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Gerontechnology Education: Beyond the Barriers

Diane J. Cook, Maureen Schmitter-Edgecombe, and Lawrence B. Holder

EDITOR'S INTRODUCTION

This issue's column describes a two-course sequence that integrates gerontology with pervasive computing and related technologies. The course is part of an Integrative Graduate Education and Research Traineeship project on health-assistive smart environments at Washington State University. Your comments and suggestions for this column are welcome. Please contact me at midkiff@vt.edu.

Multidisciplinary education lets students break outside the sometimes narrow confines of their primary discipline. Unlike traditional graduate education, wherein narrow specialization isolates students from the contextual understanding required for interdisciplinary research, Washington State University is designing new classes in health-assistive technologies that provide crossover training and experience to effectively lead research on interdisciplinary challenges and transition scientific advances into real-world solutions (see the "Quick Facts" sidebar).

BACKGROUND

As society and technology advance, there is a growing interest in adding intelligence to our living, working, and social environments. Due primarily to the population's aging, the number of individuals unable to live independently in their homes because of cognitive and physical limitations is rising rapidly. Researchers are now beginning to recognize the importance of developing new technologies to assist with health assessment and interventions for these special needs populations. According to the Secretary of State for Health, the possibilities for using technology to assist people with special needs are "extraordinary."[1]

Although the need for health-assistive technologies is abundant, individuals who are cross-trained in healthcare and in technology design are not. Today's medical program graduates are largely unaware of the assistance that technology can provide[2] and engineers are often blind to the needs of the individuals that can potentially benefit most from the technology. The National Academy of Engineering and the Institute of Medicine recognize a need for a closer partnership between these disciplines.[3]

In response to this need, a new PhD training program, sponsored by the US National Science Foundation, has been introduced at Washington State University for the study of health-assistive smart environments. As part of this program, we offer a two-semester course sequence on gerontechnology, a field that combines gerontology and technology. This course sequence is team-taught by professors from engineering and clinical psychology and in its first offering included students from eight disciplines: computer science, computer engineering, chemical engineering, mechanical engineering, clinical psychology, experimental psychology, human development, and neuroscience. In this article, we describe the nature of this educational approach and how it breaks down the barriers between disciplines in order to better understand aging and special health needs and to better design technologies that will improve the quality of life for people with these needs.

PROGRAM OVERVIEW

At the Washington State University Center for Advanced Studies on Adaptive Systems (CASAS), the research emphasis is to create smart environments that acquire and apply knowledge about the physical setting and its residents to improve their experience in that setting,[4] as Figure 1a shows. Research studies are conducted in CASAS testbeds, which include two on-campus apartments as well as homes of volunteer participants. The testbeds are equipped with a grid of motion detectors as well as sensors for door open/shut status, temperature, light, power usage, and item usage.

Students design technologies to sense and identify activities that take place in a smart environment. This information can be used to perform automated assessment of the resident's well being. Ultimately, various automated

EDUCATION & TRAINING

QUICK FACTS

- Courses: Gerontechnology I (CptS 580 and Psych 507), Gerontechnology II (CptS 580 and Psych 507)
- Units: School of Electrical Engineering and Computer Science, Department of Psychology, Center for Advanced Studies on Adaptive Systems (CASAS) Lab
- Institution: Washington State University
- Instructors: Diane Cook, Maureen Schmitter-Edgecombe, and Larry Holder
- Level: Graduate
- URL: http://eecs.wsu.edu/~cook/gt

COURSE TOPICS

- Smart environments
- Sensors
- Networks
- Machine learning
- Activity recognition
- Aging and senses
- Aging and motor function
- Aging and speeded processing/attention
- Aging and memory
- Aging and executive function
- Caregiver burden/socialization
- Human factors
- Design for aging

interventions are designed with the goal of improving resident health and autonomy. These interventions are evaluated in the context of resident activities performed in residents' everyday settings, as Figure 1b shows.

To be better equipped to be leaders in the area of health-assistive technologies, graduate students in this program take a leadership course that teaches skills in time management, communication, and teamwork. The students work with two research advisors, one in their major discipline and one in a complementary field. They choose two thematic classes from a list that includes neuropsychology, machine learning, wireless networks, technology ventures, and engineering teaching and learning. Finally, each student takes a two-course sequence on gerontechnology.

GERONTECHNOLOGY COURSE SEQUENCE

We designed our gerontechnology course sequence to provide an introduction to the interdisciplinary topic (see the "Course Topics" sidebar). In the first class, faculty from engineering and psychology teamed up to introduce students to topics in both fields, and each class period was punctuated by discussions of how technology could be designed and used to better understand and address challenges that arise with aging. Throughout the semester, visitors provided unique perspectives on issues. These visitors included physicians who posed challenge problems to the students, a panel of area-wide caregivers who discussed the challenges they face, as well as experts on human factors and on architectural design for aging communities.

