

Design of Interactive Technology for Ageing-In-Place

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Abstract. In this paper we describe work directed at exploiting existing consumer electronics to present just-in-time reminder cues to assist ageing-in-place. We describe our methodology which first employed a series of structured interviews to gain insight into older people's opinions and expectations of consumer electronics and of the notion of autonomous and persuasive reminder systems. We then discuss our initial efforts to design and evaluate (using a Wizard-of-Oz methodology) a system which can make use of the existing programmable and wirelessly-networked, technology within the home, to provide a rich messaging service to older people as they conduct their everyday activities. Our research has the long-term aim of providing just-in-time, appropriate cues via multimodal displays to aid safer ageing-in-place for the older population.

Keywords: Aging-in-place, persuasive technology, smart homes, pervasive computing.

1 Introduction

The UK and world's population is "ageing", that is the proportion of older people within the total population is increasing and the trend is set to continue. In the UK it is estimated that there will be 27.2 million people aged 50 and over by the year 2031 and by this time 3.8 percent of the population will be over 85 [1]. This increase in the aged population will place an inevitable strain on health services and support networks.

Maintaining an independent lifestyle, and living in their own homes – so called ageing-in-place - is often an integral social need of many older people and could also have direct cost benefits for the full-time care sector. There is also evidence to suggest that older people are healthier and report a genuinely higher quality-of-life if they remain independent [2]. However, independence can, at times, lead to vulnerability and this can also put increased demands on other sectors of the healthcare sector as well as on supporting families and other caregivers. Deterioration in older people in areas such as cognitive ability, memory, and physical dexterity lead to concerns around such issues as the neglect of nutrition and medication, physical well being (falls) and social isolation. Autonomous, and intelligent assistive systems which

support independent living by providing reminders and other pertinent information that can assist in decision-making processes – particularly in a just-in-time fashion – have the potential to make a significant positive impact on the lives of older people and their care-givers [3]. However, to-date, the requirements of such autonomous systems, and particularly their interface and social acceptability to older users is not well understood. Despite this, a striking number of “smart home” technology demonstrators have appeared in recent years which are aimed specifically at the deployment and evaluation of context-aware and pervasive technology to support ageing-in-place. Many such demonstrators have been built around conventional houses where the walls, floors and appliances are all used as displays and/or input devices for a controlling computer [4, 5]. A number of groups are even exploring the use of augmented reality (AR) technologies within the home, such as in the ‘kitchen-of-the-future’ scenarios described variously in [6, 7 and 8] or by deploying numbers of smaller devices to form distributed displays [9]. While undoubtedly impressive, such interactive installations at present would be extremely difficult to recreate in real homes, often requiring significant amounts of custom hardware, software and special infrastructure such as cabling [10], whilst also remaining, for the time being at least, prohibitively expensive.

A slightly alternative research agenda to develop persuasive computing systems to support healthy ageing has been put forward in [11]. In this, it is concluded that current research effort should be directed at exploiting emerging consumer electronics to “motivate healthy behaviour as people age by presenting just-in-time information at points of decision and behaviour”. The research presented here is conducted in this spirit in that we have chosen to exploit only consumer electronics that are readily available in most homes as the displays to provide reminders about particular in-home tasks. The remainder of this paper firstly discusses relevant previous work in persuasive and reminder-based technology for older people, before going on to describe our own work in firstly assessing older peoples’ attitudes to some of the technology that already exists in their home. We go on to describe our efforts to design a system which can make use of the existing programmable and wirelessly-networked, technology within the home, to provide a rich messaging service to older people as they conduct their everyday activities. We then outline a short series of evaluation experiments in which we recruited a number of older people to engage with our prototype system and we finally describe our findings and future directions.

2 Persuasive Reminders and Older People

Intille [11] stresses that technology can have a positive impact on the lives of older people in that it can contribute towards them being able to live in their homes for longer than otherwise possible. His reasoning for this is that health related messages can be given at appropriate times – “specifically (at) a point of decision or behaviour where when an easy to understand message might have an impact on behaviour”. There are in fact many recent studies showing that context aware technology can indeed have a *persuasive* and positive effect on user behaviour (e.g. see [12]). Unsurprisingly, a number of researchers are already investigating the potential of

information appliances as vehicles for persuasive reminders. Recent research by a number of groups worldwide has given rise to the development of many experimental systems, or devices, which can give users obvious reminders and unavoidable information about their daily activities. These include the development of active medicine bottles [13], “aware home” appliances such as the now infamous Internet Fridge, specialized reminder/memory aids [14, 15, 16, 17], and, for the longer term, plans for holistic systems to give us reminders about almost everything to do with our daily-lifestyle [18]. In fact some aids to memory (such as pill bottle alarms) are readily available through local health professionals responsible for deploying general assistive technologies. Some researchers refer to all such developments as *cognitive orthotics*, though such a term has previously only generally been applied to devices developed for people with severely impaired memory function [19]. It should also be pointed out that good deal of earlier activity (e.g. [20], [21]) was ongoing in this area long before the field of pervasive and mobile computing became as widely investigated as it is today

Many of the systems developed above are still very much in their infancy and much has to be learned about their efficacy as well as their acceptability by older people – indeed many systems by their own design will mark their owners out as being unusual in some way – a common criticism of much assistive technology. Emerging technologies such as AR could, in future, provide an ideal medium for persuasive messaging – however at present we are wary of adopting such technology as a platform to build experimental systems for reasons of cost and also sheer strangeness, and novelty, in a home setting. In our research we are striving towards systems which do not intrude into older peoples’ everyday lives but provide flexible and socially acceptable persuasive messaging and which assist with an everyday activity in an effective manner.

