CASASviz: Smart Home Web-based Visualizer System for Care-giving

Chao Chen, Prafulla Dawadi, and Han-yun Tseng

{cchen, pdawadi }@eecs.wsu.edu, hanyun.tseng@email.wsu.edu

School of Electrical Engineering and Computer Science, Department of Human Department

Washington State University

Introduction

It has been a long-lasting interesting in developing in-home based technology to improve the quality of care-giving systems, and in turn, to prolong the ability of older adults to live independently at home and avoid institutionalization. To assist older adults and people with disabilities to live independently, smart environments have become a very popular research area. In order to understand all the information of the smart environments, the goal of the current project is to improve the accessibility of smart environment technology to the public by creating a user-friendly, visualized interface to represent the information gathered from smart home technology .

CASASviz System Architecture

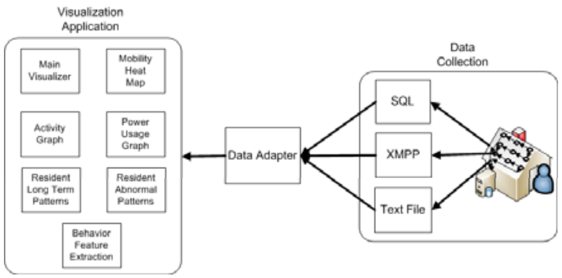

Figure 1 System Architecture of CASASviz system.

Data Collection in CASAS Smart Environment

As shown in Figure 2, to track people's mobility, we use motion sensors placed on the ceilings. The circles in the figure stand for the positions of motion sensors. They facilitate the residents who are moving through the space. A simple power meter records the amount of instantaneous power usage and the total amount of power which is used. An in-house sensor network captures all sensor events.

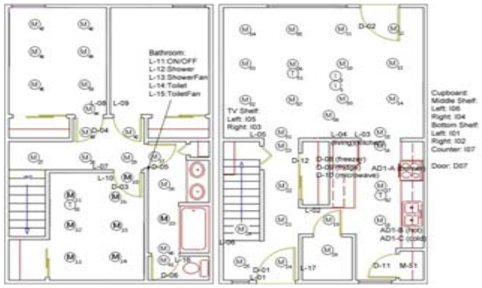

Figure 2. Three- (T), water (W), burner (B), telephone (P),and item (I)) bedroom smart apartment used for our data collection. (motion (M), temperature

Multi-Platforms Compatibility

CASASviz is a web-based visualization system to represent and explore residents' behavior patterns in our CASAS smart environment. To implement CASASviz, we make use of Scalable Vector Graphics (SVG) , which is an application of XML-format that makes it possible to describe two-dimensional vector graphics. SVG graph is compressible, scalable, and can be zoomed without degradation. To be compatible with different platforms, we use web-based technologies to implement the CASASviz system. Thus, CASASviz can be used on Windows, Linux, and even smart phones without worrying about compatibility. Figure 3 shows the CASASviz interface on an iPhone device.

Figure 3. The interface of CASASviz on an iPhone platform.

DATA ADAPTER MODULE

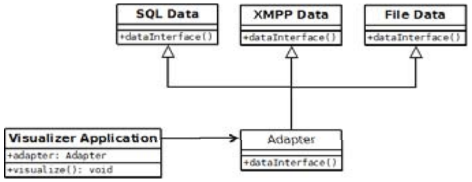

Figure 4. Data Adapter module expressed in UML.

Since there are three different data sources assessed to our CASASviz, we develop a Data Adapter module to translate three different original data formats to a compatible interface for various visualization applications. As shown in Figure 4, we use the adapter pattern expressed in UML to implement the Data Adapter module in our CASASviz system.

Visualization Application Module

1.Main Visualizer

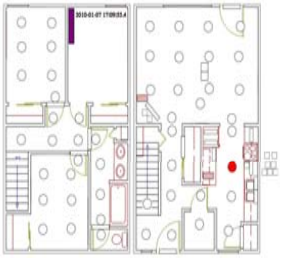

Figure 5. CASASviz main visualizer interface.

Figure 5 shows the interface of our CASASviz main visualizer. As shown in the figure, the red circle represents the location of the resident in our CASAS smart environment. Through XMPP middleware, we can monitor the resident's mobility in real time. We also provide playback mode from a captured file or SQL database storing the sensor readings for reviewing the mobility history of the resident.

2. Power Usage Visualizer

Figure 6. CASASviz Power Usage Visualizer.

In smart environments, power usage is also an important factor to represent behavior patterns of the residents. As shown in Figure 6, CASASviz provides an energy usage visualizer to express energy fluctuations that occurred during the time the user defined. This graph can be used to identify trends and abnormalities of power consumption..

3. Mobility Heat Map

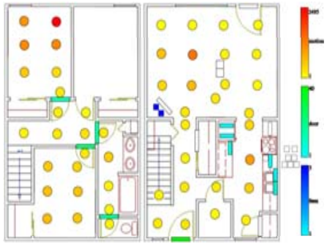

Figure 7. CASASviz Mobility Heat Map.

Figure 7 illustrates the mobility heat map of our CASASviz visualization, which describes the frequency of the sensor events triggered by the residents by incremental colors. The heat map uses three different color sets (yellow, green, blue), which represent the frequency of motion sensors, door sensors, item sensors respectively, in the specified time window. Higher frequencies are represented by dark colors and lower frequencies are represented by lighter colors.

4. Activity Graph

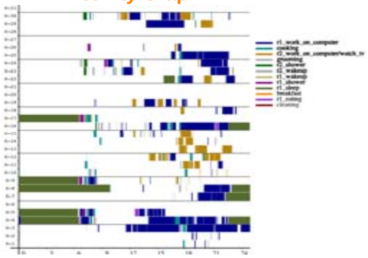

Figure 8. CASASviz Activity Graph.

As seen in Figure 8, a graph of annotated activities can be generated from a single or multiple annotated data files and each color stands for a monitored activity. With the help of an activity map, researchers can identify changes of behavior patterns in the habit of an inhabitant and look for anomalies in this data. Visually comparing differences between human-generated and AI-generated annotations has also been done using Activity Graphs.

Future Plan

1. Long-term and Abnormal Patterns Visualizer

To discover long-term and abnormal behavior patterns of the residents, we are planning to extend a data structure of suffix tree as an efficient sensor event representation to analyze the global structural patterns of sensor events. Intuitively, for a sensor stream S, we consider a sensor pattern p in S to be an anomaly, if the frequency of this pattern does not satisfy a pre-specified threshold. If the frequency of the pattern is one of the highest in all the patterns, we define this pattern will be a long-term behavior pattern for the resident.

2. Activity Feature Extraction

In smart environments, we need to make use of machine learning techniques to do some predictions, such as activity recognition and energy prediction. Before making use of these learning algorithms, another important step is to extract useful features or attributes from the raw annotated data. We have considered some features that would be helpful in prediction and recognition. These features have been generated from the sensor data by our feature extraction module.

3. Need assessments and user-end design evaluation

We are also planning to conduct a pilot study with our focus group of interest. That is, caregivers who have experience using in-home based monitoring systems would be best candidates. We are currently interested to learn more about the desired features/functions, desired interface design, desired platform (e.g., SmartPhone, laptop, or desktop) and when, where and how the visualizer system be useful and benefit their everyday caregiving at home or in a distance. We expect such information will be useful for future improvement of our visulizer system.