Digitally Augmented Homes: Telehealth for Smart Homes

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• Introduction/ Definitions
• Examples
• A Case Study
• Discussion
Smart homes

• Origins of the concept in the late 1970s and the 1980s: “intelligent buildings” designed to improve energy efficiency and ventilation

• Such an infrastructure can be customized to address neurological and/or cognitive disorders in the elderly or disabled population, and enhance residents’ ability to function independently within their home setting.
Smart home

- A residence with embedded technology that facilitates passive monitoring of residents to enhance their safety, independence and well-being
Hierarchy of home functionality

- Homes which contain intelligent stand-alone objects
- Homes which contain intelligent, communicating objects
- *Connected* homes
- *Learning* homes
- *Attentive* homes

“The Aware Home at Georgia Tech is a three-story, lime-green-and-white house with a computerized brain - a vast network of intertwined sensors, cords, and computers, all designed to unobtrusively enhance the life of its lucky occupants.”
Aware Home: Technologies

- Gesture pendant that allows wearers to use simple gestures to control electronic devices
- Digital portraits to connect family members to their senior relatives
Practical Indoor Sensing

- Floor mats
- Room-level positioning
TigerPlace

- Interdisciplinary team of researchers (nursing, health informatics, computer engineering, social work)
- Focus on:
  - gait analysis
  - falls
  - activity levels
  - sleep
Technology

- Bed sensor
- Stove sensor
- Sensor mat
- Motion sensors
- Video sensors*

Sept. 2006

Oct. 2007
Functions of a smart home

- Physiological monitoring
- Functional monitoring/ Emergency detection and response
- Safety monitoring and assistance
- Security monitoring and assistance
- Social interaction monitoring and assistance
- Cognitive and sensory assistance
HEALTH-E

http://www.health-e.info
Background

- Older adults vary in the development and progression of chronic disease and decline at varying rates in areas of well-being.
- Efforts to date have addressed a single aspect of older adults' wellness.
- Holistic approach to wellness is needed.
- Technology applications have the potential to introduce tools that enable non-obtrusive monitoring and assessment wellness.
Theoretical Framework: Wellness

- Social support and network, perception of isolation
- Vital signs, quality of life, instrumental activities of daily living, gait characteristics
- Social well-being
- Physiological/functional well-being
- Mental/cognitive well-being
- Spiritual well-being
- Spiritual behaviors and beliefs, views on guidance and meaning
- Mood, quality of life, response time, working memory, task shifting, planning
Phase 1 Study Aims

• test an integrated monitoring system for wellness that utilizes diverse and innovative technologies
• utilize existing hardware systems that can be easily installed in a community setting
• assess issues of acceptance and usability
Subjects and Setting

• Eligibility criteria included:
  – age of 62 years or older
  – residents of an independent retirement community
  – independent in activities of daily living (ADL)
  – able to provide written informed consent

• Setting:
  – Community room
Technologies

- Telehealth Kiosk
Technologies (cont.)

• *CogniFit*
  – a brain fitness web-based software solution
  – assessment and over time the improvement of several key cognitive abilities
  – tested for reliability and validity
Procedures

– Initial visit (informed consent, demographic information, baseline assessment)
– Participants come to community room:
  • 3 times a week provide cognitive assessment data (approx. 20 minutes per session)
  • Weekly to use telehealth kiosk
– Exit questionnaires
– Focus group
Methods: Assessment Technologies

Telehealth kiosk

HealthAnywhere database

Exported datasets

Cognitive Function software

CogniFit database

Exported datasets

Study database

Algorithms for correlations and pattern extraction
Results: Sample

- 27 subjects
- 9 male and 18 female
- Average age 88.2 years (Range 78-94)
- Educational level:
  - Graduate degree 13 (52%)
  - Undergraduate degree 8 (32%)
  - Community college 3 (12%)
  - High school 1 (4%)
- Experience with computers:
  - Highly comfortable 3 (12%)
  - Moderately comfortable 13 (52%)
  - Slightly comfortable 7 (28%)
  - No experience with computers 2 (8%)
Results: Technology Adaption

• Adjustments needed to maximize usability for participants with various health conditions
• Assistance needed decreased over time; users became independent in short time
• Monthly reports were useful to some participants
• Visualization focus groups revealed diverse preferences for personal wellness records
Results: Focus Groups

• Positive attitudes towards wellness assessment
• Acceptance of technologies
• Alerts and reports led to changes in individual plans of care
• No privacy concerns
• Some participants self-monitored parameters (e.g. blood pressure, weight) at home prior to enrollment.
• Want to know how they could positively influence wellness on individual level (e.g. specific interventions) and how they compared to peers
My Wellness in October 2011

My Wellness Score Is

- PHYSICAL: 78
- COGNITIVE: 82
- SOCIAL: 95
- SPIRITUAL: 71

My progress over the last 12 months

Doctor's Note
Results looking good!
Oct 21, 2011
Hi Laura, I just reviewed the CT result and looks good to me...

