



There's No Place Like

HOME

Future computing technologies will allow senior adults to live independently longer.

by JANE M. SANDERS

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Arthur was in great condition for a man of 91 years, but age had begun to take its toll on his short-term memory.

Arthur would start to cook a meal in his farm home, and the phone would ring. Forgetting he had something on the stove, he would start watching television. Then the smoke alarm would go off, alerting Arthur to a burning saucepan of food. This scenario

repeated itself enough times that Arthur's son, Bill, became concerned for his father's safety.

Bill carefully suggested the idea of moving to an assisted living facility, realizing the expense, but trading it off for peace of mind and safety. There, Arthur would have his own apartment, but not have the responsibilities of cooking and cleaning. He would have people nearby to help in an emergency and to socialize with every day. Arthur agreed and now seems happy in his new home. Bill is relieved that his father is close by and that Arthur is eating nutritious meals prepared by a professional cook.

Arthur is one of more than 35 million Americans over age 65. Many of them are facing or will soon face the same issue



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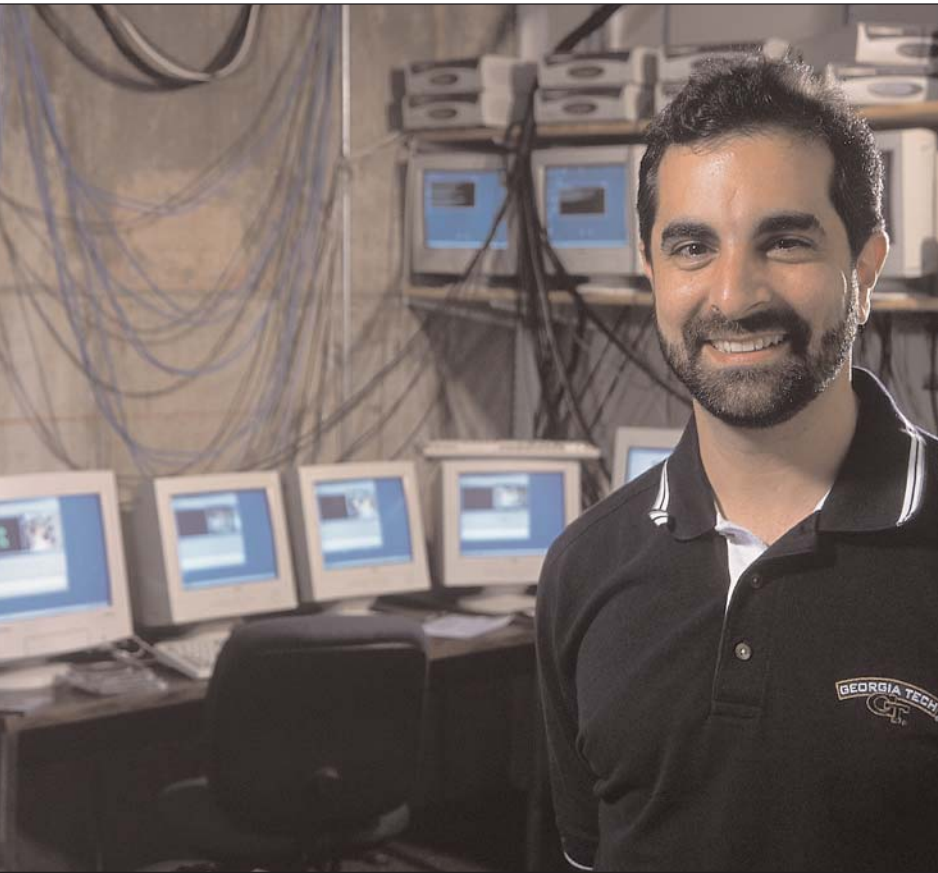


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An interdisciplinary research team led by Associate Professor of Computing Gregory Abowd is conducting a project called the Aware Home Research Initiative with a specific focus on using computing technology to allow seniors to live independently longer. The project is based in the unique 5,040-square-foot Broadband Institute Residential Laboratory, a three-story home adjacent to the Georgia Tech campus.

