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Context Awareness in Communication around Fall Handling with PERS

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Abstract. Assuring timely intervention after falls is important to enable older adults to live independently for a longer time. There are two strategies where technology could assist timely intervention: 1) automated fall detection and 2) handling of falls - the process of sending help to a fall victim - using a personal emergency response system (PERS). This paper presents first insights on using sensors not only on the patient's side but also on the caregiver side. We present the results of two studies that were part of a more encompassing approach to improve fall handling and draw conclusions based on these results. The first study investigated the willingness of informal caregivers to (automatically) share information that can influence timely fall handling. Based on the results, a prototype of a fall handling system was made. The second study evaluated the prototype with the different types of users that would use this system. Results indicate that while the envisioned users were in general open to context-aware fall handling, fall-back scenarios need to be present because the needed technology may not be available to all users at the same time and some people might not be able or willing to use the technology.

1 Introduction

Falls among older adults can cause major physical and psychological harm and, they also are a major cost to the people affected as well as society [1]. Therefore, a great amount of research is being conducted on fall prevention and fall detection. However, there is also a need to further investigate fall handling, which we define as the process of sending help to a fall victim.

Fleming and Brayne [2] report that many people having a fall alarm did not use it when they fell. A PERS (personal emergency response system) is generally used to indicate an alarm system that contacts a call center for help when a need is detected by a push on a button or using connected sensors. Several reasons can be identified for non-use of PERS: not able to reach the button, not developing a habit to wear it and not seeing its advantage [3]. Many others did not perceive a need to have a fall alarm themselves. Heinbucher et al. [4] came to a similar observation [4] and further noted that the notion of relevance, rather than satisfaction was an important predictor of PERS use.

While several fall detection services have been proposed that include notification to social contacts [5][6][7], the focus was mainly on the fall detection. For most (if not all) of these no evaluation of the fall handling system is provided. These systems use various approaches to contact caregivers or a call center, but rely on phone calls and/or text messages.

We thus identify some opportunities to improve fall handling: **Usage**: convincing care receivers to use the system (when they are in need); **Caregiver search**: identify the most useful person to attend a fall; **Information exchange**: inform caregivers when needed.

In this paper, we build on preliminary results on using context-awareness in this situation in call center interfaces that were presented by Van den Bergh et al. [16]. We extend this work through two studies we performed as part of a more encompassing approach to investigate the acceptance and feasibility of a context-aware fall handling procedure as part of a PERS system (operated by nurses). These studies provide insights from (potential future) care receivers, caregivers and nurses involved in the PERS system.

2 Related Work

Several studies have explored the willingness of people to share location information with social contacts in non-care contexts. Lederer et al. [8] as well as Consolvo et al. [9] came to the conclusion that the most important determinants to decide whether to share information were who was asking it and why. There seems a common theme that turning off automatic context sharing seems more related to concerns for their peers (modesty) rather than personal concerns (secrecy) in several circumstances [10][11]. A long-term study [12] on surveillance at home showed that while surveillance did not cause higher stress levels, some types of sensors such as cameras, audio and PC surveillance did cause frustrations and even anger, and altered behavior. After a couple of months most people became accustomed to it. Bentley et al. [13] found that adults (ages 21-52) were willing to share travel time with family and friends in a chat app during a field trial lasting 21 days.

Study 1 in this paper contributes to this research as it addresses location and availability sharing from a very specific and different context: sharing in function of a commitment helping a care receiver after a fall.

iFall [5], Living++ [14] and SEHMS [6] are smartphone based fall detection and handling systems that notify the care receiver of a detected fall. When the care receiver does not cancel the alarm, predefined caregivers get a text message or e-mail. If they call back, the call is automatically answered after a notification sound. There is no PERS integration in this case. Teroso et al. [7] proposed a

wearable sensor connected to a smartphone to do fall detection. When a fall is detected, the care receiver gets the options to send a text message (with the GPS position) or call a predefined caregiver. In case of a timeout a text message is sent automatically. The system also has a server allowing caregivers to monitor and configure the system for the care receiver.

These approaches have not been tested with envisioned end users and seem to focus on demonstrating technical feasibility. The emphasis of this paper is on the opportunities and challenges identified with potential future end users of such a system. Our research focused on fall handling rather than fall detection.

