2013

Advancing Technology to New Heights

ANNUAL REPORT

Georgia Tech | GVU Center
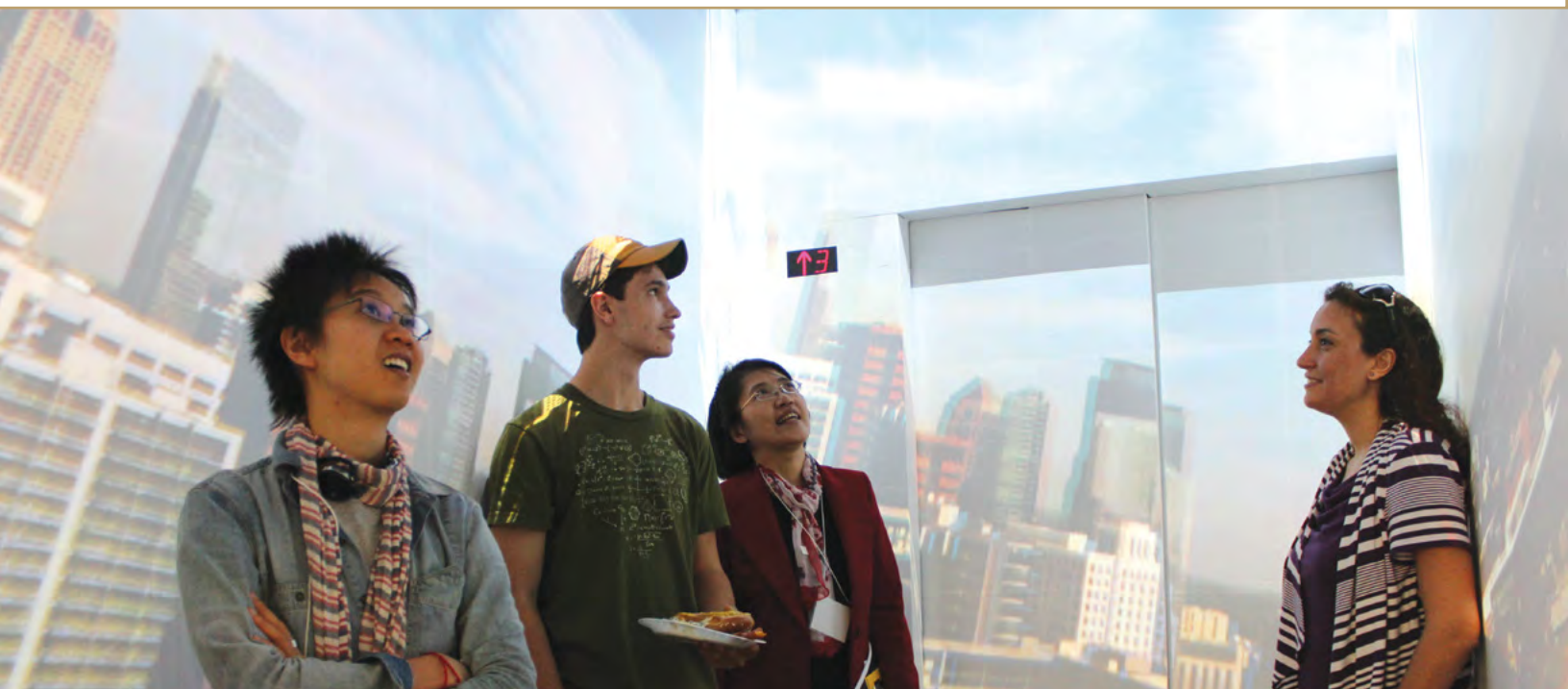
MESSAGE FROM THE DIRECTOR

The GVU Center is pushing the boundaries of how people interact with technology. From pioneering innovations in wearable computing, to new methods for enhancing computational literacy, to technologies that enhance creativity, GVU researchers are empowering people through technical innovation. Over its 22-year history, the GVU Center has always brought together researchers across disciplines. Starting from core domains such as computing, psychology, and architecture in the 1990's, GVU now brings together researchers from public policy, international affairs, transportation engineering, industrial design, and more: crossing disciplinary boundaries is a core part of what we do.

