2010
ANNUAL
REPORT

THE PROBLEM SOLVERS

GTRI

Georgia Tech | Research Institute

Problem. Solved.
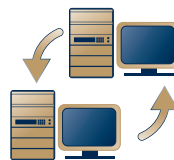
MESSAGE FROM THE DIRECTOR

The Georgia Tech Research Institute is internationally known as a research powerhouse, a dynamic organization with the breadth and depth of expertise to truly make a difference for the world – both today and tomorrow. When I was contacted about the possibility of serving as GTRI's director, I was immediately excited about the opportunity.

GTRI has high aspirations. We want to be the world's premier applied research and development organization, and we have a strategic plan that maps the course to that objective. The plan includes expanding our technical preeminence in core research areas and continuing to build research teams of world-class experts who provide innovative solutions to complex problems associated with our nation's security and economic vitality.

GTRI uniquely serves as the applied research arm of the Georgia Institute of Technology, which ranks second among U.S. universities in the dollar volume of engineering research and development conducted each year. Being an integral part of Georgia Tech, therefore, means that in meeting our sponsors' needs, we can easily draw upon the outstanding faculty within our academic colleges to supplement the exceptional researchers in GTRI itself.

Developing our nation's future scientific and engineering leaders is one of my great passions. Consequently, I was pleased to learn that GTRI researchers mentor more than 330 students each year. These students are among the very best in the nation, and they help us to delight our customers by contributing their own innovative problem-solving ideas to many of the Institute's applied R&D projects. Encouraging and challenging these bright young people is among the most important things we do.

I'm very proud to be part of the Georgia Tech Research Institute, and look forward to building upon the tremendous success GTRI has already achieved. I hope you enjoy this brief report on our accomplishments in 2010, and that you'll work with us to further expand GTRI's impact on important challenges facing our nation and the world.

Sincerely,

Robert T McGrath

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

THE GEORGIA TECH RESEARCH INSTITUTE

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.

OUR NUMBERS

2010 RESEARCH REVENUE **$205.4M**

INTERNAL RESEARCH & DEVELOPMENT INVESTMENT **$7.8M**

TOTAL NUMBER OF EMPLOYEES **1,520**

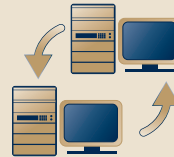STUDENTS EMPLOYED BY GTRI **330**

Statewide Impact

AMOUNT GENERATED BY GTRI FOR EVERY DOLLAR PROVIDED BY GEORGIA **$30**

ESTIMATED ANNUAL ECONOMIC IMPACT ON GEORGIA .... **$400+M**

RESEARCH FOCUS AREAS

- SYSTEMS ENGINEERING
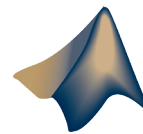- INFORMATION & COMMUNICATION TECHNOLOGIES
- SENSORS
- TEST & EVALUATION
- ELECTRONIC WARFARE
- MODELING & SIMULATION
- SECURITY
- RADAR
- ANTENNAS
- OPTICS
- MEDIA, HEALTH & EDUCATION
- ROBOTICS AND UNMANNED SYSTEMS
- AEROSPACE TECHNOLOGIES

OUR CUSTOMERS

- DEPARTMENT OF DEFENSE: 72%
- FEDERAL SUBCONTRACT: 12%
- NON-DOD: 8%
- STATE AND LOCAL GOVERNMENT: 6%
- PRIVATE (UNIVERSITY, INDUSTRY, NONPROFIT): 2%

THE PROBLEM SOLVERS
GTRI

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 1,500 scientists, engineers and other professionals, GTRI helps solve the most difficult problems facing government and industry across the nation and around the world.

Following are examples of how GTRI researchers have applied expertise, creativity and innovation to solve important challenges. To learn more about any of these projects, please visit **www.gtri.gatech.edu**.
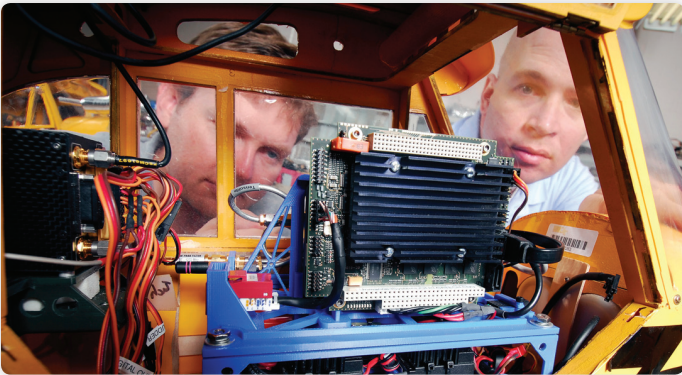
Helping Autonomous Vehicles Collaborate

