Requirements gathering using drama for computer vision-based monitoring in supportive home environments

Stephen J. McKenna PhD
Fran Marquis-Faulkes PhD
Alan F. Newell PhD
Peter Gregor PhD

Division of Applied Computing,
University of Dundee, DD1 4HN, Scotland, United Kingdom
E: {stephen,afn,pgregor}@computing.dundee.ac.uk

S.J. McKenna, F. Marquis-Faulkes, A.F. Newell, P. Gregor, Requirements gathering using drama for computer vision-based monitoring in supportive home environments, Gerontechnology 2006; 5(1):29-45. The use of theatrical techniques to provoke discussion amongst potential users of gerontechnology in order to assist with the design process was investigated. Specifically, the technology being developed was automated visual tracking and monitoring to support older people within their homes by analysing their activity and raising the alarm should they fall. A professional author produced a variety of stories, manifested as relatively short video scenarios, illustrating the various ways in which the technology might operate and be used. Professional actors played out these scenarios as video clips which were shown to groups of potential users as a means of generating discussion. The result was a rich, qualitative method of data collection used successfully with older people and providing a systematic way of accessing their valuable input on the design of a tool to help them to live independently. The method provided a way in which the results of drama, and the discussions provoked, could be fed back into the design process.

Key words: dramatised scenarios, fall detection, computer vision

The potential use of advanced, computer vision-based sensors in supportive environments for the elderly was being investigated. Specifically, an automated tracking and monitoring system was envisaged to support older people within their own homes by monitoring their activity and detecting falls. A prototype vision system has since been developed using ceiling-mounted cameras[1]. Van Bronswijk et al.[2] proposed a taxonomy for gerontechnology in terms of domains and impacts. The technology being investigated here applies to the domains 'health and self-esteem' and 'housing and daily living' as identified in that taxonomy. Its potential for impact is predominantly in the area of 'care support and organisation'.

The context in which technology is used becomes particularly important when it will support individuals in their own homes. If social alarms are to become part of broader intelligent telecare systems, it is vital to establish the ways in which potential users would prefer systems to operate and not to make major decisions before a proper consultation with users[3,4]. Previous experience with functionally similar technology (such as the wall-mounted and pendant community alarms) can affect users' expectations of such systems.

The novelty of this application of technology and its context of use, mean that the designers need to address usability, acceptability and ethical considerations

at a very early stage in the design process. It is therefore important to utilize a *user-centred design process* which involves potential users early on. This is especially important when the user group has very different characteristics from the designers, such as when the user group is made up of older people[5]. There are, however, particular challenges in involving older people in such a process; Newell and Gregor[6] suggested the concept of *user-sensitive inclusive design* rather than user-centred design in order to capture these differences. There are, for example, significant problems in facilitating discussions with older people, particularly if these discussions are concerned with new technology. Various studies report on the problems of running focus groups with older adults. Keeping focus groups 'on task' and retaining their attention while collecting in-depth information has been found to be difficult with groups of more than three older adults[7,8] and there are major difficulties in discussing abstract issues. The fact that older people may be very much less aware of modern technology than younger age groups presents a further challenge. Therefore, traditional focus groups, even if they operate a story-telling metaphor, would not be very successful with older users. There is a need to provide concrete examples of the use of a system which would be understandable by older people. It is thus necessary to find instantiations of a technology, prior to it being developed, which can be used to facilitate discussion on the characteristics of possible systems which would make them useful for, and acceptable by, older people. We believed that theatre, recorded and presented on video, could be an effective and appropriate method of facilitating such discussion. It was thus decided to investigate the novel use of this art form in order to assess its utility in this context and to inform the development of the prototype monitoring system.

The next section motivates and discusses the use of computer vision for monitoring older people at home. The paper then discusses the use of user stories, scenarios and drama in the context of involving users in the technology design process. A methodology based on drama on video is then described and applied to the case of vision-based home monitoring. The outcomes, and more generally the use of such a methodology for requirements gathering for gerontechnology, are then discussed and some conclusions are drawn.

Vision-based sensing for supportive home environments

The population of the developed world is getting older. In Scotland, for example, recent estimates are that 19% of the population is of pensionable age and that the proportion of people aged 60 and over will increase by more than a third by 2026 while the population as a whole will show a slow decline over the same period[9]. The increasing numbers of older people and the decreasing numbers available to take care of them[3] provide a strong motivation to find ways to use technology to help assist people to provide the caring that is going to be needed.