I hope the news highlights in this report give you a sense of the work going on in the GVU Center, and the potential for impact it has on the world. If you're an alum or friend of GVU, I'd like to invite you to reconnect. If you're an industry partner –or potential industry partner– I invite you to contact me to learn more about the innovation going on at GVU, and how we can partner with industry to provide cutting edge insight into real world problems.

Keith Edwards
Director, GVU Center

GVU 20TH ANNIVERSARY CELEBRATION HIGHLIGHTS

Pictured Left to Right: Presenter Keith Edwards, Doug Bowman, Renata Le Dantec, Vivian Chandler, Mike Pinkerton, Jason Freeman, Beth Mynatt, Don Schoner, Thad Starner, Greg Turk, Aaron Bobick, and Richard Catrambone. (Not pictured: Shwetak Patel)

▶ gvu.gatech.edu/impact-awards

In October 2012, the GVU Center celebrated its 20th anniversary, with a day-long symposium, student-led art commissions, research showcase, and more.

As part of this celebration, the center honored and celebrated the contributions of a handful of passionate, skillful, and committed individuals through the **GVU Impact Awards**. Each of the recipients have played a key role in GVU's growth, and embodies the interdisciplinary mindset and commitment to real-world impact that is a hallmark of GVU's identity.

RESEARCH LABS

Commitment to Innovation in the Research Enterprise: Labs are more than just space at GVU – they are where the ideas of today are shaped into the technology of tomorrow.

App Lab Hackerspace for mobile innovation and exploration, industry talks, marathon programming and workshops.

Prototyping Lab Makerspace available for students to fabricate physical objects for research: includes 3D printers, laser cutters, circuit mills, and more.

Usability Lab Dedicated lab set up for usability studies, including two-way mirrors, cameras, and more.

Learn more about these labs at:

▶ gvu.gatech.edu/connect-with-us

Tangible Anchoring explores potential practices for data gathering, analysis, and news reporting afforded by the convergence of tabletop computing, mobile user-generated content, the Web, and broadcast media channels.

About the Cover

For the GVU Center's 20th Anniversary, a young talented team of Digital Media researchers created a live view of Midtown Atlanta inside a windowless elevator in the Technology Square Research Building, evoking the feeling of a hot-air balloon ride.

