

# Project Generates Energy by Harvesting Radio Waves

**T**wo scientists have developed a system that uses ambient radio waves to generate energy, potentially eliminating the need for batteries in mobile devices.

Their research would address the limitations that many electronic devices experience because they depend on batteries that lose their power over time or in temperature extremes such as those found on job sites in very cold or hot climates, said Duke University assistant professor Matt Reynolds.

Reynolds and Georgia Institute of Technology assistant professor Jochen Teizer are working on integrating their energy-harvesting system into a prototype hard hat. The SmartHat sounds a warning when the wearer inadvertently gets too close to nearby potentially dangerous equipment—such as earth-moving vehicles or construction cranes—on a work site.

The ambient radio signals that power the SmartHat would come from transmitters mounted on the equipment. Because falls are a common problem on work sites,

Reynolds noted, warning transmitters could also be mounted at the edge of areas such as pits and trenches.

SmartHat's energy-harvesting system uses a rectifier, which transforms alternating current into direct current. The rectifier converts incoming ultrahigh-frequency radio signals, a form of AC, into the DC required to run the SmartHat circuitry.

A reservoir capacitor stores harvested energy—which lets the SmartHat continue to function even when there are no nearby radio signals—and a power management circuit sends the power to the hat's various parts.

The energy-harvesting system powers both the microprocessor that runs the SmartHat's software and its warning beeper. The microprocessor monitors the strength and direction of the radio signals emanating from transmitters on work-site equipment and sounds a beep when the signal exceeds a certain strength, indicating that the user is too close.

Reynolds said he designed the SmartHat's circuitry to consume as little of the limited available power as possible.

The SmartHat is tuned to the frequency of the transmitter attached to the construction equipment. Other items that use radio waves—such as Wi-Fi transmitters, cellular-phone antennas, and radio stations—transmit signals on different frequencies.

Until recently, Reynolds explained, using radio waves to power wireless electronic devices was difficult because the signals dilute quickly as they spread. However, he said, chip designers have become adept at optimizing circuits to work with small amounts of power.

Teizer said he has conducted on-site experiments at construction sites on the Georgia Institute of Technology campus and plans additional testing at a large commercial building in Atlanta.

A system limitation is that it can warn users only about machinery or hazards equipped with radio transmitters, according to Reynolds.

According to Teizer, companies will want to use the technology only if workers feel comfortable with it, it is reliable and rugged, and the cost is reasonable enough for implementation in thousands of hard hats.

The researchers are continuing to refine the technology and plan to work with commercial equipment manufacturers and construction companies to prove the SmartHat's utility.

By harnessing ambient radio waves to power devices, innovative engineers like Reynolds and Teizer are part of an emerging cohort of researchers transforming how we address our energy needs, said Joshua Chamot, a media officer for the US National Science Foundation, which helped fund the project.

Reynolds said the system is still in the early prototype stage, so it's premature to speculate how and when the technology could be commercialized. **C**



Two academics have developed a system that uses ambient radio waves, rather than batteries, to generate energy for mobile devices. They have built the system into a prototype hard hat that uses the energy to detect if wearers get too close to potentially dangerous equipment on a work site and to then sound a warning.