GTRI

2012-2013 YEARS IN REVIEW

Georgia Tech | Research Institute

Problem. Solved.

Georgia Tech Research Institute
2012-2013 YEARS IN REVIEW

The Georgia Tech Research Institute (GTRI) is a highly regarded applied research and development organization that is part of the Georgia Institute of Technology, one of the world's top-ranked research universities. With more than 1,700 scientists, engineers and other professionals, as well as students, GTRI helps solve the most difficult problems facing government and industry across the nation and around the world.

In this annual report are examples of how GTRI researchers have applied their expertise, creativity and innovation to solve important challenges the past two years.

MESSAGE FROM THE DIRECTOR

The Georgia Tech Research Institute (GTRI) solves problems that no one else can. Our scientists, engineers, researchers and support team are driven by a vision of making GTRI the world's premier applied research and development organization. One glance at our report and you'll see that we are well on our way.

In both fiscal years 2012 and 2013, our new R&D contract awards topped $300 million. But numbers tell only part of the story.

Open this brief report and you'll find stories of innovation, accomplishment and contribution to the greater good of Georgia and the nation. Read about vastly improved monitoring of blast effects on U.S. soldiers enabled by our new sensor systems integrated into soldiers' uniforms and vehicles.

Discover how GTRI is helping to protect computer networks from malicious software through a threat intelligence system. And I think you'll be intrigued by one of our newest capabilities, GAUSS – the GTRI Airborne Unmanned Sensor System, which flies with an integrated flexible array of electromagnetic, optical and other unique sensors, to support a variety of missions spanning agriculture, defense and homeland security.

All of these amazing stories are enabled by one of the most capable and hardworking research teams in the world. I can think of no better way to introduce you to GTRI's important work than by encouraging you to meet our people. Our philosophy of hiring outstanding people and turning them loose on tough problems continues to result in exceptionally positive feedback from our sponsors and customers.

We are a team of more than 1,700 poised to assist with getting to the bottom of the most complicated problems confronting your enterprise. So if you need help with difficult engineering, technology, software or system level problems, give us a call or drop us an email.

In the past, we have published our annual report in the spring the year after the fiscal year closed. We are shifting the publication date to the late summer to be more timely. To accomplish this change, we have included fiscal years 2012 and 2013 in this report. The last two years have been great, and we look forward to even greater accomplishments in the year ahead.

Thanks for taking the time to review our report.

Robert T. McGrath
Director, Georgia Tech Research Institute
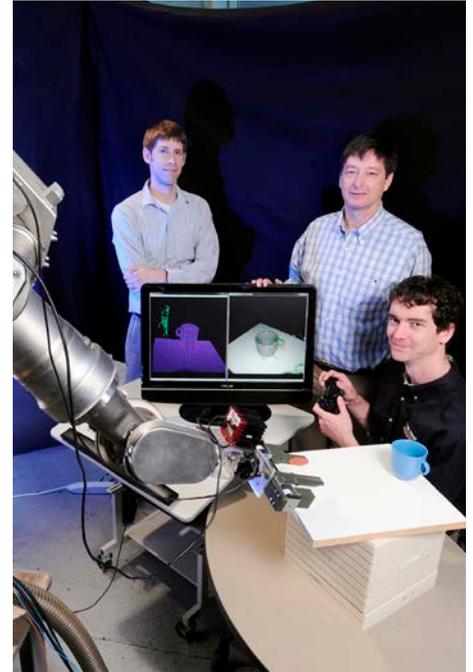Senior Vice President, Georgia Institute of Technology

Georgia Tech Research Institute
2012-2013 CHALLENGES AND SOLUTIONS

Airborne Test Capability Supports Sensor Development

GTRI is developing an aerial testing capability for sensors, communications devices and other airborne systems. Known as the GTRI Airborne Unmanned Sensor System (GAUSS), the test bed is based on an unmanned aerial vehicle made by Griffon Aerospace and modified by GTRI. Designed for low-altitude testing, GAUSS can carry a 40-pound payload and includes camera, signals intelligence, GPS navigation and multichannel ground mapping radar packages. Phased array radar will be added to the aircraft, which can be flown autonomously or piloted from the ground. GAUSS supports the emergence of UAV and robotics research as a key capability in GTRI's research portfolio.

