Advanced Technologies Group programs aim to improve security

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The Robert H. Mollohan Research Center, located in Fairmont's I-79 Technology Park, is home to the WVHTC Foundation's Advanced Technologies Group.

Looking ahead to the next 10 years and beyond, our nation and world face an ever-increasing range of dangers. From the military threats posed by terrorists and rogue nations, to the domestic threats posed by drug smugglers and organized crime, to the natural threats posed by storms, earthquakes, and even solar flares, those charged with our protection need to be armed with the latest science and technology in order to ensure our safety. Some of the new tools required to protect the world are now being developed right here in the Mountain State. Here, we look at a few of these advanced technologies, currently under development at the West Virginia High Technology Consortium (WVHTC) Foundation.

The WVHTC Foundation's Advanced Technologies Group (ATG) is engaged in a wide array of cutting-edge science and technology research programs that will someday produce major benefits to the nation's military, homeland security and law-enforcement communities. Based in the Robert H. Mollohan Research Center, ATG scientists and engineers conduct basic and

When deployed, the Tactical Analysis of Video Imagery (TAVI) system will give warfighters the capability to detect, track, and identify potential adversaries using computer face recognition technology.

applied research projects in physics, electrical engineering and computer science for government customers in the departments of Defense, Homeland Security, Justice and the National Science Foundation. The first priority of every ATG project is to create, through science, an unprecedented new capability for the customer that will contribute to the improved security of the U.S. and its citizens.

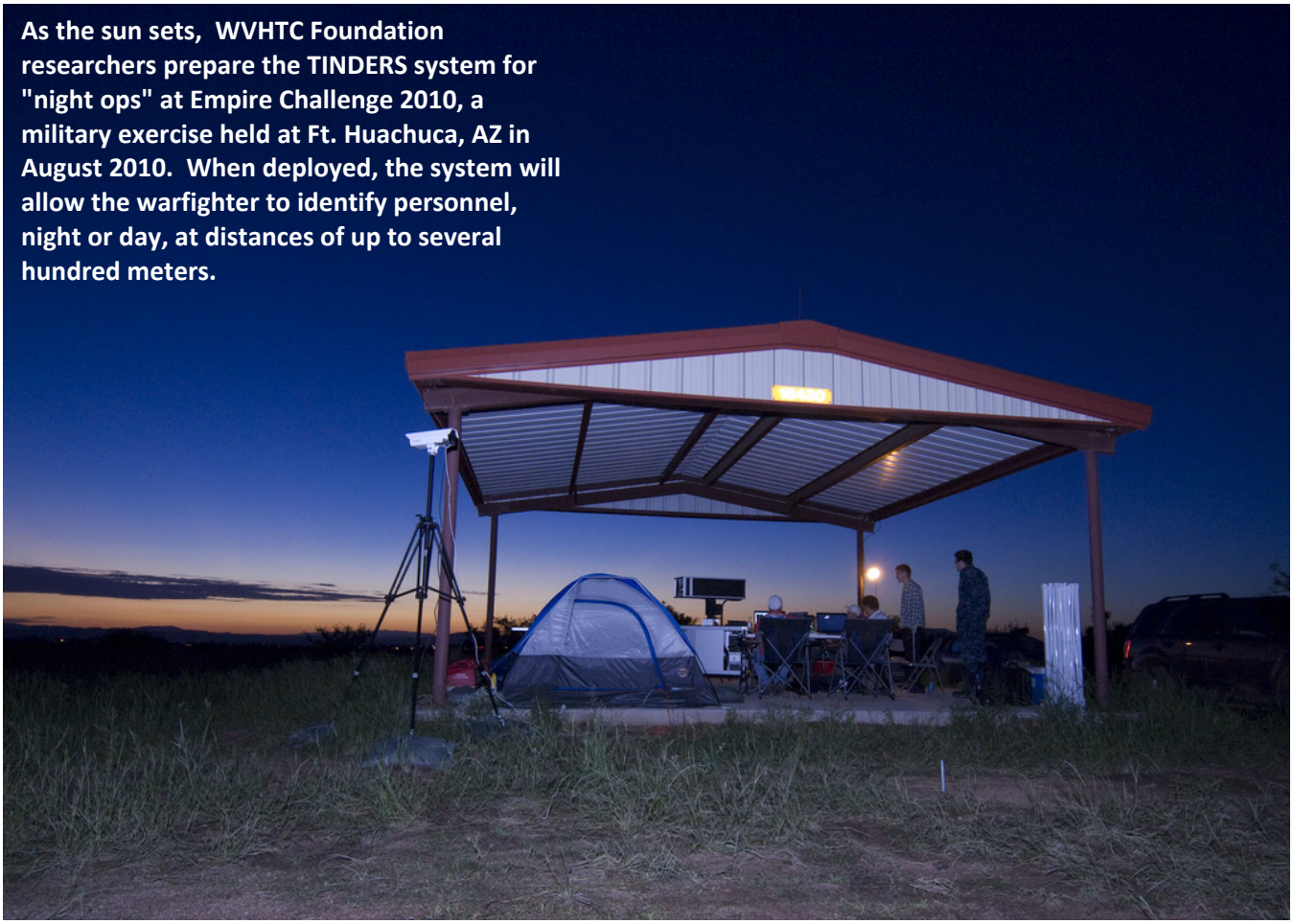
Intelligent video surveillance, recognition and tracking

