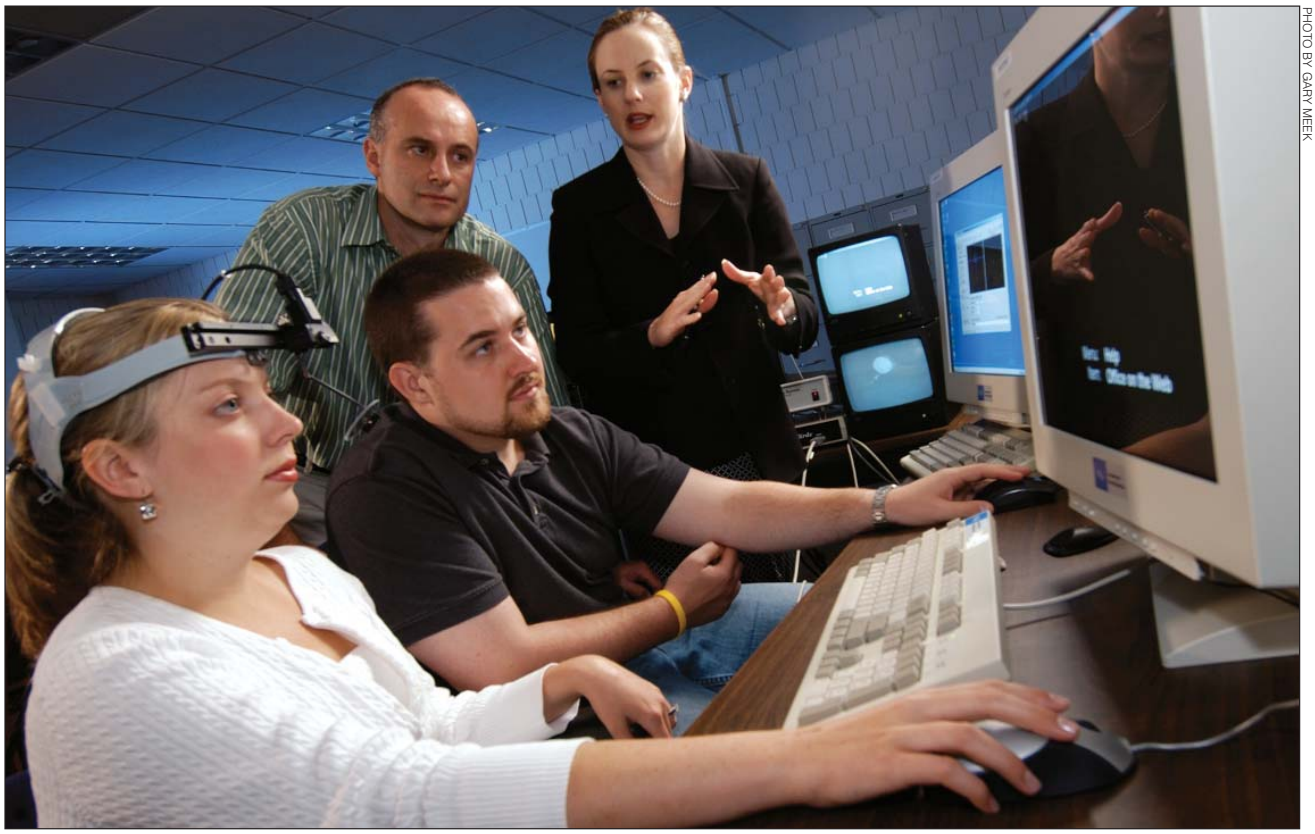


PHOTO BY GARY MEEK

*Above: In their experiments, researchers use a tracking apparatus that captures eye movements at a rapid rate. Seated are graduate students Katie Emery and Kevin Moloney. Standing are Professors François Sainfort and Julie Jacko.*

# One Size Doesn't Fit All

## *Software under development would customize graphics-based computerinteraction for people with low vision.*

BY JANE M. SANDERS

**@ Georgia Tech researchers are designing software that measures the capabilities of computer users with low vision and automatically customizes computer graphical user interfaces (e.g., file and folder icons, drop-down menus) to provide greater accessibility.**

In the prime of her life, Virginia Jacko began gradually losing her vision to a disease called retinitis pigmentosa. The disease forced Virginia, now 62 and completely blind, to leave her high-profile job several years ago.