Simulator Helps Defend Against Hostile UAVs

Unmanned aerial vehicles are becoming increasingly important to military operations worldwide, so U.S. forces must be prepared to confront hostile UAVs – and to counter the surveillance technologies they may be carrying. As part of its broad-based research in electronic warfare, GTRI researchers are developing integrated hardware devices that simulate the sensors that may be operating on these hostile UAVs. Designed with support from the U.S. Army Threat Systems Management Office, the GTRI devices allow evaluation of countermeasures that are under development. The simulation equipment is being tested on a Diamond DA-40 piloted aircraft.

Intuitive Control Provides Better Robot Operation

Using a novel method for integrating video technology and familiar control devices such as joysticks and game pad controllers, GTRI researchers have developed a technique for making the remote control of robotic devices more intuitive. The goal of the project, known as Uncalibrated Visual Servoing for Intuitive Human Guidance of Robots, is to enhance a human operator's ability to perform precision tasks using a multi-jointed robotic device, such as an articulated mechanical arm. The technique would be particularly helpful when the robot is controlled by an operator watching it on a video monitor for applications such as remote bomb disposal and handling of hazardous materials.

Wearable Sensor System Records Blast Effects

Improvised explosive devices pose a growing challenge to U.S. forces. To help reduce this threat and provide better care to injured soldiers, GTRI worked with the Army's Rapid Equipping Force to develop a sensor system that measures the physical environment of an explosion, collecting data that can correlate what a soldier experienced with long-term medical outcomes. The Integrated Blast Effect Sensor Suite (IBESS) is the first system of its kind to acquire integrated, time-tagged data during an explosive event. IBESS consists of two subsystems, one worn by soldiers and the other operated in a vehicle. In Afghanistan, IBESS has been issued to 650 troops and installed in 42 vehicles. IBESS is an excellent example of GTRI's ability to respond to urgent customer needs.

Chemical Companion Assists First Responders

First responders to accident scenes must often deal with unknown and potentially toxic spilled chemicals. To help them assess the risks they face and select the best response options, GTRI developed a software tool known as the Chemical Companion in 2006 and updated it for a re-release in 2012 as it expanded into international use. Based on a physical description of the chemical and medical symptoms of victims, the Chemical Companion provides decontamination and safety recommendations. Since its launch, Chemical Companion has been made available to emergency personnel in the United States, Australia, Canada, the United Kingdom and Israel, and expanded to include information on more than 550 chemicals. Now programmed for Windows machines, the tool will soon be made available for Apple iOS and Android mobile devices.

Adaptive Threat Response Powers New EW System

To counter electronic warfare threats that are becoming increasingly sophisticated, GTRI is developing a new generation of advanced electronic warfare technology based on novel machine learning technology. Known as Angry Kitten, the project will provide fully adaptive and autonomous capabilities that aren't currently available in jammers. At the start of an electronic engagement, this next-generation system will choose the optimal threat response, assess the results as the engagement proceeds and adapt its strategy if needed. Angry Kitten will also collect information about new threats it encounters to accelerate the development of countermeasures.

Agile Aperture Antenna Tested at Sea

Antenna technology originally developed to send and receive information through a software-defined military radio may soon be used to transmit ocean data from a wave-powered autonomous ocean vehicle. The GTRI-developed Agile Aperture Antenna technology maintains a satellite uplink for the Wave Glider by automatically compensating for the movement of the antenna as waves move the craft around on the ocean's surface. The agile aperture antenna requires less power and takes up less space than traditional antenna solutions including mechanical systems and phased-array antennas. The technology also exhibits higher reliability than mechanical systems and is less expensive than phased-array antennas. The antenna technology was successfully tested off the coast of Hawaii.