Unintentional falls in older people were estimated to have cost the UK government £981 million in 1999, imposing a substantial burden on health and social services[10]. The cost of falls in the US was estimated[11] as $20.2 billion in 1994. Approximately one third of older people living in the community fall at least once a year (many suffering multiple falls) and falling rates increase with age above 65 years[12]. In community-dwelling older people about half of falls occur in their homes[12]. Falls are a major cause of death in older people. They are the key event in the pathogenesis of hip fracture and can play a role in accelerating the downward spiral in a

frail older person[13]. Falls are a serious problem not just in terms of actual risk but also of perceived risk which can reduce activity following a fall[14]. As Tinnetti et al.[15] noted, "fear is a fall-related consequence that may limit function beyond what might be expected from the effects of injury or underlying physical ability alone". However, perceptions of risk vary. One recent study of community-dwelling older people reported that 72% of those who had experienced a fall in the previous 12 months did not consider that they were at risk of having another fall[16]. A French study[17] found that 10 out of 48 elderly patients hospitalised after a fall had been on the ground for more than one hour[14]. Wild et al.[18] found that half of those experiencing a *long lie* (i.e. remaining on the ground for more than one hour after a fall) died within six months of the fall. This was even when there was no direct physical injury: death was usually from a complication such as bronchopneumonia, dehydration or hypothermia. The speed with which emergency help is alerted to a fall is crucial to the faller's health, especially when that person is older.

Passive fall detectors worn on the hip are available commercially[19]. However, they are often not worn when returning home, during housekeeping tasks prone to cause false alarms, or when uncomfortable[20]. Similarly, active alarms made available on pendants or bracelets are often not worn[21]. There is evidence that home environments able to monitor the activities of their occupants automatically can be used to help extend independent, quality living and reduce healthcare costs[22-25]. Sensors embedded in the physical, built environment have the advantage of ensuring compliance within the home. For example, passive infra-red (PIR) sensors, pressure pads and fridge door sensors enable room occupancy, presence in a particular area or use of a fridge to be monitored, respectively[22,23,26]. Preliminary work has been performed using low-resolution infra-red sensing for fall detection[27-29]. High resolution infra-red sensing remains relatively expensive. However, sensors based on visible spectrum images and video signals can potentially provide rich sources of information[30,1,25]. Perhaps more than with other types of sensors, issues of acceptability and ethics need to be addressed.

A number of interpretive aims can be envisaged for image-based sensors, ranging in complexity from monitoring room occupancy, to automatically detecting falls and performing detailed analyses of activity patterns. Significant dynamic factors that are predictive of falling and that could be monitored visually include low mobility, long times in bed and poor lighting. Reduced mobility can be predictive of a fall and has other health implications. Inactivity detection can, in a context-dependent way, indirectly indicate ill-health or a fall. Activity patterns such as repetition as well as significant changes in daily or weekly patterns might also be detected. The resulting information could be used as part of an alarm system, potentially detailing the nature of the alarm event and providing evidence for this information. It could be used for prediction and thus prevention of falls through risk assessment. Retrospective analysis of logged data (for instance, summary statistics, trajectories and perhaps image data) could also be used to provide insights into behaviour and health for care providers and researchers. Importantly then, it must be decided at what level of abstraction to interpret automatically the activity and behaviour of the older person and how to use the resulting data.

User stories and scenarios in a human-computer context

User stories are a traditional way of gathering requirements and exploring design and usability issues within technology development. Such stories are the real or imagined experiences of people: what they do and what they want. Imaz and Benyon[31] suggest that they are the "first artifacts that we use in order to describe interactions". Original user stories can be rich in contextual information and capture much of the intentions of the user. *Scenarios* are narratives describing what people do when engaged in particular activities and are more structured than the original user stories[32]. Scenarios can be based on in-depth ethnographic studies[33] or on brief collaborative sessions with potential users. They are designed to raise particular issues, taking the essence of what users have said and combining selections from a number of stories. Scenarios have been used to "clarify implicit assumptions, raise design questions, suggest design solutions and aid communication within the design team", helping to maintain user focus and providing an effective communication tool[34].

A wide range of views on scenario-based design were collected together in Carroll[32], emphasizing contextual information and the HCI-software engineering perspective where the adoption of *use cases* has been advocated[35]. Carroll[36] has developed the use of scenarios throughout system development. *Scenarios of use* facilitate the gathering and use of contextual information. User stories with specific concrete details are developed into precise *use cases* which attempt to completely formalize all of the requirements relating to a particular interaction with the system. Benyon and Macaulay[34] make a distinction between *concrete* and *abstract* scenarios. They suggest that concrete scenarios are useful for prototyping and `walking through' design ideas, and that *use cases* can provide the formal specifications required by software engineers. In contrast, abstract scenarios are useful for generating ideas and developing an understanding of the domain. They suggest that "the designer needs to abstract, or conceptualise experiences from a range of user stories to come up with an abstract scenario, make design decisions and then come up with concrete scenarios which can then be collected into use cases."