A unique feature of this class is that every assignment was carried out in multidisciplinary teams. Students were asked to complete two homework assignments, make a class presentation, and create design specifications and prototypes for group projects. Each assignment teamed at least one engineer with at least one nonengineering student.

In the first homework assignment, the engineering students participated in an activity-recognition experiment conducted in the on-campus testbed. With the nonengineers as consultants,

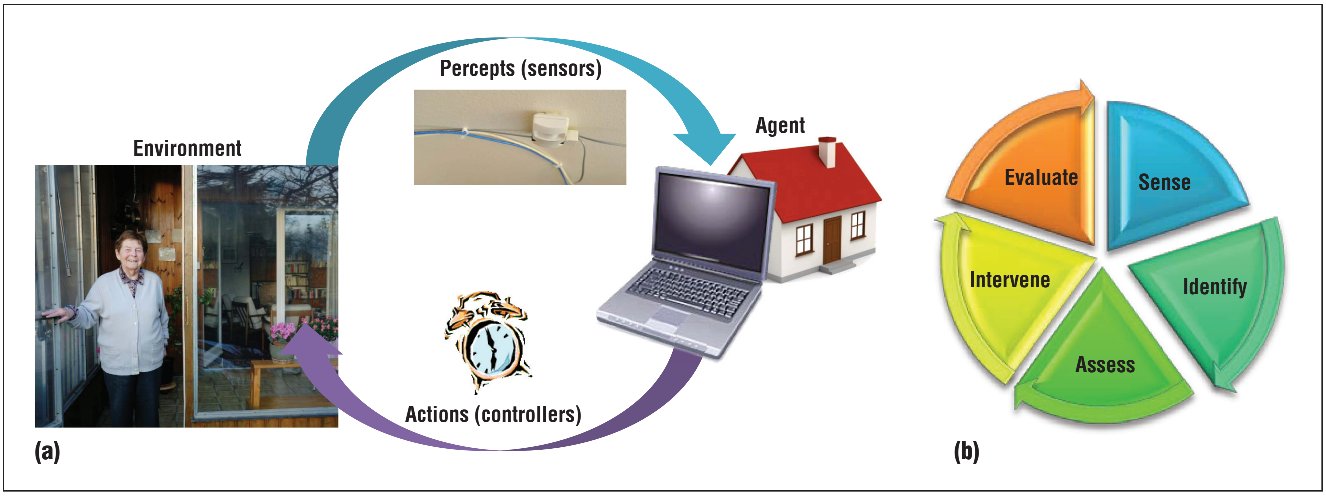

Figure 1. A smart environment (a) can be viewed as an intelligent agent and (b) performs health assistance through a cycle of sensing, identifying, assessing, intervening, and evaluating activities.