GTRI researchers have developed an advanced approach to enabling autonomous collaboration among dissimilar robotic vehicles. The GTRI system, called the Collaborative Unmanned Systems Technology Demonstrator (CUSTD), uses two small aircraft and a full-size ground vehicle to perform complex, interactive missions without human intervention.

The system's approach to facilitating collaboration between the two aircraft and the ground vehicle was demonstrated at Robotics Rodeo 2010, an event held in October at Fort Benning, Ga. CUSTD uses advanced collaboration software and novel sensing systems, along with an "auction" strategy that helps select the best vehicle for a given task depending on the unique capabilities of available vehicles.

Addressing a Wide Range of Cyber Threats

To apply its broad expertise in cyber-related research and experience in systems engineering to a wider range of information security issues, GTRI has formed the new Cyber Technology and Information Security Laboratory (CTISL).

The lab's researchers will develop cutting-edge capabilities for sending data across trusted networks to ensure effective missions. The work will focus on providing resilient command and control solutions to warfighters operating in contested environments, helping industry defend against cyber criminals and safeguarding the nation's critical infrastructure.

CTISL brings together researchers from several GTRI laboratories to focus on developing and applying new cyber solutions and technologies. It will collaborate with Georgia Tech academic researchers on specific information security issues.

Giving Robots the Capability of Deception

A robot deceives an enemy soldier by creating a false trail and hiding so it will not be caught. That scenario is part of a new study conducted by GTRI and a Georgia Tech academic researcher to examine the role of deception in future robotic systems.

The researchers developed algorithms that allow robots to determine whether or not they should deceive a human or another intelligent machine, and how to select the most advantageous deception strategy. Beyond its military value, deception in robots could be useful in search-and-rescue operations to calm panicky victims.

While the study showed that deception could be useful in protecting robots, the researchers cautioned that ethical questions about the strategy's use still must be answered.

Using Game Hardware to Protect Workers

GTRI engineers are applying equipment designed for digital gaming to study physical stresses on the arms of workers in poultry processing plants. The research uses custom software, together with inexpensive game-console remote controllers developed for the Nintendo Wii. The combination handles sensing tasks that would otherwise be done with equipment costing thousands of dollars – risky in the wet poultry processing environment.

Information provided by the devices, known as Wiimotes, helps engineers redesign work environments to minimize the stresses. The low cost of the digital gaming equipment allows researchers to study multiple workers.
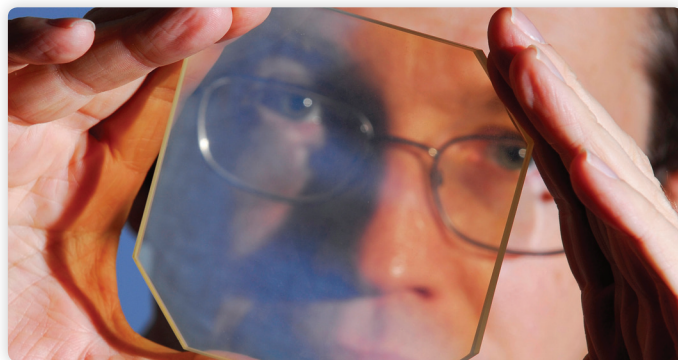
Testing High-Energy Laser Weapons

Technologies for using laser energy to destroy threats at a distance have been in development for years and today are maturing toward deployment. GTRI researchers have developed a system to help test and evaluate the high-energy laser systems that will be part of these directed energy weapons.

