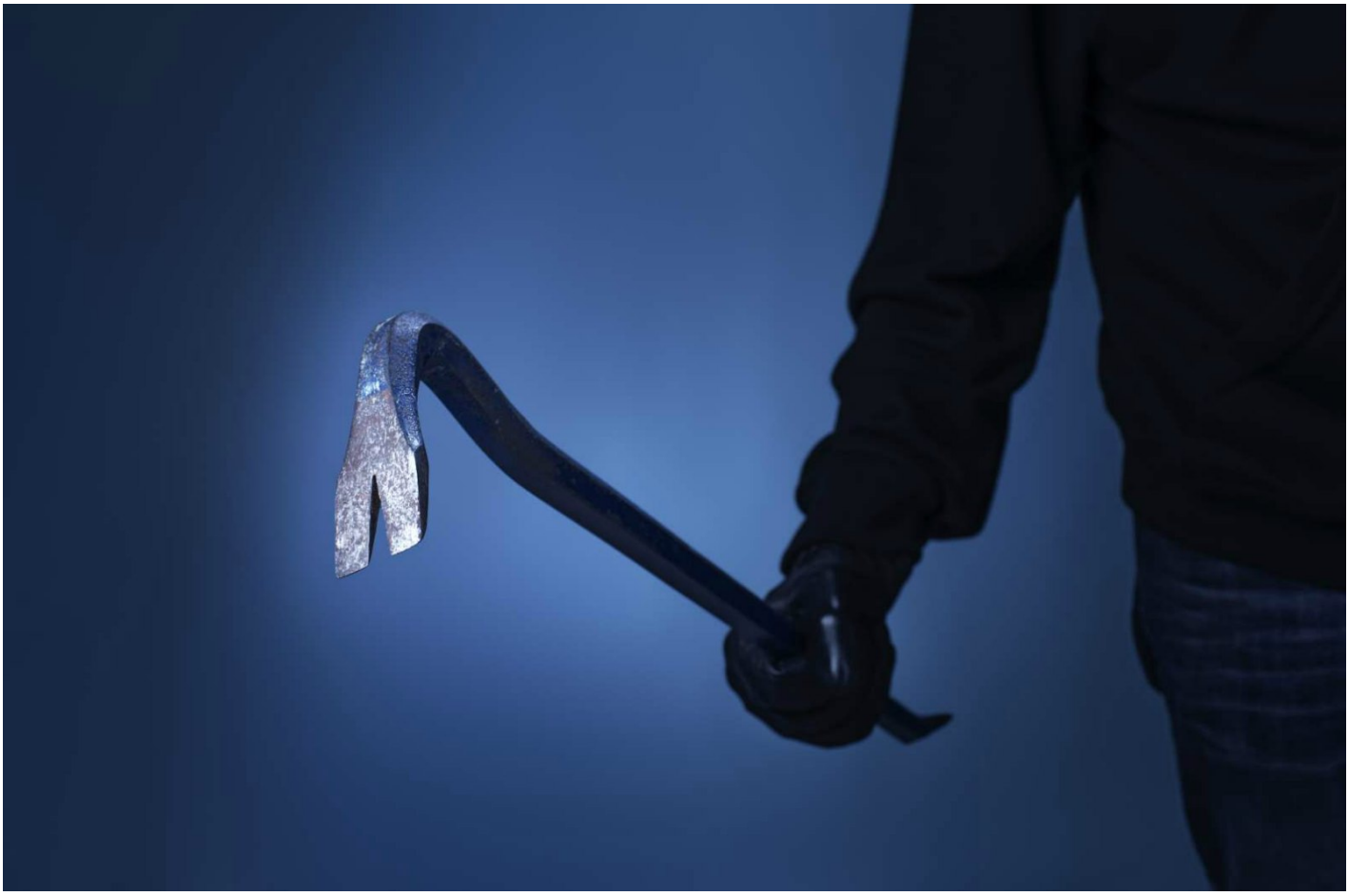
Radio Tomography Sparks Next Wave In Security

University of Utah



The heist film is a Hollywood staple, entertaining moviegoers with ingenious plots to outsmart elaborate alarm systems to pull off the ultimate caper. In real life, criminals are all too often successful at evading laser beams, security cameras, infrared heat sensors and other alarm devices — costing homeowners and businesses billions of dollars in losses each year.Virtually hidden from the human eye and impervious to walls, a new technology developed at the University of Utah (U of U) named radio tomography may finally stymie the efforts of would-be thieves. What's more, because radio tomography is able to sense human movement, the invention has a myriad of other potential applications, from finding survivors inside damaged buildings to monitoring older adults in their homes.

Blanketing Buildings with Radio Waves

Both Neal Patwari, Ph.D., and Joey Wilson, Ph.D., remember the first time they saw radio tomography work.

Patwari and a group of graduate students were ready to test his idea for a novel application of radiolocation to detect the movement of people inside a building.