Watch the documentary at:
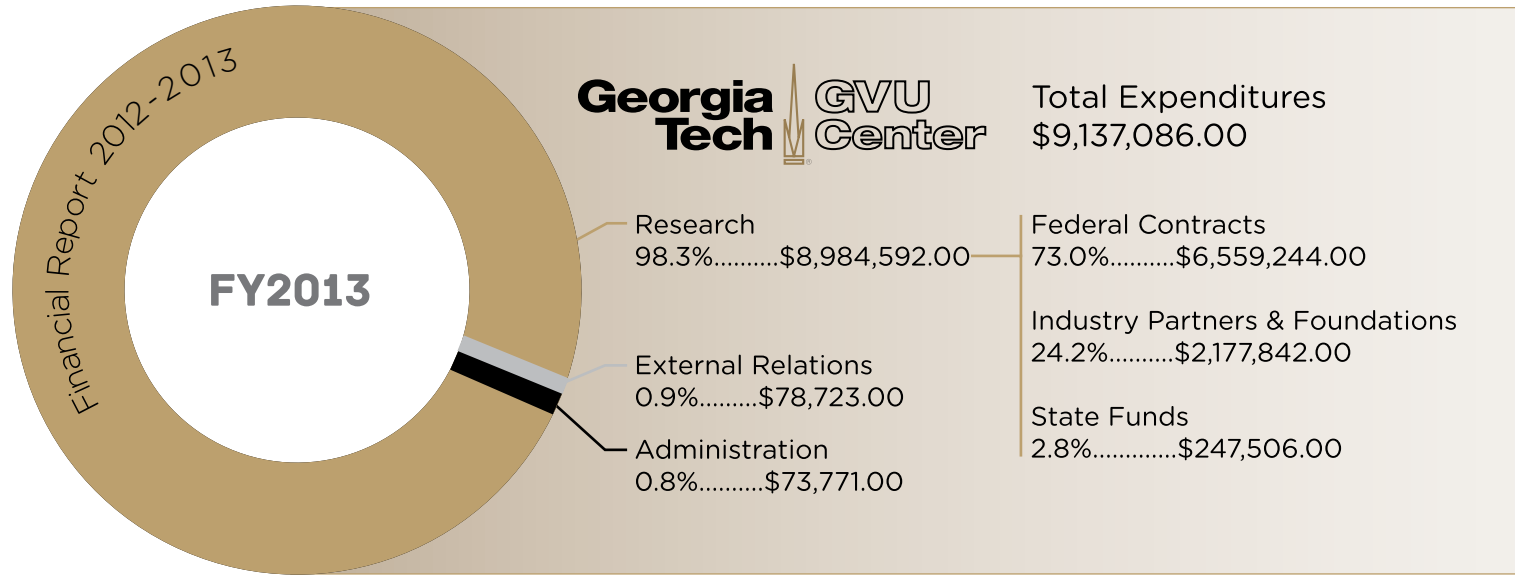
▶ gvu20ascent.weebly.com

GVU RESEARCH SHOWCASE

Experience one of the most hands-on research events Georgia Tech has to offer. The biannual GVU Research Showcase, taking place in the fall and spring, allows attendees to try out many technologies that give a glimpse of the future of interactive computing. Apps and innovations in **wearable computing**, healthcare, social networking, education and civic engagement are only a few of the experiences that are offered.

Financial Report 2012-2013

FY2013

Georgia Tech | GVU Center

Total Expenditures
$9,137,086.00

Research
98.3%..........$8,984,592.00

External Relations
0.9%.........$78,723.00

Administration
0.8%..........$73,771.00

Federal Contracts
73.0%..........$6,559,244.00

Industry Partners & Foundations
24.2%..........$2,177,842.00

State Funds
2.8%.............$247,506.00

FOLEY SCHOLARS 2012-2013

The James D. Foley GVU Center Endowment supports students and research activities of the GVU Center, and it funds the Foley Scholars Fellowships, awarded annually to two graduate students based on the vision and potential impact of their research. To learn more about the Foley Endowment or to give go to gvu.gatech.edu/foleyscholars.

Andrew Miller, a PhD candidate in Human-Centered Computing, studies social systems that encourage students to get more physical activity throughout the day. Miller's system, called Stepstream, is a social network site for middle school students to share and encourage everyday lifestyle activity.

PhD DM alumna Jill Fantauzzacoffin focused her graduate research on artwork installations incorporating high technology and interactivity. Her artwork has spun off a series of haptic (touch-based) technologies that hold promise in the cell-phone and videogame controller industries as well as in therapeutic textiles addressing SIDS and PTSD.

Photo (Left to Right): GVU Center Director Keith Edwards, Andrew Miller, Jill Fantauzzacoffin, and James Foley

▶ gvu.gatech.edu/2012-foley-scholars

On-Demand Video of World Experts in Interactive Computing

Georgia Tech | GVU Center
Brown Bag Seminar Series

The GVU Brown Bag Series is available on-demand with more than 100 hours of research insight and technology leadership from renowned technology leaders from across campus and around the world. As one of the longest continuous seminar series at Georgia Tech, the GVU Brown Bags bring together faculty and students at Georgia Tech to experience new research and open new opportunities for collaboration.

2013 GVU
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▶ gvu.gatech.edu

Across Georgia Tech, computing is a key enabler in advancing innovation and solving long-standing societal challenges. The GVU Center nurtures its community of researchers and risk takers to help solve these challenges and create pathways to the new technologies that will advance our lives.