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System Shares Malware Threat Intelligence

To counter malware attacks that are expanding into new domains and focusing on industrial espionage, GTRI researchers have developed an intelligence sharing system that helps corporate and government security officials know more about the threats they face. The system is at the heart of a security community established to help companies share information anonymously, creating a knowledge base shared among all participants. The system, which now has more than 100 user organizations, builds on a GTRI threat analysis system that includes a malware repository with more than 53 million samples of malicious code. Researchers from these projects also worked with the Georgia Tech Information Security Center (GTISC) to produce annual cyber threats reports. The most recent report warned of new and increasingly sophisticated means of capturing and exploiting user data, escalating battles over the control of online information and continuing threats to the U.S. supply chain. Specific concerns included cloud-based botnets, search history poisoning, mobile browser and mobile wallet vulnerabilities and a counteroffensive from malware authors. The research gave rise to a new system called Phalanx to help organizations fend off spear phishing attacks – malicious emails that trick users into downloading malware or visiting malicious Web sites. Phalanx will analyze corporate email servers to flag emails that may indicate attacks. It will also warn users about suspicious emails.

Device Helps Monitor Hurricane Strength

A device designed by GTRI engineers is part of the Hurricane Imaging Radiometer (HIRAD), an experimental airborne system developed by the Earth Science Office at the NASA Marshall Space Flight Center. The GTRI-developed device, known as an analog beam-former, is a key part of the radiometer, which is being tested by NASA on a Global Hawk unmanned aerial vehicle. The radiometer measures microwave radiation emitted by the sea foam produced when high winds blow across waves, providing a means of remotely measuring surface wind speeds. The project could one day lead to the use of unmanned aerial vehicles to replace manned aircraft now monitoring storms.

## Automated System Seals Pavement Cracks

Sealing cracks in roadways extends the time between major repaving projects, but conventional manual crack sealing operations expose workers to dangerous traffic and are limited in the amount of roadway they can cover each day. To address these challenges, GTRI developed a prototype automated crack detection and sealing system with funding from the Georgia Department of Transportation. In tests, the system detected cracks smaller than an eighth of an inch wide and efficiently filled them from a vehicle moving at three miles per hour. The system uses LED lighting and a camera system to detect cracks, and can be operated by one person.

Adaptive Technique Optimizes Flight Simulators

GTRI researchers have developed a technique that dramatically reduces data retrieval time for a new flight simulator, allowing it to achieve more realistic performance. The technique met a need of the Naval Air Warfare Center Aircraft Division for a flight simulator to give pilots an improved experience with electronic warfare systems, while collecting data on interactions between pilots and simulated threats. Highly detailed scene data slowed the system until GTRI researchers introduced optimization methods, including adaptive sampling techniques and a look-up table for the most important threat information.
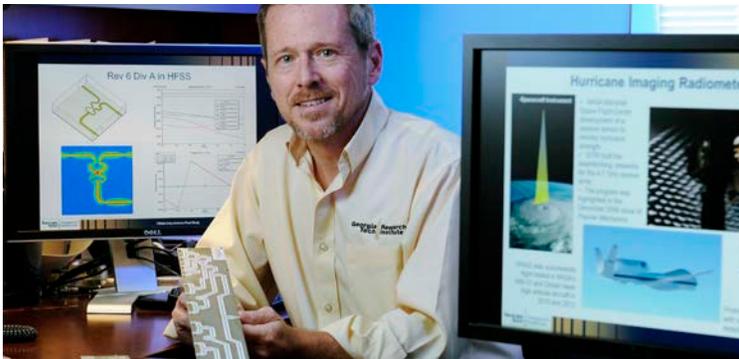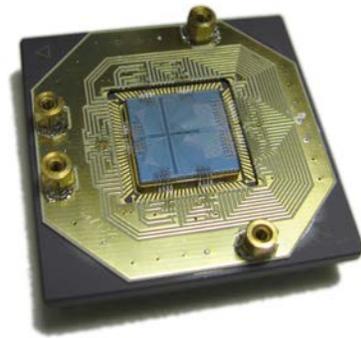
New Ion Traps Expand Quantum Computing