Design by storytelling or scenario building has been described by Moggridge[37] as a way to enable the visualisation of possible design solutions. He describes their use within a four-step process involving understanding, observing, visualising and evaluating. In such a process, storytelling or scenario building forms the key connection between observing and visualising. This technique has been used for eliciting design needs of older people. Storytelling can provide a wealth of qualitative and contextual information, some of which can be very germane to the design process. Much of the data from storytelling, however, may not be directly relevant to the design questions being asked. Listening to stories and extracting what is relevant to the specific design is not a trivial process and requires significant learned skills.

The Use of Drama

The discipline of writing fiction is one way of encouraging a focus on the important and relevant issues in life stories and this is often instantiated as drama. Drama, derived from the Greek word *dran* meaning 'a thing done', implies action; it is about creativity, imagination, feeling, symbol and metaphor. Theatre thus provides a very powerful way of telling stories and should have a place within user-centred design processes.

Theatre in design

Salvador and Howells[38] describe what they call a *focus troupe*, involving the use of live drama with a group of naive potential users to create a common context for a new product concept[39]. They showed that the common, shared contextual experience that could be established by actors allowed an audience to understand a new product concept quickly and to discuss it with each other and company representatives. The use of drama to communicate the product concept to the audience allowed them to make suggestions about the possibility of use in contexts not considered by the designers. Salvador and Howells reported that production of a focus troupe event could be speedier than a more traditional focus group. They concluded that this was a unique methodology for eliciting relevant comments about products that did not yet exist.

Dishman[40] describes the use of what he called *informance* (informative performance) in the design process, specifically in the ElderSpace project. Designers adopted personae based upon combinations of people they had studied. Each designer advocated for his or her persona and used improvisation and acted-out storyboards. Subsequently, the designers shared their design ideas with other design engineers through a live performance. Informance helped the designers consider how individual users were embedded in larger social systems and to evaluate the technical and interaction infrastructure.

Strom[41] has borrowed from theatre by using mobile devices as props in role playing exercises within a design process. This provided interesting insights into the design of such devices. Strom warned that scenarios often give a misleading and overly optimistic impression of the users, of what can be implemented in an interface, and of how an interface will function in actual situations of use. He investigated the use of creative writing techniques, which occur more naturally in theatre, for developing realistic scenarios. He found that scenarios which are driven by the emotions and motivations of believable characters, may result in a more realistic evaluation than more traditional, 'objective' scenarios.

Howard et al.[42] proposed the use of contextual scenarios based on current practice in the design process. Stakeholders participate in design sessions by acting out these scenarios.

Forum theatre

A particularly powerful theatrical technique called *forum theatre* was developed by Augustus Boal within his 'Theatre for the Oppressed' in Brazil as a way of empowering audiences to address questions of political importance[43]. Forum theatre is essentially interactive theatre in which a theatre company sets the scene for a discussion by acting out a concrete example of an issue in a way which includes the essential elements of theatre: the emotional aspects of the characters and conflict. Discussions with the audience are then conducted by a highly trained facilitator who encourages the transition from a narrow focus on the situation portrayed into a more general discussion of the issues. The actors take part in these discussions, staying in role as the characters they are representing. As part of this process, the scene may be re-played with the audience taking the role of director of the play. The suggestions made by the audience thus control the sequence of events in the play, rather than the original scripts. Other theatrical techniques may also be introduced such as the actors staying in role and responding to questions from the audience or the audience being asked "what is a particular character thinking

at this time?" Forum theatre has been used in the UK to address many issues including homelessness and empowering young people. Foxtrot Theatre, an independent theatre company in Scotland, has further developed forum theatre techniques for training medical students and palliative care staff and for community consultations concerning the delivery of social and health services to older people. This pioneering approach to training and consultation has been shown to be very successful in encouraging people to address complex issues. It has the characteristics of role play but is much more successful as it uses professional role players and avoids the embarrassment often found when members of an audience are asked to role play. It has the advantage of depersonalising an issue, e.g. a fictional character is blamed rather than a real person. A particular, concrete and realistic situation can be discussed which may be very personally relevant to members of the audience but they can comment on it as an event happening to an actor rather than to them. These techniques have been found to be particularly useful for addressing ethical issues, the needs of older people and for encouraging professional carers of older people to address complex issues of care in the community.

Methodology using drama on video

The proposed drama-based methodology is inspired by forum theatre but uses drama on video rather than live drama. This is more economical, allowing a range of different audiences to participate at different times and in different physical locations. The methodology begins with user stories along with technological considerations and proceeds with development of scenarios which are then acted, recorded and used in a series of facilitated discussions. The process, which will now be described in more detail, is iterated using more specific scenarios and the findings are fed into the design process.