By partnering with and supporting our community in pioneering new technologies, the GVU Center seeks to advance computing's preeminence in the research enterprise.

New Computing Education Model Applied to Mobile App Development

GVU researchers are employing cutting-edge education research to teach programming novices how to create mobile apps using Android App Inventor. Using instructional materials that they labeled with subgoals, PhD Engineering Psychology student **Lauren Margulieux** (pictured), Professor **Mark Guzdial** (pictured, Interactive Computing) and Professor **Richard Catrambone** (Psychology and Interactive Computing) designed the approach so that students could easily create mental models that reduce cognitive overload and advance student computing knowledge. Their results show that using subgoals, students outperform a group not using the subgoal method on several programming competency measures.

Gaze-tracking and Facial-analysis System Advances Autism Studies

A novel computational application for automatic detection of eye contact by children is advancing the study of autism by helping categorize problem behaviors. Through the Center for Behavior Imaging, Regents' Professor **Gregory Abowd** and Professor **James Rehg** (Interactive Computing) are using a system that combines special gaze-tracking glasses and facial-analysis software to identify when a child makes eye contact with the glasses-wearer.

Children at risk for autism might be reluctant to make frequent or prolonged eye contact. A video of a child interacting with an adult was captured by a camera (mounted on the glasses and worn by the same adult). After the video was processed with facial recognition software, the system was able to detect eye contact in the test interaction with a 22-month-old with 80 percent accuracy.

Augmented Reality Enhances Mobile Game Design

NerdHerder is a new type of mobile gaming experience, created to explore how augmented reality can combine physical actions and a mobile phone-based interface. The game contributes new design patterns for mobile, augmented reality gaming, and provides a platform for user studies that further contributes to player interactions and experiences. MS HCI alumnus **Sam Mendenhall**, Associate Professor **Blair MacIntyre** (pictured, Interactive Computing) and Assistant Professor **John Sharp** (Literature, Media and Communication), along with other team members, led the development of Nerdherder, which is now available in both the iOS and Android app stores.

Creating Computing Competency through Music

EarSketch, a computational music creation and remixing software, has been developed by GVU researchers as a new way to teach high school and introductory college computing education curricula. It teaches students computing principles through music composition and collaboration and seeks to engage high schoolers, especially minorities and females, in computing disciplines. Created by Associate Professor **Jason Freeman** (pictured, Music) and Assistant Professor **Brian Magerko** (Literature, Media and Communication), EarSketch utilizes the Python programming language and Reaper, a digital audio workstation program similar to those used in recording studios throughout the music industry. Students remix samples and loops to create their own tracks. Earsketch faculty have partnered with Gimel "Young Guru" Keaton - who has engineered 10 albums for hip-hop superstar Jay-Z - to create new audio content for the program.
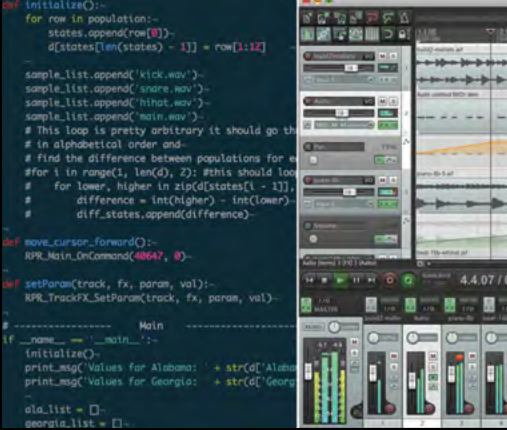
Public Design for Sustainable Food Industries

A concept called "public design" was put into action in spring 2013 to conceptualize and prototype new uses of information and communication technology in support of local food issues and food systems. Associate Professor **Carl DiSalvo** (pictured, Literature, Media and Communication), with PhD Digital Media candidate **Thomas Lodato** and PhD International Affairs student **Amanda Meng**, co-organized the first Atlanta Food Data Hack to help farmers, computing researchers, business leaders and designers to evaluate technology solutions to food challenges. Attendees explored ways that digital media could be used to support local food initiatives and to grow a community of producers committed to open government. DiSalvo's Public Design Workshop, a research studio at Georgia Tech, is taking the food concepts and further developing them through public design experiments.

