Making moves and harvesting energy

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Engineers are tossing the batteries and making advances to save wasted energy in more effective and realistic ways

Today's technology offers the OEM more cultivated and feasible power options for wireless networks and devices. Also known as "power harvesting" or "energy scavenging", energy harvesting is when energy originates elsewhere, from an external source. The amount of energy captured and stored is very low, so it is can only be used to power small wireless devices, like wireless sensor networks (WSN) and cell phones. Instead of relying on batteries, as most have been doing in the past, OEMs are harvesting energy – and they're doing so in some very fascinating ways.

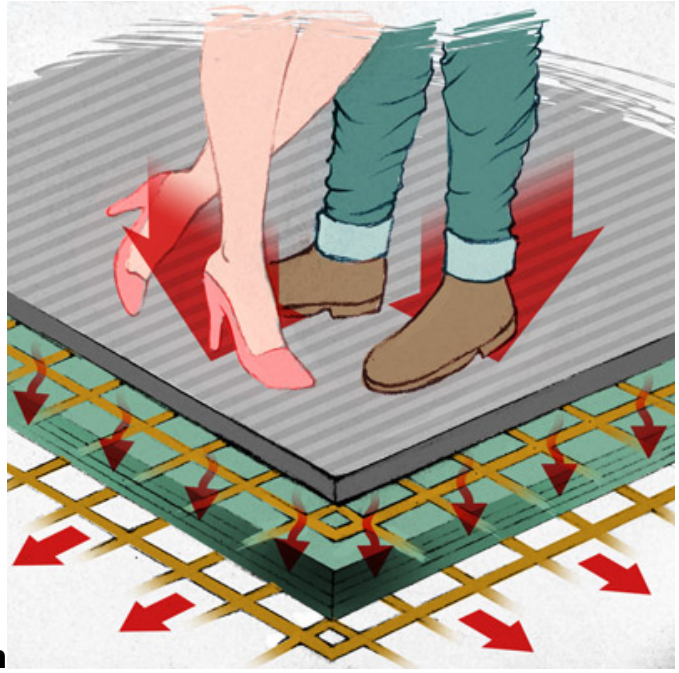
Some everyday examples of these sources are solar power, thermal energy, wind energy and kinetic energy. Interestingly, there are also a few examples of energy harvesting that are not so every day like – and they're powered by you (and me).

Vibration energy harvesting

Energy harvesting is on the rise and its moving fast. One process, known as vibration energy harvesting, uses wasted vibration most commonly from a piece of industrial machinery. The vibration is harvested and converted to useful electrical energy. One of the most prominent applications for WSNs is to monitor machinery, like the health and status within industrial manufacturing environments. This makes the process easy and economical to monitor and measure points in the plant area that are more difficult than normal, and would normally require a hard wire monitoring solution, or even an extra set of hands. Wirelessly relaying the information to a remote location is a huge convenience. Eliminating batteries, with their limited life span and disposal requirements, will reduce cost and hassle, while also eliminating maintenance. By adding a Vibration Energy Harvester there will be maintenance free power even beyond the WSN life cycle. This is the most widespread use of vibration energy harvesting.

The technology is known as piezoelectricity, where electric energy from mechanical

vibrations is captured through a unimorph piezoelectric membrane transducer. When a piezoceramic trandsucer is stressed mechanically by a force, its electrodes receive a charge that tends to counteract the imposed strain. This charge may be collected, stored and delivered to power electrical circuits or processors.



