JOURNAL WATCH

Smart Headphones Warn of Nearby Cars

HOW CAN PEDESTRIANS safely tune out the world? Perhaps with a pair of intelligent headphones that alert them to oncoming vehicles.

The number of pedestrians killed on U.S. roads reached a three-decade high in 2018. Smart headphones are unlikely to prevent most pedestrian deaths—but a few seconds' warning might spare some lives.

Xiaofan Jiang, an assistant professor of electrical engineering at Columbia University, developed the Pedestrian Audio Wearable System (PAWS) with collaborators at the University of North Carolina at Chapel Hill and Barnard College. They published their work in the October 2019 *IEEE Internet of Things Journal.*

Many cars with collision warning systems rely on cameras, radar, or lidar to detect objects. But Jiang and his colleagues decided to use inexpensive microphones to serve as low-power sensors for their system.

The group placed four microphones in different spots in a pair of commercial headphones. The system's main hardware fits inside the left ear housing and draws power from a rechargeable lithium-ion battery. A custom integrated circuit saves on power by extracting only the most relevant sound features from captured audio. It transmits that information to an app, which hosts machine-learning algorithms trained on audio from 60 types of vehicles in different environments.

The latest prototype can pinpoint the location of a single vehicle from up to 60 meters away—but it can't plot the vehicle's or pedestrian's trajectories. The system also has trouble estimating how many vehicles are present and tends to focus on the loudest vehicle, which may not be the one closest to the pedestrian.

"We have to take into account other information to make this collision detection more useful," Jiang explains. The project has received US $1.3 million from the National Science Foundation.

—JEREMY HSU

An extended version of this article appears on our website in the Journal Watch section.

MANJUNATH KIRAN/AFP/GETTY IMAGES

INDIA GRAPPLES WITH VAST SOLAR PARK

The pros and cons of the 2-gigawatt Pavagada installation

IT'S 10 A.M. AND Indian peanut farmer Venkeapream is relaxing at his family compound in Pavagada, an arid area north of Bangalore. The 67-year-old retired three years ago upon leasing his land to the Karnataka state government. That land is now part of a 53-square-kilometer area festooned with millions of solar panels. As his fields yield carbon-free electricity, Venkeapream pursues his passion full time: playing the electric harmonium, a portable reed organ.

With a capacity of 2 gigawatts and counting, Pavagada's arrays represent the world's largest cluster of photovoltaics. It's also one of the most successful examples of a solar "park," whereby governments provide multiple companies land and transmission—two big hurdles that slow solar development. Solar parks account for much of the 25.5 GW of solar capacity India has added in the last five years. The states of Rajasthan and Gujarat have, respectively, 2.25-GW and 5.29-GW solar parks under way, and Egypt's 1.8-GW installation is one of several new international projects.

Alas, even as they speed the growth of renewable energy, solar parks also concentrate some of solar energy's liabilities.

Sheshagiri Rao, an agricultural researcher and farmer based near Pavagada, says lease payments give peanut farmers such as Venkeapream a steadier income. But Rao says shep-

NEWS

BIG SOLAR: Construction on Pavagada began in October 2016. The land was leased for 28 years from 2,300 farmers.

herds who held traditional rights to graze their fields were fenced out without compensation, and many have sold out. In Venkeapream's village, flocks once totaled 2,000 to 3,000 sheep. There are now only about 600 left.

The constant need to keep dust off the panels, meanwhile, has put more strain on already overtapped groundwater supplies. Local farmers bring water to clean the more than 400,000 panels at the Pavagada site of Indian energy developer Acme Cleantech Solutions. "At least 2 liters of water is required to clean one panel. This is huge," says B. Prabhakar, Acme's site manager. Robotic dusters allow Acme to clean just twice a month, but most operators lack such equipment.

Then there are the power surges and drops created as clouds pass over Pavagada—generation swings that must be countered with coal-fired and hydropower plants. Balancing renewable energy swings is a growing challenge for grid operators in Karnataka, which leads India in solar capacity and also has more than 4 GW of variable wind power.

Karnataka capped new solar parks at 0.2 GW after launching Pavagada. Analysts heralded the state's apparent shift toward distributed installations, such as rooftop solar systems, during a November 2019 meeting on sustainable energy in neighboring state Tamil Nadu. As Saptak Ghosh, who leads renewable energy programs at the Bangalore-based Center for Study of Science, Technology & Policy (CSTEP), put it: "Pavagada will be the end of big solar parks in Karnataka. Smaller is the future."

Just a few days later, though, news broke that Karnataka's renewable energy arm was acquiring land for three 2.5-GW solar megaparks. The state's move may reflect pressure from the national government to accelerate solar installations, as well as confidence that Pavagada's shortcomings can be fixed.

Instead of harming shepherds, for example, solar operators could open their gates. Grass and weeds growing amidst the panels pose a serious fire risk, according to Acme's Prabhakar. Increasingly, operators in other countries rely on sheep to keep vegetation down.

Higher-tech solutions may ultimately address Pavagada's water consumption and cloud-induced power swings. Israeli robotics firm Ecoppia is already providing what it calls "water free" cleaning at the Pavagada site operated by Fortum, a Finnish energy company.

Karnataka's solution for power swings at its new megaparks, meanwhile, is to plug the parks straight into the national grid's biggest power lines. The trio of plants are a joint project with the national-government-owned Solar Energy Corporation of India, and designed to export renewable electricity to other states. Power stations outside of Karnataka will balance the solar parks' generation, according to Ghosh's colleague, CSTEP senior research engineer and power-grid specialist Milind R.

India's government is eager to help, having promised to boost renewable capacity to 175 GW by March 2022 and to 450 GW by 2030. As Thomas Spencer, research fellow at the Energy and Resources Institute, a New Delhi–based nonprofit, noted at the November meeting in Tamil Nadu, India is "well off the track" for meeting either target.

—PETER FAIRLEY

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4 WAYS TO HANDLE MORE QUBITS

Cryochips, microrelays, and other tech could help quantum computers scale

AS RESEARCHERS STRIVE TO boost the capacity of quantum computers, they've run into a problem that many people have after a big holiday: There's just not enough room in the fridge.

Today's quantum-computer processors must operate inside cryogenic enclosures at near absolute zero, but the electronics needed for readout and control don't work at such temperatures. So those circuits must reside outside the refrigerator. For today's sub-100-qubit systems, there's still enough space for specialized cabling to make the connection. But for future million-qubit systems, there just won't be enough room. Such systems will need ultralow-power control chips that can operate inside the refrigerator. Engineers unveiled some potential solutions in December during the IEEE International Electron Devices Meeting (IEDM), in San Francisco. They ranged from the familiar to the truly exotic.

CryoCMOS

Perhaps the most straightforward way to make cryogenic controls for quantum computers is to modify CMOS technology. Unsurprisingly, that's Intel's solution. The company unveiled a cryogenic CMOS chip called Horse Ridge that translates quantum-computer instructions into basic qubit operations, which it delivers to the processor as microwave signals.

Horse Ridge is designed to work at 4 kelvins, a slightly higher temperature than the qubit chip itself, but low enough to sit inside the refrigerator with it. The company used its 22-nanometer FinFET manufacturing process to build