Arthur and Bill confronted. Will they be able to continue living in their own homes as memory and physical abilities decline? In five to 10 years, the answer may be more hopeful.

Researchers at the Georgia Institute of Technology believe they can lengthen older adults' independence, perhaps even for several years, with computer-based "aware home" technologies. Sensors can feed information to computers, giving a home an awareness of the residents' activities so it can support their needs — in this case, ways to combat the common impairments of aging.

"This is a well-grounded, pragmatic problem to be looking at," says computer scientist Beth Mynatt, an associate professor in the College of Computing and member of an interdisciplinary research team conducting a project called the Aware Home Research Initiative, with a specific focus on the issue of aging in place. "It's feasible that the technology will be affordable and socially acceptable in the broader context of other options available to senior adults."

The Aware Home project is based in the unique 5,040-square-foot Broadband Institute Residential Laboratory, a three-story home adjacent to the Georgia Tech campus. Construction of the residential lab, which opened in May 2000, was funded by a \$700,000 grant from the Georgia

Research Alliance (GRA). Additional GRA funds are supporting the maintenance and upgrade of the facility.

"With this project, we are trying to determine how one might design a home to enable older adults to be functionally independent longer and to minimize the transition into an assisted living center," explains Wendy Rogers, a professor in the School of Psychology and another team member. "... What kind of technology supports do they need to live in their own home longer? At the same time, we'll be designing those supports.

"For example, what is the best way to present information to a senior adult on their medication regimen?" Rogers adds. "You could present visual display reminders and instructions on how to take the medication. You might also track whether they took the medication and then remind them. So we want to design the best interface so they can process the information and benefit from it."

"Economically, it provides a tremendous savings if older adults can stay in their own homes rather than move to an institutional setting..."

Research funded by the National Science Foundation, corporate sponsors and the GRA centers around three themes: 1) development of technological building blocks that promote awareness of occupants and activities in a home setting; 2) gaining an understanding of the needs of an aging population and creating applications to meet those needs; and 3) development of software infrastructure to engineer robust applications using the technological building blocks, explains Gregory Abowd, director of the Aware Home project, associate director of the Broadband Institute at Georgia Tech and an associate professor in the College of Computing.

Researchers bring various areas of expertise to the project, and their collaboration in the residential lab is vital to the project's success. For example, applications will be driven by the capabilities of sensing and computer perception technologies that are designed and tested in the Residential Laboratory, researchers say.

The technologies developed from this research will benefit not only older adults, but other groups with cognitive impairments and eventually, as the technology becomes pervasive, the general public. "As we develop the technology, we find the value



PHOTO BY GARY MEEK

of it for a larger group of people," Abowd says. "This is referred to as universal design, and from my perspective it is a goal."

There will be other benefits to the general public, as well. Economically, it provides a tremendous savings if older adults can stay in their own homes rather than move to an institutional setting, says research team member Aaron Bobick, an associate professor in the College of Computing and director of the Graphics, Visualization and Usability Center, with which all research team members are affiliated. Not only is the expense of elder care facilities an issue, so is the availability of them, adds researcher Irfan Essa, an associate professor in the College of Computing.

Bobick cites another impact of Georgia Tech's research: "The Georgia taxpayer also has the benefit of the residential lab and our research being here, making the state grow in national reputation regarding elder care and technology. That means companies will locate significant facilities here and increase the range of technical expertise associated with Georgia."

Though they have not located new facilities in Georgia, companies such as Intel and Motorola have already taken an interest in research at the residential lab. Along with four other companies – Mitsubishi Electric Research Lab (MERL), Hewlett-Packard (HP), Accenture and Visteon – they sponsor research in the form of annual gifts to the Aware Home Research Initiative. These companies support the research, hoping to apply its findings about the future of personal computing, the future of connecting broadband communications to all homes and the interaction between these two issues, says Nikil Jayant, director of the Broadband Institute and a professor in the School of Electrical and Computer Engineering.

