

Caloo: An Ambient Pervasive Smart Calendar to Support Aging in Place

Alexandra Voit, Dominik Weber, Elizabeth Stowell[◊], Niels Henze

VIS, University of Stuttgart – Stuttgart, Germany – {firstname.lastname}@vis.uni-stuttgart.de

[◊]Northeastern University – Boston, US – stowell.e@husky.neu.edu

ABSTRACT

Many countries are confronted with aging societies. With the increasing need for elder care, it is necessary to investigate how technology can support aging in place. In this paper, we propose an ambient smart calendar system that supports the self-sufficiency and activeness of older adults. We report the results of a survey of older adults on their use of physical and digital calendars. Based on the results, we developed *Caloo* (*Calendar of opportunities*) – a prototypical smart wall calendar which supports older users by generating awareness about their daily schedules as well as supporting them in remaining active in their lives through event suggestions. We evaluated *Caloo* in a study with retired older adults. Overall, we received positive feedback and identified data sources for events, which the smart calendar can suggest to the user. Our results indicate the potential of deploying an ambient and pervasive smart calendar system that supports aging in place.

Author Keywords

Aging in place; ambient information system; smart calendar.

ACM Classification Keywords

H.5.2. User Interfaces: Information and Presentation

INTRODUCTION AND BACKGROUND

The United Nations predict that the percentage of the world's population of people that are 60 years or older will grow from 12.3% to 21.5% by 2050 [19]. As a result, the need for technological support of the care of older adults increases. Aging in place technologies, which support users living longer and more self-sufficiently in their homes, can support the increasing need for elder care. One of the major concerns in developing new technologies is acceptability. Peek et al. found that anticipated benefits, perceived need and privacy concern are major factors for the acceptance of such technologies [13]. Rashidi and Mihailidis identified challenges for designing technological support systems [15]. They found that simple interfaces and avoidance of parallel tasks were beneficial to avoid errors as well as control over the system.

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Figure 1. *Caloo*, our prototypical smart calendar, is shown to a participant during the interviews.

McGee-Lennon et al. found that people from all age groups are likely to forget about appointments or tasks such as unloading a washing machine [9]. Calendar systems have been used for scheduling and reminders for thousands of years. Related work investigated how people use calendars to organize private daily schedules. Abdul Razak et al. investigated how seniors (aged 55–60 years) use physical and digital calendars [1]. They found that calendars for seniors must be simple to use, and that their participants preferred to see the date prominently displayed. Further studies investigated how other groups, such as families or friends, manage their personal [3, 5, 6, 10, 12] or shared calendars [6, 14, 18]. Working parents use calendars as a way to organize their days as well as to get an awareness about their own schedules and what their family members were up to [5, 11, 12]. Thayer et al. found that calendars are mainly shared to coordinate appointments [18]. Calendars can reveal information about the calendar's owner – especially if shared with others. Users often have more than one shared calendar to control who has access to which information [18]. Users are often concerned about putting their personal events in their work calendar, because they do not want to lose privacy or open themselves up to judgment from their peers [5]. To address users' privacy concerns, Schaub et al. developed a prototype that changes the appearance of a public work calendar based on the people who are present, and personal privacy settings [16, 17]. Displaying their calendar data in physical spaces can increase the awareness and attention regarding upcoming appointments. Related work investigated how calendar data can be displayed with tangible objects as cubes to increase the user's awareness regarding appointments and additional information such as weather information [8]. Other work investigated how calendars and technology can be combined in home environments [4, 10, 14]. Crabtree et al. investigated

how groupware calendar systems should be designed for the use in home environments and found that it is important to display the digital information in the users' homes where they can be seen frequently [4]. Plaisant et al. developed a shared calendar information system for multi-generational families using digital paper and pens [14]. Additionally, Neustaedter et al. used an inkable family calendar to coordinate family affairs [10]. Furthermore, Boll et al. developed a multimodal reminder system using sound and ambient light as well as tactile feedback that reminds their users about calendar events such as upcoming tasks or appointments [2]. Especially for novel reminder systems, McGee-Lennon et al. found that using existing metaphors and strategies supports the acceptability and usability [9]. Social networks suggest events to their users, allowing the user to plan to attend a suggested event or to attend events that their friends will attend. However, there is no link between current calendar systems and event suggestions. Voit et al. envisioned a smart calendar system, which communicates with smart home devices to support older adults in their daily activities [21]. Their proposed smart calendar system aims to support healthy older adults by learning the user's interests and preferences, and by reinforcing healthy behaviors. It also should support older adults when they develop health concerns by motivating the user to adopt or readopt healthy behaviors to address the concerns. Our work is motivated by this envisioned smart calendar.

