

# Inside the Home of the Future

Houses that make your coffee, lock your doors and even measure your health are closer than you think.

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As you pour the detergent into your last load of laundry, you realize the bottle is almost empty. But instead of making a mental note to add it to your grocery list, or running to the kitchen to scribble it down, you simply say out loud, "Remember: Buy laundry detergent." The word "remember" is picked up by a microphone in the wall and triggers a computer to transcribe your words to your to-do list.

It might sound like a sci-fi vision of the future. But it's actually a project called Audio Notes, currently in the works at the Georgia Institute of Technology's 5,000-square-foot Aware Home, a combination house and laboratory in Atlanta where scientists are dreaming up futuristic housing technology.



"I love that shopping list," says Eileen Lange, a 68-year-old retiree from Lithonia, Ga., who toured the house and tried out some of its projects last year.

Researchers and commercial labs around the country are building experimental homes to test technology that could make domestic life easier and extend the independence of older homeowners. Such efforts go

beyond so-called universal design, a trend toward building houses with wider doorways, grab bars and adjustable kitchen cabinets that took off in the early 1990s.

"These are lifestyle services empowered by a new generation of technology," says Joseph Coughlin, director of the Massachusetts Institute of Technology's AgeLab in Cambridge ([web.mit.edu/agelab/research/hnh.html](http://web.mit.edu/agelab/research/hnh.html)).

In many cases, the mechanics for the gizmos already exist -- mainly wireless sensors, cellphones, broadband access and home computers. What's been missing, and what researchers now are trying to develop, are ways to harness the hardware to run your entire house with little effort or technological savvy -- letting you turn up the heat remotely, anticipating when you want the lights on, or deciding automatically how long your food should cook.

And for the baby boomers who start remodeling and building houses for their retirement soon, the technology should be in place when they need it.

"If we can sneak these things into people's homes when they're young, for the convenience, they'll be there as we all get older and help us stay independent longer," says Beth Mynatt, an assistant professor of computing who directs Georgia Tech's project.

Here's a look at what's in store for your home in the future.

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## 1. THE INTELLIGENT HOUSE

Would you like your home to "know" you better? Computer scientists at the University of Texas-Arlington are building a home with this scenario as the goal:

At 6:45 a.m., the house turns up the heat, without

programming, because it has learned on its own that it needs 15 minutes to warm up before your alarm goes off. At 7 a.m., when your alarm sounds, it signals the bedroom light and kitchen coffee maker to turn on. When you step into the bathroom, the morning news pops up on a video screen, and the shower turns on automatically. While you shave, the house senses (through the floor) that you are two pounds over your ideal weight; it adjusts your suggested menu and displays it in the kitchen.

When you leave home after breakfast, the house locks itself. Later that morning, it notes that the refrigerator is low on milk and cheese, and it places a grocery order to be delivered just before you get home. When you arrive, the food is there -- and the house has cranked up the hot tub for you.

What's powering all the automation is something called machine learning, which would enable the computer monitoring the house to observe a resident's habits for a while, and then anticipate individual needs and make decisions about what to turn on and off, says Diane Cook, the project's manager (see more at [ranger.uta.edu/smarthome](http://ranger.uta.edu/smarthome)).

At the University of Florida in Gainesville, researchers are using a cellphone to run a home. (So far, the "home" is a simulated apartment inside a lab, but there's a real house under construction that should be finished in June.) When someone rings the doorbell, you either hear it or feel your cellphone vibrating. Then, you can open your phone and see a picture of the person at the door. (A video camera relays the picture.) If you recognize the visitor, you can push a button on your cellphone to unlatch the door. If it's dark and you can't see the visitor, you can push another button to turn on an outside light.

The project, started three years ago, has "evolved from focusing just on smart phones to the smart house," says William Mann, who heads Florida's Rehabilitation Engineering Research Center on Technology for Successful Aging ([rerc.ufl.edu](http://rerc.ufl.edu)).

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## 2. THE WALLS ARE WATCHING

Other projects are aimed at installing eyes and ears in the woodwork and could help families keep an eye on aging relatives from a distance.

Home Guardian LLC, spun off from the University of Virginia's Medical Automation Research Center, is testing a wireless monitoring system at about two dozen independent-living and assisted-living apartments for senior citizens in Minneapolis. It takes only about 20 minutes to install, and it uses sensors, rather than cameras or microphones, to pinpoint "where you are in the home at any particular time," says Robin Felder, the company's head and center's director ([smarthouse.med.virginia.edu](http://smarthouse.med.virginia.edu)). So far, the monitors have detected four residents' falls.

Another monitoring system, being developed by the University of Rochester's Center for Future Health in New York, uses both sensors and video cameras to track how people walk around in the house. Researchers are searching for ways to use data from the patterns for early detection of strokes, and to track changes in people with chronic conditions such as arthritis or Parkinson's disease.

"Our goal is active intervention, all the way to prevention, as much as possible," says Philippe Fauchet, the center's director.

