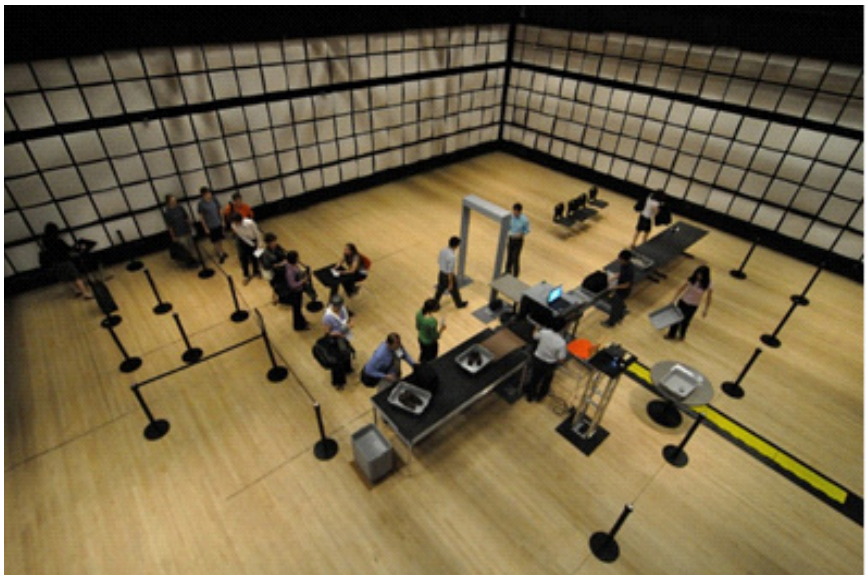
# Recent Highlights

**ALERT** Awareness and Localization of Explosives-Related Threats

Listed below are some of the highlights of the ALERT Center's research and educational accomplishments during the past year. The highlights span the wide application domains that are indicative of the power and promise of the ALERT mission.

## RPI establishes first-of-its-kind indoor tracking testbed

An experimental facility has been established by Prof. Rich Radke at Rensselaer Polytechnic Institute (RPI) that allows the simulation of truly human-scale environments while placing cameras and other sensors at nearly-arbitrary locations. This 2500 ft2 studio building has been outfitted with a permanent grid of ceiling-mounted, downward-facing cameras and a reconfigurable set of wall/ceiling-mounted pan-tilt-zoom cameras. In this environment, Prof. Radke has built a full-scale simulation of an airport carry-on baggage checkpoint. The movements of "passengers" through the simulation are recorded by approximately 20 video cameras. The research goal is to develop algorithms that determine which bags/items belong to which people using automatic computer vision algorithms. This facility is unique among research universities and will provide a rich source of data for ALERT and other video tracking efforts.



**"Passengers" move through a full-scale simulation of an airport carry-on baggage checkpoint.**

## HTT&T laboratories bring homeland security technologies to wider audiences

A signature educational program that has been developed and used to great effect in connection with ALERT is the "High-Tech Tools and Toys" (HTT&T) concept. The idea is to explose students to sensors and devices in the context of a freshman level, programming hands-on laboratory environment. Students are encouraged to play with equipment while learning to control the devices by computer. The ALERT educational team has leveraged the HTT&T laboratories by creating new modules for the HTT&T laboratories emphasizing homeland security technologies.

**ALERT Education Director Prof. Stephen McKnight supervises his students in the Northeastern University HTT&T laboratory.**

Under the supervision of ALERT Education Director Prof. Stephen McKnight, two undergraduate students have begun work on a module that involves the use of spectroscopy to collect spectra to discriminate between samples of corn oil, motor oil and olive oil, as well as a module on imaging of concealed objects based on the acoustic sensing of objects behind cloth. Both modules will include a series of exercises that will engage students and instruct them in real-time

This material is based upon work supported by the U.S. Department of Homeland Security under Award Number 2008-ST-061-ED0001.

ALERT at Northeastern University
http://www.northeastern.edu/alert
617-373-4673

computer control. The modules will be suitable for courses in beginning engineering programming or introduction to engineering and can also be used for upper-level undergraduate instruction. Additional undergraduate modules based on homeland security-related technology will be prepared and disseminated for use in engineering core and elective courses.

Professor McKnight has also successfully engaged local community colleges regarding the HTT&T concept. He has launched a two week professional development experience to introduce community college faculty to High-Tech Tools and Toys modules, which will be adapted for engineering courses at Middlesex Community College, Mass Bay Community College, and Northern Essex Community College during the upcoming academic year. The ALERT program will be leveraged to produce modules that are inexpensive and portable for this collaboration.