3 Study 1: Interviews with Informal Caregivers

3.1 Method

Sixteen interviews with informal caregivers (12F; 4M) were conducted and analyzed based on the following criteria: the aging care receiver had to live independently and not with the interviewed informal caregiver, since a PERS and sharing contextual information seemed less relevant when care receivers live with their informal caregivers.. Their average age was 49.5 years (s.d. 14.2). The corresponding care receivers were on average 82.3 years old (s.d. 6.1).

2nd year bachelor students of communication science conducted and transcribed the interviews with people labeling themselves as informal caregivers (partners, children, other relatives and friends of care receivers) and were selected with purposeful quota sampling. The students received training, a list with interview questions and a movie with a voice-over explaining the contacting of informal caregivers based on location data and availability. Examples of interview questions are: Are you willing to share data about your location/digital calendar with the call center in case a call is placed via a PERS of your care receiver? How detailed may this information be? Who would you allow to have access to this information?

3.2 Results and Discussion

The interviews were iteratively coded by one of the authors using grounded theory [15] starting from open coding, axial and then selective coding. Dedoose, a web-based application for qualitative research, was used. After coding 16 interviews, data saturation was reached; no new information appeared.

In general, the informal caregivers had a more positive attitude towards sharing information with the call center about their location than sharing information about their availability. This was mainly due to privacy concerns.

Based on the results of study 1, we can state that caregivers are prepared to share their location with the call center and even with other caregivers. Several respondents even wanted to share the location with the care receiver. The following quote illustrates this: "*It is for example possible that I go to the store one day and that I'm further away than my brothers. (...) Then it makes sense that the call center calls my brother first, because he would be here first to help my mother. This is a very big solution for me in case I would not be present in the house.*" (F, 49). A few caregivers did not see the value for the care receiver as illustrated by the statement: "*I don't think this is a good idea, I immediately have the feeling that 'Big Brother' wants to keep an eye on me*" (F, 54). We thus propose to limit sharing location with the care receiver to cases where there is a clear benefit; such as when the care receiver is waiting for a caregiver.

During the interviews sharing availability based on calendar data appeared to be misunderstood as sharing all data contained in the calendar. The following quote illustrates this: "*Well, honestly I do not think that is a good idea.* [Sharing] *my location is one thing, but on top of that they don't need to know what I'm doing there...*" (M, 20). Another concern for using the calendar was that it would be the (only) way to determine who should attend a fall; "*So, you are forced to register* [your activities]*, because otherwise the system cannot function, in that way it brings you extra duties (...) and if you don't register, it is possible that they count on you being the first one to be there* [at the care receiver]*, while it might be the case that you are sick and your sister is just at home.*" (M, 49).

Limited usage and willingness to start using a digital calendar (and maintaining it) excludes it from being the only way to determine availability. Another easy way to specify availability should thus be present.

The majority wanted to receive call status information through message. "*Yes* [I would like to receive a message]*, it would be comforting to know what exactly is going on so I can anticipate if such an incident occurs again.*" (F, 48). This view was not universal: *No,* [I don't expect a message from the call center]*, because my brother will contact me if it is serious.*" (F, 54).

Although informal caregivers preferred to be contacted by phone, some were willing to be informed by text messages. We decided to further explore usage of text messages as it can reduce time spent communicating with caregivers.

4 System Description

The proof-of-concept system consisted of a native Android app for three types of usage that applied most of the design guidelines of Massimi et al. [17]:

A *call centre app* (designed for tablet, Figure 1, left) with a focus on handling a reported fall including the possibility to view information about the care

receivers and their context (information from sensors installed at the care receiver's home) as well as information about registered caregivers, including name, contact information, availability and when relevant, location. The app can be used to call a care receiver and send (textual) messages to care givers using instant messaging over XMPP.

A *care receiver app* (designed for smartphones, Figure 1, middle) with the possibility to ask for help via the call center when this is needed (for instance, after a fall). A care receiver can also send her mood using happy / unhappy smileys or contact available caregivers in "less urgent" situations.

A *caregiver app* (designed for smartphones, Figure 1, right) with the possibility for caregivers to specify their availability and to receive messages or calls when their care receiver needs help. The app can also automatically detect the location of the caregivers and assist in determining the distance to the care receiver when a fall has been detected.