Calendar
TODAY
- Jane’s Birthday: 4:30 pm Hair Cut

TOMORROW
- 6 pm Jane’s Birthday Party

Next Week
MONDAY
- 10:30 am Doctor’s Appointment
- 12 pm Lunch with Paul, Harry...

TUESDAY
- 7 pm Movies night

THURSDAY
- 8 pm Happy Hour

FRIDAY
- 11 am Lunch with Amy, Sam
- 3 pm Shopping

Messages
- Re: Happy Birthday Jane
  27 mins ago
  Thanks, Laura :) I am having a wonderful day. Are you comi...
My Wellness in October 2011

Wellness Score: 81.5

My Age Group: 65

Wellness Score: 74.2

My Community

Previous month: October 2011

Next month:

My wellness progress over the 6 months period:

- May 2011: 63
- Jun 2011: 53
- Jul 2011: 67.5
- Aug 2011: 73
- Sep 2011: 81
- Oct 2011: 81.5

Doctor’s Note:
Results looking good!
Oct 21, 2011
Hi Laura, I just reviewed the CT result and looks good to me...

Messages:
Re: Happy Birthday Janet
27 mins ago
Thanks, Laura :) I am having a wonderful day. Are you comi...
My Wellness in October 2011

Wellness Score
65
Wellness Score
81.5
Wellness Score
74.2

My Age Group
ME
My Community

My wellness progress over the 6 months period

63 53 67.5 73 81 81.5

Doctor's Note
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Next Phase: Sensor Study

- Stove sensor
- Motion sensors
- Hydrosense
- Electrosense
Evaluation framework

• Cost
  – Installation
  – Testing
  – Customization
  – Maintenance
  – Sustainability
  – Human Resources

• Early Detection and Intervention
• Accuracy of Sensors and other Devices
• Acceptability
• Extent to which design addresses functional limitations and health care needs
• Ethical concerns
Obtrusiveness

• A summary evaluation by the user based on characteristics or effects associated with the technology that are perceived as undesirable and physically and/or psychologically prominent

Obtrusiveness Framework

Physical Dimension
- Functional dependence
- Discomfort or strain
- Excessive noise
- Obstruction or impediment in space
- Aesthetic incongruence

Usability Dimension
- Lack of user friendliness or accessibility
- Additional demands on time and effort

Privacy Dimension
- Invasion of personal information
- Violation of the personal space of home

Function Dimension
- Malfunction or sub-optimal performance
- Inaccurate measurement
- Restriction in distance or time away from home
- Perception of lack of usefulness

User Perception of Obtrusiveness

Human Interaction Dimension
- Threat to replace in-person visits
- Lack of human response in emergencies
- Detrimental effects on relationships

Self-concept Dimension
- Symbol of loss of independence
- Cause of embarrassment or stigma

Routine Dimension
- Interference with daily activities
- Acquisition of new rituals

Sustainability Dimension
- Concern about affordability
- Concern about future needs and abilities

Obtrusiveness Dimensions

• Physical
  – Physical aspects of a technology and their effects on users or the home environment

• Usability
  – Accessibility for users and the additional demands on time and effort associated with using a technology

• Privacy
  – Informational and physical privacy of the individual

• Function
  – How the equipment works, including its perceived reliability and effectiveness

Obtrusiveness Dimensions

- **Human Interaction**
  - Negative effects on human interactions, responses, or relationships

- **Self-concept**
  - Self perception as physical, social, and spiritual or moral being and how you think you are perceived by others

- **Routine**
  - Effects on users’ daily routines or rituals and/or the acquisition of new ones.

- **Sustainability**
  - Concerns about keeping or maintaining the technology in the future related to affordability or their own functional ability

Privacy
Challenges

• Privacy and Confidentiality
• Accessible Design
• Reimbursement
• Promoting dependency rather than supporting independence
  – Reduction of social contact
  – Substitute personal forms of care and support
  – Over-reliance on automation
Discussion

• a shift from institution-centric to patient-centric care
• New set of opportunities and challenges in the home
• The home in the context of the quantified self
Contact

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