The initial stage involves an informal gathering together of stories about the target groups' relevant experiences. This includes the use of traditional focus groups to consider generic issues. Even at pre-prototyping, a number of technical decisions will have been made and it is important to integrate these at this stage to provide an appropriate focus for discussions. However, this must be carefully balanced against the danger of excluding technical possibilities of potential interest. Therefore, while technical considerations are used to provide focus, discussions initiated within the groups concerning other related technologies are not inhibited.

The resulting stories and technological considerations are then communicated and explained to a professional scriptwriter and director who collaborates with the developers in distilling the essence of the various stories and anecdotes so as to compile a set of specific stories about fictional characters which embody ways in which users might act in the context of the novel technology. Important points to be addressed by potential user groups are identified. These scenarios are then developed into short video scripts designed to prompt discussion of these points. The use of professional writers and actors with experience of theatrical techniques and the ability to *suspend disbelief* is essential in order to create realistic characters and believable drama (as Strom recommends[44,45]). The scenarios are designed to be short and concise and, crucially, do not aim to resolve situations or provide solutions. They promote the conflict between characters which is essential for a powerful theatrical experience.

Following appropriate rehearsals, scenarios are filmed, possibly multiple times, using audio and multiple video camera viewpoints. The time such a process takes depends on the nature and length of each scenario. Previous experience of interactive theatre suggested that five minutes of drama typically leads to about twenty minutes of discussion. Following filming, the video material is edited to provide coherent dramatic scenarios. It is subsequently shown to several different target groups. Each video scenario is followed by a facilitated discussion of the issues raised in it. The discussions are recorded by a dedicated note-taker and, when appropriate, using audio-video recording. A suitable format is to show a short video scenario (typically between two and five minutes) and to allow approximately 20 minutes of discussion stemming from it, aiming for a total time for a whole session of approximately 90 minutes.

After qualitative analysis of the discussions, issues which remain unresolved and important issues arising are identified. The process is iterated to explore these issues, generating a further set of video scenarios for discussion with further groups.

Method

This drama-based methodology was applied to help investigate the applicability and feasibility of using intelligent visual sensors for automatically monitored supportive environments for older people. In particular, it was intended to identify the requirements of potential users including occupants, family members, professional carers and sheltered housing wardens.

The process began by collecting stories of older people's experiences of falling at home, including a focus group of older people who met to consider the generic issues related to falls in the home. This produced a number of stories. Scenarios were written based on these stories and the technical considerations outlined earlier, focusing particularly on ethical and pragmatic issues.

Three professional actors were used for the videos: a young woman and an older man and woman. The older actors played both an older person falling and in other scenarios acted as carers. Several scenarios involved actors falling so health and safety issues had to be appropriately addressed. Most scenes were filmed in domestic environments similar to those in which the sensors would be installed. Initially, a video consisting of four scenarios was produced and used for discussions. Subsequently, further issues were identified and a second video containing three scenarios was produced. Each video containing multiple scenarios was planned to last between 15 and 20 minutes (in order to have sessions approximately 90 minutes in length). Filming, using a Sony XM camcorder, took two days per video.

Full scripts are not reproduced here for the sake of brevity. Scenarios in the first video included older people falling and carers discussing a new monitoring system and how it worked. These were designed to provoke discussion about: (i) What currently happens when an older person falls; (ii) How a fall detector might work in the case of a fall; (iii) How the information about a fall should be transmitted to a carer; and (iv) In what circumstances activity monitoring could be accepted and appreciated.

The second video consisted of three scenarios to address remaining issues in greater focus. The first scenario built up a story about an older woman who had had a fall detector installed and whose busy daughter was alerted unne-

cessarily (*Figure 1*). It was designed to provoke discussion about false alarms and how best to minimise their impact, for example. In the second scenario, the same older woman fell back into her chair unconscious but the monitoring system failed to detect a problem. This raised discussion about system reliability and scope as well as dependency on the technology, for example. The third scenario explored, in a humorous way, the balance between the advantage of receiving support from a system and the possible intrusion of family or carers receiving information about the older person's activities and, by implication, their state of health.

The videos were shown to several groups which included professional carers, family carers and older people in a variety of living situations (independent, sheltered housing and council housing), some with and some without a community alarm (pendant or pull cord system). There were in total eight sessions and the groups that took part in each are summarised in Table 1. There was some overlap between the groups shown the two different videos. The discussions were led by a trained facilitator. While the overall goal was to investigate the use of vision-based sensing, discussion relating to other transducers such as pressure mats or body worn monitors was not inhibited.

Summary of Discussion Outcomes

Some of the main points arising from the sessions are summarised here to illustrate the type of input to the design process obtained. Commonly arising points are organised according to topics of relevance to development of the technology.