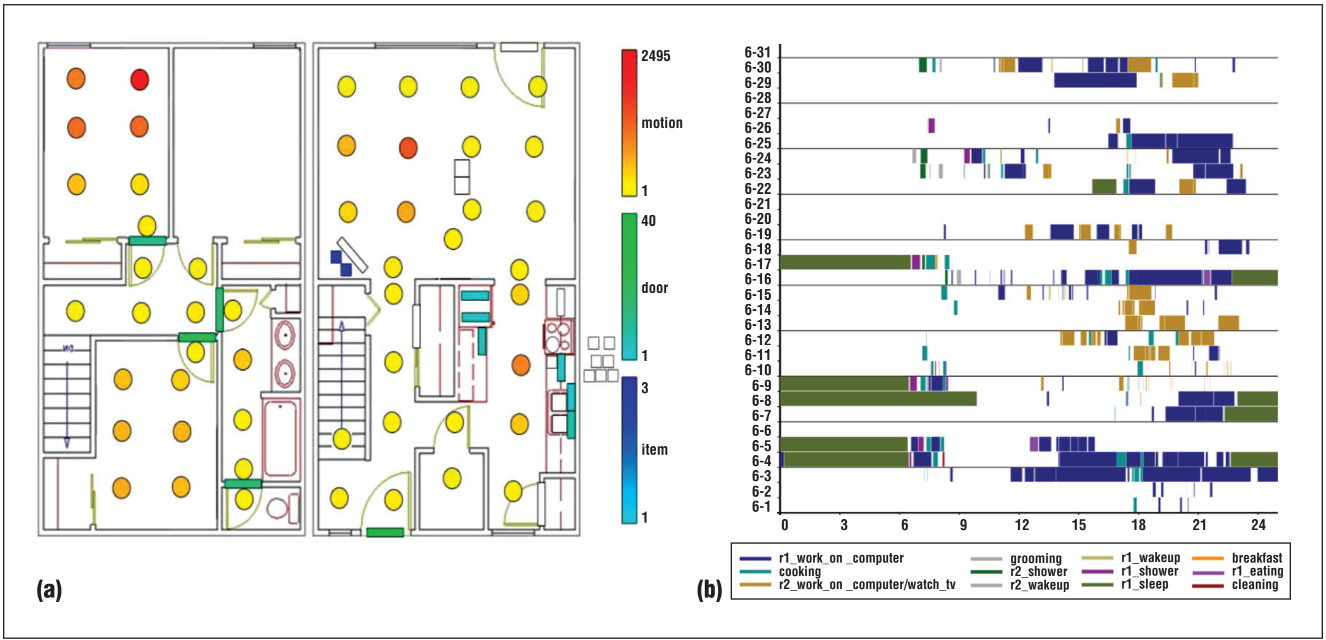

Figure 2. CASASViz shows (a) real-time or historic movements in the environment and (b) a time chart of automatically recognized activities that the resident performed.

the students summarized their observations regarding the experiment's realism and the technology's usability, and proposed next steps for the study. At the same time, the nonengineers downloaded and used computer software to apply activity-recognition algorithms to sensor data that was collected in the same testbed. With the engineers as consultants, the students answered questions about the performance of the various algorithms and the effect of varying conditions and parameter choices on the results.

The second homework assignment created new teams of students. In this case, the nonengineers spent 10 hours observing patients and therapists and providing assistance in one of several healthcare facilities in the area. With the nonengineer teammates as consultants, the students needed to answer questions about the types of challenges elder patients and caregivers faced and how technologies could potentially help with these issues. The nonengineer students used Weka, an open source data-mining toolkit, to perform machine-learning-based classification of individuals as Parkinson's or non-Parkinson's patients. With the engineer teammates as consultants, they answered questions about the types of features that could be used for various types of diagnoses and what types of machine-learning models were best-suited to these classification problems.

At the end of the first course in the sequence, students grouped themselves into multidisciplinary teams. Each team identified a technology and addressed a particular health problem, some specifically in response to challenges that visitors posed during the semester. During the second course, the teams implemented the technology, designed a study to evaluate the technology and obtained institutional review board approval (IRB), tested the technology with human subjects, and wrote up the findings in a form ready to be submitted as a paper. During this second course, experts visited the class to discuss the IRB process of approving experiments involving human subjects, to discuss issues related to intellectual property and copyright, and to introduce additional ideas and challenges for the student teams.

GROUP PROJECTS

A number of class projects emerged from the gerontechnology course sequence that address a spectrum of issues related to aging and health assistance. Here we highlight a few of these projects.

One of the team projects focused on designing a smart home visualization tool that gives caregivers a real-time or playback view of what and how residents are doing in their everyday spaces. Figure 2 shows two of the images produced by the technology. The psychology student in the group designed a measure to allow smart environment residents, scientists, and caregivers to provide feedback on the accessibility, usability, and ability to interpret the visualized information.

Another project that also focused on interfaces was the *Puck on a smartphone* project. In this project, activities are automatically predicted and recognized in a smart environment. When they don't occur as normal, the resident receives an audio and/or visual prompt via his or her mobile device to initiate the activity. If the activity is left incomplete, the resident receives

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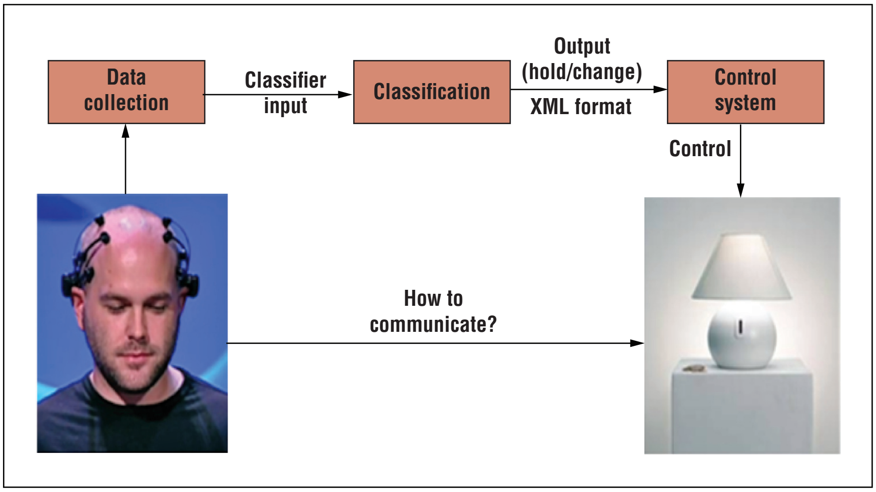

Figure 3. Machine learning can be used to map electroencephalogram (EEG) readings to command choices. Wireless device control can then be employed to control devices consistent with these commands.

a prompt to complete the remaining steps.