A "Digital Family Portrait" being tested by a Georgia Tech alumna and his mother, in her 70s, allows the adult child living far away from a parent to keep an eye out. The mother's house has sensors under the floorboards that track her level of activity, and her son's house has a digital screen where he can get a report at a glance.

The screen looks like a picture frame with her photo in the middle and is bordered by 28 digital butterflies of various sizes. The butterfly representing the current day is white (the rest are shaded pink). The larger the butterfly, the more active his mother has been that day. Touching the butterfly switches the screen to a report of the weather, indoor temperature and his mother's level of room-to-room movement for that day. (There's an example at [www.cc.gatech.edu/fce/ecl/projects/dfp/index.html](http://www.cc.gatech.edu/fce/ecl/projects/dfp/index.html)) . If the mother's level of activity changes sharply for no known reason, her son can give her a call to see what's up, says the school's Dr. Mynatt.

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### 3. INTERACTIVE LIVING ROOM

Already, thousands of people have bought egg-shaped lamps that sit on coffee tables and change colors when the stock market or the outdoor temperature rises or falls. The information is transmitted over a wireless network, not phone lines or cable (see it at [ambientdevices.com](http://ambientdevices.com)). The goal of David Rose, president of Ambient Devices Inc. in Cambridge, Mass., maker of these "orbs," was to provide information at a glance, much like an old-fashioned barometer.

"It's trying to be as simple as possible, and exist on your periphery and not be intrusive," he says.

Now, the company is expanding into other tabletop devices, starting with a three-needle display it calls a dashboard. And it's working with M.I.T.'s AgeLab to figure out how to use such gizmos to help people monitor their own health. One idea: You could keep a pedometer strapped on all day, then place it at night in a cradle that would transmit the day's record of your steps through the network to the device. The next day, you could compare the previous day's activity level with that of two earlier days.

Above the fireplace mantel in Georgia Tech's Aware Home, a large TV screen displays one researcher's effort to help people sift through their home videos to find specific clips, often a needle-in-a-haystack quest.

"It's important to help us treasure, organize and enjoy memories from the past," says Gregory Abowd, an associate computing professor. To do so, he's developing software to tag each scene based on the people involved, the occasion, and even the car in the background. Once tagged, he can group scenes together and export them to a computer file or DVD. A second project in the works: a video camera that can annotate images as they're being recorded, cutting down on the organizational work later.

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### 4. KICKED-UP KITCHEN

Scientists are devoting considerable attention to this room, where busy families can be distracted by caring for children, parents or both.

One tool on the drawing board, Georgia Tech's Cook's Collage, would use four cameras mounted under the kitchen cabinets to film your hands as you mix ingredients on the countertop below. The pictures, formatted like a filmstrip, would show what you've done most recently. That way, if you're interrupted by a phone call, or children needing help with homework, you can review what you've done to see whether you already had added the salt, for example, or to recall how many cups of flour you had sifted.



Since the cameras are focused on the counter, not on your face, study participants who have seen the tool haven't felt self-conscious about being filmed. "It avoids the bad-hair-day issue," says Dr. Mynatt. (There are pictures at [www.cc.gatech.edu/fce/ecl/projects/cooking/index.html](http://www.cc.gatech.edu/fce/ecl/projects/cooking/index.html)).

At the University of Florida, researchers are working on microwave ovens that can read a new kind of label, known as a radio-frequency identification tag. Such labels can store more information than bar codes and are expected to replace them eventually, says Dr. Mann, who heads the project.

For example: You might decide to make instant oatmeal for breakfast, which the computer screen in your kitchen might suggest as part of a menu that complies with your recommended diet. The microwave would recognize what you're preparing from the tag on the package and automatically set the appropriate time and power -- whether or not you remember the cooking instructions. It also could tell if the food

could cause you to have an allergic reaction.

A range at the LifeWise Home in Bowie, Md., built by the National Center for Seniors' Housing Research, first acts as a refrigerator, so you can pop in a casserole in the morning, then set it to bake later in the afternoon. If two hours pass after the cooking time has finished and you haven't removed the dish from the oven, it turns back into a refrigerator. (It's already commercially available through Whirlpool.)

"It's great for someone who's working, or [busy] during the day with volunteer work," says Charlotte Wade, the program director for the center, part of the National Association of Home Builders. It also could prevent people with memory loss from eating spoiled food.

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## 5. BEDROOM CHECKUP

Imagine a mattress that could flag early health problems while you sleep. Dr. Felder's lab in Virginia has come up with an inexpensive strip -- much like the ones placed across the chest to work with heart-rate monitors -- that goes under your mattress pad.

"By measuring your breathing and pulse all night long, we can test for sleep apnea," usually something that can be done only in a sleep laboratory, he says. "The measurements aren't as good, but they can indicate problems and lead to an earlier trip to the doctor."

The bed monitor will work with two people by installing one on each side of the bed. Most couples always sleep on their same side of the bed, Dr. Felder says, even when they stay in hotels, and thus one would get data on the same individual each night.

