Through-the-Wall Surveillance Technologies

By Allen Hunt, Chris Tillery and Norbert Wild

Authors' Note: *The views and opinions in this article are those of the authors and do not necessarily reflect those of the U.S. government. References to any specific commercial products by trade name, trademark, manufacturer or otherwise do not necessarily constitute or imply its endorsement, recommendation or favoring by the U.S. government.*

Inmates have barricaded hostages in a room without surveillance access. You do not know where or how many inmates or hostages there are. You do not know if they are armed or if correctional officers will be in harm's way if they are sent in. This is one of the worst situations corrections professionals face because unknown information could cost lives. But what if you could "see" through the walls?

Each year correctional and law enforcement officers are injured because they lack the ability to detect and track offenders through building walls. The National Institute of Justice's Office of Science and Technology (OS&T) has a comprehensive program to help solve that problem and has made the development of through-the-wall surveillance (TWS) technologies a top priority. The technology projects that comprise the program are divided into two broad categories: relatively inexpensive, handheld devices that alert officers to the presence of an individual behind a wall or door; and portable, personal computer-based devices that will enable Special Weapons and Tactics (SWAT) or Special Operations Response Team (SORT) team commanders to better visualize events during hostage situations.

Simple to Complex

OS&T has concentrated on developing low-power, radar-based devices that do not pose health risks to users or the public. Those devices do not provide pictures; they do not work like a television. The handheld devices simply provide a blinking light or modulating sound that indicate movement behind a wall or door. That movement may be as slight as the breathing motion of an individual's chest.

The Georgia Tech Research Institute (GTRI) is developing an inexpensive, handheld radar device that will detect individuals through interior walls and doors. A laboratory model of the Radar Flashlight was able to detect an individual through sections of home siding and drywall, a wooden front door and a section of brick and mortar.

Portable PC-based TWS devices are more capable but more expensive than handheld devices. The handheld devices should be available for a few hundred dollars, the portable devices will probably sell for several thousand dollars. With extra money, an agency will purchase added capabilities ranging from providing the direction and distance to individuals moving in a building, to providing an outline of a room and the location of individuals on a computer screen. In addition to indicating interior walls, such devices also may be able to indicate large pieces of furniture, as well as where individuals are located within a building or room.

Raytheon (formerly Hughes Missile Systems) is developing a portable, briefcase-size device for SWAT applications. This device, the Motion and Ranging Sensor (MARS), is a modification of a commercial motion detector sold by Hughes Missile Systems. It employs a radar that can locate and track an individual through reinforced concrete or brick walls.

"Sorting Out"

Researchers also are exploring ways to sort the "good guys" from the "bad guys." SWAT and SORT team members can be targeted with markers that send back a unique signal to the radar source — in this case the TWS device. The unique signal positively identifies the team member as a good guy. Additionally, in a corrections environment, all staff and other appropriate personnel could be covertly tagged, as could be VIPs in a non-corrections environment. OS&T entered into discussions with British Aerospace (formerly the Sanders division of Lockheed-Martin Sanders (LMS)) to assess the utility of a passive tagging technology for TWS application.

Seeing Through Limitations

The MARS device is unable to map a building or room interior and cannot tell how many walls are between the user and the monitor. To do this, one must have access to a building blueprint. Last year, OS&T funded Akela Inc. in the development of a device capable of mapping internal wall structure and locating people. The system employs tomographic image reconstruction, similar to methods used to provide CAT scans.

Radar devices also have limitations. Buildings that have solid metal walls or insulation with foil backing are a problem for radar-based TWS devices — while radars can exploit openings such as windows or air vents, they will not penetrate a solid metal wall. Recognizing that, OS&T also is looking at non-radar based technologies — a magnetic sensor and a device using ultrasound.

The magnetic sensor technology device is designed to identify those carrying weapons. The device, developed by the Sanders Division of LMS for the military, also is being assessed for its ability to overcome the limitations of radar-based devices and identify individuals hidden behind metal walls. Rather than locating and tracking the individual, it would identify and track large, weapon-sized quantities of metal moving behind the wall, which would likely indicate weapons being carried by individuals.

In addition to looking at the magnetic technology device, OS&T has funded Jaycor Inc. to develop a device that uses ultrasound. Development, testing and evaluation are under way. One of the drawbacks of this technolo-

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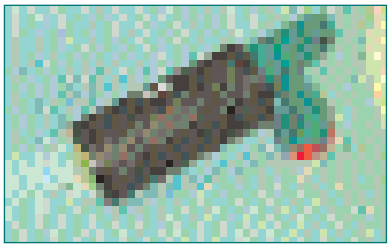
gy is that unlike radar devices, the sensors have to be attached firmly to the building wall. Thus, while users can run cables back from the sensors to the computer, enabling remote monitoring, someone has to put the sensors on the outside of the building or room — running the risk of the sensors, cable or individual placing them being detected.

