J.L. Fozard, W.D. Kearns (Conveners). Where and how are you?: Location aware technologies to assess gait and everyday activities. Gerontechnology 2010;9(2):87; doi:10.4017/gt.2010.09.02.028.00 **Participants:** *A. Glascock (USA), A. Milhailidis (Canada), M. Skubic (USA), J. Craighead (USA), and P-C. Tuan (Taiwan), discussant.* **ISSUE** Aging in place incurs hazards of poor mobility related to old age and dementia. This symposium informs on technology-based measurement systems to assess gait changes in everyday living environments and clinical gait assessments. The research goal is to provide a basis for preventive or compensatory interventions supporting continued functional independence. **CONTENT** The technologies discussed include passive and active motion detectors, devices distinguishing multiple moving individuals, cameras, gait mats, accelerometers and video cameras. Placing these presentations in a single forum illustrates the various roles these technologies play in data collection and service systems. It also illustrates several approaches to addressing reliability, validity and privacy issues unique to monitoring a person's movements. **STRUCTURE** Drs. Glascock and Kutzik describe a system to monitor time required to ascend and descend stairs in a home using motion detectors at the top and bottom; their videoconference presents inter- and intra-day variability data. Dr. Mihailidis will describe an intelligent emergency response and health monitoring system (HELPER) using computer vision and speech recognition to monitor activity levels and spontaneous adverse events. Mihailidis describes work in progress for machine learning of everyday patterns, such as sleeping, kitchen and hygienic activities, so deviations from typical routines can be automatically detected. Stone, Anderson, Skubic and Keller describe a system that extracts and visualizes footfalls using bicameral silhouettes monitoring a person walking, from which a 3D Voxel reconstruction, provides footfall and gait parameters. The presentation compares the Voxel and GAITRite mat results and presents Voxel data gathered in unstructured settings with the ultimate goal of providing continuous movement monitoring in home environments. Drs. Craighead and Jasiewicz will describe a prototype system being developed by the Veterans Administration that simplifies formal gait and balance assessments with precision beyond existing technology. Dr. Pan-Chio Tuan, chairman of the Department of Herontic Technology and Service Management at Nan Kai University of Technology in Taiwan is the discussant. **CONCLUSION** The presentations highlight advances in location aware technologies to monitor movement patterns in home settings and formal gait and balance assessments. The overall goal is to relate long and short term changes in movement patterns to changes in health.

Keywords: location aware technologies, human movement patterns, gait and balance

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A.P. Glascock, D.M. Kutzik. The use of behavioral monitoring to determine changes in human movement over time. Gerontechnology 2010;9(2):87-88; doi:10.4017/gt.2010.09.02.029.00
Purpose The authors have undertaken research over the last decade on the monitoring of everyday activities in the residences of elderly and chronically ill individuals living in a variety of residential settings. The research has focused on the ability of a non-intrusive behavioral

monitoring system, that the authors had developed from a prototype (Everyday Living Monitoring System—ELMS) to a commercialized product, (GE-QuietCare) to determine variation from normal behavior on the part of the individual that could indicate a change in functional status. The system uses trend analytical algorithms to interpret sequential firing of motion detectors to first determine 'normal' behavior for the particular individual and then alerts care providers to variation in the behavior, for instance, changes in the number of overnight bathroom visits. Since the monitoring system was intended, from its inception, to be a means for care-givers to have more timely and accurate information upon which to base care decisions, the system did not and does not deal directly with issues of gait and human movement. **Method** However, following the approach of Powell Lawton in relation to activities of daily living, our system is able to determine 'footprints' that indicate the accomplishment of specific task oriented behaviors, for instance, meal preparation, getting out of bed. Thus we have been able at various stages of our research to draw some conclusions about gait and overall movement of individuals in their own residences. The remainder of this presentation is a discussion of how a specific example of the monitoring system can be used to assess changes in human movements. The particular example is taken from the earliest stages of the research when a prototype of the ELMS was employed in a series of residences to test the system's reliability and validity. As part of this testing period, an experiment was set up to find out if it was possible to use the system to determine changes in the amount of time an individual took to accomplish a specific task. Several tasks were considered—the time taken for an individual to get dressed or to prepare a meal—but each proved too complicated to monitor with any degree of reliability and validity. The task that was eventually selected was walking up and down stairs, primarily because it was discrete and, as a result, relatively easy to monitor through the use of two of the system's motion detectors, one being placed on the top and the other on bottom steps of the given stairway. This allowed the determination of the time it took the individual to walk up or down the steps and additionally allowed us to compare these times both during a single day and across days. Very quickly, we were able to determine when a person had a 'bad' day, i.e., the individual took longer to walk up the steps than 'normal' and even to see how the individual became tired during a single day, i.e., the times increased as the day continued.