In this paper, we investigate a smart wall calendar prototype called *Caloo* (*Calendar of opportunities*), which supports the self-sufficiency of older adults by promoting an awareness of their daily schedules with the common calendar functionality. In addition, our smart wall calendar supports older adults to remain active in their daily lives. This is a first step towards a smart calendar that supports aging in place. Our contribution is threefold. 1. We report an online survey with 21 retired older adults about their usage of calendars and other reminder tools and found that retired older adults use a broad range of physical calendars as well as digital calendars. 2. We outline the development of *Caloo* - a smart wall calendar to support aging in place. 3. We describe the results of interviews with retired older adults to gain feedback about our prototype application and investigate factors, which influence the perceived need and the acceptance. Our results from both studies can guide the development of an ambient intelligent system that supports aging in place.

ONLINE SURVEY

We conducted an online survey to gain an understanding how retirees use calendars. We focused physical and digital calendars, types of entered events, and privacy aspects. Participants were recruited via mailing lists of senior computer clubs.

Method and Participants

In total, 22 people participated in our online survey. We excluded one participant who was not retired. The remaining 21 retired people (14 male, 7 female) were aged between 63 and 82 years ($M = 71.90$, $SD = 6.76$). Two participants lived in assisted living homes, eleven with their partner, two with their partner and family members and four alone. All participants owned a desktop computer or laptop, 16 a smartphone, eight

a mobile phone without internet access, and seven a tablet. The survey consisted of three parts. First, we asked for demographic data. Then, we asked how they use calendars. Finally, we asked for feedback about calendars. All questions were mandatory and consisted of 5-point Likert items, multiple choice questions and open questions.

Results

For the open response questions, we conducted a thematic analysis. After inductively developing a codebook, three researchers deductively applied the codes to all responses independently. Any disagreement between the coders was discussed until an agreement was reached.

The most used calendars were digital calendars (15) and the most used physical calendars were wall calendars (12), followed by pocket (10) and table calendars (7). Physical calendars were used more often than digital calendars for social events, appointments as well as special events (cf. Table 1). In general, participants appreciated the ability of digital and physical calendars to provide them with an overview (11). Other valued aspects were the reminder function (6), being able to see public holidays (3), the mobility of calendars (3), and the ability to use the calendar as a diary (3). For physical calendars, participants disliked limited space to enter their events (3), that recurring events must be entered manually each time (2), and the immobility of the calendar (2). Important features for calendars were the use of color codes (3), and preloading important dates and public holidays (2) were suggested. We also asked who is using the participants' physical and digital calendars as well as who can see their calendar entries (see Table 2). The participants used their calendars either alone or together with other family members within the same household. Most often family members within the same household have access to the participants' physical and digital calendars. Regarding the privacy of certain event types, six participants stated that they would share all calendar entries. Four participants stated that personal and private appointments should not be shared and three participants stated that no calendar entries should be shared. Another two participants stated that their willingness to share calendar entries depends upon the person with whom they would share them. Additionally, they noted that they would share everything with family members. Finally, we asked about reminder tools other than calendars. Eleven participants used digital devices, seven used sticky notes, and four used notebooks or notepads. Six participants stated that they only use calendars. The most common uses for reminder tools were birthdays (10), private social events (9), shopping lists (6), doctor's appointments (5), public events (5), contact information (4), trips (3), and talks (2).

Discussion

The participants used both physical and digital calendars. The most used physical calendars were wall calendars. Physical calendars were mainly used for special events, appointments, and social events. Compared to younger users [18] retired older adults use calendars less to coordinate appointments with others and use them alone or share their calendar data mainly with family members living in the same household. Most participants were therefore not concerned about privacy

	Physical Calendars			Digital Calendars		
	<i>Md</i>	<i>M</i>	<i>SD</i>	<i>Md</i>	<i>M</i>	<i>SD</i>
Appointments	5.00	4.10	1.58	3.00	2.90	1.70
Social events	5.00	3.81	1.75	3.00	2.86	1.74
Coordination with others	3.00	3.05	1.56	2.00	2.86	1.85
Awareness of family	3.00	2.76	1.61	2.00	2.62	1.72
Intake of medicine	1.00	1.24	0.89	1.00	2.05	1.60
Special events	5.00	4.00	1.61	3.00	3.10	1.73
Repeated events	3.00	2.67	1.77	2.00	2.61	1.69

