Global Leader in Information Security

Ask and You Shall Research

Researcher Uses Technology to Entice Shoppers

Focusing on the discoveries and innovations faculty and students are making at Florida Institute of Technology.

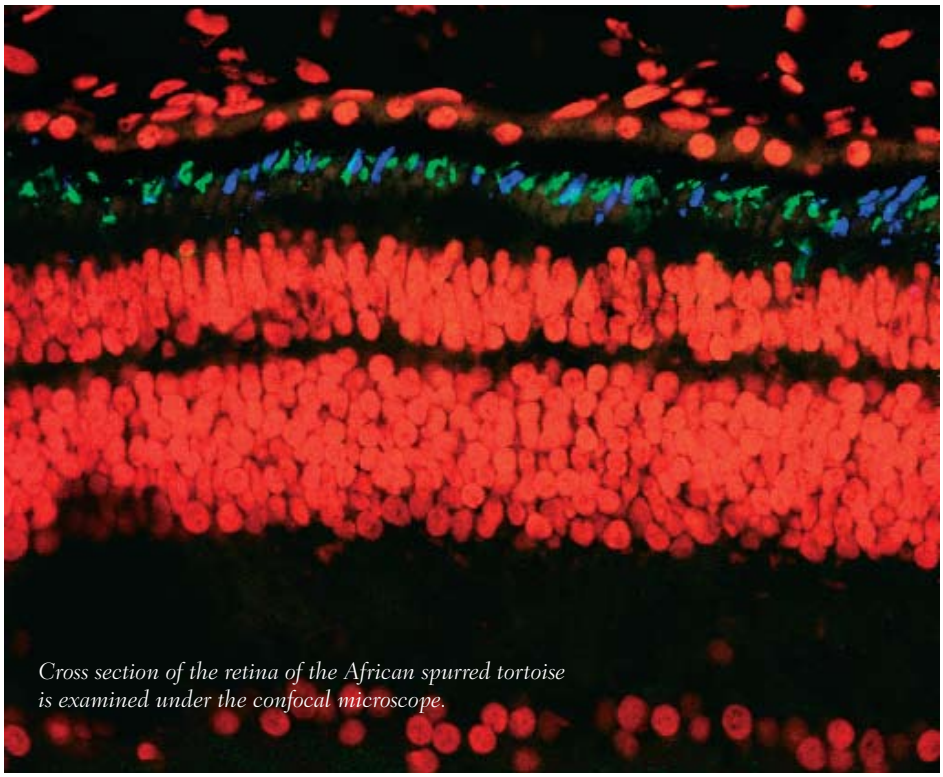
Volume 8, Issue 1

DISCOVERY: Florida Tech

Seeing Is Believing for Vision Researchers

To learn how snakes, tortoises, marine fish and sea turtles see the world around them, Florida Institute of Technology biologist **Michael Grace** needed a new way to, well, see for himself. As a result of a $420,000 National Science Foundation grant, Grace and his fellow Florida Tech biologists can do just that, utilizing a new, highly advanced Nikon C1Si laser scanning multispectral confocal microscope.

"This tool is extremely important in biology and in the biomedical sciences," says Grace. "Confocal microscopes have been around for a while, but this one ups the ante by providing us with full spectrum color (instead of traditional tri-color)—the ability to detect many different fluorescent signals inside materials. It also provides both an upright microscope for looking into tissue slices and an inverted microscope for studying living cells in the same machine."



Cross section of the retina of the African spurred tortoise is examined under the confocal microscope.

Michael Grace and student Ofego Okpobrisi examine a green snake.

The new confocal microscope is part of Florida Tech's High Resolution Microscopy and Advanced Imaging Center; Grace is the center director.

The new tool comes at an important time for Grace's ongoing research projects. Grace is a recognized leader of research into how pit vipers and other snakes see in both the color and infrared spectrums. His research in this field is helping humans create novel, highly sensitive infrared detectors and other devices for biomedical, industrial and defense applications.