### ALERT-funded graduate student reports terahertz sensors breakthrough

Terahertz technology is a very promising approach for identification of explosive materials at stand-off distances. Unlike x-rays, terahertz radiation poses little or no health threat, and terahertz waves are more precise in spectroscopic detection than x-rays and microwaves. However, difficulties with absorption by water in the atmosphere have previously limited the utility of THz detection.

**Jingle Liu, left, X.-C. Zhang, center, and Jianming Dai work in Zhang's lab.**

Recently, a breakthrough discovery by ALERT researcher Prof. X.-C. Zhang at RPI's Center for Terahertz Research is providing a feasible approach for standoff detection. The work, led by ALERT Ph. D. student Jingle Liu, has reported success in using a new terahertz frequency spectroscopy technique to detect explosives, drugs, and chemical spills 20 meters away. The RPI team plans to adapt their discovery into a portable device, making it a natural for airport security and remote IED detection.

"It will be very competitive technology. Terahertz can immediately tell you the fingerprint of the chemical compounds," says Jingle Liu, primary author of the *Nature Photonics* paper that the work was reported in. "We can extend the sensing range of current machines."

The work in *Nature Photonics* has been reported in over 60 national and international media outlets, including BBC, *Popular Science*, *Wired*, *Science Magazine*, *Nature*, ABC News, Discovery News, among many others.

### WSU professor teaches ALERT short course at Northeastern University

Northeastern University hosted an ALERT short course titl "Dynamic Compression & Fracture of Materials," from August 17-21, 2009. The short course was taught by ALERT researcher Professor Yogendra M. Gupta of Washington State University, with guest lecturers Dr. Marcus D. Knudson of Sandia National Laboratory and Dr. George "Rusty" Gray of Los Alamos National Laboratory.

Dr. Gupta's course, taught at the level of a graduate course in physical sciences and engineering, focused on the problem of understanding and modeling the response of materials to dynamic loading, characterized by high stresses and short time scales. This material response is central to mitigation strategies against explosive loading and/or high velocity fragment impacts.

Dr. Gupta developed this short course to provide the attendees with a comprehensive learning

Prof. Gupta

experience regarding the dynamic compression and fracture of materials. The course emphasized fundamentals, contemporary developments, and future challenges. The audience for the course comprised 17 faculty and students from within and outside the ALERT partnership, at institutions such as Northeastern University, Boston University, the University of Mississippi, the University of Connecticut and Missouri Science & Technology. The short course was well-received; as a student participant said, "It truly was a successful week and we came away with valuable knowledge."

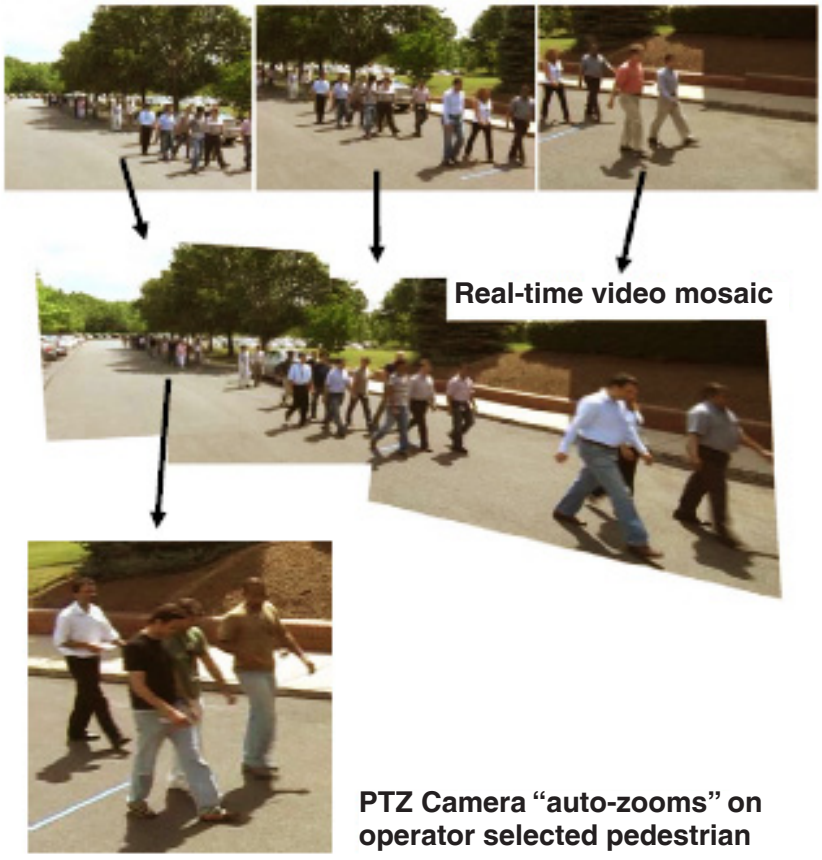
It is anticipated that short courses will be provided at least once a year on topics related to the ALERT core mission. The next short course will focus on explosive detection sensor system technologies.