Two of the projects use recent technology in electroencephalogram (EEG) monitoring to provide emotional assessment and thought-based control of devices in a smart home (see Figure 3). This technology would be particularly valuable to individuals with physical limitations that make it difficult to live independently in their own homes.

Two other group projects provide assessment information for Parkinson's patients and their doctors. These projects were designed in response to challenges posed by class visitors. The first project provides quantification of tremor severity using sensors attached to a patient's hand (see Figure 4a). The second quantifies how an individual stands and walks to provide detailed gait analysis (see Figure 4b). This project relies on shoe inserts with a grid of sensors that collect information while patients stand, turn, and walk.

The final project combines student backgrounds in computer science, clinical psychology, and neuroscience. The group hypothesizes that there is a relationship between evoked neural and hemodynamic responses, cognitive function, and age. The project combines electrophysiological and optical-imaging techniques with neuropsychological tests to determine the state of an individual's neural response and his or her level of cognitive function. Machine-learning techniques are intended to predict cognitive performance and age based on cerebral responsiveness.

CHALLENGES AND BENEFITS

Teaching a multidisciplinary class, like taking a multidisciplinary class, is challenging. All of the professors must balance discussions to not overly emphasize material with which students are familiar, but at the same time give an understandable introduction to students outside the field. At the beginning of the semester, all of the students were nervous about working outside their fields, or comfort zones. Through the team-based assignments and group projects, the students felt that they realized a substantial benefit from thinking about issues from new viewpoints and working with students in other disciplines. The engineering students were able to get a personal view of the individuals who need the technologies, and students outside of engineering were exposed to a wealth of ideas that can help them with data collection, analysis,

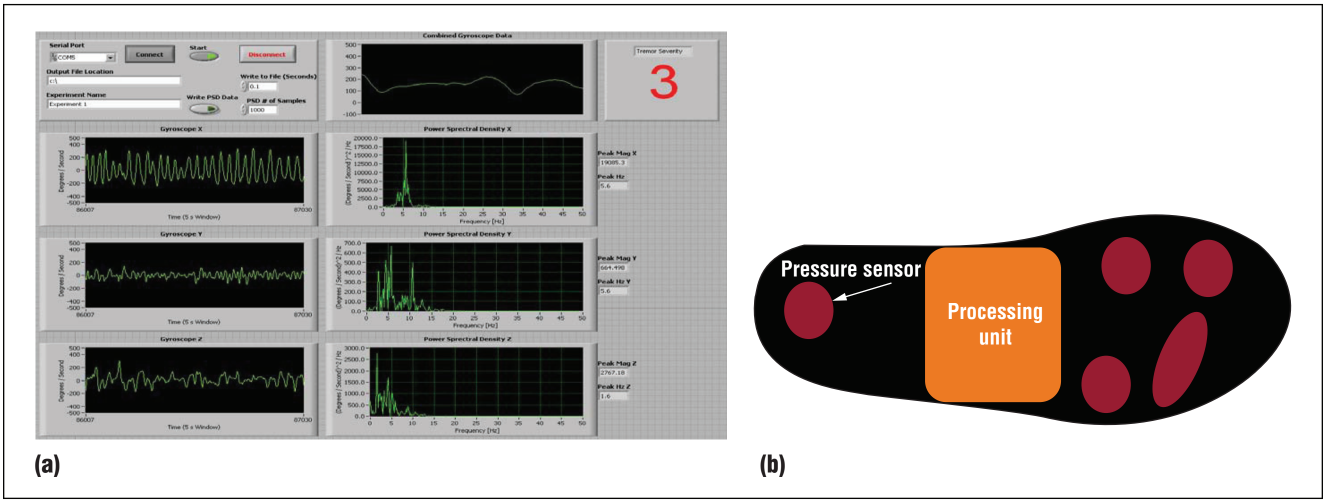

Figure 4. Two other group projects—(a) tremor analysis and (b) gait analysis—help physicians diagnose and assess the effectiveness of treatments for Parkinson's patients.

and interventions for target populations. Student evaluations of the course included quotes such as “It was the first multidisciplinary class that I’ve taken and I learned to work with students from different majors,” and “New interesting topics, presented ideas from angles I have not thought of before.”

Throughout the course sequence, students began to take increasing interest and ownership of the ideas. Breaking down the barriers of an individual field allowed them to expand their creativity. We also feel that this process will help the students become greater leaders in the real, and inherently multidisciplinary, world.

ACKNOWLEDGMENTS

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