But with considerable determination and energy, she has learned to adapt with help from her guide dog "Tracker" and her innovative daughter, who has made a career out of improving the quality of life for people with uncorrectable visual impairments.

Virginia's daughter is Julie Jacko, an associate professor in the Georgia Institute of Technology's School of Industrial and Systems Engineering (ISYE). An expert in human-computer interaction, Jacko was moved by her mother's experience to create software that measures the capabilities of computer users with low vision and automatically customizes computer graphical user interfaces (e.g., file and folder icons, drop-down menus) to provide greater user accessibility to the tens of millions of people who need it.

Virginia's condition is too advanced to benefit from the software Jacko and her colleagues are developing; she must use a speech interface to interact with her computer. But for others suffering from disease-related vision loss, the researchers hope to provide new options within the next couple of years. (See Virginia's story at **www.gtresearchnews.gatech.edu/reshor/rh-f04/virginia.html**).

They are developing customizable software that will provide visually challenged computer users with multiple feedback mechanisms, such as auditory and haptic (touch-related) cues. This information will allow them to interact with traditional and handheld computers using the graphical interfaces that most people use.

"Generally, most feedback from a computer is visual," Jacko explains. "But people who are visually impaired need other types of feedback to supplement this. For example, a haptic mouse provides vibratory cues when a user moves closer to a target on the screen. Or the user might hear a sound and feel a vibration as they move the cursor closer to a file."

Both auditory and haptic feedback may increase or decrease in intensity depending on the user's movements around the screen. "In our experiments, we are manipulating the variables to determine which combination is best for people with different types of capabilities," she says.

Jacko began this research with a National Science Foundation (NSF) Career grant in 1997 while at the University of Wisconsin-Madison. Subsequently, a prestigious Presidential Early Career Award for Scientists and Engineers (PECASE) grant from NSF extended Jacko's research and involved her colleague and husband ISYE Professor François Sainfort as a collaborator with expertise in health and decision support systems. The couple brought the project to Georgia Tech when they joined the faculty in 2000. Since then, they have received additional NSF support, as well as funding from the Intel Corporation.

The researchers initially focused on age-related visual deficits, specifically age-related macular degeneration (AMD), which is characterized by central vision loss, while peripheral vision remains relatively intact. The researchers have since expanded their study to include people with other eye diseases, including retinitis pigmentosa, which usually begins with peripheral vision loss followed by central vision loss, and diabetic retinopathy, which affects people of all ages. Diabetes-related vision loss is variable and unpredictable, which presents unique challenges in adapting computer interfaces, Jacko notes.

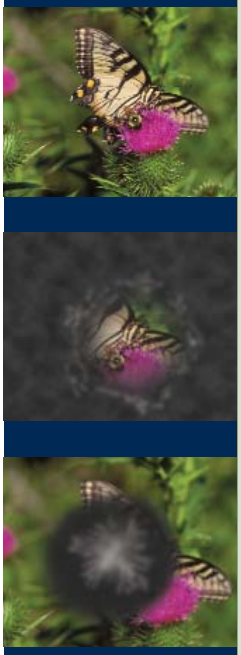
Jacko and Sainfort have also broadened their research beyond a study of just manipulative computer tasks. Their experiments now capture subjects' eye movements so they can understand the behavior and strategies people employ when using a computer, or even a personal digital assistant (PDA).

"We want to know how a patient's eye movements vary depending upon the type of ocular pathology they have and their resulting functional capabilities," Jacko explains.

