaces generators and that motion creates energy through electromagnetic induction, according to the company. Each tile also transmits real-time movement data. For a while that kinetic energy was only enough to keep lights on, but recently Pavegen introduced a line of new, more efficient triangular tiles called V3 and began talking about powering a wider range of devices.

Wood Waste Flooring

One technology Harrop highlighted is triboelectric energy-harvesting nanogenerators, or TENG for short. This approach emerged within the last several years and works by capturing the electrical charges produced when two materials rub against each other.

Xudong Wang, an associate professor of materials science and engineering at the University of Wisconsin–Madison, came up with a flooring TENG device made from wood waste. When chemically treated cellulose nanofibers derived from wood pulp come into contact with untreated fibers, they produce an electric charge, according to the university. Wang and his team think using low-cost materials will make the flooring affordable.

Electrochemical Sheets

In early 2017, materials science and engineering professor Ju Li and his team at MIT reported in the journal Nature Communications that they created a device for harnessing small motions that doesn't rely on piezoelectrics or the triboelectric effect. Instead, the system is a veritable metal and polymer sheet sandwich. When bent slightly, the battery-like electrochemical prototype produces a voltage, Li explained to the Institute.

The device, the team wrote in their journal article, demonstrates a practical way "to harvest low-grade mechanical energies from various low-frequency motions, such as everyday human activities."

Ambient Sensors

IDTechEx's Harrop highlighted the University of Cambridge spinoff 8power, which he wrote has a different approach to electrodynamic vibration harvesting that efficiently produces tens of milliwatts. Using patented technology that came out of the university, the startup's tiny environmental sensors work without batteries and in extreme temperatures. They combine direct and parametric resonance to capture ambient vibrations.

Last year 8power's sensors were put to the test in a field trial on the Forth Road Bridge between Edinburgh and Fife. The busy bridge has suffered from structural strain, prompting a limit to the traffic load and plans to build a new bridge. After placing 8power sensors underneath the bridge's deck, the team found that the devices successfully took structural condition measurements and transmitted that data wirelessly - powered only by vibrations from traffic and wind.

Wearable Fabric

Georgia Tech materials science and engineering professor Zhong Lin Wang has long been searching for ways to capture energy that would otherwise be wasted. A pioneer in developing triboelectric generators, he led the creation of a new fabric in 2016 that harvests energy from sunshine and human motion at the same time (abstract). The textile contains triboelectric nanogenerators and lightweight solar cells woven together with wool.

"This hybrid power textile presents a novel solution to charging devices in the field from something as simple as the wind blowing on a sunny day," Wang told the university.

All that tech really does go with the flow.