An intelligent video surveillance system that can monitor a wide area and automatically detect and identify known people from a watch list would be a game-changing capability for troops overseas and law enforcement officers here at home. ATG researchers, working under funding from the Office of Naval Research (ONR), have developed the Tactical Analysis of Video Imagery (TAVI) system, which has enabled this very capability. Software that can identify people through automatic face recognition is available from many vendors; however, such software relies on having high-quality facial images. Systems that use face recognition for real-time security traditionally require a person to stand still and face the camera, usually at a range of only a few feet.

The TAVI system is able to identify people tens or even hundreds of feet away from the camera and more importantly can automatically identify people who are walking or even running. When configured with multiple cameras, TAVI can simultaneously track and identify multiple people and even detect when two people are meeting one another. This can provide valuable intelligence to a warfighter fighting an insurgent cell in Afghanistan or to an investigator fighting a gang of criminals here at home. ATG is also working to extend this capability to a city-sized area by developing algorithms that allow one or more TAVI systems and other video surveillance cameras, spread out over a wide area, to work together to track and identify people. The group is now working with several organizations within the military and law enforcement communities to deploy the TAVI technology.

Night/day long-range imaging and face recognition

While the TAVI system provides an important new capability, it is limited by the capabilities of existing video cameras. In particular, TAVI cannot see in the dark, and its range is limited to not much more than 100 meters. To address the need to detect and identify people day or night at ranges up to several hundred meters, ATG is has been developing the Tactical Imager for Night/Day Extended-Range Surveillance (TINDERS). Also funded by ONR, the TINDERS system will covertly detect, track, zoom into and identify



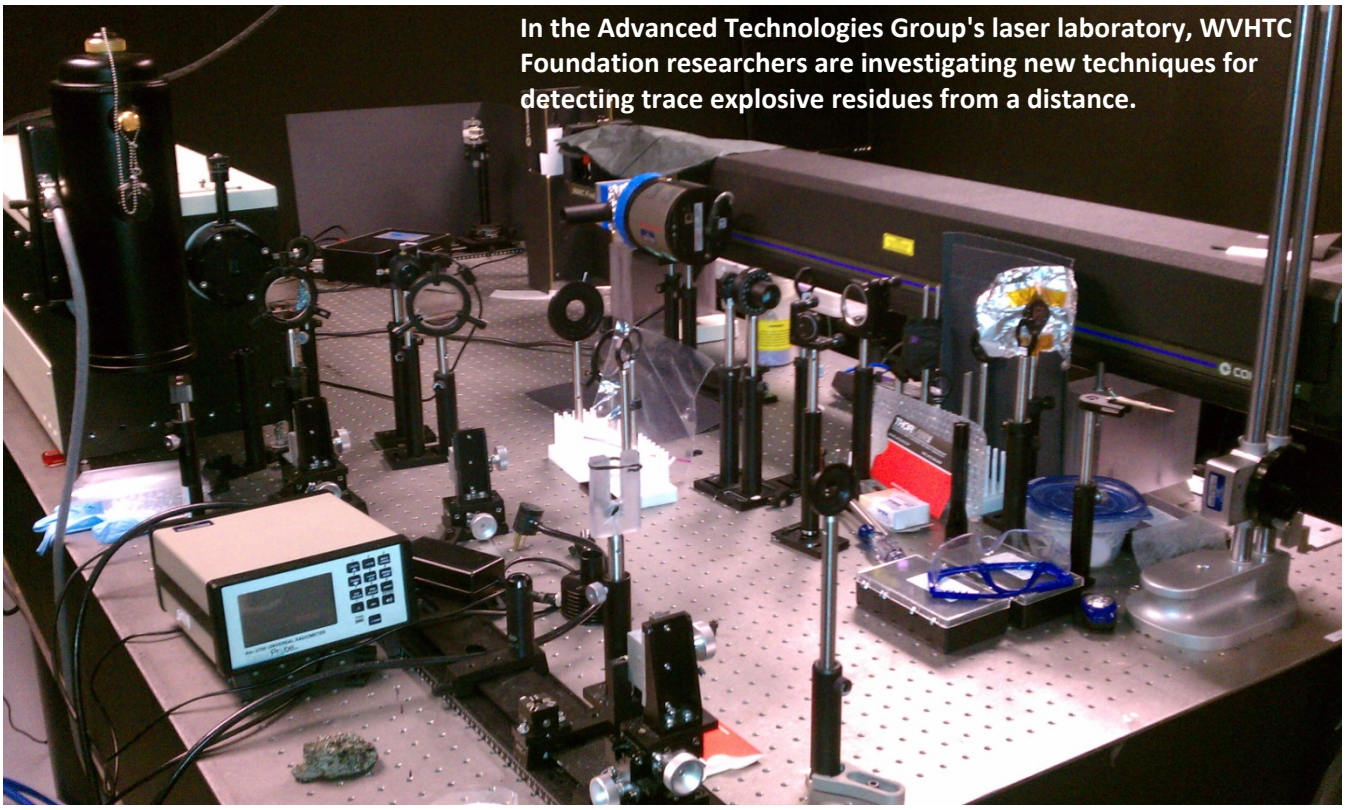
As the sun sets, WVHTC Foundation researchers prepare the TINDERS system for "night ops" at Empire Challenge 2010, a military exercise held at Ft. Huachuca, AZ in August 2010. When deployed, the system will allow the warfighter to identify personnel, night or day, at distances of up to several hundred meters.

