FINAL AUTHOR VERSION

Experience Tags: Enriching Sensor Data in an Awareness Display for Family Caregivers

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Abstract. The design of awareness displays to support family care has been explored in many recent studies. Whereas user studies indicate that caregivers are interested to know seniors' subjective experiences regarding activities, events and general attitudes, product developers tend to focus on using sensors to automatically detect the state and context of seniors in time, resulting in systems that are unable to capture the seniors' experiences. This short paper presents *experience tagging*, a mechanism which enables end-users to enrich sensor data using subjective tags. A research concept of an awareness display for family caregivers is presented to illustrate how the mechanism can be integrated in the design of an awareness display. The preliminary findings from a 4-week field trial with three caregiver/senior couples are presented. As a next step, the use of experience tags could be studied in other settings where people or systems are interested to know the user perspective on sensor data.

Keywords: Interaction design, awareness displays, subjective tags.

1 Introduction

Awareness displays can be characterized as displays that continuously present information that is needed for a certain activity, task or goal, without distracting the user inappropriately from other tasks [1, 2]. Whereas the early research on awareness displays primarily targeted at office settings, awareness displays are increasingly being used in the care setting.

Awareness displays for family caregivers have been studied in several projects. A key example is Digital Family Portrait (DFP) [6]. DFP aims to improve peace of mind of remote caregivers by capturing observations that would naturally occur when someone lives in the same home or next door. Based on interviews with adult children, five key information categories were identified towards creating day-to-day assurance: health (mood, sleeping pattern, food intake, physical exercise), environment (home, weather), relationships (emotional wellbeing, social interactions), activity (physical activity) and events (planned and unplanned, richness and variety in life). In a 1-year field trial with one couple of participants, physical activity was used as the primary information source, since it could easily be measured using sensors. Perceived awareness was found to be stable for the duration of the study. Awareness

might have been improved by addressing the subjective information needs as identified in their user analysis, including emotional wellbeing and social interactions.

Consolvo et al. studied awareness displays to support day-to-day care of an elder by the local care network [3]. Exit interviews in their field trial indicated that caregivers experienced lower stress levels. The quality of communication increased since practical information was communicated through the display. Interestingly, even though moods were recognized as highly relevant in a day-to-day care setting, moods were not part of the CareNet display.

Affective messaging as part of an awareness display for family care was studied by Dadlani et al. [4]. Aurama was designed to create peace of mind and improve connectedness for adults that are peripherally involved in the care for their elderly parents. Sensors were used to detect presence, weight and sleeping patterns. Affective messaging through physical tokens (happy face, neutral face, sad face) was used to complement sensor information. A 6-month field trial showed that the participating couple enjoyed affective messaging, even though they did not communicate negative emotions. Sharing affective states was valued for achieving connectedness and peace of mind. Interestingly, communication of moods and communication of sensor data were provided as two independent communication channels within a single system.

The use of sensors in combination with self-reports was studied by Morris. Solar Display [5] aims to induce behavioral changes both for the elderly and for caregivers, by creating awareness of the changing quality and quantity of a social network of a senior. A 3-month field trial (6 dyads of seniors and caregivers) showed that self-reflection was encouraged and awareness improved. The improved awareness resulted in reflections on the social network by seniors and their caregivers. Based on the new insights, the elderly participants were more actively involved in strengthening their social network. Morris suggests studying the use of annotation tools to track subjective social satisfaction, next to the objective measures used in Solar Display.

MarkerClock [7] is an interesting example of how sensor data can be combined with abstract user annotations. MarkerClock aims to improve mutual awareness of living routines by visualizing the amount of activity detected by a webcam in time. Users can place abstract symbols on their own traces, as an additional form of communication. The field evaluation showed that the participants used the presence information for finding good times for visits or calls. Since the information display was limited to presence information and abstract symbols, it was however hard to communicate affective messages.

Next to the academic studies, there are examples of sensor-based systems commercially available that create awareness of the context and state of the elderly. The combination of sensor data and user input to clarify sensor data has not yet been applied in a commercial setting.

Existing awareness systems tend to focus on presenting data that can be automatically collected using sensors. Recent focus group sessions with family caregivers (publication pending) did however show that sensor data often raises new questions. For example, if the senior got out of bed late, would this indicate a need for care, or was the senior feeling fine? The present paper describes experience tagging, a mechanism that enables end-users to annotate sensor data using subjective tags. A research prototype was designed and evaluated in the field. The preliminary findings from a 4-week field trial with three caregiver/senior couples are presented.

2 Concept Development

User exploration: To better understand the context of family care and the information needs of the family caregivers, a focus group session was organized. Four participants (adult children who provide care to their parents) were asked to discuss how they experience the family care activity, and to describe in detail what information would help them be better prepared for the care activity. All participants indicated that they felt responsible for their parents in need of care, and they had many worries regarding the present needs of their parent and the changes in time. The worries can be summarized in three categories: *physiology* (food intake, medicine intake, acute physical problems, etc.), *safety* (whereabouts, environment, incidents/prevention, etc.), and *love and belonging* (emotional state, social state).

