TECHNOLOGY

Dancing with robots

High-tech gadgets such as sensors that detect falls and robots that can fetch items are helping people stay independent and safe into their later years.

BY NEIL SAVAGE

Marilyn Rantz knows only too well how vulnerable old age can make us. Her mother fell one day, badly fracturing her shoulder. She owned a wearable device that would summon help at the press of a button, but had left it just out of reach from where she fell. After eight hours on the floor, she was able to crawl to the device and call for help, but the stress of those hours bearing untreated injuries took its toll — within six months she was dead.

To circumvent the limitations of such devices, Rantz, a gerontologist and associate director of the Interdisciplinary Center on Aging at the University of Missouri in Columbia, prefers systems that people don't have to carry with them. "It's one of the reasons we've moved to environment-based sensors instead of wearable sensors," she says, "because people don't wear them."

Rantz and Marjorie Skubic, an electrical and computer engineer and director of the university's Center for Eldercare and Rehabilitation Technology, are developing systems to monitor the health and well-being of older adults.

Research into this type of technology is burgeoning in line with the growing proportion of elderly people. Sensors are being developed that can not only detect falls, but also monitor changes in gait or daily routine that could flag concerns and alert caregivers before physical problems become acute. Other technologies, such as robotics, could prolong independence and help people stay active.

NOT SO TECHNOPHOBIC

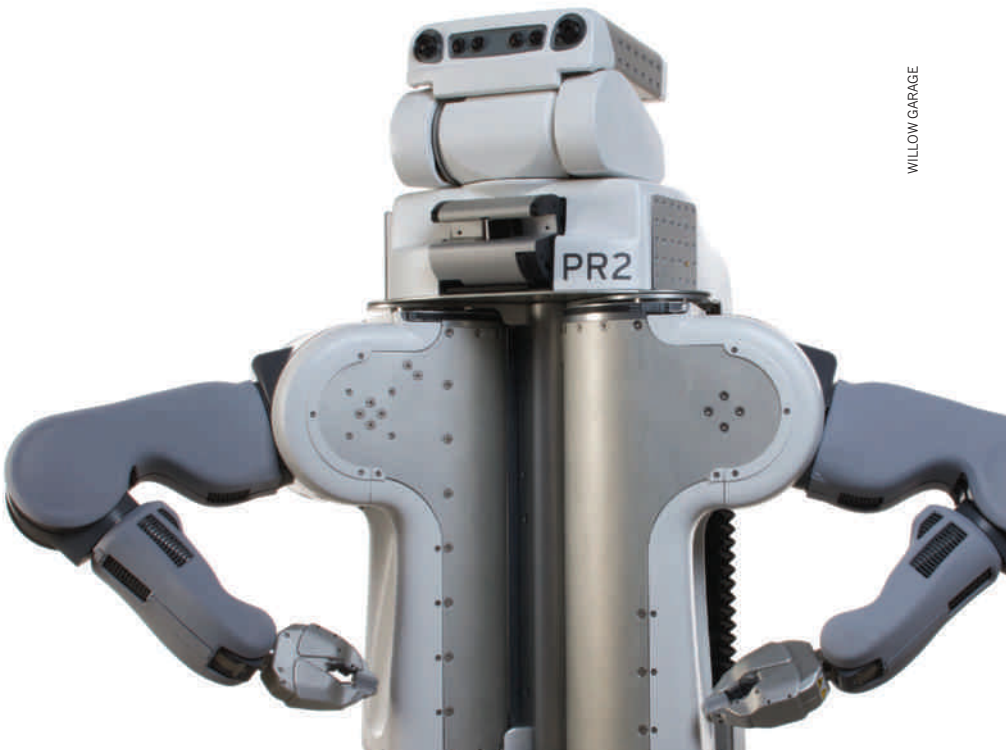
Although elderly people can be reluctant to embrace new gadgets, they are happy to adopt technology if it's easy to use and will help them retain their independence, says Wendy Rogers, an engineering psychologist at the Georgia Institute of Technology in Atlanta. Over-65s have a wide spectrum of abilities and conditions, says Rogers, and range from people who are still working to those in the late stages of dementia. Their needs require a wide variety of technologies from smartphone fitness apps for the active to vital-sign monitors for the bed-ridden.

To study how technology can best help older adults, the University of Missouri, in collaboration with private company Americare, developed Tiger Place — an active retirement community. The aim is to allow people to stay in their apartments until the end of their lives without moving into nursing homes — a trend known as ageing in place. Rantz is executive director of the Aging in Place programme at Tiger Place, and she says that most people prefer not to move frequently; the stress of transition can contribute to health problems and earlier death. "Just the process of moving is enough to kick some people over — people who might have had many years ahead of them," she says. And for most people, going into a nursing home lessens the incentive to help themselves, leading to reduced activity and a loss of physical capability.

Tiger Place provides an environment for researchers to test their sensors. Some measures installed in its apartments are simply infrared motion detectors, the kind developed for security systems. The detectors help researchers discern individuals' personal patterns of activity: how much they move around, when and how often they leave their home, and how long they're gone for. Changed activity levels can be early warnings of problems — they can be more telling than a questionnaire in a doctor's office, and can highlight problems a lot sooner, Rantz says. A one-bedroom apartment in Tiger Place might be discreetly equipped with 10 motion sensors, a gait-monitoring system, and bed sensors that can measure restlessness, heart rate and breathing.