His new research focuses on the vision of endangered tortoises and sea turtles as well as marine fish. Grace and other conservationists and scientists hope that a better understanding of

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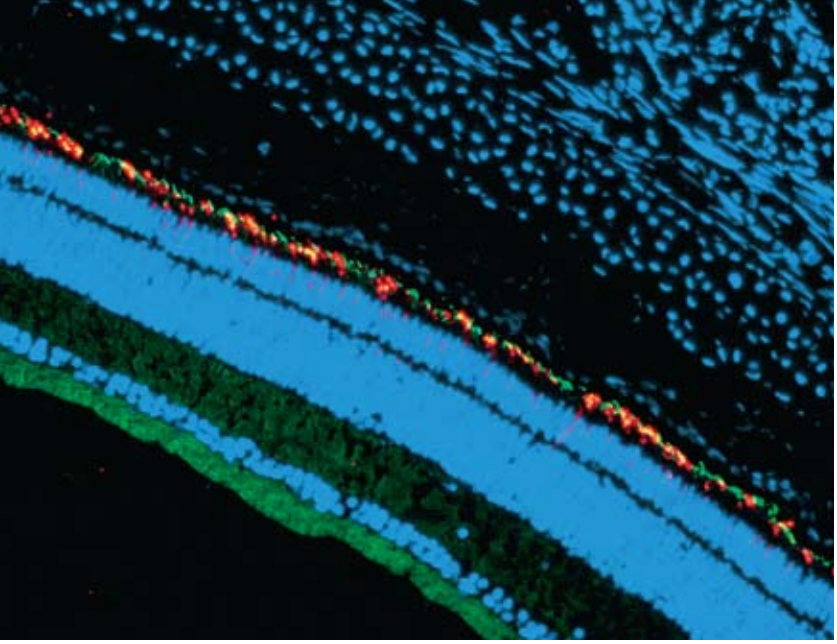

A cross-sectional slice through the retina, showing DNA in blue (each cell's nucleus is stained blue). The red is labeling opsin protein in rod photoreceptors (the cells that we use to see in dim light), and the green is labeling opsin protein in cone photoreceptors (the cells that we use in bright light and that give us color vision).

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how these animals see the world will allow for better conservation efforts on their behalf.

But the new confocal microscope has broad applications and is available to researchers and students across Florida Tech's many programs. Grace says it should "immediately benefit anyone studying how cells function, the organization of tissues and disorders such as cancer and Alzheimer's disease."

The confocal microscope differs from its counterparts in two key ways. First, it produces razor-sharp images by eliminating out of focus clutter in the foreground and background that is common to regular microscopes. Because of this, scientists can use the confocal to look at much thicker material. Grace says the new microscope's computer can set the image's Z dimension by .1 micron and produce a series of crystal clear images; these individual images can be merged into one single image or stacked into a 3D computer representation that can be viewed from any angle.

"If you have something to look at that has some thickness, you can see every level and not miss anything that may be important," says Grace. "It's like taking photos at the Grand Canyon. If you focus only on the front edge of the canyon, then you don't get a sense of the enormity of it all."

For Grace, the confocal's abilities become significant when viewing a retina.

Grace's research focus may lead to improved survival chances for endangered tortoises like the ones below.

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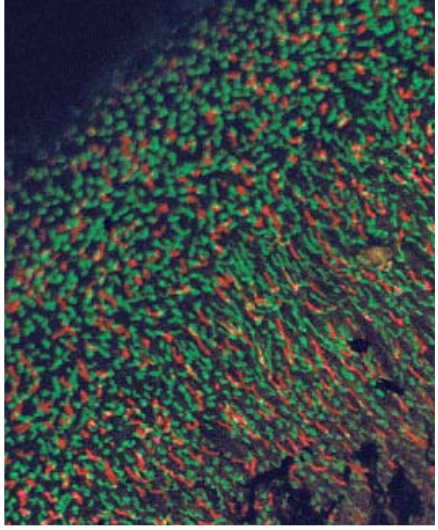

This image shows what is known as a retinal whole-mount. The images are looking down onto the surface of the retina of the African spurred tortoise and show the array of rod and cone cells (red and green, respectively) across the surface of the back of the eye.

The critically endangered Madgascan radiated tortoise is a close relative of the African spurred tortoise, the subject of some of Grace's confocal microscopy work. Grace's radiated tortoise colony is part of a collaborative research program between his lab, the Brevard Zoo and the Phoenix Zoo.

