Miniscule MEMS AM Technology Used to Charge Cellphones

by Todd Halterman
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A research associate and an electrical engineering professor at UT Arlington have designed a micro-windmill capable of generating wind energy which may one day offer an alternative to cell phone battery recharging. They say it may also prove useful in home energy generation, an application where large windmills are unsightly.

The device uses Micro-electro-mechanical systems, or MEMS, technology. MEMS are very small devices which are made up of components between 1 to 100 micrometres in size. Such devices generally consist of a central unit used to process data and several other components which interact with their surroundings. Richard Feynman’s groundbreaking lecture, There’s Plenty of Room at the Bottom, first postulated the idea of MEMS devices.

In general, commercial wind turbines have been constructed on a massive scale to make them capable of generating enormous output. Increases in efficiency have led from windmills which produce 300 kW capacity in 1990 to 7.5 MW in 2011, but now professor J.C. Chiao and Dr. Smitha Rao of the University of Texas at Arlington have turned the ‘bigger is better’ mantra on its head.

The pair have developed a MEMS device of nickel alloy so small that 10 of them can be...
mounted in series — all on a single grain of rice.

The idea is to harvest energy on a very small scale for applications like smartphones.

Called horizontal axis wind turbines, the 'windmills' feature a three-bladed rotor 1.8 mm in diameter which is then mounted on a tower only 2 mm tall. The mount, which serves as a friction hub, becomes a sort of 'air bearing' when the rotor is spinning. In total, the thickness of each windmill is around 100 microns. Though they're exceptionally tiny, these micro-windmills can tolerate very strong winds. Constructed of a nickel alloy in place of the silicon and silicon oxide layers of most other MEMS devices, their aerodynamic design makes them tough indeed.

"The problem most MEMS designers have is that materials are too brittle. With the nickel alloy, we don't have that same issue. They're very, very durable," Rao said.

So how much power can they actually generate? The answer is a bit of a surprise.

While modern turbines can convert around 45 percent of the energy they encounter, a micro-windmill can deliver a significant fraction of a milliwatt. Put a thousand micro-windmills together and it might be possible to create 5-10 watt hours of power in a day, and that's close to what's needed by a cell phone battery.

The sensor assemblies in development now function at sub-microwatt levels as they slowly accumulate data which triggers a signal to move a short burst of power transmission. The core engineering challenge is to then take those fractions of a milliwatt and transform them into mechanical energy and then electrical energy. Experts say the most likely scenario would involve an electrostatic generator in which the windmill itself becomes the generator.

The micro windmills underwent successful tests during September 2013.

"Imagine that they can be cheaply made on the surfaces of portable electronics," Chiao said, "You can place them on a sleeve for your smart phone. When the phone is out of battery power, all you need to do is to put on the sleeve, wave the phone in the air for a few minutes and you can use the phone again."

Have you heard the news? 3D Printer World Expo is coming to Seattle.

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