Creativity Support for Novice Digital Filmmaking

PhD HCC student **Nicholas Davis** (pictured) is helping novice filmmakers create better movies. Davis developed a digital tool for moviemakers who use machinima, a new form of creative digital filmmaking that uses real-time graphics rendering via computer game engines. The research team, including Associate Professor **Michael Nitsche** (Literature, Media and Communication) and Assistant Professor **Mark Riedl** (Interactive Computing), explored whether or not novice machinima creators benefit from creativity support tools. Their work shows that novices generally have difficulty adhering to cinematographic conventions. The results identified four conventions novices typically violate. Researchers subsequently used a rule-based intelligent system that can reduce the frequency of errors that novices make by providing information about rule violations without prescribing solutions.
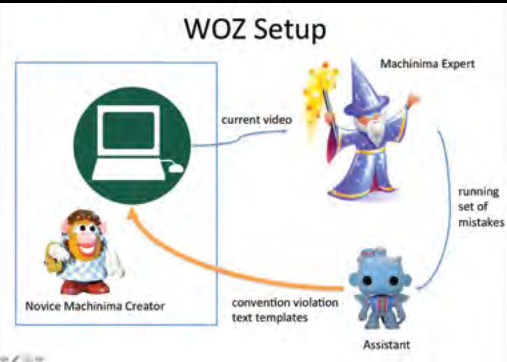
New Technology Network Helps Older Adults Stay Independent

Senior Research Engineer **Brian Jones** (pictured, Interactive Media Technology Center), director of the Aware Home Research Initiative, helped launch the Georgia Tech HomeLab, a new effort designed to support companies in evaluating in-home use of emerging health technologies. HomeLab will assist companies by advancing a statewide network of adults, 50 years of age and older, to evaluate the in-home usability and effectiveness of consumer products designed for the aging adult population. These adults will outfit their homes with products to help them live healthy lifestyles, manage chronic conditions and remain connected with their caregivers. The Aware Home will be a testbed for some products before they are installed in participants' homes.

How to Get More Followers on Twitter

Looking at a half-million tweets over 15 months, a first-of-its-kind study of Twitter revealed reliable predictors for building a base of followers on the service. The research, performed by PhD HCC student **C.J. Hutto**, Assistant Professor **Eric Gilbert** (pictured, Interactive Computing), and PhD HCC alumna **Sarita Yardi**, determined several useful tactics: Don't talk about yourself – tweeting informative content has an impact that is 30 times higher than the effect of tweeting content about the tweeter; Be happy - Twitter is mainly based on weak social ties, so stay away from negative posts; and limit hashtags - hashtag abuse can impede the message. Hutto, Gilbert, and Yardi explored relative effects of social behavior, message content and network structure and showed which of these factors has more influence on the number of Twitter followers.

Musical Robot Companion Enhances Listener Experience

Shimi, a musical companion developed in the Center for Music Technology and revealed at the 2012 Google I/O Conference, recommends songs, dances, and finds music based on user tastes. Developed by Professor **Gil Weinberg** (pictured, Music) and other collaborators, including those from the Media Innovation Lab at IDC Herzliya, Shimi is a smartphone-enabled, one-foot-tall robot that gains the sensing and musical generation capabilities of a user's Android phone when docked to it. Using the phone's camera and face-detecting software, the bot can follow a listener around the room and position its "ears," or speakers, for optimal sound. If the user taps or claps a beat, Shimi analyzes it, scans the phone's musical library and immediately plays the song that best matches the suggestion.