The bedroom might be the choice for another new device, as well. Georgia Tech has dreamed up what it calls Dude's Magic Box and Grandma's Lap Desk, with the idea of helping grandchildren interact with their grandparents through show-and-tell before they're old enough to do much through e-mail.

"When kids are four to eight years old, they like to say, 'Hey, look at this,'" explains Dr. Mynatt.

Here's how it works:

The grandchild puts something in the box, such as a pet turtle, then the box takes a photo of it. A cartoon character (called Dude in the prototype) pops up on a screen and says, "This is cool! Do you want to send it to Grandma?" At the grandparent's house, a message pops up on a flat-panel screen or home computer. It sounds futuristic, but the main costs are simply a basic computer with a camera and a no-frills laptop (see more information at [www.cc.gatech.edu/fce/ecl/projects/dude](http://www.cc.gatech.edu/fce/ecl/projects/dude)).

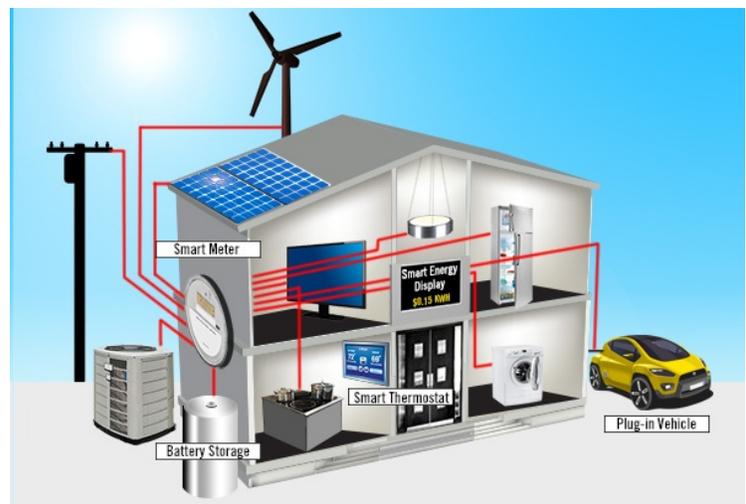
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## 6. BATHROOM CLINIC

This room's getting a makeover, too. Researchers are working on ways to use toilets for instant urinalysis, which could provide data for tracking hypertension, diabetes and other chronic conditions.

"Smart toilets already exist -- they cost \$2,000 in Japan," says M.I.T.'s Dr. Coughlin. "You shave, you brush your teeth, then you use it to check your glucose. It's for the paranoid well."

If scientists find an efficient way to send that data to your physician, says Dr. Cook at Texas-Arlington, "we could integrate this information together to get a total health picture, then look for deviations from the norm. The nice thing is, this information could be given to the doctor without the person having to leave home."



Another toilet innovation could, to put it delicately, wipe out your need for toilet paper. The LifeWise

home has a washing-and-drying toilet that provides a quick rinse with warm water, much like a bidet, then uses a built-in dryer to finish the job. Like many new home gadgets, this one often appeals to baby boomers as a luxury -- but could provide needed help as they age as well, says Ms. Wade.

Your medicine cabinet might talk to you in the future, offering advice about interactions among multiple medications. At the University of Rochester, researchers have developed an interactive-computer system with a talking, cartoon pill on the screen that listens to your question, tries to figure out why you said what you said, and responds with an answer from its bank of drug data, which you customize by scanning the bar codes of your medications into it. (You can see a video of how it works at [www.futurehealth.rochester.edu/smart\\_home](http://www.futurehealth.rochester.edu/smart_home)).

The main thing holding the system back right now, says Dr. Fauchet, is that the natural-language interface needed to let you ask about drugs in your own words "is not to the level that we would like," but researchers are scrambling to improve it.

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## 7. TUCKED IN THE CLOSET

Looking for a way to save precious square feet as you downsize from a two-story colonial to a one-story villa? A new sort of water heater, demonstrated in the LifeWise home, heats the water quickly as it passes through, eliminating the need for a big storage tank and saving four square feet of closet space. It comes as a small box that can hang on the wall behind the washer and dryer.

"It's a little bit of cost upfront, but you get it back in energy savings," says Ms. Wade in Maryland.

## OUTSIDE WORK BY ROBOT

Most of the research is indoors, but one effort by the Texas scientists could make a difference for people with big spreads: They are trying to control a robotic lawn mower (already commercially available) and sprinkler system through the Internet. So, during your month in Florida or Alaska or Europe, you could still get the lawn mowed regularly and turn the water on during a drought, or off during a tropical storm.

The research problem: "There isn't yet a really good standard for being able to interact with robot lawn mowers, vacuum cleaners" and other appliances, says Dr. Cook. "The market has really focused on these individual devices. There hasn't been an emphasis on how to use them as a whole."

But as researchers figure out how to link new appliances and toys with home-control systems through the Internet, and tie in more technology that absorbs homeowners' habits, that should change, she predicts.

"I can't wait to have a house that can learn my patterns and preferences -- and have the hot tub waiting for me when I get home."