These findings are in line with findings from related work [4, 6]. Family caregivers express a need for information. Part of the information can be collected using sensors, in particular the information related to physiology (e.g., medicine intake) and safety (e.g., fall detection). The participants also expressed an interest in the emotional state of the senior. Since present sensors are unable to accurately detect emotional states of people in a home setting, the information needs to be collected in a different way.

To better understand the needs of the seniors, a focus group session was organized with five participants (>65 years of age, living independently). We asked the seniors their view on using a monitoring system to support family care, and their view on the use of sensors as a privacy threat. Interestingly, all participants could imagine other people using a monitoring system, whereas none of the participants found themselves in need of a monitoring system. Furthermore, the participants indicated that they were willing to accept sensors in their homes, as long as there would be a clear and direct benefit for themselves.

The user exploration shows a basic need of family caregivers to be aware of the functional state and context of seniors. Family caregivers would also like to be aware of the emotional state of the seniors, even in the early stages of the care process. At the same time, seniors do see the value of communicating experiences and affective states. When designing an awareness display for family care, one should however be aware that even though seniors recognize the value of a monitoring system in the later stages of the care process, they are skeptical towards using a monitoring system in the early stages of the care process. When targeting ‘younger’ seniors, designers need to find new ways to create benefit for seniors when using awareness displays and monitoring systems.

Design rationale: Family caregivers are interested to know the general attitudes and the subjective experiences of the caretaker regarding activities, events, whereas present sensor-based systems are unable to capture these subjective views. Experience tags will enable end-users to annotate sensor data and thereby enhance awareness.

We decided to focus on ‘younger’ seniors who are capable of independent living. The design aims to create meaningful awareness for both the caregivers and the seniors, rather than providing ’functional’ awareness and monitoring functions. A symmetrical system design was selected, in which both the senior and the family caregiver are treated as equal parties. The system can be regarded as a generic home awareness display, which cannot only be used to support family care, but also to increase social connectedness.

Figure 1 shows a prototype of the experience-tagging awareness display. The display shows two activity traces, one for the family caregiver, and one for the senior in need of care. The activity traces are based on sensor data. In the prototype, passive infrared sensors are used to detect physical activity in the kitchen, living room and bedroom doorway, and tags are used to capture subjective experiences. The prototype thereby covers the information category *love and belonging* and partially covers the category *safety*. To support the later stages of the care process, the system would need to use additional sensors and monitoring functions.

Fig. 1. A touch-screen display was used as an interactive awareness display in the homes of participating seniors and family caregivers (left figure). The display shows an activity trace for both the family caregiver and the senior in need of care (right figure). Users can add subjective annotations to the local activity trace, and can add question marks to the remote activity trace

Experience tags enable users to add a subjective view to the sensor data, and can be linked to the activity traces. Users select a mood from 9 predefined mood tags ranging from excited to sad [8], and they can add text. The senior in figure 1, for example, added an experience tag indicating that he felt happy because the weather was nice.

A key challenge is to motivate users to add experience tags. In the prototype, users could themselves motivate their remote partner by adding question marks. A question mark can be placed on the activity trace of the remote partner. The remote partner can click on the question mark, and will be asked to enter a mood and/or text.

Evaluation: A pilot study with two family caregiver/senior couples for approximately two weeks each was conducted to fine-tune the methodology and to test the technology. Next, a field trial was conducted with three couples of participants for 4 weeks each. Semi-structured intake-interviews and exit-interviews were used to better understand the care-relationship between the participants, to find out how participants experienced the prototype, and how the prototype affected the care relationship. Daily experience sampling questions were used to measure day-to-day changes in feelings of connectedness and awareness.

One couple actively used the experience tags. They appreciated the sensor-based presence information, and they were very positive about the system. They used the tags to ask both questions regarding the sensor data, and to communicate general messages. They felt the system indubitably improved their feeling of connectedness, they felt they were better aware of the remote setting, and they were sad to hand in the system at the end of the trial. Both participants indicated that the system contributed to their peace-of-mind, knowing that things were well at the remote location.

The second couple were inactive users of the system. The junior started by adding experience tags, but the senior did not react. After two weeks, it was decided to move the awareness display in the home of the senior to a different location of the living room, where the senior would more often glance at the display. Whereas more experience tags were added, the tags were generally used as short text messages without a link to the sensor data. Even though the use of the tags was limited, both participants did consider the system to be a valuable add-on to their life.

The third couple primarily used the system as a sensor-display. Tags were only used in a functional way ('are you home?'). In the exit interviews, though, both participants valued the improved awareness as created by the system.

3 Conclusions and Next Steps

The key innovation in the present project was the focus on experience tagging, which enabled seniors and their family caregivers to add their subjective experiences to sensor data. Moreover, the users were invited to elicit experiences from their counterparts. The project aimed to increase mutual awareness and ultimately improve connectedness and peace of mind. The user evaluation showed that participants varied in how often and in what way they used the experience tags. In general, however, participants appreciated the system and valued the system as a tool for family care.

As a next step, (1) motivational strategies to encourage users to enter subjective data will be studied, (2) mechanisms to allow for group communication will be explored, and (3) mechanisms for lightweight acknowledgement will be studied to avoid false expectations.

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