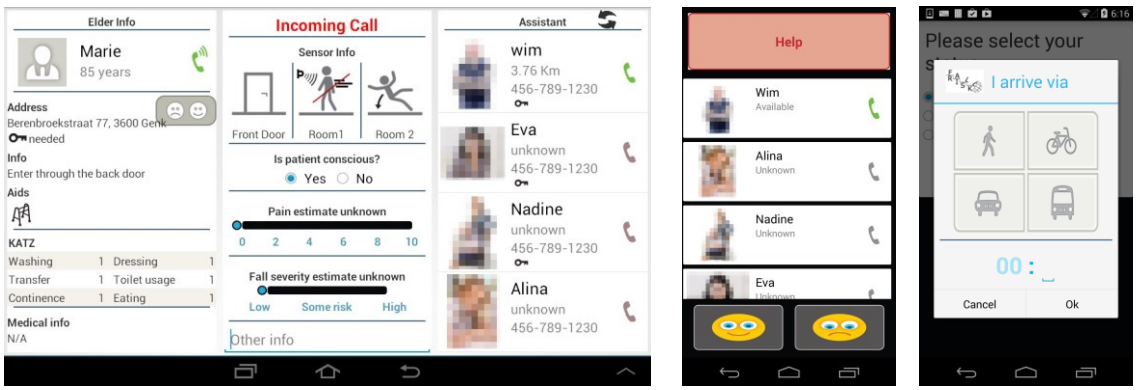

Figure 1 Call centre interface during call (left), main care receiver user interface (middle), a preliminary caregiver screen to specify time to arrival (right).

The app displays one's presence through a colored phone icon. For the care receiver, a green icon is shown when the caregiver is available, when the caregiver is busy or unavailable, the caregiver is removed from view, and when she is disconnected or no information is available, a grey icon is shown. A similar convention is used for the call center although in this case a busy status is also mapped to a green icon. This way caregivers can make a distinction in their availability for call center and care receiver. Voice communication between call center and care receiver apps was simulated using icons. No real voice communication was implemented as the system was designed for evaluation and demonstration of the concept within a single room. The app supports location detection through the Android location application programming interface (API) and availability was determined based on the Android Calendar Provider API. Different calendars can be combined for a single user. One can configure whether presence of a calendar items should reflect "busy" or "unavailable".

5 Study 2: User Tests with Older Adults and Nurses

The goals of Study 2 were (1) to explore the opportunities and challenges of fall handling and (2) to validate the findings of study 1 as well as our design choices.

5.1 Method

Eight user tests following the same protocol were organized. A total of 12 participants took part in the user tests: 8 older adults, including three former nurses (3M; 5F) with an average age of 69.5 (4.5 s.d.) years old and four home care nurses (2M; 2F) with an average age of 41.3 (s.d. 9.0) years old having regular experience with a PERS system. The 8 older adults were purposefully chosen, since they are potential future users.

In four of the user tests two older adults participated and in the next four user tests a home care nurse contributed (none of them participated in Study 1).

Each user test started with *role playing two scenarios*: (1) to experience how fall handling with PERS works and (2) to gain understanding how the new apps affected the new and proposed fall handling procedure. The scenarios were based on current and envisioned practices of fall handling at a home care organization using information from observations and interviews with employees of this home care organization. The scenarios described what happened after a fall victim needed help. Next, the researchers asked questions to explore the opportunities and challenges of the designed apps and assignments. Questions asked include: Can you describe to us what you see? What do you think it means? An example assignment is: Please indicate your availability on the caregiver app.

In the scenarios, the nurses acted as a nurse in the call center or a nurse responding to an emergency call. In the sessions with two older adults, one played an informal caregiver, while the other played a care receiver. During each session, the apps were shown on a smartphone (caregiver and care receiver app) or a tablet (call center app). Screenshots of smartphone apps were printed in color, so both participants could see the interface during the discussion.

5.2 Results

The interviews were transcribed by students. The results were analyzed similarly as in Study 1, however, different software was used (MS Word for open coding and MS Excel for axial and selective coding) after which the results were written.

During the user tests, older adults quickly accepted their role as care receivers or informal caregivers. Role playing scenarios with the proof-of-concept apps turned out to be a successful method to demonstrate the envisioned use of the

apps; we succeeded to let the participants ask questions and share their opinions and concerns regarding the envisioned use of these fall handling apps.

Overall, the older adults were positive about the care receiver app, even though most of them were visibly not used to having a smartphone and were concerned about care receivers' ability to use smartphones. *"I thought, it would be very complicated, but when you see it like this, I think it's really easy for the patient."* (Older adult, F, 72). The same older adult mentioned she liked seeing the pictures and the contact details of the caregivers on the app (Figure 1) as it was a good reminder of who is who. The older adults viewed the app as more than a fall handling system. They suggested, for example, to use it for communication in general, not only for emergency situations.