Quantum computers promise to perform certain types of computations, such as breaking encryptions or searching large databases, much faster than traditional computers. Quantum computers encode information in quantum bits, known as qubits. One approach that can be used as a qubit is individual trapped ions. GTRI researchers are designing novel ion traps that can be used as the building blocks of a trapped ion quantum computer. The research is sponsored by the Intelligence Advanced Research Projects Activity through the Army Research Office.

Analysis Guides Decision on Replacement Radar

In a project for the Federal Aviation Administration (FAA) and the National Oceanic and Atmospheric Administration (NOAA), GTRI researchers are analyzing alternative approaches to the radar systems that currently support the nation's air traffic control and weather monitoring systems. These systems currently use older technologies that have many mechanical components and require frequent repairs and maintenance. GTRI is examining the feasibility of replacing the multiple existing radars with a single new system based on phased array technology, which uses solid-state electronics in place of many mechanical components.

To learn more about any of these projects, please visit the case studies page at www.gtri.gatech.edu.

ONE GEORGIA TECH
GTRI supports Georgia Tech's core research areas

In addition to significant breakthroughs in GTRI's domains, this past year has seen a number of important contributions by GTRI in the overall research enterprise at Georgia Tech. Here are a few examples of how GTRI is a part of the larger Georgia Tech research effort:

Team Supports Big Data Machine Learning

GTRI researchers are part of a four-year effort to develop new computational techniques and open-source software tools for processing and analyzing defense-related data. Led by Georgia Tech's School of Computational Science and Engineering, the DARPA-funded team will produce novel machine learning approaches capable of analyzing very large-scale data. The team will pursue development of distributed computing methods able to quickly process data analytics algorithms by simultaneously utilizing supercomputers, parallel processing environments and networked distributed computing systems. Funding is from DARPA's XDATA program, a multi-agency initiative. GTRI researchers will support XDATA's hardware requirements with expertise on low-cost graphics processing units (GPUs), which offer performance levels reached only by supercomputers until recently. Clusters of linked GPUs could help provide the processing power needed to satisfy XDATA requirements.

Innovation Network Focuses on Health IT

GTRI researchers are collaborating with the Veterans Health Administration (VHA) in a vendor-neutral health IT innovation network designed to stimulate development of new ideas and shorten the time required to bring new solutions into practice. The project will address interoperability issues, accelerate the development of integrated health IT solutions, provide an unbiased environment for testing new products and help train future health IT leaders and developers. Collaborating with researchers from Georgia Tech's Institute for People and Technology, GTRI is part of the Interoperability and Integration Innovation Lab (I3L) – which is now connected electronically to the VHA's own innovation unit.

GTRI's STEM Initiatives are Building Momentum, Changing Lives

GTRI continues to give considerable attention to STEM (science, technology, engineering and mathematics) education in Georgia. In February 2013, GTRI participated in the Health Sciences and Technology STEM event at North Springs Charter High School in Sandy Springs, Ga. GTRI partnered with Georgia Tech students and the Sandy Springs Education Force to introduce students to health sciences and technology career opportunities. The two-part event featured interactive health sciences and technology exhibits designed to inspire and educate many of the Sandy Springs-area middle- and high-school students. Nearly 700 students participated in the afternoon session and more than 300 attended the evening event for the community. The STEM@GTRI initiative coordinates with the Center for Education Integrating Science, Mathematics and Computing (CEISMC) at Georgia Tech and sponsors such successful and well-known programs as the Laser Project and Direct to Discovery, which connects students in classrooms across Georgia with Georgia Tech instructors.