## Spindex Improves Auditory Menu Acceptance and Navigation Performance

Research in the Georgia Tech Sonification Lab investigated how advanced auditory cues enhance menus on a smartphone through tapping, wheeling, and flicking input gestures. PhD Psychology alumnus **Myounghoon "Philart" Jeon** and Associate Professor **Bruce Walker** (pictured, Psychology and Interactive Computing) developed the technique using a spindex (speech index) in which audio cues provide feedback to users about where they are in a menu. Their work demonstrates how to reduce both target search time and subjective workload using spindex, regardless of visual display mode.

A Text Message A Day Keeps the Asthma Attack Away

Using a system created by PhD HCC alumnus **T.J. Yun** (pictured) and Senior Research Scientist **Rosa Arriaga** (pictured, Interactive Computing), pediatric asthma patients received interactive information about their symptoms via SMS text messages. Patients showed improved pulmonary function and a better understanding of their condition within four months, compared to other groups. Yun and Arriaga's findings suggest that text messages acted as an implicit reminder for patients to take their medicine, and also led children to be more knowledgeable about their illness. The results of the research could lead to advances in using mobile devices to improve health and wellness.

Arriaga and Yun at CHI2013
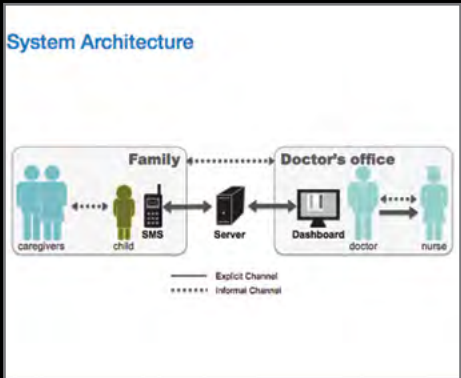
Squirrels and Birds Inspire Researchers to Create Deceptive Robots

Using deceptive behavioral patterns of squirrels and birds, Regents' Professor **Ron Arkin** (pictured, Interactive Computing) and his team have developed robots that are able to deceive each other. The researchers learned by reviewing biological research results that squirrels gather acorns and store them in specific locations. The animal then patrols the hidden caches, routinely going back and forth to check on them. When another squirrel shows up, the hoarding squirrel changes its behavior. Instead of checking on the true locations, it visits empty cache sites, trying to deceive the predator. Arkin and PhD ECE student **Jaeeun Shim** implemented the same strategy into a robotic model and demonstration. The deceptive behaviors worked, and the deceiving robot lured the "predator" robot to the false locations, delaying the discovery of the protected resources.

FIDO - Facilitating Interactions for Dogs with Occupations

Working dogs, whether assistance, medical, or military dogs, must communicate with their human handlers, and Georgia Tech is leveraging the extensive experience of its researchers in wearable computing to enable new ways humans and animals can share information. Associate Professor **Melody Moore Jackson** (pictured) and Professor **Thad Starner** (Interactive Computing), along with Research Scientist **Clint Zeagler** (Industrial Design), have created the Inter-species Interaction Lab to establish Georgia Tech as a pioneer in the little-explored space of Animal-Computer Interaction. Their current project, FIDO or Facilitating Interactions for Dogs with Occupations, allows canines to learn distinct commands and then pull on a certain part of a sensor-embedded vest worn by the dog and associated with that command, allowing the dog to communicate more effectively with its human handler.

'Big Data' Algorithm Used to Customize Video Game Difficulty

Researchers in the Entertainment Intelligence Lab have developed a computational model that can predict video game players' in-game performance and provide a corresponding challenge they can beat, leading to quicker mastery of new skills. PhD HCC student **Alex Zook** (pictured) and Assistant Professor **Mark Riedl** (Interactive Computing) created their model using collaborative filtering, a popular technique employed by Netflix and Amazon in product ratings and recommendations. While Netflix recommends movies, the gaming model recommends the next challenge for players, adjusting game difficulty by computationally forecasting in-game performance. The approach, which can scale to tens of thousands of users, takes participant scores and applies algorithms that predict how others with similar skill sets would perform and adjusts the difficulty accordingly.

