Remote Monitoring of Older Adult's Daily Routines: A Case Study

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Motivation

The boom of in-home monitoring technology offers unprecedented information about in individual's interaction with the environment, as they experience changes in health.

Participation in everyday activities may change as the older adults experiences illness symptoms and adverse health events.

Routine – an established and predictable sequence of behaviors repeated over time, linked to sleep quality, functional status.

Deviation from an individual's "baseline" may signal a change in health.

Smart home - living space equipped with various sensors

Tool for unobtrusive long-term monitoring of daily routines

Research question: What parts of the daily routine are most sensitive predictors of functional decline that precedes adverse health events, as measured by the smart home technology?

Methods

Setting: TigerPlace, an aging-in-place facility in Columbia, MO. a collaborative, interdisciplinary research project between the Schools of Nursing and Engineering/Computer Science.

Sample: 87 year old female with history of hypertension, Afib, macular degeneration, hypothyroidism.

Data Collection: 2 months prior to hospitalization and death (November 2013-January 2014)

Clinical Context – EHR assessments, nursing notes

Falls, primary care visits, reported symptoms

Baseline SF-12, ADL/IADL, MMSE, GDS

Smart Home Apartment – PIR motion sensors (Fig.5, top), Microsoft Kinect depth sensor (Fig.5, middle), hydraulic bed sensor (Fig.5, bottom)

Features of daily routine: frequency, timing, duration of activities in 4 apartment regions (Fig. 2)

Analysis: Descriptive exploratory case study

Semi-automated sensor data pre-processing (Fig.3)

Visual time series analysis of routine features (Fig.6)

Results

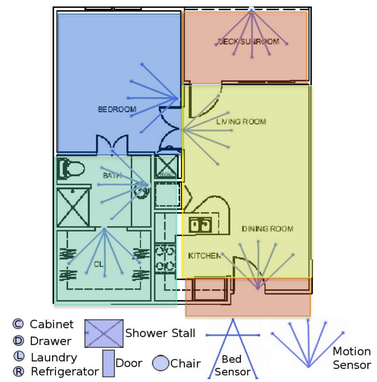


Figure 1: Typical TigerPlace apartment floor plan with the locations of various sensors.

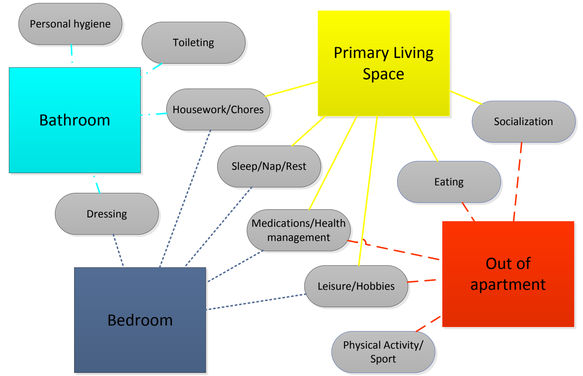
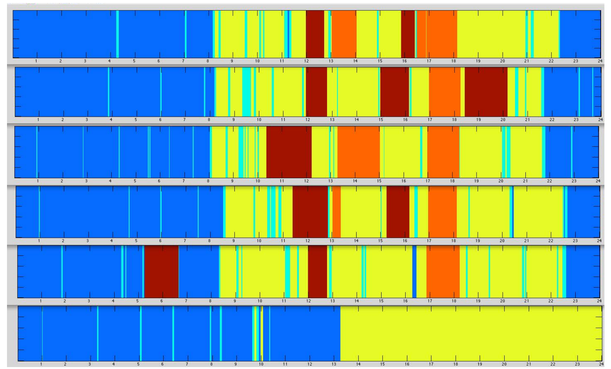


Figure 2. Apartment regions and daily activities that occur in those spaces.



Note: bedroom - blue; bathroom – teal; living room – yellow; out of apartment – orange/red.

Figure 3: Routine activity for 6 days before hospitalization leading to death (each band is a 24 hour period 12am-12pm)

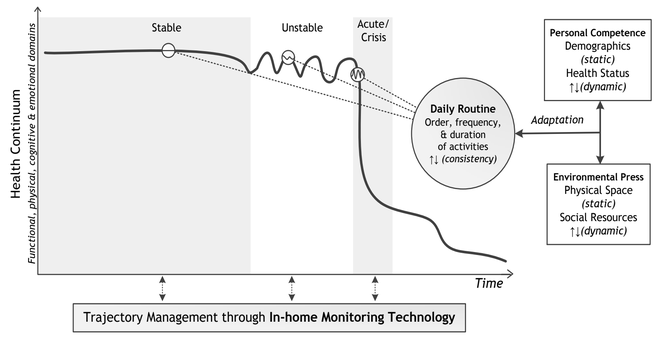


Figure 4: Proposed Theoretical Model for the Health Trajectories of Daily Routines over time and relationship to person-environment interaction.

Figure 5: Sensors used for monitoring activity.

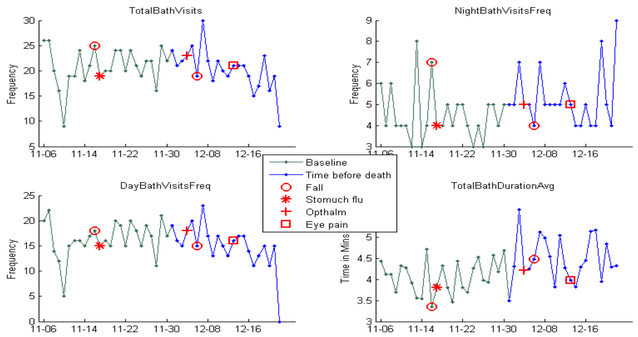


Figure 6: 2-month trajectory of daily routines: frequency and duration of bathroom visits. Overlaid are reported symptoms from nursing notes (red).

Discussion

Abrupt changes in time spent in bedroom may signal a need to monitor the individual more closely to assess the reason for the change and to intervene.

Long term changes in bathroom activity parallel the deteriorating functional status of the resident.

Monitoring daily routines with smart home technology can capture short-term (acute) changes and long-term trajectories of health.

Implications

Smart home technology is a low-cost, automated, unobtrusive tool to detect changes in daily routines that coincide with older adult's health trajectory.

It can help healthcare providers in selecting **timely and appropriate interventions** to promote independence and function of older adults.

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Defining Daily Routines