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Looking Through Walls

June 1997, Pico Rivera, California—The Los Angeles County Sheriff's Department responds to a call for assistance when an armed suspect barricades himself within a business warehouse, a maze of interior office spaces, interior doors, and closets. And in the center, a pitch black open space offering a myriad of hiding places—vehicles, shelving, and debris—for him to elude capture.

The SWAT team is called when the suspect shoots multiple rounds through the walls.

The suspect is eventually discovered hiding in a small bathroom. But when attempts are made to extract the suspect, a gunfight ensues. Two deputies are wounded and the suspect is killed.

Later that same year, the National Institute of Justice (NIJ) sponsored a re-enactment of this incident to demonstrate a motion detection radar technology—a two-dimensional concrete-penetrating radar device that could have been used to track the movements of the Pico Rivera suspect right through the wall. The successful demonstration of this through-the-wall technology, originally developed and built by Hughes Missiles Systems, now part of the Raytheon Systems Company, led to an NIJ grant to modify and improve this through-the-wall surveillance technology.

NIJ, through the Joint Program Steering Group (JPSG), a joint effort of the U.S. Departments of Defense and Justice in collaboration with the Air Force Research Laboratory/Information Directorate, and other organizations have sponsored research and development in technologies that would support through-the-wall surveillance for several years, according to Dr. Pete Nacci, JPSG co-chair. "Earlier efforts had shortcomings—through-the-wall systems did not provide reliable data or the data were difficult to interpret. The variability of wall construction also limited the performance of earlier systems."

The ability to "see" through walls, Nacci says, would give law enforcement and corrections operations significant tactical advantages in a number of situations. Through-the-wall surveillance can reduce the risk to officers by providing a safer way to locate hostile forces, evaluate the number of potential adversaries, and evaluate conditions for offensive operations. The data may then be used to determine the most effective use of available forces for an operation. Through-the-wall surveillance can also support search and rescue operations in hostage situations and in disaster events, such as earthquakes.

Currently, Nacci says, NIJ is funding one component of a radar-based, through-the-wall surveillance system known as MARS (Motion and Ranging Sensor). This concrete and masonry penetrating radar is an improved version of the earlier technology demonstrated at the Pico Rivera warehouse reenactment. MARS marries an enhanced two-dimensional, concrete-penetrating radar technology with three-dimensional imaging radar that

THUNDER MOUNTAIN

In the fall of 1999, the Thunder Mountain Evaluation Center at Fort Huachuca, Arizona, played host to a demonstration of through-the-wall surveillance systems sponsored by the Technical Support Working Group (TSWG). TSWG is an interagency organization that includes the National Institute of Justice (NIJ) and is responsible for developing counterterrorism technologies. The Thunder Mountain Evaluation Center evaluates many types of equipment and technologies for the military.

Thirty-six companies and organizations responded to an announcement of the demonstration. From this initial group, six were able to provide operational systems that could be evaluated in a neutral environment under a standardized demonstration protocol.

The general objectives of the demonstration were to identify the presence and general location of people in a space, identify the number of people in that space, and evaluate the minimum amount of movement needed for detection. The demonstration was set up to evaluate imaging through standard Sheetrock™ walls with

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can penetrate interior walls as well as map both fixed and moving objects. While the two-dimensional technology is able to detect movement, the three-dimensional imaging offers the ability to "see" depth or range.

"The MARS operator can display many different views of a potential situation on the computer screen," says Larry Frazier, technical manager and system developer for Raytheon. "MARS can display a birds-eye view as if the observer were looking down on the room, a side view that indicates the height of all the objects in the room, or a three-dimensional image that maps objects from any point in the room. There are an additional 50 modes of data display that can enhance each of the basic display modes."

Although the actual sensor technology remains essentially unchanged, MARS will be improved by better, faster computer hardware and software. Plans are to complement the custom software with commercially existing software to develop more readable displays. The sensor will also include data processing to analyze motion, displaying only the radar returns that represent likely human movement. The size, weight, and power consumption of this next generation through-the-wall surveillance system will also be reduced by improved electronic devices and by a newly designed three-dimensional imaging radar antenna, which represents a five-fold reduction in size.

In addition, the previous three-dimensional system weighed 90 pounds and was packed in three suitcases, while the two-dimensional system weighed 40 pounds and fit into one suitcase. MARS will weigh in at less than 35 pounds and fit into a briefcase. A single individual will be able to carry and deploy the equipment. Because it can be operated via battery and a radio frequency communication link, the user can also set up the sensor and then move to another location for safety or to conduct a hidden surveillance.

MARS is currently at the "breadboard" (a one-of-a-kind unit built to demonstrate capability) level of development, with one working demonstration unit in existence. NIJ is funding Raytheon to build four prototype units that will be assessed at the U.S. Air Force Research Laboratory in Rome, New York. NIJ will then evaluate these units with local law enforcement agencies to determine what changes, if any, are needed for a production system. A nationwide demonstration is planned for FY 2001.

For more information about through-the-wall surveillance systems, contact Dr. Pete Nacci, co-chair, Joint Program Steering Group, at 703–351–8821 or pnacci@darpa.mil. Or, contact David Ferris, technical manager, U.S. Air Force Research Laboratory, at 315–330–4408 or ferrisd@rl.af.mil.

***Thunder Mountain** (continued)*

wood interior studs, plaster walls over lathe, a 24-inch reinforced concrete wall, a tile wall, cinder block, wood walls, and multiple interior walls. Imaging into an aluminum trailer was successfully demonstrated by imaging through obstructed glass windows and through the nonmetallic floor.

Through-the-wall surveillance technology has great potential, but, according to system evaluators at the Thunder Mountain demonstration, there is room for improvement. Most of the systems demonstrated were too large for the anticipated end-users. The surveillance systems also need to employ more user-friendly displays to eliminate uncertainty and confusion. Limitations in radar physics mean that the images are markedly different from human visual images; instead, movement is represented by a series of dots.

NJ is working with TSWG and Raytheon Systems Company to address these two issues.

Also in R&D: Radar Flashlight

Also in development in through-the-wall surveillance technology—the National Institute of Justice, through the Joint Program Steering Group, is sponsoring the Georgia Tech Research Institute (GTRI) to develop an inexpensive, handheld, low-power radar flashlight that will allow law enforcement and corrections officers to detect motion through interior walls. GTRI has designed a prototype unit that was able to detect an individual through sections of home siding and drywall, a wooden front door, and section of brick and mortar in the laboratory. An assessment of the radar flashlight is being conducted with law enforcement agencies nationwide through the National Law Enforcement and Corrections Technology Center–Southeast.

While the Raytheon Systems Company through-the-wall surveillance system is envisaged for SWAT applications, the GTRI-developed system lends itself to use by a police sector supervisor or by personnel in a corrections setting.

For more information about the radar flashlight, contact Dr. Pete Nacci, co-chair, Joint Program Steering Group, 703–351–8821 or pnacci@darpa.mil. Or, contact Bill Deck, National Law Enforcement and Corrections Technology Center–Southeast, at 800–292–4385 or bdeck@nlectc-se.org.

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