StoryMap Tracks TV Narratives with Second Screen

An iPad prototype app called StoryMap, and developed in the Experimental Television Lab, is a second-screen companion designed to keep TV viewers oriented to fictional worlds, remind them of plot threads, and allow users to review important story sequences across episodes. Using the iPad's digital interface, Professor **Janet Murray** (pictured, Literature, Media and Communication) and her team created navigation patterns and auxiliary information streams to minimize confusion and maximize immersion in the story world. The tablet app enables viewers to access the multi-episode story arcs of long-form TV series without confusion or distraction. A context-sensitive character map, with explanatory icons, text annotations, and video summaries are offered in close synchronization with specific scenes and dialog references.

INVENTING THE FUTURE OF
WEARABLE TECHNOLOGY

Wearable technology isn't new if one considers prescription glasses or the mechanical wristwatch, and consumers for years have accessorized with devices such as portable music players and pedometers. Within the last decade, advanced computing has made smartphones and other mobile devices indispensable for work and leisure.

Now, a new entrant in wearable innovation has arrived in the form of Google Glass, an eyeglasses-styled device that arguably seeks to redefine the capabilities of this class of technology. The new wearable hardware is defined in part by its potential to create instantaneous access to a networked world in unprecedented ways.

The GVU Center at Georgia Tech has been at the forefront of research in wearable computing for more than a decade; in fact, innovations at GVU have led directly to the new forms of wearable computing exemplified by Google Glass. **Thad Starner** (pictured), a professor in Georgia Tech's School of Interactive Computing, is a technical lead on Google Glass.

Starner envisions a wearable world, having worn head-mounted computing prototypes since his pioneering research in the 1990s. He is now advancing the adoption of his lifelong professional work in wearable computing by enabling researchers nationwide to develop applications for Google Glass.

An application developed in Starner's own Contextual Computing Group at Georgia Tech has been customized for Glass to leverage the power of the futuristic headset. Re-envisioning the SmartSign app, which lets parents of hearing-impaired children learn sign language, Glass puts sign language lessons right in the user's field of vision as frequently as the virtual tutor on the screen is needed.

Today Georgia Tech remains at the forefront of wearable computing research. Glass devices are being used for a variety of innovative research projects across the GVU Center and Georgia Tech, in partnership with Google and other industry leaders. Applications ranging from health and wellness, to assistive technologies, to transportation, to gaming are being led by some of the research community's most innovative thinkers to advance the vision of always-available computing promised by this wearable technology.

Find out more about GVU's research with Google Glass at:

▶ gvu.gatech.edu/glass

◎ gvu.gatech.edu   f facebook.com/gvucenter   🐦 twitter.com/gvucenter

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GVU RESEARCH AND ENGAGEMENT GRANTS 2012-2013

The CycleTracks app tracks the existing routes of cyclists using their smartphones and allows comparison of these routes to the quickest path from origin to destination. *Kari Watkins (pictured left, Civil Engineering) and Chris Le Dantec (pictured right, Literature, Media and Communication)*

Campus driving simulation and research is focused on creating methods and conversion processes to allow any 3D model to be integrated into driving simulators used for in-vehicle research. *Bruce Walker (Psychology and Interactive Computing) and Racel Williams (Architecture)*

Computational play explores robots as peers to humans, interactivity, open-ended tasks, and evolving social roles of robots. *Brian Magerko (Literature, Media and Communication), Andrea Thomaz and Mark Riedl (Interactive Computing)*

Collaborative analysis of DMITRI project data addresses challenges of analyzing data for diabetes management for adults by applying expertise in pattern recognition and wearable sensing to identify correlations and patterns in the dataset. *Thad Starner (Interactive Computing) and Nate Heintzman (Biomedical Informatics, UCSD Dept. of Medicine)*

▶ gvu.gatech.edu/2012-research-and-engagement-grants