Some older adults found it important for a care receiver to view the status of their caregiver. Available and not available were interpreted as was intended (being or not being available to be contacted to help a care receiver in case of emergency). Both nurses and older adults liked the possibility of the care receiver app to send happy or unhappy smileys. Sending smileys was perceived as an accessible way for care receivers to let their caregivers know how they feel. A couple older adults viewed an unhappy smiley as a trigger to make a phone call to care receivers and one older adult (F, 72) could see herself using it.

Sending the estimated time it would take to get there to the most available emergency contact was valued by the nurses. Multiple older adults stressed that this would make care receivers feel more at ease. In one session, the older adults (who were former nurses) were concerned that care receivers would undesirably contact caregivers also for non-urgent reasons, such as loneliness.

In general, the older adults preferred receiving a text message with a request to help a care receiver to receiving a phone call, as a message was perceived as quick and efficient. An appropriately adjusted volume and ringtone was perceived by the older adults to be a necessity to hear the messages.

In one session, older adults argued a message to all caregivers is always desired in case a care receiver needs help, because even if you cannot help, you will at least know that the care receiver had fallen when you visit him/her the next time. Since nurses handling the falls usually do not know the care receiver, they need additional information*: "Sometimes this* (information) *is on file; we have a file with every patient. Or sometimes I find it on my tablet. Or sometimes, when the patient is conscious, I just ask if there is somewhere a telephone number, can I reach someone or should I call someone?"* (nurse, F, 33).

Most older adults did not mind the automatically calculated estimated duration of travel, but emphasized that one needs to be able to adjust this estimation, for instance in case of a traffic jam. One older adult (M, 65) suggested that it was important to be able to update the estimated duration of travel.

Some older adults considered filling out a report with a few questions, after they 'helped' their care receiver (as part of the scenario) a task for the call center or more knowledgeable people (like a doctor), while others said they would feel more comfortable filling in the report via the phone (and calling the call center). The nurses appreciated the possibility to (get reminders to) fill out the report, because they sometimes forget to write it. *"You know, this* (smartphone)*, you always have it with you. I work full time, and when I come back from a visit, someone has fallen, and then I'm just not in the mood to do this work at home. And then I sometimes forget it."* (nurse, F, 33). They made suggestions to include specific information with dedicated user interface controls such as sliders.

The older adults seemed to prefer to indicate availability manually, as none of them used a digital calendar. Nurses saw integrating their work calendar as an opportunity. Some older adults linked usage of a digital calendar to sharing caring arrangements with respect to availability to care receiver with call center or sharing planned unavailability. While the nurses were concerned that the caregivers would forget to fill in their availability (as is currently the case with PERS), the older adults perceived providing correct information about their availability as an obligation that comes with being an emergency contact.

The nurses liked the more flexible list of caregivers and the three levels of availability (available, busy, unavailable) seemed handy to receive information about a call, but still being able to finish the work they were doing. *"It could be when working in the day shift* (...) *that I'm doing my round. If there is a call, we should respond of course, we could indicate that we will go, but you can't just drop your other patient."* (nurse, M, 40). The automatic registration and digital approach is seen as useful support, although one nurse expressed concerns about the disappearance of some of the verbal communication in the current system.

In general, the nurses were positive about the call center app: it is easy to read and it gives a good overview of relevant information presented in the app. One nurse insisted to still have the possibility to have verbal communication with both patients and informal caregivers in a crisis, mainly for reassurance. He feared that with digital communication there could be more misunderstandings.

The new approach of availability and the more flexible list of caregivers in the call center app were appreciated by the nurses. Integration of the agenda of patients was suggested. A potential challenge in the app is explaining why the second person in the list was contacted to avoid discussions afterwards.

6 Lessons learned

We could identify and confirm *opportunities* of context-awareness in PERS systems. Relative location, which caregivers are willing to provide, was found to

be valuable information during several stages of a fall handling. Caregivers are willing to share availability and it proved useful to facilitate communication.

Several caregivers appreciated that (textual) messages allowed to access information about the care receiver and the fall when they needed it, although they should not be sent in the same manner as SMS, as in earlier work. The potential speed of using messages was also considered important by informal caregivers. Furthermore, textual messages allow contacting or informing multiple people at once, automated inclusion of relevant information and consultation at a later time. Emoticons showed potential to trigger contact with a care receiver and to lower the threshold of contacting someone, a problem seen with PERS usage.