"Retinas are extremely complex," says Grace. "By using thicker slices, we are able to build a better understanding of the inner workings of vision."

This ability is already paying dividends, leading to an important early discovery in his research on endangered tortoises.

"In our research on endangered tortoises, we set out to learn if they have color vision and whether they can see in both daylight and at night," says Grace. "For over 100 years, scientists have believed that tortoises only have cones—meaning that they could see some color but that their vision was limited to daytime. We've discovered they also have rods, which means that they can also see at night and have a greater range of spectral sensitivity than long believed."

Grace believes this is important for conservation because vision is so important to turtles and tortoises. "Pollution and loss of favorite food items might have important effects on wild animals, and in captivity, the quality of light in which the animals are kept may affect their food choices, their nutrition," says Grace.

> "In our research on endangered tortoises, we set out to learn if they have color vision and whether they can see in both daylight and at night."
>
> *Michael Grace*

He expects more discoveries to come, and relatively quickly, through the new confocal microscope.

"The new microscope really helps us in three ways. It speeds up the research process, creates more aesthetically pleasing images for presentations and allows for more efficient analysis of the biochemistry and structure of the nervous system."

This analysis will be critically important to Grace as he moves forward in other research arenas. In addition to his work in sensory neurobiology, Grace is working with **Kunal Mitra**, Florida Tech professor of mechanical engineering, on laser-based systems to detect and treat cancers.

"We'll use the scope to study laser-tissue interaction. The hope is to create a process that will kill cancerous cells, spare healthy tissue and speed wound healing," says Grace. "Because the microscope has its own lasers, we can watch how tissue responds in real time."

And, thanks in part to the new confocal microscope, Grace and Mitra may soon be making life-saving discoveries in real time as well.

Jay Wilson

New Institute Becoming Global Leader in Information Security

Editor's Note: On May 20, 2008, Florida Institute of Technology broke ground on the Harris Center for Science and Engineering. The new 27,000-square-foot center will include at its heart the new Harris Institute for Assured Information. The new institute will build on the university's world-renowned research and academic program in computer security through an active partnership with Harris Corp., a world leader in assured communications.

Heading the new institute will be Richard Ford, Florida Tech associate professor of computer sciences. Ford, who earned a doctorate from the Queen's College at the University of Oxford, sat down with Discovery: Florida Tech to discuss the new institute.

Q: What will the priorities be for you as you transition into the new institute?

A: They're pretty simple, actually. The thing I think we do remarkably well at Florida Tech is incorporate pragmatic funded research into the undergraduate and graduate experience. There's a real synergy between what we teach and what we practice in the lab. Florida Tech's mantra is "High Tech with a Human Touch," and we're certainly going to embrace that in practice at the new institute. Our priorities are to preserve what's best about our current approach, apply a vision of next generation technologies and integrate them into the new institute to strengthen both our research and educational goals.

Artist's rendering of the new Harris Center for Science and Engineering.

Q: How does the emergence of this new partnership with Harris Corp. align with the institute's current and upcoming research initiatives?

A: The creation of the new institute is a case of perfect timing. In the last two years, we've been primarily working on a large grant from the U.S. Army related to the security of wireless networks. This research dovetails nicely with the work being conducted in computer security by Harris Corp. It's really a perfect fit and should provide a good win-win. Harris works on hard problems for specific pieces of the marketplace and provides an excellent technology transfer partner.

Historically, this partnership represents an evolution of what Dr. James Whittaker envisioned when he founded the Center for Information Assurance here a decade ago (Whittaker now works for Microsoft Corp.). With our new partnership with Harris, the theoretical research foundations will evolve to working examples for future systems.

Q: What is the impact of Harris Corp.'s imprimatur on Florida Tech's research efforts in computer security?

A: Our new partnership with Harris Corp. has given us the ability to do three really important things. First, we have our own dedicated physical space, which is important in our research because there are times we need to be disconnected from the university's network in an isolated environment. Second, we have financial support for students (*ed. note:* part of the $5 million gift that established the center will fund scholarships and fellowships). This is long-term endowment money that will enable us to attract the best and brightest minds to Florida Tech and fund an ongoing joint research program with Harris. Finally, we gain a Harris Chair in Information Assurance, which enables us to raise the profile of the institute in important peer circles.

