NEW TECHNOLOGIES FOR HARVESTING ENERGY FROM HUMAN MOVEMENT
A Rapidly Expanding Market

Harvesting energy from human movement provides solutions for small-power applications, including ubiquitous wireless sensor nodes, portable, flexible and wearable electronics and monitoring devices. As an example, the number of smart devices linking everyday objects via the internet is estimated to grow to over 50 billion by the 2020.

Most of these Internet of Things devices will be small and in many cases embedded, wirelessly providing useful data that will make our lives easier, safer, better and more energy-efficient. The only sustainable way to power them is using ambient energy harvesting that lasts through the sensor product lifetime.

Key Market Applications

The market sectors that can rapidly adopt these unique energy harvesting solutions include:

- Footwear
- Apparel
- Sporting equipment
- Recreational equipment

Key applications include: in-shoe power generation for recharging mobile devices and a wide range of wearable electronic sensors for monitoring and location applications.
NEW INNOVATIONS FOR GENERATING AND STORING ENERGY FROM HUMAN MOVEMENT TO POWER/RECHARGE PORTABLE ELECTRONIC DEVICES

POWER GENERATION

Cantilevered piezoelectric transducers are the simplest means of energy harvesting directly from ambient vibrations. These devices are well suited to MEMS, are relatively easy to manufacture, require no input voltages or charges and do not need complex circuits. Piezoelectric devices can comprise ceramic and polymer materials.

HOW IT WORKS

The vibrational energy harvester has a base and a piezoelectric transducer formed from a cantilever layer of piezoelectric material and extending between a first end at the base and a second end. At least a portion of the piezoelectric transducer is arranged in a zigzag pattern between the first and second ends. A magnetic component provides a magnetic field within which at least a portion of the piezoelectric transducer operates so that it exhibits nonlinear behavior to achieve higher power levels.

ADVANTAGES

Small size with a scalable power density generation with wide bandwidth and optimized for low frequencies using a novel zigzag design and non-linear mode to deliver higher voltage/power densities. The cantilevers can operate in transverse and longitudinal vibration modes. The piezoelectric energy harvesters can be made robust to variations in resonance vibrations. Originally developed for energy scavenging from a vibrating heart with variable beats to charge pacemaker batteries.

POWER CONVERSION AND STORAGE

Traditional rectifier bridge circuits are generally used with energy harvesting devices. These exhibit energy loss and also use energy for the AC to DC conversion. The novel circuit does not (1) place a threshold limit imposed by diodes and/or the output voltage on mechanical vibrations, (2) lose power across an otherwise additional stage (i.e., across a rectifier), and (3) limit how much the circuit dampens the transducer (to produce more power).

HOW IT WORKS

The circuit captures electrical energy from a piezoelectric source can charge a capacitor and battery. The circuit includes an inductor that is configured to store electrical energy. A diode bridge-free switching network is configured to direct electrical energy from the piezoelectric source to the inductor during a first portion of a piezoelectric charge generating cycle; and direct electrical energy from the inductor to the battery during a second portion of the piezoelectric charge generating cycle.

ADVANTAGES

Efficiently converts the small amounts of energy generated by piezoelectric transducers from AC to DC with a power cache that can used to charge supercapacitors or batteries. The circuit design can capture energy from short, non-periodic vibrations and can scale from microWatts to Watts, depending on the power density of the energy harvester device. In addition, the circuit can be integrated with other types of energy harvester devices, to fit different applications.

<table>
<thead>
<tr>
<th>Patents</th>
<th>Number</th>
<th>Title</th>
</tr>
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<tbody>
<tr>
<td>University of Michigan</td>
<td>WO 2014/12690</td>
<td>Piezoelectric vibrational energy harvester</td>
</tr>
<tr>
<td>Georgia Tech Research Corporation</td>
<td>US 8,368,290</td>
<td>Rectifier-free energy harvester/battery charger circuit</td>
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Note: Tekcapital holds exclusive licenses to these patents

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