The need for a passive system

There was agreement in all of the groups that a passive system capable of autonomously raising the alarm in case of an emergency would be useful and desirable. Many stories were told in the sessions about community alarm pendants that were out of reach when needed and of pull cords that were tied up to prevent them being pulled accidentally and which were therefore inaccessible when required. It was, however, thought that there would probably still be a need for an active system so that someone who felt unwell could raise the alarm themselves. Therefore, there might still be a need to have a body-worn piece of equipment. If this was to be incorporated into the system, it was suggested that a waterproof wrist-worn item should be designed that did not get in the way (as the pendant did) and that was not likely to be knocked accidentally like a wall-mounted pull alarm. (It was also suggested that there be some sort of physiological measurement taken from a wrist monitor so that

Table 1. The groups in the video discussion sessions

Video #	Name	Group size	Nature
1	Servite Housing	7	Sheltered housing wardens; 1 director of a housing charity
	Celebrate Age	9	Over 65s living in sheltered housing; 1 carer
	Edinburgh	7	75-87 years, retired professionals living independently
	Age Concern	17	Mainly in 70s and 80s, some fragile, partially sighted, early dementia, or fell often; 4 carers
2	Servite Housing	3	As above
	Celebrate Age	11	As above
	Edinburgh	9	As above
	Stroke	15	Carers & people who had had strokes

people with the onset of health problems such as a stroke or a heart attack could receive some warning). Many people were afraid of falling and it was widely believed that lack of confidence and fear of falling led people to move out of their own homes. There was a desire for some help to allow people to live at home for longer and to do so confidently. It was thought that the reassurance provided by a reliable system would help to provide such confidence.

Domain of operation

The highest risk areas for falling were generally thought to be the bathroom and the bedroom. There was, however, a strong desire for a system to cover all parts of the home. It was suggested that a system could even usefully monitor garden and utility areas adjacent to the home. It was generally thought that visits to the bathroom during the night constituted the greatest risk of falling without a wearable alarm (e.g. pendant) being worn. Other than simply forgetting to put the alarm on, one reason given why people do not wear their pendant alarms in such a situation was fear of accidentally bumping them and causing false alarms. Several participants commented that such visits to the bathroom were not always done with a light on and that a vision-based system might therefore need to be linked to a light that came on automatically.

Integration with existing systems

When current community alarm systems reach an alarm state, a voice connection is usually provided between the occupant and either a warden or a call centre. The occupant will typically know the contacting person and an important and reassuring human link is thus established and can be maintained while the emergency services are called, for example. This approach whereby someone who has fallen can be constantly reassured until help arrives is one which potential users wanted to have replicated in any new system. Most people prefer this to an automated voice system, for example. Carers also wanted to be alerted in case of an alarm by a real person rather than via an automated message. It was thought that it would provoke high levels of anxiety in the carer if she had to hurry to a relative after being alerted by a machine. It was agreed that it would be preferable to integrate any new alarm with existing alarm systems; as the group of wardens pointed out, it could be too confusing for the occupant to have more than one system in place.

System sensitivity

It was suggested that the sensitivity of a passive detector should be tuned to the user's circumstances. For example, a person who had just come out of hospital might need a more sensitive detection system than one who was fairly healthy and unlikely to fall. In other words, the system should err on the side of caution at the risk of raising false positive alarms in the case of a person at higher risk. One borderline case was identified as being when a person, perhaps feeling unwell, fell backwards into a chair or onto a bed upon trying to stand up. It was thought that raising the alarm in this circumstance would usually constitute a false alarm.

Visual output

Several researchers have previously expressed the opinion that image-based monitoring would be unacceptable to older people. The findings in this study contradict this `received truth'. In fact, all the groups were happy to accept that although the system was based on video input, it was not necessary for it to store or transmit any visual images. Although generally there was no desire for carers to be able to see the older people, the point was made that there could be situations in which this would