Intel has the most interest in aging in place applications, Abowd says. Meanwhile, MERL is interested in smart environments, as are Accenture and HP. Motorola wants research results on wireless communications, and Visteon is seeking

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applications that will connect the home and the car, he explains.

"Although research at the Residential Laboratory is industry guided, we have to date not created a platform that is compelling enough for industry to be physically close to the lab," Jayant adds. "Its impact will be at a fundamental-knowledge-creating level. On the other hand, most companies that are attracted to Atlanta and Georgia Tech are attracted even more when they discover the Residential Laboratory as part of our research infrastructure. We'd love to see start-up companies make some use, even if it is indirect, of our research and the intellectual property resulting from it."

While companies are taking notice, Essa expects that retirees will also be attracted to Georgia's advances in elder care and aware home technologies.

In the broadest sense, the Aware Home project "brings to bear what technology should be doing in our homes," Essa says. "... We are asking questions like, 'What is computing technology good for except Web surfing?' We should start thinking about computing having the same impact on society as mechanical engineers have had on cars." **RH**

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Researchers are creating technologies to address memory problems associated with aging.

Top left: The "Aware Home" at dawn.

Below: Associate Professor of Computing Irfan Essa, left, and his students are focusing on sensing technology, with the Residential Laboratory serving as the test bed. "The goal is to build an infrastructure so an aware home can see and hear its inhabitants and interact with them like a normal person would," Essa explains.

PHOTO BY GARY MEEK



Jogging the Memory with Information from Sensors

Researchers make progress in aware home applications and infrastructure.

PHOTO BY GARY MEEK



To promote social interaction between seniors and their grandchildren, Associate Professor Beth Mynatt, visiting researcher Itiro Sii and graduate student Jim Rowan have developed an application called Peek-A-Drawer. It provides virtual shared drawers for grandparents who want to share a part of their living space with grandchildren who live far away.

Gorgia Tech researchers involved with the Aware Home project are making progress in several areas, including age-related applications and the infrastructure of computer awareness technology.

The Digital Family Portrait, developed in prototype form by Associate Professor of Computing Beth Mynatt, is one application that is forging ahead. Its goal is to give adult children a virtual awareness of the condition and activity level of their independently living parent, who often resides in another town.

The portrait — actually a computer screen with the older adult's picture displayed in a digital frame — might hang on a mantel over a fireplace in the adult child's home. Sensing data from the parent's home feeds the portrait's frame with 28 butterfly icons that change in size, indicating the parent's daily activity levels for a 28-day period.

If the adult child wants more information about a particular day, she touches that icon and gets a more detailed visualization for that day. In this screen, information indicates the weather and temperature at the older adult's home, and a bar graph reflects the person's room-to-room activity.

Sensors in the Broadband Institute Residential Laboratory can already track movement of people from room to room, giving researchers a broad sense of activity based on an inhabitant's motion. Mynatt has experimented with using this data in the portrait application. In addition, she has conducted studies involving actual families in their own homes using information from interviews with the senior adult to supply data for the portrait. Mynatt plans more experiments like these, both in the Residential Laboratory with actual human subjects and in the field with additional families whose houses will be instrumented with simple sensing systems.

"The sensing information will provide a visualization for a unique footprint of a person's daily life," Mynatt explains. "We might find out that the older adult got up during the night a couple of times to go to the bathroom. Then they got up and had breakfast, and then there was a lull of activity followed by another burst of activity around dinner

PHOTO BY STANLEY LEARY



The Digital Family Portrait, developed in prototype form by Associate Professor of Computing Beth Mynatt, will give adult children a virtual awareness of the condition and activity level of their independently living parent, who often resides in another town.

and bedtime. So without breaching the privacy boundary, you can still get a good sense of a person's overall activity level using the Digital Family Portrait. If you know that person well, you gain a sense over time about whether today looks like a normal day."

