Lending a Helping (Robotic) Hand

Jennifer Maybin

Imagine employing a staff member who can offer assistance to residents in performing activities of daily living (ADLs), encourage medical compliance, provide household help or scheduling, and even enhance safety and security in your facility—all without asking for a paycheck. It may not be long until such "employees" are available. Some of them will be able to increase mobility or facilitate communication and social relationships among residents, families, and the surrounding community, whereas others may facilitate "virtual" house calls to improve resident care and reduce unnecessary visits to the emergency department (ED).

Although still in development and not yet possessing full functionality and affordability, several sophisticated humanoid robots may one day provide such assistance to residents in assisted living (AL) settings.

For example, a Nursebot[1] named Pearl (Figure 1) was tested in the Longwood Retirement Community in Oakmont, PA, where "she" reminded residents of planned activities on their calendars and led them to the activities when necessary. A robotic walker[2] has been designed for the same project and was used to provide mobility assistance while preserving residents' fine motor control. These robots were part of research designed to study autonomous navigation,[1] activity planning,[3] cognitive prosthetics, and human–robot interfaces. The Nursebot's expressive head and touchscreen seemed to enhance client interactions in the testing studies. However, Nursebot is not yet developed enough to interact with the environment manually and so it could not perform work on behalf of Longwood's residents. It was also not able to function as a remote service provider (family member, doctor, or therapist).

The RP-7 robot, by InTouch Health (www.intouchhealth.com), was developed to support timely interaction between doctors and possible stroke patients in an emergency department (ED) setting. This robot stands about 4.5 feet tall, has a touchscreen for a head, and enables a remote doctor to drive it using a teleoperator interface. Such mobility significantly enhances more traditional teleconferencing technologies, and RP-7 promises to decrease the average amount of time that a stroke patient must wait before being treated.

Pebbles, a teleconferencing robot, enables clients to be (virtually) in places they could otherwise not be.[4]

Other robotic devices are often used for therapeutic and rehabilitative functions. Most robotic rehabilitation work uses a hands-on approach in which the robot aids the movement of a patient's limbs during therapeutic exercises. A therapist robot may assist rehabilitation by providing social interaction and encouragement. Several companion robots function as pets—cats, teddy bears, and even seals have been designed and used to demonstrate stress- and depression-reduction therapeutic value. (See also *Telerounding Gets Patients Home Faster.*)

All of these applications have successfully demonstrated various but limited aspects of assistive robots in therapeutic settings. Each offers highly specialized functionality using special-purpose interfaces. To date, however, no personal robot has been able to act as a local embodiment of remote users who have different goals—for example, family, community services, and medical services. Project ASSIST is attempting to answer this need.

Figure 1. Pearl, an RP-7 robot, walks the halls of Longwood Retirement Community with a physician consult.

Project Assist

Project ASSIST is a multi-institutional and interdisciplinary research project to explore how technology can best be shaped to support the needs of elderly clients and others in AL settings. Members of the ASSIST research team include the University of Massachusetts Amherst Computer Science Department (computer vision, robotics, distributed sensor systems, human computer interaction), the Smith College School for Social Work (social science and geriatric social work), local elder community centers in western Massachusetts, and the Veteran's Administration (Connecticut Health Care System, West Haven campus). This project combines innovative research with field assessment in a team approach that includes computer science researchers, social scientists, and gerontologists to evaluate how technology is adopted and its impact on well-being and healthcare delivery for the elderly population.

Technology delivered into the residential environment must adapt to special needs, lifestyles, preferences, residential layout, and environment. The ASSIST project is developing technological aids that facilitate daily living and interaction between residents and remote services—and the client is at the center of the framework. The technology comprises a distributed sensor network and a novel mobile manipulator that provide core services to track client activities, implement client interfaces, and provide physical and cognitive prosthetics. The objective of the project is to improve quality of life while simultaneously reducing the strain on human and other resources associated with community support services. AL residents and those in other long-term care (LTC) settings are participating in the ASSIST project as users of the prototype robots.

