NOVELTIES

Bye-Bye Batteries: Radio Waves as a Low-Power Source

By ANNE EISENBERG
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MATT REYNOLDS, an assistant professor in the electrical and computer engineering department at Duke University, wears other hats, too — including that of co-founder of two companies. These days, his interest is in a real hat now in prototype: a hard hat with a tiny microprocessor and beeper that sound a warning when dangerous equipment is nearby on a construction site.

Enlarge This Image

Jochen Teizer

Using only radio waves for its electrical power, the SmartHat has a beeper that alerts the wearer to dangerous construction equipment nearby.

What's unusual, however, is that the hat's beeper and microprocessor work without batteries. They use so little power that they can harvest all they need from radio waves in the air.

The waves come from wireless network transmitters on backhoes and bulldozers, installed to keep track of their locations. The microprocessor monitors the strength and direction of the radio signal from the construction equipment to determine if the hat's wearer is too close.

Dr. Reynolds designed this low-power hat, called the SmartHat, with Jochen Teizer, an assistant professor in the school of civil and environmental engineering at Georgia Tech. They are among several people devising devices and systems that consume so little power that it can be drawn from ambient radio waves, reducing or even eliminating the need for batteries. Their work has been funded in part by the National Science Foundation.

Powercast, based in Pittsburgh, sells radio wave transmitters and receivers that use those waves to power wireless sensors and other devices. The sensors, for example, monitor room temperature in automatic systems that control heating and air-conditioning in office buildings, said Harry Ostaffe, director of marketing and business development.

The company recently introduced a receiver for charging battery-free wireless sensors, the P2110 Powerharvester Receiver, and demonstrated it in modules that sense temperature, light level and humidity data, he said. The modules include microcontrollers from Microchip Technology, in Chandler, Ariz.

Until recently, the use of radio waves to power wireless electronic devices was largely untapped because the waves dilute quickly as they spread, said Joshua R. Smith, a principal engineer at Intel's research center in Seattle and an affiliate professor at the University of Washington.

"That's changing," said Dr. Smith, who explores the use of electromagnetic radiation. "Silicon technology has advanced to the point where even tiny amounts of energy can do useful work."

Two types of research groups are extending the boundaries of low-power wireless devices, said Brian Otis, an assistant professor of electrical engineering at the University of Washington. Some researchers are working to reduce the power required by the devices; others are learning how to harvest power from the environment. "One day," Professor Otis said, "those two camps will meet, and then we will have devices that can run indefinitely."

Professor Otis, who designs and deploys integrated circuits for wireless sensing, is in the first group. Dr. Smith of Intel is one of the harvesters, gathering radio power that is now going to waste. And there are plenty of radio waves in the air to provide fodder for him as they spread from Wi-Fi transmitters, cellphone antennas, TV towers and radio stations.

Some of the waves travel to living-room televisions, for example. But others, which would otherwise be wasted as they rise through the atmosphere into space or are absorbed in the ground, can be exploited, he said. "Ambient radio waves," he said, "can already provide enough energy to substitute for AAA batteries in some calculators, temperature and humidity sensors, and clocks."

At Intel, Dr. Smith, working with the researcher Alanson Sample of the University of Washington, created an electronic "harvester" of ambient radio waves. It collects enough energy from a TV station broadcasting about 2.5 miles from the lab to run a temperature and humidity sensor.

The device collects enough power to produce about 50 microwatts of DC power, Dr. Smith said. That is enough for many sensing and computing jobs, said Professor Otis. The power consumption of a typical solar-powered calculator, for example, is only about 5 microwatts, he said, and that of a typical digital thermometer with a liquid crystal display is one microwatt.

DR. SMITH and his colleagues have built a second device, powered by radio waves, that collects signals from an outdoor weather station and transmits them to an indoor display. The unit can accumulate enough energy to send an updated temperature every five seconds.

Dr. Reynolds of Duke has long been interested in electronics and wireless equipment. One company he helped found, Zensi, developed a system to sense the amount of electricity used by home appliances; Zensi was bought by Belkin, an electronics concern.

Many electronic devices are limited by batteries that fade away or can't survive temperature extremes, he said. But, he added, "we are on the cusp of an explosion in small wireless devices" than can run on alternatives to battery power. "Devices like this can live on and on," he said.

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