With the Digital Family Portrait well under way, Mynatt and colleague Wendy Rogers, a professor of psychology, want to develop technologies to address memory declines in older adults. So they are investigating interfaces that make up for short-term memory impairments, as well as systems to provide near-term reminders. If an older adult is interrupted or distracted from a task, he might forget what he was doing. An aware computing system could continuously gather information and visually present information back to the resident to jog his memory.

Mynatt, Rogers and Gregory Abowd, an associate professor of computing and research director of the Aware Home project, developed a prototype interface called "What was I cooking?" In a demonstration of the technology, cameras under the kitchen cabinets record a person putting white ingredients into a bowl. For the prototype only, containers are also instrumented with sensors.

PHOTO BY GARY MEEK

Researchers use the sensing information to create a cartoon-strip-format display of the person's recent actions. Then when the person's activity is interrupted and they forget what ingredients were added to the bowl, the display provides a reminder.

A similar visual reminder system could prompt recall when older adults start a task in one room, then must go to another room to complete it. When they get to the other room, they often forget why they needed to go there. Rogers also wants to develop interfaces for prospective memory – memory to do something in the future (e.g., remembering to take medication). "So the house could become a surrogate memory system," Mynatt adds.

To promote social interaction between seniors and their grandchildren, Mynatt and visiting researcher Itiro Siio and graduate student Jim Rowan have developed an application called Peek-A-Drawer. It provides virtual shared drawers for grandparents who want to share a part of their living space with grandchildren who live far away. When a user puts something in an upper drawer of a chest and closes it, a photograph is taken automatically. Then the image appears on a monitor in the lower drawer of a chest in the relative's house. "The operation is so simple that even children can communicate with their grandparents," the researchers report. "Also, as the camera only takes pictures of objects inside the drawer, privacy is assured."

"...the house could become a surrogate memory system..."

Meanwhile, Associate Professors Irfan Essa and Aaron Bobick are focusing on sensing technology, with the Residential Laboratory serving as the test bed. "The goal is to build an infrastructure so an aware home can see and hear its inhabitants and interact with them like a normal person would," Essa explains.

Two prototype sensing systems exist in the Residential Laboratory, though neither is continuously operating for now. In the kitchen, optical sensors in the ceiling can locate a person in the room and approximately track where they are headed (e.g., toward the refrigerator or oven). In another room, cameras and microphones are embedded in the walls. Researchers are primarily concerned with data collection for now, rather than data processing, Essa says. But they can interpret audio data with commercial speech recognition software.

Later, researchers want the system to recognize a person's location when they speak. Then if



the person is speaking in the dark, the cameras can move where the person is located. Next, researchers will instrument the Residential Laboratory with sensors focused on specific areas, like the sink in the kitchen to gather data on when an inhabitant is washing the dishes, for example.

Altogether, the video sensing systems in the Residential Laboratory will provide generic location information — where people are and when — and then add basic activity recognition capabilities to the system, Bobick says. "One simple example is sitting on the sofa," he explains. "To assess your cognitive engagement, it matters a lot whether you are watching TV, reading the newspaper or sleeping. So once the tracking system identifies a person on the couch, I want to have more computer vision to tell me which level of activity they are engaged in."

Though prototype sensing systems may be apparent to users, future versions will not be. "We don't want people to feel tracked without giving any value back to the individual," Abowd says. "We have a desire to make sensing invisible in the house. We want to leave it to the house to be aware, and that is primarily a sensing challenge. But we also want people to be comfortable about what is being known about them.... We have found that people are willing to give up some privacy to have the ability to maintain their quality of life and stay in their own home."

It is in these issues where technology and real life intersect. Aware Home researchers have anticipated this intersection and are crossing it in advance of technology design.

– Jane M. Sanders

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In a prototype technology demonstration called "What was I cooking?", cameras under the kitchen cabinets record a computer science student, Mahmudul Jilani, putting white ingredients into a bowl.