In their experiments, researchers use an eye-movement-tracking apparatus to capture eye movements at high frequencies (60 to 100 Hertz). Subjects may wear a head-mounted optical apparatus or be monitored by a remote optical device that allows researchers to capture pupil and corneal reflection and pupil diameter.

Researchers track the subjects' pupil diameter because research elsewhere shows it is a physiological indicator of cognitive workload in people with normal vision. Pilots, for example, exhibit changes in pupil diameter in response to the complex operations they perform.

"We want to understand pupil behavior in people with visual pathologies," Jacko says. "For example, people with diabetic retinopathy sometimes exhibit aberrant pupil behavior.



ORIGINAL PHOTO COURTESY U.S. FISH & WILDLIFE SERVICE. PHOTO ILLUSTRATIONS BY EVERETT HULLUM

*People with normal vision see the full image of the butterfly. But the vision of people with retinitis pigmentosa (middle) and age-related macular degeneration is obscured as depicted in these simulations.*

GEORGIA TECH FILE PHOTO

*Test subject Bess Kronowitz participates in an experiment using prototype software developed at Georgia Tech.*

"It will be wonderful someday if people with low vision can sit down and their computers adjust to their level of vision."

— **Virginia Jacko,** accessibility advocate for people with low vision

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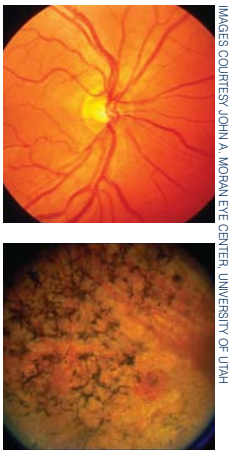
People with AMD exhibit relatively normal pupil behavior, but compared to people without AMD, you see clear trends with respect to the way the pupil responds to information on a computer screen."

With the statistical expertise of ISYE Professor Brani Vidakovic, Jacko and Sainfort are analyzing the pupil data they have collected in their experiments. The researchers have successfully demonstrated new tools for analysis of complex pupil response data from people who are aging and/or have visual impairments.

The researchers' goal is to create a commercially available software program that analyzes pupil and other data in real time and then adapts computer interfaces as needed by the user. They have constructed a prototype based on experimental data from about 200 subjects — including Jacko's mother — with uncorrectable visual impairments, as well as normal vision. The subjects ranged in age from 60 to 90.

In addition to directing the software design, these experiments have yielded guidelines for the interaction of visually healthy older adults and their computers. "We've learned we could supplement their display with specialized auditory feedback that may enhance their computer performance," Jacko notes.

A grant from the NSF Integrative Graduate Education and Research Training (IGERT) program to Professor Marie Thursby in the College of Management has enabled Jacko's Ph.D. student Katie Emery to work with Georgia Tech management students and Emory University law students on a business proposal for a commercially viable software product. This has led to a proposal for a Small Business Innovation Research grant. If funded, this work could lead to patent applications and the establishment of a start-up company within two years, the researchers say. The final product could be integrated into the Microsoft Windows operating system.



IMAGES COURTESY JOHN A. MORAN EYE CENTER, UNIVERSITY OF UTAH

*These images show the differences between a normal retina (top) and one diseased with retinitus pigmentosa.*

"It will be wonderful someday if people with low vision can sit down and their computers adjust to their level of vision," Virginia says. "The programming technology is there…. Now, Julie's work is using low-vision subjects to guide the interface design work and test it."

@ **Read more at: gtresearchnews.gatech.edu/reshor/rh-f04/low-vision.html**

IMAGE COURTESY VIRGINIA JACKO

*Virginia Jacko lost her vision to a disease called retinitis pigmentosa. But she has learned to adapt with help from her yellow Labrador retriever guide dog "Tracker" and her innovative daughter, who is leading development of software that will provide visually challenged computer users with multiple feedback mechanisms.*