Telerounding Gets Patients Home Faster

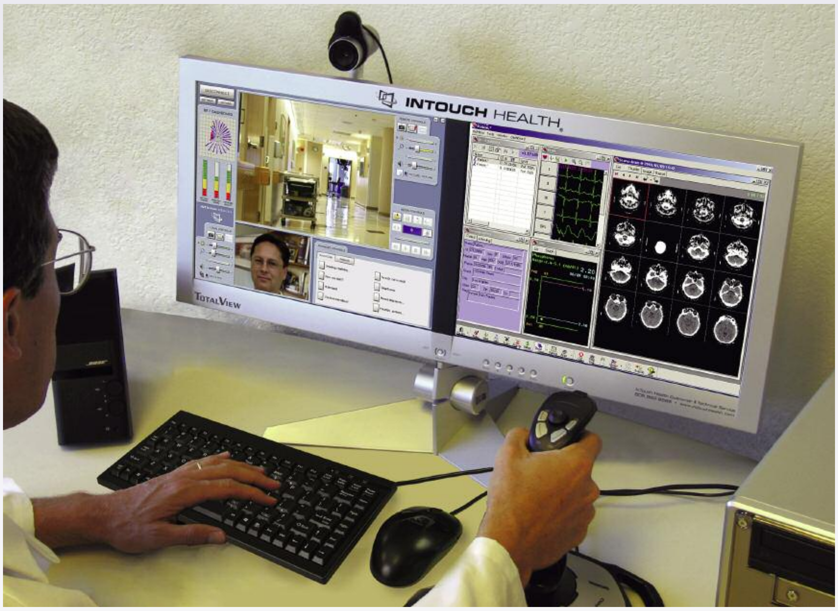
Authors of a study conducted at Sinai Hospital of Baltimore using robotic telerounding demonstrated that robotic telerounding may significantly reduce the length of stay of patients undergoing laparoscopic gastric bypass surgery if used to supplement standard postoperative visits made by surgeons.

The study evaluated 376 patients, 284 of whom were assessed by standard bedside physician rounds during the postoperative period. The remaining 92 patients were assessed by traditional surgeon bedside visits, supplemented by robotic telerounding. A 5-foot, 5-inch robot, displaying the doctor's face on a 15-inch screen, was guided by a joystick from a computerized control station into patients' rooms (see Figure). Onboard, 2-way cameras, microphones, and wireless technology allowed physicians to review charts, lab work, and x-ray results without being in the hospital.

Seventy-seven percent of patients who were assessed with robotic rounds were discharged on the first postoperative day, whereas none of the patients assessed exclusively by bedside rounds were discharged on Day 1.

"One of the crucial keys of delivering the high-quality care patients have come to expect at Sinai is communication. The technology used in the robotic telerounding offers both physicians and patients increased access to each other beyond traditional in-room visits," said Alex Gandsas, MD, lead investigator and head of the Division of Bariatric and Minimally Invasive Surgery at Sinai Hospital.

For the full article, see Gandsas A, Parekh M, Bleech MM, Tong DA. Robotic telepresence: profit analysis in reducing length of stay after laparoscopic gastric bypass. *J Am Coll Surg*. 2007 Jul;205(1):72-77.



A physician at a remote site can guide the telerounding robot into patients' rooms where it allows the physician to review charts and more.

Results from ASSIST Focus Groups

The ASSIST project has conducted 4 focus groups in which elderly residents have recommended the following:

- A fall-detection system
- A customized, daily activity reminder system
- Custom interfaces tailored specifically to elderly clientele for communicating with friends, family, and service providers

The focus group participants were also enthusiastic about the use of video technology (eg, videophone), despite concerns about privacy, because they anticipate that their own future impairments will override those concerns. And because they believe technology will benefit them in some way, the focus group participants didn't seem to be technophobic. Enthusiastic support was shown for active small robots that could be used in the home—for example, to take preemptive action to prevent falls by cleaning up clutter.

The concerns among focus group participants were that they may have to spend too much time in front of a computer or that they couldn't understand talking computers. Based on this feedback, the ASSIST group is exploring an interface in which a mobile robot serves as a "communication kiosk" with an onboard touchscreen that can follow a client around the house while he or she does other tasks or activities.

Core ASSIST Technologies

ASSIST's system provides tracking and localization services, face detection and identification, and activity modeling, and it serves as the "eyes" for the mobile manipulator. The mobile manipulator is both a physical prosthetic and an embodied interface. It serves as a cognitive focal point for the resident and as a surrogate for remote service providers. It is capable of natural language communication with anthropomorphic gestures and large-scale movement.