Richard Ford, Florida Tech associate professor of computer sciences

Q: Describe the working relationship between yourself and other faculty members and the computer scientists at Harris Corp.

A: One of the best things with this (new partnership) is that my counterpart at Harris—Ronda Henning—has a good understanding of research and the ways of the academy. For my part, I have a decade's worth of experience working in industry. So, each of us is well-grounded in the other's world.

This insight helps us in two ways. First, it ensures that the research we conduct at the institute is highly relevant with immediate real-world applications. There's nothing worse than working a problem that is either irrelevant to customers or that is already solved. Second, it helps keep the faculty here very much aware of the skill sets that companies need from our graduates. This, in turn, will help us to assess our curriculum and adapt to market requirements. Florida Tech students are already in high demand among corporate recruiters—my goal with the institute is to make sure that demand increases.

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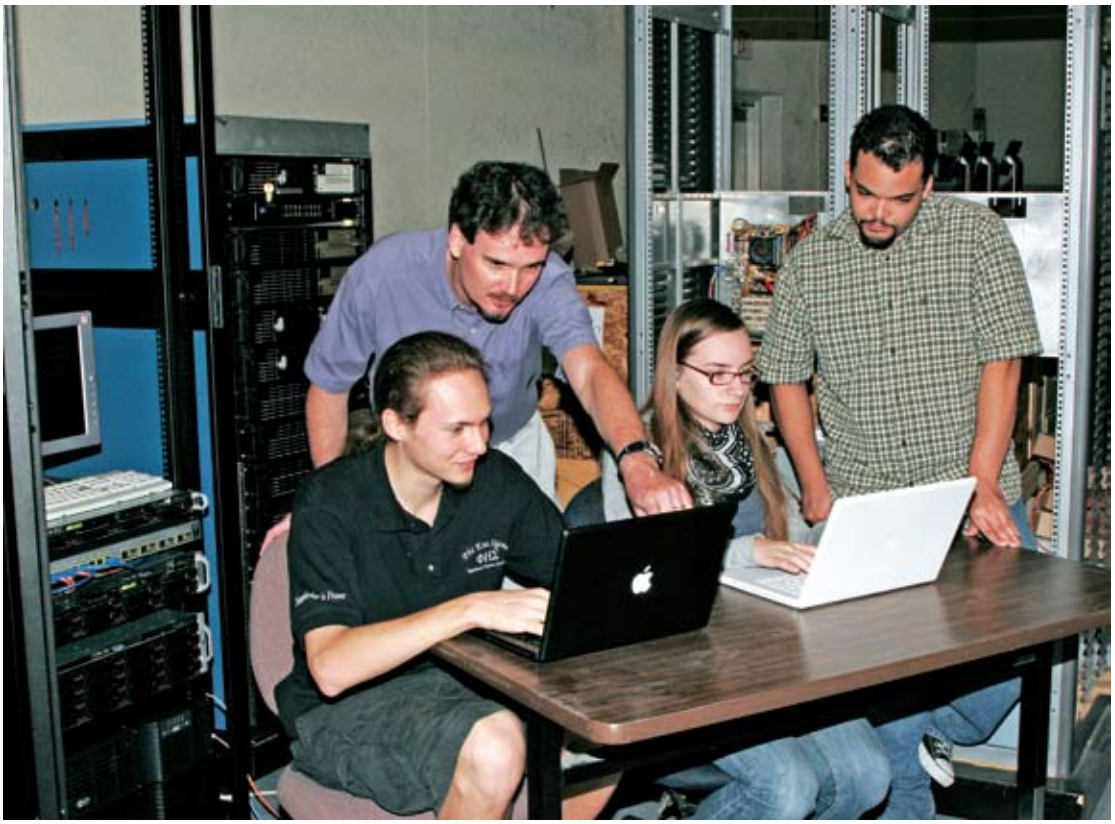

Marcus Hohlmann discusses with Patrick Ford the server software that operates the high-performance computing cluster in the High Energy Physics Lab that is shown in the background. Also pictured, Jennifer Helsby and David Peña develop a simulation for Hohlmann's Homeland Security project.When the simulations are complete, the team will shift its focus to developing readout software for the detector hardware.