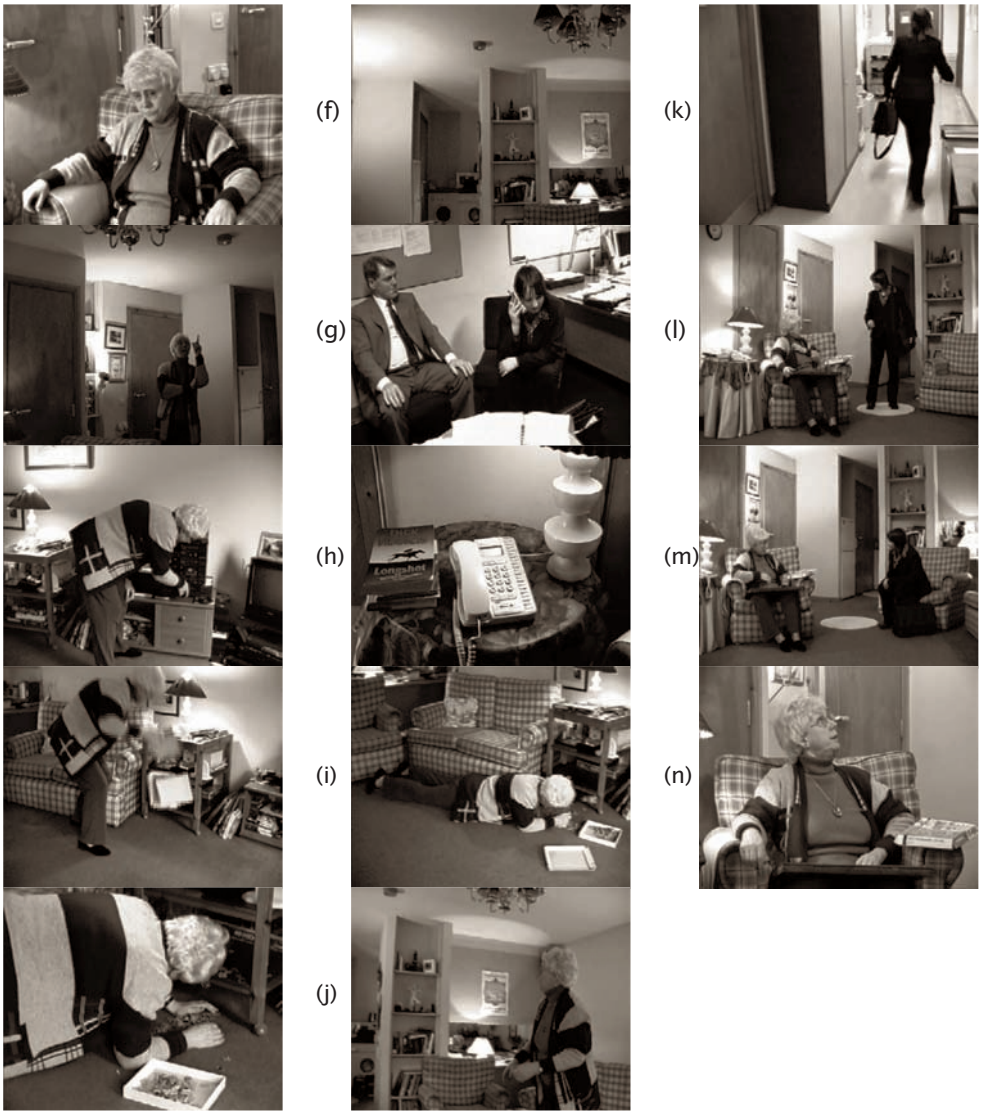

Figure 1. Stills from one of the video scenarios; Scene 1 of 'Peggy and the Fall Detector':
(a) Peggy sits and wonders;
(b) Peggy tells the monitor that it is important that it works;
(c) Peggy puts on some music;
(d) Peggy drops a jig-saw;
(e) Peggy lies down to pick up pieces;
(f) The fall detector begins to flash;
(g) Gill receives phone call about her mother;
(h) Gill rings Peggy to see if she is alright;
(i) Peggy is busy and does not respond to the phone;
(j) Peggy hears the phone, but it has stopped ringing before she answers;
(k) Gill assumes an emergency when her mother does not answer;
(l) Gill hurries to her mother's home and is upset – there is no problem;
(m) Peggy and Gill discuss what has happened;
(n) Peggy is angry with the monitor that has led to a problem.

be useful. For example, if the system made a visual image available only when it signalled an emergency, this would provide a mechanism for immediately checking how serious the alert was and whether it was, in fact, a false alarm. Some people, especially those who had had strokes tended not to mind the idea of a system providing visual images in such circumstances. Others did not want this to happen in any circumstances. A flexible system able to be configured to cope with different needs and preferences was thought to be best.

Notification and cancellation of alarms

Much of the discussion following the scenario with the false alarm (in the second video) concentrated on how to alert occupants to the fact that an alarm had been raised and how to provide them with ways in which to safely cancel a false alarm. Older people were keen that there should be an easy and quick way for them to cancel false alarms in order to avoid help being called unnecessarily so that any associated embarrassment or feelings of being a nuisance could be avoided. It was suggested that an alarm state should trigger an audio signal similar in volume to that of a domestic smoke alarm to help ensure that it was immediately recognised by the occupant and could be quickly cancelled if necessary. Some consideration was given to older people who were deaf and it was felt that a flashing light could be used to alert a deaf person. A large button on the phone or on a wrist watch-like device were suggested as interfaces for false alarm cancellation. It was pointed out that older people need to be given sufficient time to respond to an alarm and in particular to cancel a false alarm: hurrying to do so could of itself cause an accident.