Acoustic Time Delay Device Shrinks Phased Arrays

Phased array technology is replacing traditional radar systems in many applications with smaller and faster solid-state electronics. But the need for electromagnetic delay lines to properly sequence the transmission of radar signals can limit the space savings of phased array systems. In collaboration with Georgia Tech's School of Electrical and Computer Engineering, GTRI researchers are developing miniature acoustic devices to replace the delay lines. The principle is simple: acoustic signals travel more slowly than do electrical signals. The ultra-compact passive true time delay can be embedded entirely within thin film materials, and has so far been used to create delays of up to 10 nanoseconds.

Online Tool Provides Catch-Up Vaccination Plans

A new online tool developed by Georgia Tech researchers – in collaboration with the Centers for Disease Control and Prevention (CDC) – generates a customized catch-up vaccination schedule for children who may have missed one or more scheduled immunizations. Childhood immunization schedules are complex, and health care providers previously had to create these customized schedules themselves, often while patients waited. GTRI researchers worked with colleagues in the Georgia Tech School of Industrial and Systems Engineering to develop the system, which has been used more than 115,000 times since it was launched. The online system replaces an earlier downloadable software program.

ABOUT US

OUR MISSION
We solve complex problems through innovative and customer-focused research and education.

OUR VISION
To be the world's premier applied research and development organization.
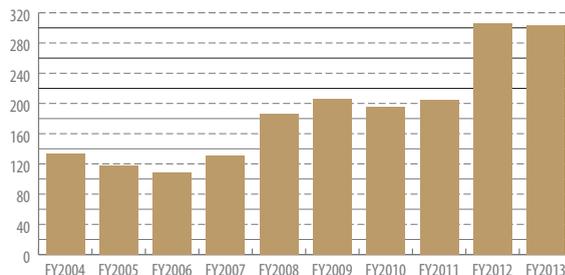
AWARDS

OUR NUMBERS

2013 Contract Awards:	**$305M**
2012 Contract Awards:	**$306M**
Total Number of Employees including students (as of June 30, 2013):	**1,765**
Students Employed by GTRI Included in Total Number:	**309**

AWARDS HISTORY

From FY04 to FY13

■ Research Awards (in millions)

RESEARCH FOCUS AREAS

Advanced Computing
Antennas
Aerospace Technologies
Communications
Cyber Security
Electronic Warfare
Information
Materials
Media, Health & Education
Modeling & Simulation
Optics
Radar
Robotics & Unmanned Systems
Sensors
Systems Engineering
Test & Evaluation

**GTRI also provides professional education in the above areas.**

LOCATIONS

Aberdeen (MD) Field Office
Atlanta (GA) Headquarters
Cobb County (GA) Research Facility
Dayton (OH) Field Office
Hampton Roads (VA) Field Office
Huntsville (AL) Research Center

Orlando (FL) Field Office
Pax River (MD) Field Office
Panama City (FL) Field Office
Pearl City (HI) Field Office
Quantico (VA) Field Office
San Antonio (TX) Field Office

San Diego (CA) West Coast Operations
Shalimar (FL) Field Office
Tucson (AZ) Field Office
Warner Robins (GA) Field Office
Washington (DC) Operations

OUR CUSTOMERS
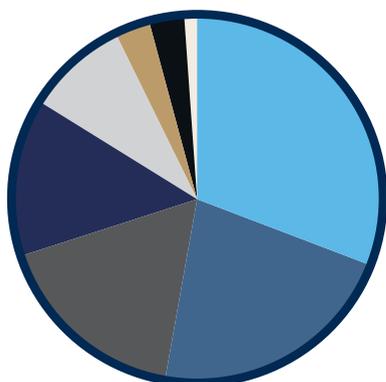
■ Air Force	31%
■ Army	22%
■ Other DoD	17%
■ Navy	14%
■ Federal Pass-Throughs	9%
■ Other Non-DoD Federal Agencies	3%
■ State and Local Governments	3%
■ Private (Universities, Businesses)	1%

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