Ask and You Shall Research

It used to be that undergraduates expected to spend the first two years fulfilling degree requirements before finally tackling their majors and the courses of real interest.

At Florida Tech, undergrads often dive into real-world research as early as their freshman year. Some students say all you need to do is ask.

"You have to seek out the research if you want to do it, but the opportunities are there," said **Andrea Cross**, a senior marine biology major.

In her freshman year, she volunteered in the aquaculture laboratory and soon was studying invasive catfish in Associate Professor **Jonathan Shenker**'s undergraduate research course. This led to a paid internship with the St. Johns River Water Management District, doing studies on wading bird ecology and collecting sea grass and water quality data.

This summer, Cross is continuing research on the retina of the African spurred tortoise in Florida Tech's Behavioral Neuroscience Laboratory. These studies already won her the Brooks Award for best research presentation at the regional conference of Tri-Beta, the biological honor society.

Cross' summer research is funded by a prestigious summer research fellowship she earned from the American Microscopical Society. She's using Florida Tech's prized confocal laser scanning microscopy and transmission electron microscopy capabilities to study the development of photoreceptor arrays in the retina of the reptile. A photoreceptor array is the collection of light-gathering cells of the eye.

Through microscopy, she and Associate Professor **Michael Grace** discovered the retina of a Geochelone tortoise contains rods. "All the papers we read before said rods cannot be present," said Cross. This research contradicts that and shows that these tortoises have greater spectral sensitivity than previously thought.

Andrea Cross, a senior marine biology major

"Once you understand how and what a tortoise can see, you can then understand how that influences behavior. Many of these tortoises are critically endangered, and this kind of information could enhance captive reproduction or increase understanding of human effects on habitats," she added.

Cross said she never dreamed she would be doing this kind of work as an undergraduate. "I've learned how to use all these great instruments and how to design experiments in class, which looks great on a résumé. A big part of what Florida Tech is about is hands-on research.

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Corporate Collaborations Key for Research Growth

The mandate for research growth at Florida Institute of Technology is a clear one, according to the university's vice provost for research, **Frank Kinney.**

"Our goal over the next 5–10 years is an ambitious one," he said. "But we firmly believe that we can increase research at Florida Tech threefold in this timeframe."

Part of Kinney's strategy to achieve this goal is manifested in the research office's outreach to companies throughout Florida and the nation. This outreach program is designed to build areas of research collaboration between the university and industry.

> "These collaborations enhance our ability to attract funding from state and federal agencies, they provide tangible economic benefits to the state of Florida, and they can lead to support to develop and enhance our research infrastructure."
>
> *Frank Kinney*

Kinney's reasoning, like his goal, is threefold.

"These collaborations enhance our ability to attract funding from state and federal agencies, they provide tangible economic benefits to the state of Florida, and they can lead to support to develop and enhance our research infrastructure."

Earlier this year, Florida Tech announced an agreement with Harris Corp. that Kinney believes is the model for future efforts. The new Harris Institute for Information Assurance (profiled extensively in this issue of *Discovery: Florida Tech*) will enable computer scientists at both Harris Corp. and Florida Tech to create new paradigms in computer security.

For Kinney, this is only the beginning.

"We're in consultation with a number of companies on a wide range of collaborative projects, including Siemens and Florida Turbine Technologies, just to name two," said Kinney. "I believe we'll be making many more announcements like the Harris one in the months and years to come."

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We have these opportunities because the class sizes are small; I know my professors."

And the professors know their students. Associate Professor **Marcus Hohlmann** has entrusted three department of physics and space sciences undergraduates with work on a contract from the Department of Homeland Security.

In the High Energy Physics Lab, senior **Jennifer Helsby**, junior **Patrick Ford** and May 2008 graduate **David Peña** have worked for two years on his project, that is funded so far at $818,000 by the Domestic Nuclear Detection Office (DNDO). Because the department of physics and space sciences has received substantial funded research contracts, faculty can pay summer salaries. This gives faculty members like Hohlmann continuity in their projects while the students benefit from a paycheck and enriching experiences.

"They're a very talented bunch," said Hohlmann. "I give them guidance, but they take their own initiative, which is exactly what you expect from a researcher."