Keywords: behavioral monitoring, task oriented behavior, human movement

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A. Mihailidis. An intelligent fall detection and personal emergency response system to help keep seniors safe at home. Gerontechnology 2010;9(2):88-89; doi:10.4017/gt.2010.09.02.030.00

Purpose Globally, older adults constitute the fastest growing population group. As such, finding ways of supporting older adults who wish to continue living independently in their own homes, as opposed to moving to a long-term care facility, is a growing social problem. However, the goal of 'aging-in-place' is becoming increasingly difficult as an increasing number of older adults are living alone in their homes (often in rural areas), and as the proportion of this population with a cognitive disability such as dementia increases. The goal of this project is the development of intelligent systems and smart homes that support the wellness of older adults and aging-in-place. Specifically, this presentation will provide an overview of the design approach and philosophy that is currently being applied by the Intelligent Assistive Technology and Systems Lab (University of Toronto, Canada), and a specific technology, the HELPER, which has been developed employing this design approach. **Method** The HELPER is an intelligent emergency response and health monitoring system. Using computer vision and speech recognition, this system monitors the activity levels of an older adult, including the occurrence of spontaneous adverse events, such as falls. In the case of an adverse event, the system automatically decides on the level of response that is appropriate based on a simple exchange of yes/no answers and questions with the user. The system also attempts to learn the patterns of living of an occupant by monitoring the high-level completion of various activities and tasks, such as using the washroom, sleeping, tasks within the kitchen and leaving the home. **Results & Discussion** Based on sensing these activities and simple statistical models the system learns the typical times of the day and frequency of completing these different tasks. If a significant deviation from the user's 'typical day' is detected an alert is raised by the system.

Keywords: fall detection, artificial intelligence, aging-in-place, computer vision, sensing
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E. Stone, D. Anderson, M. Skubic, J. Keller. Footfall extraction and visualization from Voxel data. Gerontechnology 2010;9(2):89; doi:10.4017/gt.2010.09.02.031.00 **Purpose** Older adults are living longer and they want to remain in their homes as long as possible[1]. This creates a need for passive monitoring of physical activity for the purpose of detecting functional decline as well as assessment of risk for catastrophic events such as falls. Prior research has been done in using anonymized video data for passively monitoring physical activity of older adults[2,3]. Furthermore, recent research has indicated that video data anonymized by creating silhouettes, alleviates privacy concerns of older adults[4]. Studies have shown significant correlation between walking speed and physical function[5]. However, current gait assessment tools generally require the explicit evaluation of a person's gait by an individual through observation or the use of expensive equipment. Additionally, previous work on measuring gait parameters using silhouettes has not included a method for visualizing footfalls during a walking sequence[2], which may provide additional insight during gait analysis. We present a method for extracting and visualizing footfalls using silhouettes obtained from multiple cameras. Two inexpensive cameras are used to obtain silhouettes of an individual walking, from which a 3D reconstruction, termed Voxel person, is built. Footfalls are extracted from the Voxel model for quantitative analysis and visualization. Our method is validated against a GAITRite mat[6] using gait parameters. **Method** Participants were asked to walk on a GAITRite mat, while simultaneously being monitored by our camera system. Footfalls were extracted from the Voxel model constructed using our camera system and validated against the corresponding footfalls obtained from the GAITRite mat. Participants ranged from elderly residents to young adults, giving a diverse set of gait patterns. Footfall data obtained from the two systems was compared visually and quantitatively using gait parameters of walking speed, stride length, step length, and step time. Our method was also tested in non-structured environments, without the GAITRite mat. **Results & Discussion** Results showed significant agreement between footfalls extracted using our camera system and those obtained from the GAITRite, both visually and in a quantitative comparison of gait parameters. Further work will examine the relationship between footfall data obtained during explicit evaluation (with the GAITRite), and continuous monitoring in a home environment; along with its impact on fall risk assessment.