## Multimode Standoff Detection Testbed to be implemented on-site at National Guard facility

There are two indicators for most suicide bombers: the metal for shrapnel and the explosive itself. Using signatures of these indicators, the testbed is envisioned as multiple detection technology integrated into a surveillance vehicle for suicide bomber detection. Potential "bombers" will be identified and continually tracked starting at distances up to 50 meters.

John Beaty, Industrial Liaison and Director of Technology Development for ALERT, has worked with Brigadier General Thomas J. Sellars, Commander, Land Component Command and Assistant Adjutant General/Executive Officer of the Military Division, Massachusetts National Guard, to locate the testbed at Camp Edwards on Cape Cod. Industrial partner Siemens Corporate Research has contributed $100K in in-kind (equipment, labor), matched by $100K from the John Adams Innovation Institute, to launch the testbed. Work on the testbed began at Siemens Corporate Research last year. Implementation has begun on-site at Camp Edwards.

The benefits of locating the testbed at Camp Edwards are tremendous. First, it allows for the use of video surveillance without concerns for privacy, as military personnel are not afforded the same privacy levels as the general public. Second, the collaboration with the first responders on-site will provide suggestions for improvement to the existing sensors and feedback on new sensors that could be developed.




**From multiple partially-overlapping video cameras, the Siemens intelligent video system (IVS) tracks each individual in the scene automatically. This enables the operator to select any individual for a close-up (bottom) from a pan-tilt-zoom camera that automatically tracks them ("auto-zooms") through the scene.**

## ALERT faculty and staff recognized for their contributions to the field

Ashkan Vaziri, a second-year Assistant Professor in the Mechanical and Industrial Engineering Department at

Northeastern University, was awarded a three-year, $360,000 grant by the Air Force Office of Scientific Research through the Air Force's Young Investigator Research Program. Dr. Vaziri's anticipated research area under the grant is the study of bio-inspired interfaces for hybrid structures, which is directly related to the ALERT mission.


Prof. Vaziri


Prof. Velez-Reyes


Ms. Duggan

Miguel Velez-Reyes, a Professor at the Department of Electrical and Computer Engineering at the University of Puerto Rico — Mayagüez, was elected as a 2010 SPIE Fellow for his achievements in hyperspectral image processing. SPIE is an international society founded to advance light-based research and technologies.

Claire Duggan, the ALERT K-12 Education Coordinator and Director of Programs and Operations for the Center for STEM Education at Northeastern, was elected as a 2010 Massachusetts Academy of Sciences Fellow. This annual award honors a select community of scientists, engineers, researchers and educators for their significant professional achievements in science research or science education.

## ALERT team develops MM-wave radar system for standoff detection of suicide bombers

NU Profs. Jose Martinez and Carey Rappaport are developing the first radar system able to identify potential suicide bombers at standoff distances. Graduate students Galia Ghazi and Justin Fernandes, as well as undergraduate students Fernando Quivira and Richard Obermeier, have also been actively involved in this scientific effort.

The new radar system is built around the idea of texture identification, which requires the radar to have a large field of view and high bandwidth. This cutting-edge radar technology has been provided by the Fraunhofer Institute in Wachberg, Germany, which has partnered with ALERT researchers in order to evaluate the first prototype constructed for this specific problem. This international collaboration grant has permitted ALERT students to travel overseas in order to perform measurements with this new radar system, giving them an opportunity to experience the benefits of global research.


Person wearing different simulants used to test the radar system.

Standoff detection has been identified to be one of the top priorities for the Department of Homeland Security. This inexpensive radar prototype developed by ALERT has the potential to detect potential suicide bombers at distances up to 20 meters and thereby become a common tool to be used by DHS officers for protection of key US infrastructure. It could also be integrated into mobile units, such as a van, to detect potential suicide bombers in the field; this new tool could provide US Army and Navy with a unique advantage when acting in international high-risk missions.