The undergrads, with graduate students and a postdoc, have been investigating the use of subatomic particles for detecting hidden nuclear materials in cargo. The effort involves muon radiography. Muons are naturally produced by cosmic rays, which arrive from deep space and constantly bombard the Earth's atmosphere.

Hohlmann is applying a novel type of micro-pattern particle detector, a gas electron multiplier (GEM). The GEM was initially developed at CERN, the European Laboratory for Particle Physics near Geneva, Switzerland.

Peña, who was hired in June by the software company Intersil, began working for Hohlmann when he first came to Florida Tech. He, Ford and Helsby have built what may be the only high-performance computing cluster put together by undergraduates. Soon to become an official site on the national Open Science Grid, the installation will enhance Florida Tech's national visibility.

Peña values his Florida Tech hands-on experiences and said, "I think that pretty much anyone can go up to a professor and ask to work on a project. Most of my professors know me by name."

Ford agreed that it's "just as easy as asking," and added, "There are plenty of opportunities for undergraduate research but not many people take them. I love to build things and these projects are so hands-on."

Helsby, a senior, earned the first-place student award at the Florida Academy of Sciences annual meeting in spring 2008 for her oral presentation of this DNDO-funded research. She came to Florida Tech, she said, for the research opportunities.

"I started work with Dr. Hohlmann my second semester here," she said. "Now we're at the point where we are publishing papers. This may not have happened at a school with bigger classes and more students."

Opportunities for undergraduate research seem to abound among the university's sponsored research projects, currently valued at more than $33 million. Sometimes a student just needs to ask.

Karen Rhine

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Currently, RFIDs are used primarily to improve inventory tracking and management. Since January 2005, Wal-Mart has required its top 100 suppliers to use RFID tags on all shipments. Typically, the tag is placed on pallets or boxes, but not on each item inside. The U.S. Department of Defense has also published requirements for its vendors to use RFID tags on shipments.

The RFID tag resembles a small piece of tape and consists of an active chip powered by a battery that sends signals to a reader. The reader, either hand-held or fixed, sends a signal to someone walking down the aisle or to a computer system. If products are marked with RFID tags, stocking associates or vendors can travel throughout the store and receive a signal that alerts him or her to these items on the shelf.

Menezes came upon his idea to use RFIDs to market products after doing some research on practical uses for them. He asked, "Can I do more clever things with these, such as change the sales model in supermarkets—make you buy on impulse?"

He proposed the following scenario. A customer places a bottle of water in his or her shopping cart that is equipped with a reader and a display. The display can tell the customer in real time what brand is selling the most because it is reading what other people are buying too. If more people are buying a particular brand of water, it must be better than the others. So, the customer decides to buy that brand.

This scenario could work for all items in the store by revealing the hottest selling item in real time. Menezes said his model suggests that customers will swarm to the best-selling brand or product.

Ronaldo Menezes, Ph.D., is a computer scientist at Florida Tech.

This is similar to what Amazon.com is doing right now. When a person goes online to research a book, he or she gets information about what other books people have bought who inquired about the same book. Utilizing RFIDs in this way can drastically change advertising.

"The model seems to indicate we can probably sell the same amount of products without giving a discount," he explained.

Another potentially useful application for RFIDs would be to test the effectiveness of store display locations. When the vendor changes the location, did sales change?

"RFIDs, shopping cart readers and displays can make the shopping experience more rewarding," Menezes said. Of course, not everyone will agree. People who don't want their shopping habits revealed could opt out, but they would not be able to see what other shoppers are doing either. There is also room for improvement with the technology before it goes mainstream. RFID tags aren't all that efficient. Currently, they only have an 80 percent successful reading rate.

It's really all about using technology and mathematical models to make life easier. "How can I use this to make life easier," Menezes said.