Piezoelectricity in action

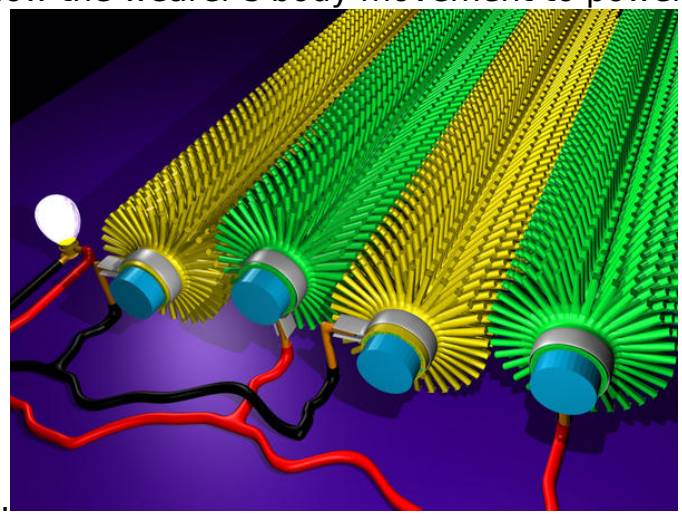
So where else can you collect energy from a vibration using piezoelectricity? Think about something you use everyday – to get to work, to the grocery store, you may even walk or ride your bike on it. That's right – roadways. Back in 2011 Mike Gatto, California Assemblyman, proposed a bill that would implement piezoelectric technology to harness energy from road vibrations. When a car or truck passes over pavement, the pavement vibrates slightly. By placing relatively inexpensive piezoelectric sensors underneath a road, the vibrations produced by vehicles would then be converted into electricity. The electricity could then be used to power roadside lights, call boxes and potentially even neighboring communities. Gatto claimed that the technology could generate up to 44 megawatts of energy from one kilometer of a one-lane highway in one year. The bill passed, with amendments, allowing California to do further research on the technology.

A similar version of energy harvesting is happening in the Netherlands, thanks to scientists from Studio Roosegaarde. Club Watt in Rotterdam uses the piezoelectric effect to generate electricity when people walk, hop, skip, jump or inevitably, dance on the energy harvesting dance floor. The

floor is made out of springs and power generating blocks, which create electricity when they're stepped on. The power is transmitted and stored in nearby batteries, which then powers the night club's electronic equipment. Move your feet to keep the beat, literally. The design has since been replicated in numerous locations around the world.

Bodies in motion

Walkers, runners, hikers and soldiers all have one thing in common – physical motion. Pairing motion with textile fibers covered with zinc oxide nanowires, makes for one strong electrical current. Combining current flow from many fiber pairs woven into a shirt or jacket could allow the wearer's body movement to power a range of portable electronic devices.



The "power shirt", which uses nanogenerators invented by researchers at the Georgia Institute of Technology, proved especially effective for soldiers in the field to power small electronic devices, such as two-way radios. The microfiber-nanowire hybrid system builds onto the nanowire nanogenerator. The system generates current from arrays of vertically-aligned zinc oxide (ZnO) nanowires that flex beneath an electrode containing conductive platinum tips. The nanowire nanogenerator was designed to harness energy from environmental sources such as ultrasonic waves, mechanical vibrations or blood flow. Coupling piezoelectric and semiconducting properties of zinc oxide nanostructures, which produce small electrical charges when they are flexed, the nanogenerators can produce up to 800 nanoamperes and 20 millivolts. The fibers could also be woven into curtains, tents or other structures to capture energy from wind motion, sound vibration or other mechanical energy.

Power walking

There are countless inventive ways to keep your cell phone powered, whether it’s a charging handbag, energy harvesting sneakers or a power walking backpack – just to name a few. The latest fad? An accessory for your knees that make the energy harvesting sneakers look weak. The Biomechanical Energy Harvester generates more than 1000 times more energy, and is just another green way to power portable devices in the future. For every step you take, you are using two different groups of powerful muscles connected to the knee. The first pushes to kick the lower leg out, and just before full extension, the second group pulls to put the brakes on. Max Donelan, Director of the Simon Fraser University Locomotion Laboratory in Burnaby, Canada, and his colleagues, created a customized knee brace that effectively uses the braking process, by turning it into electricity.

This form of generative braking, also used in hybrid cars, combines embedded sensors which detect the angle and velocity of their legs, switching the device on only during the braking phase of each swing. Each brace produces five watts of power, enough to power 10 cell phones. The prototype is so small, weighing 1.6 kg, that it in no way affects the walker. Researchers would like to lighten the load, with hopes that this application may be a perfect fit for people who depend on reliable, portable power, like patients with insulin pumps. Rumors of the technology being incorporated into the design of progressive neuroprostheses, artificial limbs directly controlled by brainwaves and deep-brain stimulators for Parkinson's disease patients, are surfacing.

Conclusion

As you can see, energy harvesting has truly emerged from where it was just a few years ago. Engineers are tossing the batteries, and are making advances that

generate power from sources such as motion and vibration much more effective. As time goes by, and designs become more efficient, these technologies will become more mainstream, and will surely be used on a day-to-day basis. Whether it be in an industrial setting, where wirelessly monitoring machinery is adding convenience and cutting costs, to consumer-based applications using wasted energy to power devices. Wasted energy, in all forms, from various sources, will be harvested to power our world – one step at a time.

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