Called uBot-4, the mobile manipulator can move about the residential environment and perform manual tasks. It carries a Web cam, microphone, speech synthesizer, and touch-sensitive LCD display. Even though the uBot-4 was designed primarily for research, design specifications make it a useful prototype mobile manipulator for many residential assistive applications.

The uBot-4 is small and lightweight and balances dynamically. Two wheels are designed in a differential drive configuration so it can traverse almost any terrain that is accessible to an ambulatory client with a moderate degree of disability. It uses elevators instead of stairs but has no problem with different types of flooring and doorway thresholds.

The uBot-4 has two arms with 4-degree rotation and a rotating trunk. Each arm is about one-half meter long. The arms are strong enough to serve as a brace when the platform is destabilized and to do a pushup to return to a vertical posture from the prone position if it falls down! Its small size and low mass helps prevent damage to itself, the resident, or the environment. The robot is designed to perform work in about the same time as a human. Its outstretched arms can carry a load of about 5 kg, it moves on a flat floor at about 3 mph, and it can respond quickly to environmental stimuli. A more recent version of the mobile manipulator, uBot-5 (Figure 2), can carry more and go faster—up to about 12 km/hour (7 mph). Despite its small size and low cost, the uBot-4 has the potential to perform many dexterous tasks. The current version performs shoveling, stacking, pushing, and throwing tasks.

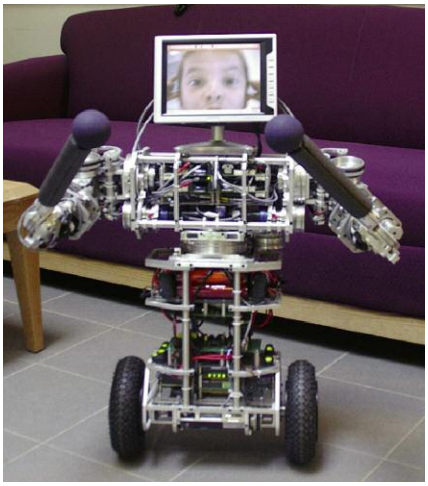


Figure 2. uBot-5 is the latest generation of the ASSIST Project's mobile manipulator.

Applications

The uBot-4 may be used as a family–client interface to facilitate social interaction via televisits through its Web cam. Its tracking features can help detect falls. The system stores data of clients' normal patterns of movement to enable it to recognize aberrations from normal and send an emergency alert. The uBot-4 can also help diagnose and rule out stroke. One prototype u-Bot-4 is capable of performing an automated attempt to arouse a fallen, unresponsive client, place a phone call to emergency contacts (a family member, an emergency medical technician, or a 911 operator), and summon an ambulance. The uBot-4 can respond either as a teleoperated device (by an emergency contact) or autonomously if teleoperation is not available. The mobile manipulator can approach a client and apply a digital stethoscope to provide relevant clinical data to the emergency medical technician enroute.

The uBot-4 is also capable of acting autonomously within a person's own environment to detect and remove an object that may be unexpectedly in the walking area. To do this, the uBot-4 is programmed to monitor for out-of-place objects and determine if they are obstacles. The mobile manipulator can then guide itself towards the object and push it out of the way.

Although uBot-4 is not yet ready for employment in the AL setting, it shows promise in improving family–client social interaction, connecting residents to community services and medical providers, and offering autonomous assistance in daily living. Project ASSIST continues to develop and test uBot-4 within the AL setting, making improvements, adding features, and responding to AL residents who may use the system in the future. See www-roboics.cs.umass.edu/Robots/UBot for more information on the latest uBot-5 improvement. ALC

The material here is excerpted with permission from the authors' text titled "Mobile Manipulators for Assisted Living in Residential Settings," to be published soon in the *Journal for Autonomous Robotics*. The authors of the original work are Patrick Deegan, Roderic Grupen, Allen Hanson, Emily Horrell, Shichao Ou, Edward Riseman, Shiraj Sen, Bryan Thibodeau, Adam Williams, and Dan Xie, of the ASSIST project at the University of Massachusetts Amherst.

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