Table 1. Agreements to the statements “I use physical/digital calendars for the following purposes”. 1 = do not agree at all, 5 = fully agree

	Access to physical cal.	Access to digital cal.	Uses my calendars
Family (same household)	11	7	10
Family (different household)	2	1	0
Friends	0	0	0
Visitors	1	-	-
No one besides myself	6	9	11

Table 2. Number of people that have access to the participants’ digital and physical calendars and who is using the calendars (N=21).

aspects of calendars. They appreciated calendars for providing an overview of events, the current date and public holidays. At the moment, our participants have to synchronize their different physical calendars such as wall calendars with the digital calendars by themselves. Another drawback of current physical calendars are that users have to add recurring events in the calendar manually each time they occur. If physical calendars offer the same functionality as digital calendars, users would not have to put effort in synchronizing their calendars.

INTERVIEWS

Based on the results of the online survey about how older adults use physical and digital calendars, we designed and implemented *Caloo*, a prototypical ambient and pervasive smart calendar system. We conducted qualitative interviews with retirees about the presented prototype. In the following, we describe the apparatus, the method and the procedure of the conducted interviews. Afterwards, we provide information about the participants and present their answers and feedback.

Apparatus

Wall calendars were the most used physical calendars in our online survey as well as in the work of Brush and Turner [3]. Further, wall calendars are often placed in hubs of the users’ home [4, 9] and generate awareness regarding upcoming appointments. Therefore, we implemented *Caloo* as a digital wall calendar (see Figure 1). For the prototype, we used two 13.3” tablets in a wooden box (see Figure 2). The calendar layout is implemented as a web application and is based on physical wall calendars, consisting of a large image, the current month and year. The picture shown on the upper part as well as the color which displays the user’s appointments can be customized. In contrast to physical wall calendars, this allows for a greater degree of personalization. The lower part of the calendar shows the user’s appointments of the current week. Appointments can be added or modified using the touch screen. *Caloo* should synchronize with users’ digital calendars. Apart from displaying appointments set by users, *Caloo* can automatically add suggestions for upcoming events of interest as new calendar entries (shown with a gray background,



Figure 2. The *Caloo* smart calendar prototype as shown in the pilot study. Event suggestions are entered as entries with gray background.

see Figure 2). These event suggestions can be accepted or declined by the user and they should allow older adults to stay active in their daily lives. For the interviews, we displayed mock-up events to ensure that all participants were confronted with the same scenario. We displayed general appointments (e.g. doctor, talks), social appointments (birthday party), as well as daily tasks (shopping) on the prototype.

Procedure and Participants

We recruited participants via a local computer club for seniors and a regional amateur radio club. Participants were compensated with 10 EUR. We interviewed 4 retired older adults (2 female, 2 male), aged between 61 and 80 years ($M = 71.25$, $SD = 7.80$). All participants lived in their homes (2 with their partner, 2 with other family members). They owned a smartphone, a tablet and a laptop or desktop computer.

In all interviews, one researcher guided the discussion while another researcher took notes. Additionally, all interviews were audio recorded to complement the notes. The interviews consisted of four parts. First, we asked how and why participants use physical and digital calendars. Afterwards, we asked them for what kinds of events they use calendars and how they are informed about events. Then, we demonstrated the smart calendar and discussed it to gather qualitative feedback. We explained the layout of the calendar and how the picture and color can be personalized. Further, we demonstrated how events are displayed, how they can be added and modified, and how event suggestions can be accepted or declined. Finally, we asked participants about possible privacy concerns.

Results

Regarding the current calendar usage, P1 stated that she uses a calendar app on her smartphone (see Figure 3) for all appointments, which are not routine (e.g. the weekly church service). Furthermore, she adds information about interesting TV shows into this calendar. Additionally, she uses a wall calendar together with her husband for garbage collection reminders. P2 mentioned that she uses a calendar app on her tablet for all appointments. She appreciates the overview that digital calendars offer and the possibility to search and filter appointments. P3 uses a calendar app on his smartphone and tablet. He enters all appointments, which he should not forget

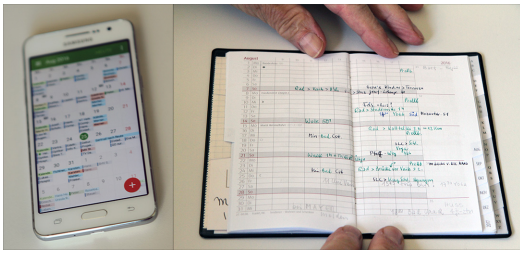


Figure 3. Two of the calendars of the participants. Left: Calendar app on a smartphone. Right: Pocket calendar.