The system simultaneously measures a laser's power and spatial energy distribution by directing the laser beam onto a unique glass target board. The reusable board and beam diagnostic system will help accelerate development of high-energy laser systems and reduce the time required to bring them into operation for national security applications.
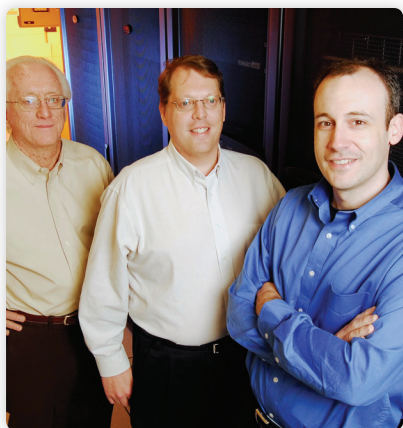
Supporting Next Generation High-Performance Computing

GTRI and Georgia Tech academic researchers are collaborating to support a national effort aimed at developing a new generation of high-performance computers that could be packed into a single rack and powered by a fraction of the energy used by today's supercomputers. Such machines would allow unprecedented amounts of computing capability to be installed on aircraft, carried onto the battlefield and made available to researchers.

Putting this much computing capability into a small and energy-efficient package, while making the resulting computers reliable and easier to program, are among the goals of the DARPA Ubiquitous High Performance Computing (UHPC) initiative. GTRI researchers are leading a portion of the effort that will develop applications, benchmarking and metrics for driving the program's system design considerations and supporting performance analysis of the designs.

Adapting Gaming Environments for the Classroom

Can the gaming worlds that keep kids anchored to computers for hours also help them in the classroom? GTRI researchers believe that digital gaming technology can be a serious teaching tool for providing immersive environments that give K-12 students experiences they might not otherwise receive.

One example is game-like environments that let students manipulate molecules in real time, allowing them to look at chemical bonds for a better understanding of how things work at the nanoscale.

GTRI researchers also are working with school systems to create learning opportunities within online environments, where – for example – students can operate a virtual fish hatchery that simulates the conditions and problems of a real facility.

## Teaching Students to be Safe Workers and Supervisors

Scientists at GTRI are bringing the life-saving subject of workplace safety and health to Georgia students at both the high school and college levels. The goal is to instill safety awareness in future workers and supervisors before they ever set foot on a job site.

On the Georgia Tech campus, GTRI safety professionals have begun teaching classes in the School of Civil and Environmental Engineering. This instruction complements the safety and health classes that GTRI has offered in high schools since 2006, and the training offered to young workers through GTRI's Southeastern Center for Young Worker Safety and Health.

Helping International Health Agencies Manage Personnel

GTRI researchers are collaborating with Emory University to help automate human resource information systems for health care professionals in two African nations. The researchers are evaluating and advising on computer systems developed to provide information for improving human resource management, policy development and health planning.

In Kenya, the goal is to move information on the nation's health care professionals from a decentralized system of paper records to a computer database. The new database would help the nation's government better manage and deploy critical health care professionals to address serious health care issues. For Zimbabwe, researchers are providing advice on design of database models and user interfaces for a similar system.
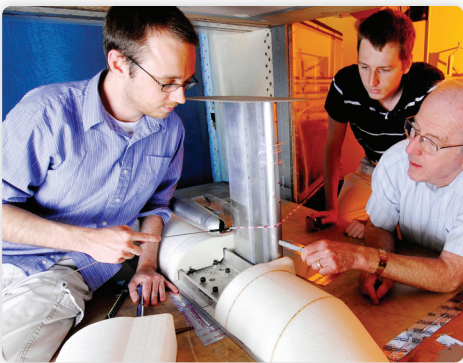
Allowing Commercial Jets to Use Shorter Runways

Research being done at GTRI could enable jet airliners to take off and land on shorter runways while also reducing the amount of engine noise heard on the ground. The work could allow future generations of cruise-efficient, short takeoff and landing (CESTOL) aircraft the size of a Boeing 737 to use runways much shorter than currently required.

GTRI's contribution to this NASA initiative includes the application of circulation control wing technology in which high-speed jets of air are directed over the upper surface of the aircraft's wings during takeoff and landing to dramatically increase lift. GTRI engineers are also assisting with the project's aerodynamics, wind-tunnel testing and acoustics control programs.

Laying the Groundwork for Quantum Computers

GTRI researchers are designing, fabricating and testing planar ion traps that could help lay the groundwork for a future generation of quantum computers able to solve certain types of computing problems – such as encryption – that remain difficult for conventional computers.

The tremendous power of quantum computers would stem from their use of quantum systems called qubits, which can exist in a "superposition" of two states at the same time, in contrast to conventional transistors which must be in states of either "0" or "1."