Developing and Testing

Developing new technology is a long, often painstaking process that requires laboratory and field testing, addressing limitations and problems, and additional rounds of testing. Through-the-wall devices are no exception and the technologies discussed in this column are in various stages of the process. Two of the technologies — Radar Flashlight and MARS— already have been demonstrated in the field.

During the past two years, OS&T conducted demonstrations of the Radar Flashlight with law enforcement officers through the National Law Enforcement and Corrections Technology Center-Southeast. Officer feedback revealed that while the technology is promising, some issues still need to be addressed. Since the flashlight is handheld, any motion of the hand tends to interfere with the radar's functioning. To compensate, GTRI recommended that the officers push the device against the wall or door to stabilize it.

MARS employs a radar that can locate and track an individual through reinforced concrete or brick walls.



Above: A conceptual graphic of a device designed by Akela depicts a sensor array positioned in proximity to an exterior wall, with an output display of an internal wall structure and persons moving inside. Right: (top) The Radar Flashlight works by detecting the slightest body motion of an individual on the opposite side of wall; (bottom) Ultrasound technologies may allow users to penetrate metallic construction materials.

However, that action causes the device to make a distinctive clicking sound. That issue, and other practitioner recommendations, will be addressed and incorporated this year, to be followed by a technical comparison with other systems conducted by the U.S. Air Force. The results, which will be shared with practitioners, will determine the next step OS&T will take with this technology.

The MARS device had a successful demonstration with the Los Angeles County Sheriff's Department and Albuquerque Police Department in 1998. It demonstrated the ability to locate and track an individual moving behind an eight-inch thick concrete wall at a range of more than 75 feet from the radar. The demonstration in Los Angeles reenacted a real incident during which two deputies responded to reports of an intruder in a warehouse. They arrived on scene and began to search the building. Because the police officers did not know where the intruder was, they stumbled into him in a bathroom where shots were exchanged. During the reenactment, with the assistance of the MARS device, the officers located and tracked the subject, allowing the officers to surprise the suspect. OS&T plans to fund further modification of this device to more accurately locate and track multiple individuals. OS&T anticipates receiving a prototype of the enhanced MARS device for technical analysis and operational evaluation with law enforcement agencies this year or early next year.

Other devices in various developmental stages include:

- **Mapping and Locating Device**. Last October, OS&T held a project kickoff meeting for Akela Inc.'s Mapping and Locating Device. Development of a laboratory model, testing and evaluation is ongoing. Upon successful proof of concept demonstration, OS&T plans to fund the development of prototypes for further assessment.
- **Tagging technology.** OS&T expects that work on the tagging technology, which will allow users to separate the good from the bad, will begin before the end of this year.
- **Magnetic sensors.** OS&T will evaluate prototypes that were developed for military use to ascertain what, if anything, will need to be done to make them usable for correctional and law enforcement officers.
- **Ultrasound device.** A project kickoff meeting was held last October for the device using ultrasound technology. Early development, testing and evaluation is ongoing. Upon successful proof of concept demonstration, NIJ plans to fund the development of prototypes for practitioner evaluation and technical assessment.

OS&T will be developing and assessing a broad range of TWS technologies. The scope of these efforts is dictated by the difficulty of the problem. As with virtually all technologies, there does not appear to be a single technology that can address all the potential scenarios. However, there's

a chance that these technologies may be combined into a more capable hybrid device. The viability of such an approach only can be determined after the technologies have matured. Efforts are just beginning to bear fruit. Over the next five years, OS&T will introduce a number of devices, of varying capabilities and costs to practitioners, that will enable them to locate individuals through most types of walls — and ultimately allow team correctional and law enforcement supervisors and officers to avoid situations in which what they do not know may hurt them.

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Video — Too Little Bang for Too Much Buck

Developing a radar-based TWS device that provides video quality, or near-video quality images, may be possible but does not appear to be cost-effective, at least from the standpoint of state and local practitioners. There are a number of reasons for this. First, only the largest agencies probably could afford the cost of such a device. Further, the type of radar that gives efficient penetration does not readily lend itself to developing video quality, or near-video quality images. Researchers might be able to develop a device that provides an image through drywall. They will not be able to develop a device that will provide video quality images through an exterior building wall constructed of reinforced concrete, particularly not if the user wants to survey a room remotely. Discussion with practitioners indicated that, while they would certainly like video quality images, being able to remotely survey a room from outside a building is more important. ◆

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