Melinda Millsap

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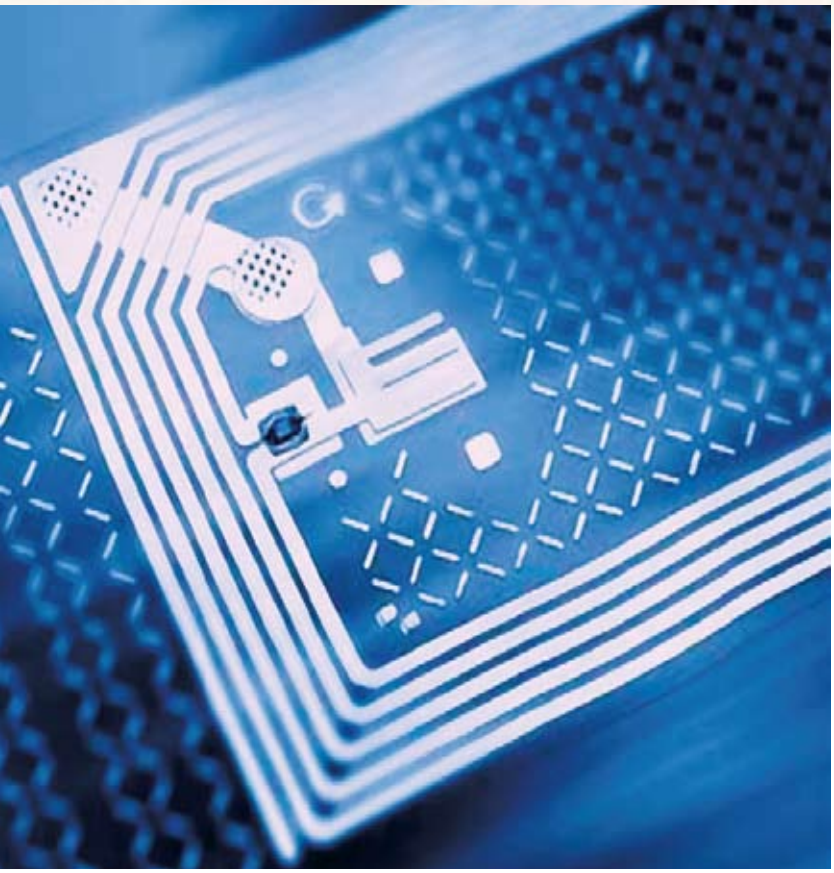
Q: What impact will the new institute have in defining Florida Tech's place in the world of computer security?

A: This collaboration builds on the already solid foundation we have and expands to address the needs of the local community. We will now be bringing internationally renowned speakers to campus, forming an ISSA chapter and luring excellent new faculty and students to our doors. This benefits not only Florida Tech and Harris, but the whole county. Most talks are open to the public, and one of our near-term goals is to work out how to better serve the high-tech community of Brevard in general. Much of the work we do is already synergistic with the needs of other local employers. The new institute will only add to that.

On a national scale, the legacy left by Whittaker was a strong one and is a foundation upon which we continue to build. The new building, coupled with Harris' expertise and contacts, will allow us to host national workshops in the new facility. This is an ability we have not previously had, and the possibilities are pretty exciting.

Overall, it's hard to really predict the ultimate effect the institute will have. The bottom line, however, is that we're all excited—everything is aligned for an incredibly fun ride ahead. We can solve real problems, research new technologies and grow the local technology community at the same time. It's a unique opportunity for Harris and Florida Tech.

Researcher Combines Swarming Mentality and Technology to Entice Shoppers



Radio-Frequency Identification (RFID) tags help shoppers find the best deals and make inventory control much easier for the merchant.

It's human nature for people to swarm to an area where they see a crowd forming. That's the premise behind **Ronaldo Menezes**' recent research that uses Radio-Frequency Identification (RFID) tags to help shoppers find the best deals.

The Florida Tech associate professor in computer sciences suggests using RFID tags on individual products and equipping customers with high-tech shopping carts so they can see what others are buying.

Shoppers are naturally curious and inclined to buy a product if they see other people swarming to it. It must be a good deal if other people are buying it, right?

The first step to this high-tech shopping experience is to replace bar codes with RFID tags. Menezes said this makes sense because RFIDs are more useful. They hold more information, making the items easier to track. Shopping and inventory control would be much easier with RFIDs.

"For example, you buy a can of Diet Coke, the bar code identifies that the product is 'a can of Diet Coke,' but does not tell the shopper which can among all the cans you purchased. This is what a RFID will be able to tell," Menezes said.

With RFIDs, retail managers can quickly spot items that are outdated or need to be recalled. "For perishable products, such as bread and cheese, this is quite important because the RFID has the information about the specific loaf of bread, when it was baked and its 'best before' date," Menezes added.

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