individuals under conditions ranging from bright sunlight to total darkness at distances ranging from 10 meters out to many hundreds of meters. To accomplish this, the TINDERS system lights up the target with an invisible and eye-safe beam of short-wave infrared (SWIR) light and images the target using a powerful, custom-designed telescopic zoom lens with a state-of-the art SWIR image sensor. New face recognition algorithms are then used to match the SWIR facial image against a watch list of standard mug shots.

The first-generation TINDERS prototype has already achieved successful face recognition, in total darkness, at distances in excess of 400 meters. This represents a brand-new capability, as no other system exists in the world that can identify a person in darkness at a distance of even 100 meters. ATG is now developing a lighter, more rugged prototype, as well as improved SWIR face recognition and tracking software. The group is also developing a second version of TINDERS meant for use by law enforcement. Known as CINDERS (Civilian Imager for Night/Day Extended-Range Surveillance), and funded by the Justice Department, this system will use algorithms developed by West Virginia University to identify people through their facial and body characteristics.

Standoff Detection of Explosives

Another area of research that ATG has worked on for many years is the capability to detect trace levels of explosives from a distance, also known as standoff detection. Clearly there would be many valuable military and



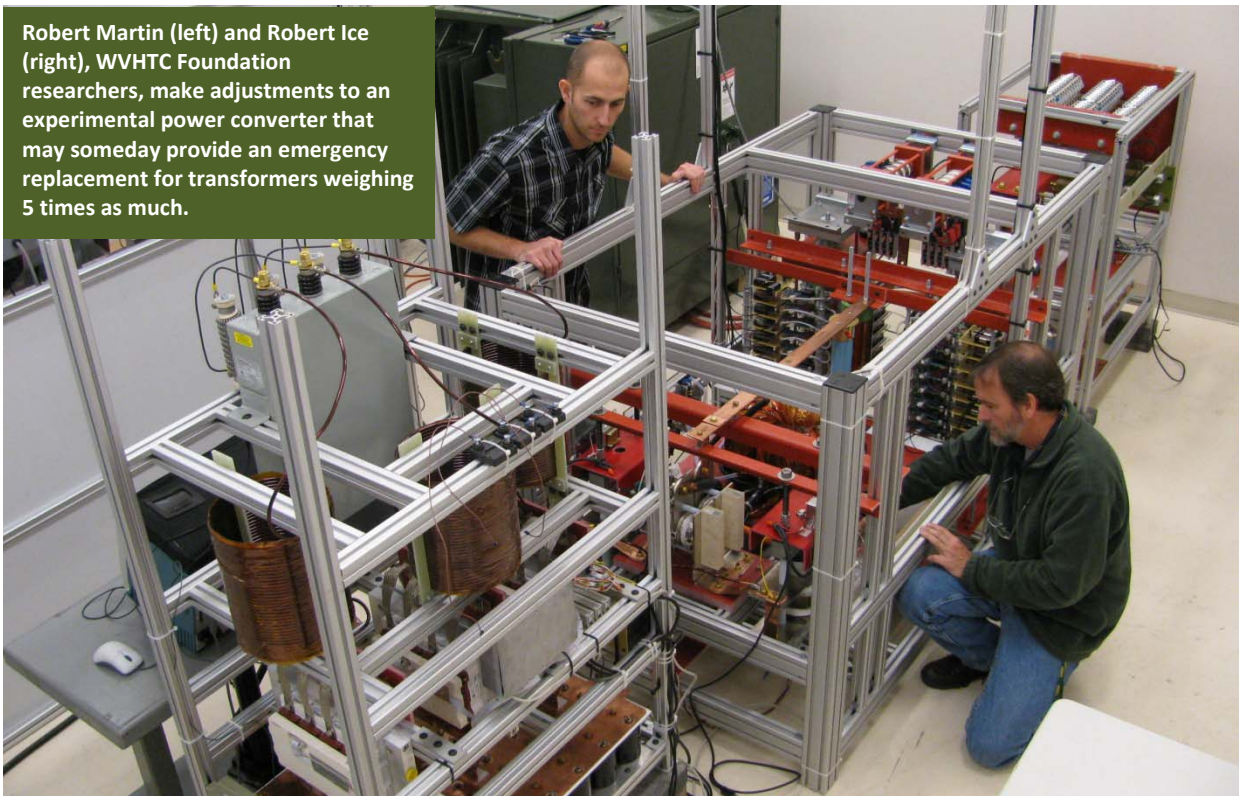
In the Advanced Technologies Group's laser laboratory, WVHTC Foundation researchers are investigating new techniques for detecting trace explosive residues from a distance.