We discovered *challenges* to using context-awareness. While digital agendas have potential to automatically determine availability, openness to using (and updating) a digital agenda is limited. Several nurses expressed a clear preference to use voice calls to exchange information with caregivers. Use of the advanced features of smartphones by any of the users should not be required. Decisions based on context information need to be traceable to answer questions of caregivers after a fall has been handled.

While the presented studies provide initial insights on how to augment a PERS system with context-aware information in a way that is acceptable to all users of the system, actual behavior can differ from stated behavior. The observed opportunities and challenges should be validated in a larger long-term study. Current PERS users were not included in this study, future research should investigate their attitudes towards the described fall handling system.

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References

[1] J. Close, M. Ellis, R. Hooper, E. Glucksman, S. Jackson, and C. Swift, “Prevention of falls in the elderly trial (profet): a randomised controlled trial,” The Lancet, vol. 353, no. 9147, pp. 93–97, 1999.

[2] J. Fleming and C. Brayne, “Inability to get up after falling, subsequent time on floor, and summoning help: prospective cohort study in people over 90,” Bmj, vol. 337, 2008.

[3] V. Hessels, G. S. Le Prell, and W. C. Mann, “Advances in personal emergency response and detection systems,” Assistive Technology, vol. 23, no. 3, pp. 152–161, 2011.
[4] B. Heinbuchner, M. Hautzinger, C. Becker, and K. Pfeiffer, “Satisfac-¨ tion and use of personal emergency response systems,” Zeitschrift fur¨ Gerontologie und Geriatrie, vol. 43, no. 4, pp. 219–223, 2010.
[5] F. Sposaro and G. Tyson, “ifall: an android application for fall monitoring and response,” in Proc. of EMBC 2009. IEEE, 2009, pp. 6119–6122.
[6] J.-V. Lee, Y.-D. Chuah, and K. T. Chieng, “Smart elderly home monitoring system with an android phone,” Int. J. Smart Home, vol. 7, pp. 17–32, 2013.
[7] M. Terroso, R. Freitas, J. Gabriel, A. T. Marques, and R. Simoes, “Active assistance for senior healthcare: A wearable system for fall detection,” in Proc. of CISTI. IEEE, 2013, pp. 1–6.
[8] S. Lederer, J. Mankoff, and A. K. Dey, “Who wants to know what when? privacy preference determinants in ubiquitous computing,” in CHI’03 extended abstracts. ACM, 2003, pp. 724–725.
[9] S. Consolvo, I. E. Smith, T. Matthews, A. LaMarca, J. Tabert, and P. Powledge, “Location disclosure to social relations: why, when, & what people want to share,” in Proc. of CHI 2005. ACM, 2005, pp. 81–90.
[10] L. Barkhuus, B. Brown, M. Bell, S. Sherwood, M. Hall, and M. Chalmers, “From awareness to repartee: sharing location within social groups,” in Proc. of CHI 2008. ACM, 2008, pp. 497–506.
[11] L. Barkhuus, “The mismeasurement of privacy: using contextual integrity to reconsider privacy in hci,” in Proc. of CHI 2012. ACM, 2012, pp. 367–376.
[12] Oulasvirta, A. P., J. Perkio, D. Ray, T. Vahakangas, T. Hasu, N. Vainio, and P. Myllymaki, “Long-term effects of ubiquitous surveillance in the home,” in Proc. of UbiComp 2012. ACM, 2012, pp. 41–50.
[13] Bentley, F. R., Chen, Y. Y., & Holz, C. “Reducing the Stress of Coordination: Sharing Travel Time Information Between Contacts on Mobile Phones.” in Proc. of CHI 2015. ACM, 2015, pp. 967-970.
[14] M. U. Iqbal, N. Fet, S. Wagner, M. Handte, and P. J. Marron, “Living++:´ a platform for assisted living applications,” in UbiComp 2013 adjunct publication. ACM, 2013, pp. 853–860.
[15] Strauss, Anselm, and Corbin, J.M. Basics of qualitative research: Grounded theory procedures and techniques. Sage Publications, Inc, 1990.
[16] J. Van den Bergh, K. Luyten, B. Aendekerk, S. Elprama, A. Jacobs, and F. De Backere, “Interdisciplinary design of a pervasive fall handling system: a case study,” in Proc. of PH 2014. ICST, 2014, pp. 235–238.
[17] M. Massimi, R. M. Baecker, and M. Wu, “Using participatory activities with seniors to critique, build, and evaluate mobile phones,” in Proc. Of ASSETS 2007. ACM, 2007, pp. 155–162.