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Keywords: gait analysis, computer vision
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J. CRAIGHEAD, J. JASIEWICZ, S. HART-HUGHES. *Integration of heterogeneous sensor systems into an easy-to-use mobility assessment tool. Gerontechnology 2010;9(2):90;*
doi:10.4017/gt.2010.09.02.032.00

Purpose The clinicians within our research center at the James A. Haley Veterans Hospital have expressed the need for mobility assessment tools that provide objective measures that are more accurate than the standard stopwatch and pre-measured distance that are currently used in practice today. There are several devices on the market that aim to provide these measures such as the thoroughly tested GaitRITE[1-4], however, they are not used in clinical practice for several reasons: cost, setup time, space requirements, and the need for extensive specialised training. These existing devices have been primarily designed by a team of engineers and researchers with little to no feedback from clinical users. The resulting systems are too complex to use practically in a clinical setting where clinician-patient time is measured in minutes, not hours as is with research. To remedy this problem we are developing a suite of portable sensor systems that provide only the necessary clinical information and require a setup time of less than 5 minutes.

Figure 1. A screen shot of the iPod interface for a balance measurement test

Results & Discussion The design process has involved VA clinicians from the planning stages and has resulted in a prototype gait and balance measurement tool that our clinicians want to use in their daily practice and can be used along with existing, accepted clinical measurements of gait and balance to provide objective measures beyond time-to-complete a given test. The tool is based on miniature wireless attitude-heading reference systems (AHRS) that are available commercially. The AHRS devices are placed on a patient's back and feet and transmit their orientation and acceleration data to a small computer which analyses the data and sends a summary for a given test to the clinician's iPod Touch or iPhone. In a forthcoming prototype the sensors will communicate directly with the iPod Touch or iPhone, eliminating the need for a computer, thus creating a truly portable gait and balance analysis system that can fit in a clinician's pocket.

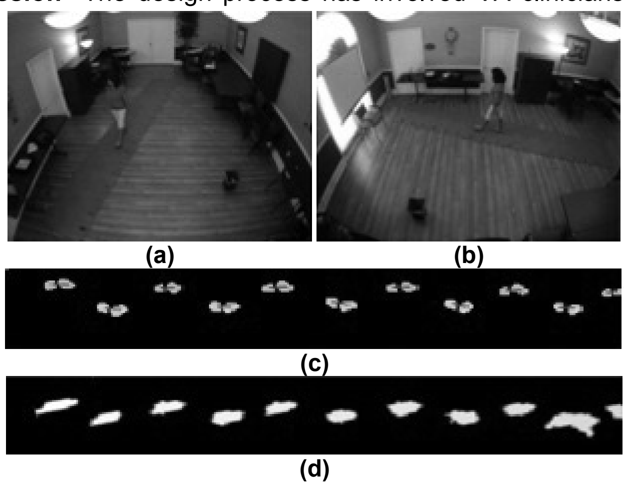

Figure 2. Footsteps from the GAITRite and from Voxel person. (a) and (b) Sample images from two cameras; (c) Footsteps obtained from the GAITRite sequence; (d) Corresponding footsteps from Voxel person

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Keywords: gait and balance, portable assessment tool
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