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Editors' Corner

The e-Health Technical Committee of the IEEE Communication Society (ComSoc) has launched a global eHealth newsletter, which provides a platform for information sharing on technology advancement, national eHealth policy, service deployment and venture investment, as well as collaboration opportunities in the eHealth area. The second edition of the newsletter brings to you the *first-of-its-kind* independent living facility in "CoMO," in the USA.

- Aravind Kailas (UNC Charlotte, USA) and Nazim Agoulmine (University of Evry, France)

University of Missouri Eldertech Research at TigerPlace

Marjorie Skubic, Director, Center for Eldercare and Rehabilitation Technology and Professor, Electrical and Computer Engineering, University of Missouri, Columbia, MO 65211, E-mail: skubicm@missouri.edu

Many senior citizens want to postpone or even avoid nursing home care, instead preferring to remain in their own homes, or *age in place*. An interdisciplinary research team at the University of Missouri (MU) has been investigating technology to support aging in place in a unique housing facility called TigerPlace (Figure 1). State legislation enabled the construction of TigerPlace, built by Americare Systems, Inc. in collaboration with the MU Sinclair School of Nursing: a state of the art independent living facility, built to nursing home standards, licensed as intermediate care so people can use long term care insurances, and operated as independent housing with 54 apartments in Columbia, Missouri. The eldertech research team, now led by the Center for Eldercare and Rehabilitation Technology in the College of Engineering, is successfully engaged with key researchers from the Schools of Nursing, Medicine, Social Work, Health Management and Informatics, Health Professions, and others at MU.

Figure 1: The TigerPlace Aging in Place Facility

In-Home Sensor Networks with Health Alerts

Sensor networks have been installed in TigerPlace apartments since Fall, 2005, totaling nearing 50 apartments for an average installation time of about two years. The suite of sensors includes motion sensors, a stove sensor, and a bed sensor capturing restlessness, and low, normal, and high pulse and respiration rates [1]. An integrated monitoring system captures data about the residents and their environment in a noninvasive manner [2]. Algorithms have been developed to extract patterns of activity from the collected sensor data and generate alerts that indicate a potential health change. The system acts as a decision support system, alerting clinical staff to potential health problems very early so that early interventions can be offered when problems are still small [3-4]. The team has also evaluated the usability of the interfaces and investigated the acceptability of the technology by seniors [5]. Figures 2-3 show examples of sensor data displays and illustrate changes in patterns that follow health changes.

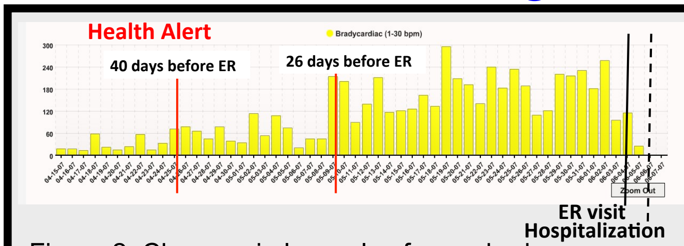

Figure 2: Changes in low pulse from a bed sensor leading up to an emergency room visit and hospitalization.

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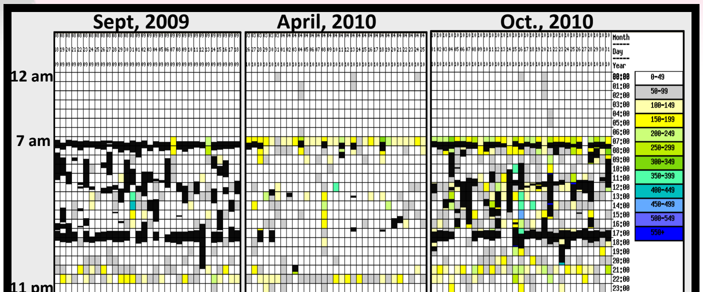

Figure 3: Motion density maps showing a changing lifestyle due to decline and then improvement after an intervention.

In a recent NIH study, the team showed statistically significant differences in health outcomes between a control group and an intervention group in which health alerts (based on sensor data) were automatically sent to nurses [6]. Nurses rated the clinical relevance of the alerts and their potential in aiding early interventions; this information has been captured in a database for future development of the health alert algorithms [7].

The MU eldertech team has also developed a new hydraulic bed sensor, placed under the bed mattress, that captures quantitative pulse and respiration rates as well as bed restlessness [8-9]. Algorithms automatically separate the ballistocardiogram heart signal from the respiration signal to compute pulse and respiration rates. This innovative bed sensor is being integrated into the health alert system deployed at TigerPlace. The hydraulic bed sensor provides more finely grained information for detecting changes in sleep patterns and physiological signals that may indicate changing health conditions.

Passive Fall Detection and Gait Analysis for Fall Risk Assessment

One in every three people age 65 or older falls each year, making falls the most common cause of injuries and hospitalizations for trauma in older adults and the leading cause of death due to injury. The MU eldertech approach to fall detection does not require the client to wear anything, push any buttons, or charge any batteries. Rather, the team is investigating sensing that can be embedded in the environment, including vision, depth images (e.g., from the Kinect), acoustic arrays, and radar [10-12]. Likewise, fall risk assessment is accomplished through daily monitoring in the home, also using sensing installed in the environment [13-16], to capture gait changes that may indicate problems in physical or cognitive health. Figure 4 shows a Kinect sensor installed in a TigerPlace apartment and an example of the 3D point cloud model constructed from the Kinect depth data. Gait parameters are extracted from the 3D point cloud model and tracked to detect changes in the gait pattern [17].

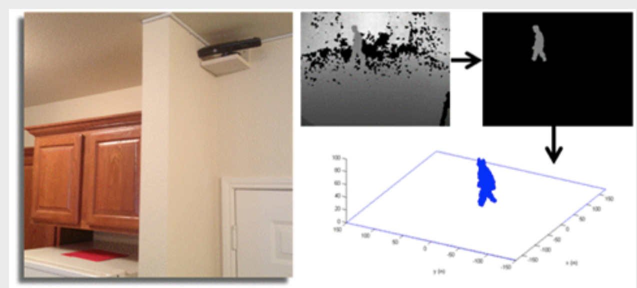

Figure 4: A Kinect sensor installation with a 3D model constructed.

Sensing systems are rigorously studied in the lab with a motion capture system for validation. Stunt actors are trained to fall in 21 different falls typical of older adults and then act out the falls for data collection. Volunteers aged 20 to 90 have participated in studies that have validated the measurement of fall risk parameters such as walking speed, stride time, stride length, sit to stand time, and body sway. The approach is being tested in TigerPlace apartments with a two-webcam voxel system, the Kinect, and the radar system. Gait parameters are captured automatically as residents walk around the home during their normal, daily activities. These systems have been installed in ten TigerPlace apartments and will remain in place for two years; data are collected monthly with the residents on fall risk instruments and with stunt actors for falls to provide ground truth in the home.

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IEEE COMMUNICATIONS SOCIETY

e-Health Technical Committee

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Alzheimer's Association, and RAND Health [18]. In a recent project funded by the NSF, the sensor network and health alert system has been installed in a 100 year old senior housing building in Cedar Falls, IA. This deployment in 15 apartments, which includes motion sensors, the new hydraulic bed sensor, and the Kinect gait analysis system, will further test the sensor-based health alert approach coupled with remote care coordination.

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