One path toward creating quantum computers is to use trapped ions as the qubits. Ion traps being developed at GTRI could be readily combined into large, interconnected trap arrays suitable for that purpose.
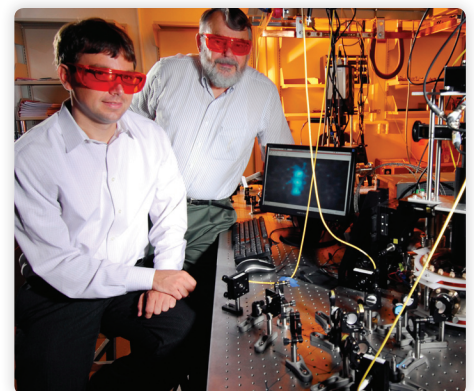
Helping Archivists Preserve Digital Files

Researchers at GTRI are sharing the results of advanced file-format recognition research with The National Archives of the United Kingdom. The effort could enhance worldwide capabilities for managing and archiving the vast array of file formats created since the computer age began.

Improving archivists' ability to categorize and access hundreds of different computer file formats is critical in the digital age. Increasingly, archives receive large quantities of government and other records in a variety of digital formats. Distinguishing among the different formats is the first step in preservation.

But detecting formats can be more complicated than simply noting file extensions such as ".doc" or ".pdf." GTRI researchers are sharing techniques developed for identifying the distinctive internal signatures of files – work originally done for U.S. government archiving agencies.
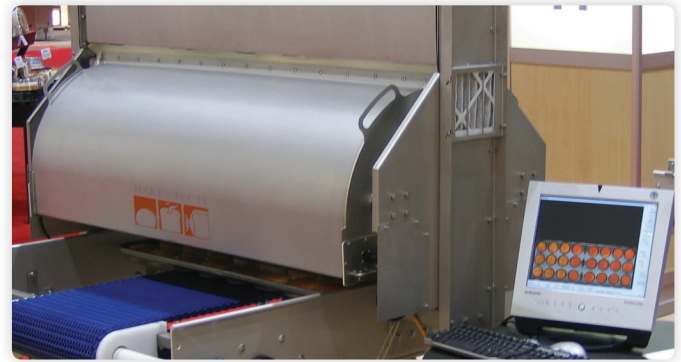
Improving Food Quality with Imaging

Food companies that require tight control over baking conditions should benefit from a new GTRI-developed system that automatically inspects sandwich buns on the production line and adjusts oven temperatures to provide products of consistent quality.

By replacing an existing process that involves periodic human inspection and manual adjustment of oven temperatures, the system will reduce the amount of off-quality product produced due to normal variations in the baking process. Working with Georgia companies Flowers Foods and Baking Technology Systems (BakeTech), a prototype system has been operating in a baking facility for more than a year.

In the future, the imaging system could be adapted to control the quality of other bakery products, such as biscuits, cookies, crackers, bread and pies.
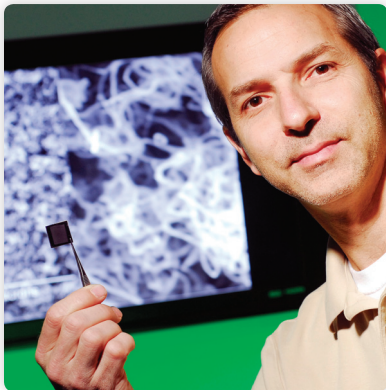
Developing Radio Frequency "Nano Antennas"

A new class of microstrip patch antenna that uses carbon nanotubes and nanometer-thickness metallic films could allow the miniaturization of devices operating at X-band frequencies for defense and homeland security applications. The design, developed by a team of researchers from GTRI, Texas A&M Kingsville and the University of Texas Brownsville, also may have applications for sensing toxic gases.

Testing shows promising reliability under a range of operating conditions, and suggests the antennas could be made electronically steerable – potentially providing 360 degrees of coverage. Fabricated on a silicon substrate just 2 centimeters square, these antennas could be useful in system-on-chip, space and other specialized applications.

Cooling Microelectronics with Silver-Diamond Composite

GTRI researchers are developing a composite material with unique capabilities for cooling small, powerful microelectronics used in defense systems. The solid material, composed of silver and diamond, offers extremely high thermal conductivity along with reliability and stability.

The work is focused on producing a composite thermal shim of unprecedented thinness – 250 microns or less. The ratio of diamond to silver can be tailored to allow the shim to be bonded effectively to a variety of wide bandgap semiconductors used in high-power applications such as radar. The material could hold significant technology transfer promise; no similarly effective silver-diamond composites are available.

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