“We locate a lot of things with radio waves,” explains Patwari, associate professor of electrical and computer engineering at U of U. “GPS satellites send signals and a receiver figures your location. Radar sends a signal to a plane and determines its location by what bounces back.”

To see if radio waves could also penetrate walls to “see” people, Patwari embedded a system of transceivers, small wireless devices that can send and receive radio signals, inside the walls of an empty building. The transceivers would continually send and receive radio signals to each other, forming a network, and processors within each transceiver were programmed to measure the strength of those signals. Any change in the signals would prompt a message to be sent to the central processing unit.

Sitting outside the empty building, Patwari watched his fledgling technology become a success: A video monitor attached to the system clearly showed a student enter into the building and move around inside.

“When people move within the network, they cause a change in signal power by creating a radio shadow behind them,” says Patwari.

The Perfect Doctoral Project

Wilson was a new doctoral student at the U of U looking for a project when he heard Patwari lecture on the new technology.

“It was still crude at that point but I knew it was something I wanted to work on,” says Wilson. “I always wanted to find a more application-oriented research project because I knew I eventually wanted to start my own company.”

Wilson convinced Patwari to take him on as a doctoral student, even before funding was available. He began developing and refining Patwari’s technology, which eventually won the support of two grants from the National Science Foundation for a total of $700,000.

“Joey was very quick getting things done, building a prototype and figuring out how to get it to work in various situations,” Patwari says.

Convinced of the technology’s potential, the pair established Xandem Technology and received additional funding, including a $150,000 grant from the Small Business Innovation Research and $50,000 from the U of U Research Foundation.

U of U’s Technology Commercialization Office (TCO) not only helped patent the radio tomography technology, it continues to actively manage the university’s equity partnership in the company.

“Rather than take a traditional technology transfer office approach, we want to be business partners with our startup companies,” explains Bryan K. Ritchie, Ph.D., M.B.A., executive director.

As an internal business partner, the TCO was a perfect match for Xandem, with deep experience in intellectual property management, company startup and product de-risking as well as network connections with a wide range of investors.

In addition, the inventors say being at a commercialization powerhouse like the U of U has been a major advantage.

"The university has been great, very supportive," says Patwari. "Getting a patent filed here not only is it easy to do, the culture is such that faculty are really encouraged to have commercialization activities."

Security in a Kit

Xandem's first product offering is the Xandem Tomographic Motion Detection (TMD) kit, which includes 6, 10 or 15 transceivers (called nodes) and one processing unit that will cover structures ranging in size from 500 to 3,000 square feet. The kits range in price from $695 to $1,395.

The Xandem TMD system is sold to end-users through integrators, companies that plan and install custom security systems. The installer places nodes around the home or building being monitored, typically inside the walls, where they are hardwired to the electrical system. When there is a change in the radio signals constantly being sent between the nodes, a signal is sent to the processing unit, which illuminates a small red light on the unit.

> *The processing unit is typically connected to an alarm system so that a break in the network can also be acted upon by the alarm system or computer panel, which, depending on how the system is programmed, may sound an a siren, send a text message or simply turn on a light.*

From Warehouse to Smart Home

Among the first customers to install the TMD system is an industrial warehouse in Salt Lake City and the owner of a new smart home in Dubai in the United Arab Emirates.

Because the TMD system nodes aren't sensitive to temperature or dirt — and are impervious to large machinery sitting directly in front of them — the Xandem system was the perfect security solution for the 5,000 square-foot warehouse, which had previously lost $250,000 in heavy machinery to theft.

In Dubai, the upscale homeowner was drawn to the Xandem system because the nodes are completely out of view — a great feature not only for aesthetic-minded customers, but also for surprising unsuspecting thieves.

"In many break-ins, the thief can see the alarm system and take measures to get around it," says Wilson, who serves as Xandem's CEO. "With the TMD system, they have no way of knowing it's there."

The Next Generation in Security

Wilson says the next generation of security systems will be focused not only on intrusion detection, but also on remotely controlled home automation, energy efficiency and senior monitoring — and he believes Xandem offers the core sensing technology that will tie each together.

"Security is the lowest use of our technology," he says. "We have a much larger vision to be a single company that will do it all: keep you safe, turn on the lights and let you know if the kids are throwing a party or if grandma is in trouble."

To that end, both Xandem and Patwari's Sensing and Processing Across Networks (SPAN) Lab at the U of U continues to research radio tomography. Furthest out on the roadmap is to the use of Xandem's technology to identify people trapped inside unstable buildings.

"There are many more challenges with an emergency situation, including needing to place the sensors outside the structure," explains Patwari. "That requires different antennas and new algorithms."

Facilitating Aging in Place

Patwari and his colleagues are also working on a system that will detect when people have fallen at home to facilitate

the trend among older adults to age in place rather than being institutionalized. That system will require special node placement and new algorithms to detect radio signals across a 3-D space.

“I think these challenges are surmountable, definitely,” Patwari says. "We’re getting closer, with better accuracy and reliability.”

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