civilian applications for a device that could be pointed at an object or surface some distance away and immediately alert its operator to the presence of explosives. While there has been much research in this area, it remains an elusive capability. ATG has focused on a technique called deep ultraviolet resonance Raman spectroscopy (DUVRRS). In this approach, a deep ultraviolet (DUV) laser beam is pointed at a surface, and the scattered light is collected and analyzed by the sensor. A computer algorithm then determines if the spectrum indicates the presence of explosives.

Previous ATG research, funded by the military, indicated that this approach could detect tiny trace amounts of explosive residue at a distance of 50 meters; however, a sensor could be easily confused by non-explosive materials that had similar-looking spectral features. To overcome this, ATG is developing a new technique, under funding from the Department of Homeland Security (DHS), that simultaneously points two or three different DUV lasers at the same target, with the combined results eliminating the confusion and unambiguously identifying the explosive. In addition to performing extensive laboratory measurements to validate this new technique, the ATG researchers are developing new types of compact lasers and spectrometers that will enable this technique to be practically deployed as a portable, rugged sensor system.

Lightweight, Compact Power Conversion

In addition to sensor technology, ATG is also developing a new lightweight power converter technology that may have a significant impact on the power distribution systems used abroad by the military and domestically following a natural disaster. Traditionally, iron-core transformers are used to convert the high-voltage power coming from transmission lines and generators to the lower voltages used for local power



Robert Martin (left) and Robert Ice (right), WVHTC Foundation researchers, make adjustments to an experimental power converter that may someday provide an emergency replacement for transformers weighing 5 times as much.

distribution. These transformers are extremely heavy and difficult to transport. In the event that one was damaged or destroyed, replacement could take months. For this reason, DHS funded ATG to develop a new type of power converter that could quickly replace a damaged transformer with a device weighing only one-fifth as much. ATG has also been funded by the Army to use the same circuit concept to develop power converters that would dramatically reduce the weight and improve the mobility of the systems used to distribute power at forward operating bases. Both power-converter efforts have achieved excellent preliminary results in the laboratory, establishing the feasibility of this dramatic reduction in the size and weight of power distribution transformers. The next step for the ATG researchers is to build rugged prototypes that can be demonstrated in the field.

Other ATG Research Projects

In the Waterborne Threat Interdiction project, funded by DHS, ATG researchers developed a new type of underwater transducer capable of generating an underwater sound wave so intense that it could be used to force an approaching diver, 100 meters away, to surface. In another ongoing effort, ATG is working with a small California-based company, under Navy funding, to develop an ultra-compact, ultra-rugged optical communications module that will enable on-board aircraft local area networks to achieve data rates in excess of 20 billion bits per second. Finally, the group has been engaged in NSF-funded basic research for many years to create theoretical models of the sun's atmosphere to help better understand the mechanisms responsible for solar wind, solar flares and other emissions of potentially dangerous radiation from the sun. Someday, this research may contribute to an early warning system that could be used to protect satellites, astronauts and even ground-based communications and power systems from the effects of a strong solar flare.