into his digital calendar. Additionally, he adds appointments for his daughter's exams. P4 records all his activities in pocket or Leporello calendars (see Fig. 3). Every year, he starts a new pocket calendar and stores calendars from previous decades. He stated that he uses the calendars as a diary and that he added all appointments, tasks and activities. Also, he uses different color codes for different activities, e.g. sport and talks. P4 owns a wall calendar but uses it solely for the images. All participants receive invitations by mail, post or both about upcoming events. Additionally, newsletters and mailing lists were noted as an important source of information for all participants. Two participants mentioned the daily newspaper. Depending on the event, participants attend events alone, with family, friends or acquaintances with shared interests.

Regarding the prototype, all participants liked the ambient overview of appointments without the need to check other devices. Three participants liked the idea of changing images at the top of the calendar (P1, P3, P4). P1 stated that she likes the idea of showing suitable images related to visitors or special days such as their own wedding day. Another participant mentioned that this concept generates an emotional connection to the calendar (P4). Two participants ask for minor changes of the application. In detail, one participants suggested to also add her husband's appointments to the calendar (P1), while another participant was interested in different view for different time scales (daily, weekly, monthly, yearly). Three participants liked the idea of automatic suggestions for events according to their interests (P1, P2, P3). These suggestions include scientific talks, appointments for club activities, local street festivals, and local music events. One participants also requested an automatic filtering of announcements in the newspaper or from theaters (P1). However, another participant mentioned that he thinks automatic suggestions are not convenient (P4). All participants mentioned that such a smart calendar application would be useful for older adults to remember for their appointments and tasks.

Finally, we asked participants if they have privacy concerns and what they think about sharing their calendars with other family members. All participants mentioned that all their appointments should be displayed in the smart calendar application. Three participants stated that they do not need specific privacy settings because they would place the smart calendar system at locations where visitors do not have access. Another participant mentioned she would hide all appointments if there were visitors in her apartment. One participant mentioned privacy issues if family members have access to her appointments in the smart calendar system. Only one participant liked the

possibility of having access to the calendars of other family members for being able to coordinate appointments.

Discussion

All participants liked the idea of a smart wall calendar system in their homes that displays their appointments because this increases their awareness of their schedule. Also, they liked the personalization options. Participants had fewer privacy concerns if their calendar data is visible to family members in their homes than we expected. However, a smart wall calendar application should offer the possibility to hide all entries if visitors or strangers are around. Furthermore, our participants liked the idea displaying automatic event suggestions from defined sources. However, the participants disliked the idea that the system could inform their friends if they are interested in events as social networks currently do.

CONCLUSION

In this paper, we presented our work towards an ambient and pervasive calendar that supports aging in place. We focused on an ambient smart calendar system that supports the self-sufficiency and activeness of older adults. We reported an online survey with 21 retired older adults about their calendar usage behavior. Informed by the results, we developed *Caloo* - a prototypical smart wall calendar. Further, we conducted four interviews with retired older adults about their calendar usage and their impression of the prototype. They used calendars mainly alone or shared them with family members in the same household. There were few privacy concerns about family members having access to calendars in home environments. Especially for older adults who share their apartments with others, smart calendars should offer support for the individual older adult as well as co-located persons, e.g. family members. Although the smart calendar system could also support local communities by sharing their calendars with friends or interest groups, participants in the interviews did not want to share their calendars with third persons. However, all participants liked the concept of automatically adding events from defined sources, e.g. mailing lists and newspapers. In both studies, the participants used a mix of physical and digital calendars to manage their appointments. The insights gained in the interviews indicate the potential of ambient and pervasive smart calendar system that supports aging in place. Limitations of the conducted studies are that the participants were members of senior computer clubs and therefore experienced with current technologies such as smartphones. However, we believe that these technologies are becoming more and more prevalent among retirees. We plan to adapt our prototype according to the findings in the interviews and subsequently deploy it in the homes of older adults to collect information about long-term usage. In the future, such a smart calendar system can notify the users about upcoming calendar events with multimodal notifications [2]. In addition, the system can be embedded into an ambient notification system that supports aging in place [22]. Instead of displaying direct instructions to support the older adult, this system could present possible actions in an unobtrusive and comprehensive way. Thus, the smart calendar could be integrated in smart environments and use different output modalities [7] to notify about different occasions [20].

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