One of the main hazards being monitored is falling. According to the US Centers for Disease Control and Prevention, a third of Americans aged over 65 fall each year; in 2009, this resulted in 20,000 fatalities. And the longer people lie injured, the poorer their prospects for healing. One Tiger Place project uses an array of microphones to detect the sound of a fall. Computers using statistical techniques can differentiate the distinctive acoustic characteristics of a body falling from, for example, a book being dropped or noise from a television. Preliminary work used stuntmen simulating falls, and microphones have now been installed in apartments to get more real-world data and make the system more accurate.

It is, of course, better to prevent falls occurring in the first place. Skubic is monitoring how people walk, gathering information about speed, stride length and sway to discover whether they have balance or other problems that increase the risk of falling. One of the sensors she's investigating is the Microsoft Kinect, a three-dimensional camera system designed as a hands-free controller for video games. Off-the-shelf sensors would hasten the adoption of these systems — the Kinect provides



WILLOW GARAGE

GEORGIA INSTITUTE OF TECHNOLOGY

Robots such as the PR2 can help elderly people with limited mobility by fetching items and reminding them to take medication.

sophisticated 3D imaging for less than US$150. The challenge lies in developing software that can make sense of the data. Skubic says that although she gets near-perfect results for gait measurement in a laboratory setting, it's more difficult to sort out relevant information from noise in a person's home, where lighting conditions vary, different people walk around, furniture gets moved, and so on.

More personal types of sensor system are under development. "When someone gets depressed, they physically slow down — and we would be able to detect that," says Tanzeem Choudhury, a computer scientist at Cornell University in Ithaca, New York. She adds that people under stress speak more loudly, with less tonal variation and more jitter in their voice; stress is a risk factor for poor health.

To test these ideas, Choudhury has developed a smartphone app, BeWell. The app listens to the sound of conversation — without keeping a recording of actual words spoken — to estimate a person's level of social interaction. The phone's accelerometer measures how much the person moves, and its GPS can tell if they're leaving the house, indicating physical activity and a higher chance of social contact. The app even attempts to monitor sleep by noting a lack of activity, although Choudhury says that's mostly a best-guess approximation. Among the unresolved issues are the willingness of older people to adopt monitoring software (or even the phones themselves) and technical considerations such as the effect on battery life.

THE RISE OF THE ROBOTS

Sensors can provide important health information, but older people often need physical assistance — and here robotic technology could fill the gap. Toyota, for instance, plans to launch four devices next year it calls Nursing and Healthcare Partner Robots, designed to assist people who have trouble walking. They range in size: the smallest is a sort of knee brace attached to a footpad, worn on a paralysed leg. An accelerometer and gyroscope attached to the thigh and a load sensor in the footpad determine when a person tries to walk and how fast, and bend the knee joint accordingly. The largest of Toyota's robots assists in actually moving an immobile person to walk between, say, the bed and the toilet.

For intensive support with independence, Yoshiyuki Sankai, an engineer at the University of Tsukuba in Japan, has designed the Hybrid Assistive Limb (HAL) suit — a wearable robot that provides joint strength and limb support for people with diminished function. Sensors on the skin read weak electrical signals involved in muscle movement and trigger the suit to move appropriately. A spin-off company from the Tsukuba lab, Cyberdyne, produces HAL suits that healthcare facilities can hire.

Machines that buzz around the house doing laundry and preparing dinner are still in the realm of science fiction.

Charles Kemp, director of the Healthcare Robotics Lab at Georgia Tech, thinks mobile robots for the home could become a reality within the decade. Kemp has been conducting research on the PR2, a robot built by Willow Garage in Menlo Park, California, that has helped a quadriplegic man shave himself. Kemp says that older adults he has worked with are surprisingly willing to have a robot help out: telling a machine to perform tasks rather than asking a relative or hiring an aide helps preserve privacy and a sense of control, he says. Kemp sees other benefits too. "Robots may enhance people's lives in surprising ways," he says. "Dancing with robots might be fun, healthy and even therapeutic."

Unlike industrial robots that perform tasks such as moving objects from one fixed location to another, personal robots will have to deal with the more variable and unstructured environment of a home. Such variation presents a challenge for their designers. "You can't completely predict where the coffee mug is going to be in the kitchen," say Kemp. The other major hurdle, he says, is the cost — a robot arm alone can cost $100,000. Kemp is optimistic that robotics will follow the same path as computers, which went from rare and expensive to ubiquitous and cheap. There are signs this is already happening: Rethink Robotics, a Boston company, recently released a robotic arm costing $22,000.

"It's going to be a while before we have robots that are fully intelligent and have human movement capabilities," Kemp says. Machines that buzz around the house doing laundry and preparing dinner are still in the realm of science fiction, but smaller devices that can pick up a dropped remote control, remind people to take medication or help with personal hygiene are possible in the next five years.

Older people may not be the digital natives of the young generation, says Rogers, but they are open to new technology if the benefit to them is clear. "They don't want novelty for novelty's sake." ■

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