Activity monitoring

The potential for the level and nature of activity to be monitored automatically was discussed. In particular, the possibility of raising an alarm in case of unusually prolonged inactivity was explored. It was pointed out that it would be useful for the system to distinguish between small body movements as one might make when reading or watching TV and total inactivity as would occur if one was unconscious. It was suggested that in cases of low activity the system might be set to give an 'assurance call' as a sheltered housing warden would do for people in her care. It was also pointed out that having built up a history of activities, the system could detect when someone was less active than usual. The design of the monitor must not interfere with normal patterns of behaviour but rather record them and then look for unusual patterns for that individual, checking with the user before raising any alarm. One participant wanted the option of going to sleep in a chair, perhaps for an entire night, without being woken by a monitor asking him if he was alright!

Privacy and security

Privacy was an important issue for all the groups; the advantages and disadvantages of allowing images to be stored and transmitted were discussed. No-one wanted to be observed in the bathroom by other people even though it was recognised to be an area of high risk. However, as one becomes more fragile, security starts to become valued more highly than privacy. The possibility of having a privacy button was explored. It was thought that any such button should not turn off the system completely but rather should leave it in stand-by mode, ready to activate again when required or after a specific time interval of say 10-15 minutes. It was thought that a privacy button would be less necessary if images were not being transmitted. However, a desire by some to guard audio privacy was mentioned since loudspeaker functions on tele-

phone-based systems can enable a warden, for example, to hear inside the home.

It was pointed out by participants that a system based on visual tracking could also serve a useful security function by keeping a video record of intruders. However, if, for privacy reasons, it was decided that no visual record should be kept then this potentially useful security function would be unavailable. If the system were monitoring the activity of a person living alone, it would need to distinguish that person from any visitors to the home. It was pointed out that a system that simply suspended monitoring when a second person entered the home could not double as a security system.

Reliability and isolation

Anxiety was voiced that the installation of a monitoring system could result in fewer visits and less interaction with carers (family and professional). It was suggested that for this reason it was especially important that a system worked reliably.

Appearance

The physical device mock-ups used in the videos revealed that, in aesthetic terms, most potential users would rather have a device that was unobtrusive. For example, a device that looked like a smoke alarm would be acceptable because other people would then not know that special provision was being made. However, in contrast to this view, some participants said that on security grounds it might be useful to have information at the front door stating that there was a monitoring system in place.

Costs

Some anxiety was expressed by potential users about the cost of the technology being discussed. It was noted in some sessions, however, that the cost of installing and operating a monitoring system needed to be balanced against the high cost of a hospital stay or home nursing care and should be subsidised accordingly.

Discussion and conclusion

This study has shown that theatre techniques, instantiated on video, can be used for assessing user needs prior to the design of a new piece of technology. This particular methodology, based on forum theatre but using video instead of live actors, enabled technologically naive people to understand and address important issues related to a very novel concept. For example, all the groups were able to distinguish between a CCTV-type system communicating video images and the proposed technology in which no visual images need ever be communicated beyond the intelligent sensing device. They were able to access a reservoir of stories relevant to important issues concerning the concept. Often these stories highlighted issues which were unpredicted by researchers. The facilitator was able to elicit comments on expectations and past history of older users and their friends and neighbours, and very rich anecdotal information was collected by listening to individual stories of the participants. For example, following the videos which showed an older man falling at home and a carer being alerted to a fall by a computer generated message, the participants told their own stories of related incidents, for instance, when they or their family and friends had fallen and when they had been alerted to a neighbour falling and the way they thought their own family would react if they fell. The close communication between the system designers and the script writers ensured that relevant issues were raised during these discussions. Thus these sessions established that short video presentation followed by discussion periods worked

successfully in terms of focussing discussion amongst older potential users of a home monitoring system. They enabled researchers to gain important information about potential users (including carers) concerning issues surrounding the use of current community alarms and what users would wish from future systems. It has been argued that the key characteristics of *dependable* domestic systems are acceptability, trustworthiness, adaptability and fitness for purpose[46]. The drama-based method was successful in stimulating discussion of each of these characteristics. Acceptability issues raised included usability, cost, responsiveness and aesthetics. Trustworthiness issues included reliability, safety and confidentiality. Adaptability was discussed in terms of configurability. Clearly much of the discussion focussed on exploring fitness for purpose and how the real needs of users could be met.

The use of video by older people in their homes, or in day or residential care settings is a familiar context and so it was easy to engage users in the process. The videos proved to be successful in encouraging focused discussion, producing many 'real stories' from the assembled potential users. Comments such as "that is so real", "that is just what happened to my mother" and "but where is the next scene?" clearly showed that the script-writer had successfully provided scenarios that emotionally engaged the audience. Basing the scenarios on fictional characters with personalities enabled the audience to empathize with the characters and the dramatic tension introduced into the scenarios meant that the audience cared about what happened to the main protagonist and were interested in what might happen next. This engagement with the process is essential when the audience is being asked to imagine themselves into a situation and report upon what support they would require in that context. The audiences were keen to participate in discussions because they felt empathy with the people represented in the video and immediately related them to their own situations. Participants were keen to engage with questions of design, to tell facilitators their concerns and to help find solutions, because the issues had been made to seem very relevant to them, their friends and neighbours. They found the experience interesting and enjoyable, which undoubtedly assisted in the elicitation process.

The use of professional actors, has advantages in terms of ethical issues and freedom of information. There are clear health and safety guidelines for the use of actors in any situation which may involve a danger to the performer. In the case of falls, for example, it would be appropriate to obtain the services of a fight director, who would advise the actors, or, for more extreme falling behaviour, employing a specially trained actor or 'stunt man'. There are, of course, no freedom of information problems in the case of filming professional actors, although the recommended fee may vary depending on the use to which the video will be put. The use of video rather than live theatre meant that the full range of forum theatre techniques could not be used. However, it provided a lower cost method of using theatrical techniques with many groups of users.

The methodology can be used on an iterative basis, as here, to clarify aspects of the system design. Initial scenarios should be generic while subsequent iterations can address more specific issues. This echoes the use of concrete scenarios having made initial design decisions based on more abstract scenarios as advocated, for example, by Benyon and Macaulay[34].

Ethnographies can also address user focused issues, and 'cultural probes' have been used to provoke inspirational responses from elderly people. Ethnography involves users within the design process, with the ethnographer observing the users in their own environments and acting as an intermediary between the users and the designers[47]. The ethnographer's role is to present as full a picture as possible of the user, their culture and their environment to the designers. This is usually in the form of a textual report but Blomberg et al.[47] also suggest other approaches to presenting ethnographies. Cultural probes[48] are a very open ended way of encouraging users to consider their attitudes to lives, environment and technology. They involve 'packages of maps, postcards and other materials' which are left with users for an extended period of time. Gaver et al.[48] describe the output from cultural probes consisting of 'masses of maps, cards and photographs' which were not analysed or summarized, but were used as a resource by the designers. They didn't "directly lead to [their] designs" but "were invaluable in making [them] aware of the detailed texture" of the users' environments and letting them ground their designs in the "detailed textures of the local cultures". The use of theatre, as described here, is a much more focussed activity which only involves the potential users for one or two hours, rather than days and weeks in the case of ethnographies and cultural probes. It addressed the requirements for a specific technology and the detailed ethical and practical considerations of such a technology in a time efficient way.

Newell et al.[49] discuss the wider use of theatre and suggest that these techniques could be used in cooperation with ethnographies (and cultural probes). A theatrical performance could be used to encapsulate the results of usability experiments or ethnographies and to present these results to designers. They report that the advantage theatre brings to this activity is that "script writers and actors are from a different tradition to usability experts or ethnographers, but they have been trained as professional observers of human behaviour, with a focus on converting such behaviour into interesting engaging stories". They are skilled both in observation and presentation of human behaviour. They are taught to distil experiences into essential, typical, and sometimes stereotypical behaviour, and present this in an interesting and engaging narrative. They know when to exaggerate for effect, and how to articulate feeling in such a way that it communicates effectively to the audience. In the words of the theatre, they are expert in 'suspending disbelief'. In addition, theatre can introduce tension and humour to keep the audience interested. The ego of the actor/user is not involved; actors are not dominated by their own emotional baggage. They can be more independent than a single user and can present a more generic picture of the 'user', exaggerating as appropriate, particularly in articulating feelings which 'real users' may have but are too embarrassed to articulate. Theatre thus plays a different role, at different stages of any requirements gathering exercise to ethnographies and cultural probes.

Dramatised scenarios have been shown to be an excellent way of setting a shared context for discussions between potential users and designers. Drama can be used to focus discussion on specific scenarios of likely system usage. The experience of watching a video can be very effective in provoking discussion of relevant details because users can imagine themselves within the scenarios shown in the video. The technique is particularly useful for provoking discussion at the pre-prototyping stage.

Once a working prototype is available, there are many advantages in evaluations of the system with real users, although situations remain where theatrical techniques may still be very valuable. These include evaluations which would put older users at risk which is particularly relevant in developments such as fall detectors. The authors also believe that, in certain circumstances, interactions between the design team and 'users' may be more open and fruitful if the user is represented by an actor.

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