3 Exploration of Older Users’ Attitudes to Technology

At the outset of our work we were interested to determine older people’s attitudes towards the technology that already exists in their home and also towards the notion of exploiting that technology as a medium for delivering just-in-time persuasive messaging. We were also keen to explore whether older people from different backgrounds and within different age-groups viewed such technology and ideas differently. We also wished to determine if findings from previous studies (e.g. [22]) held for our sample and also which devices and services were liked already and thus desirable to augment or emulate in further research.

We conducted a series of semi-structured interviews on a targeted group of older people from within our local region (the rural, largely agricultural, English county of Lincolnshire) but from different socio-economic and professional backgrounds. In total, 16 older people were recruited locally, from Age Concern day centers and elsewhere in the community and an attempt was made to obtain a distribution of participants across age, gender and background. A sample of responses from our participants when discussing in-home technology and the notion of reminder systems is given in Fig. 1.

Subject A -

1. ``I had a little trouble with it [a video recorder] --- as a new thing''
2. ``I can't hear the phone in the kitchen, so I was offered something on the wall [a strobe] that flashed. I said "wouldn't it be better if I had a cordless phone" ''
3. ``It [the remote control] looked a bit complicated to me....[I prefer] anything that's not too complicated''

Subject B -

1. ``I've had it [an old mobile phone] given to me - a cast off from my children''
2. "Would you actively avoid buying one [a mobile phone] with more features (cameras etc)?"
``Yes, as they're more expensive...I wouldn't mind experimenting with them wasn't so expensive''

Subject C -

1. ``[Devices don't annoy me] once they're set up. It's getting them to work in the first place!''
2. (on call centres and mechanistic technology in general) ``Even people who know the technology under certain circumstances want to talk to someone...a problem is lack of training for people on the end of the phone - they've got a script and if you ask a question off the script they don't have a clue what you're talking about''
3. ``If it [the phone] is flashing for no reason it doesn't seem important''
4. ``My wife writes them [appointments etc] down so I don't have to, really''

Fig. 1. Selection of responses from participants during structured interviews when discussing in-home technology and the notion of reminder systems

Our interviews revealed that our participants rarely purchased or set up their own technology, particularly in the case of entertainment systems which were often bought by relatives. This indicates that any further development of this technology must target older people, their relatives and the healthcare professionals who provide deployment advice. Subjects generally liked telephone services such as banking as this meant they could receive the service at home and did not need to use a computer. Most had no desire to use computers and no experience of interactive television despite wide ownership of digital TV or cable equipment. The familiar interaction idiom of the telephone may be preferred to the unfamiliar interaction idiom using the TV. We expect that the level of familiarity with technology will change as time passes – for example people still in work will be more familiar with computers than the current older population.

4 Evaluation of Consumer Electronics for Persuasive Reminders

Following our structured interview process, we then went on to develop a prototype ‘living-room’ system featuring a wireless network of typical home devices of telephone (both conventional and cordless), RF remote control device, analogue radio and TV. This is shown in Fig 2. Through use of open-source software technologies and standards such as Asterisk [23] SIP and MPlayer we were able to program these devices in such a way to allow them to behave like conventional consumer electronics, but also so that they could be interrupted to present synchronised persuasive messaging to a user. A number of scenarios were developed in consultation with local care professionals to capture everyday behavior. Four scenarios in Table 1 were selected to script an experiment to evaluate older peoples’ reactions to our system.

Table 1. Scenarios chosen for reminders to be issued during evaluation

	Critical	Non-Critical
Time Dependent	Attend an appointment	Watch a particular television programme
Time Independent	Take medications	Water household plants

We devised a Wizard-of-Oz (WoZ) [24] based experiment to evaluate older people’s reactions to our persuasive reminder system. Hence we utilized a human ‘wizard’ for real time analysis of user activity, generation of appropriate visual and aural cues, and the appropriate means of directing them, via our system, to the user in a given scenario. This is shown schematically in Fig. 2 below.

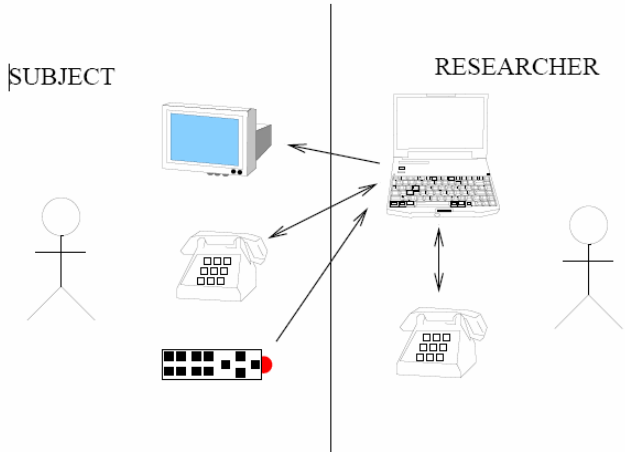


Fig. 2. Schematic of Wizard-of-Oz (WoZ) [24] approach to evaluation experiments

The system was evaluated with 8 of the participants who previously completed our structured interview process: 3 male and 5 female, 3 from professional backgrounds and 5 from non-professional backgrounds. We defined “acceptable reminders for each scenario and an order of escalation, plus “success” & “failure” conditions. Subjects were not instructed in the use of the system though paper documentation was present and the use of the remote control explained. This simulated a system placed in the home without explicit instruction, as is the case with much commodity technology.

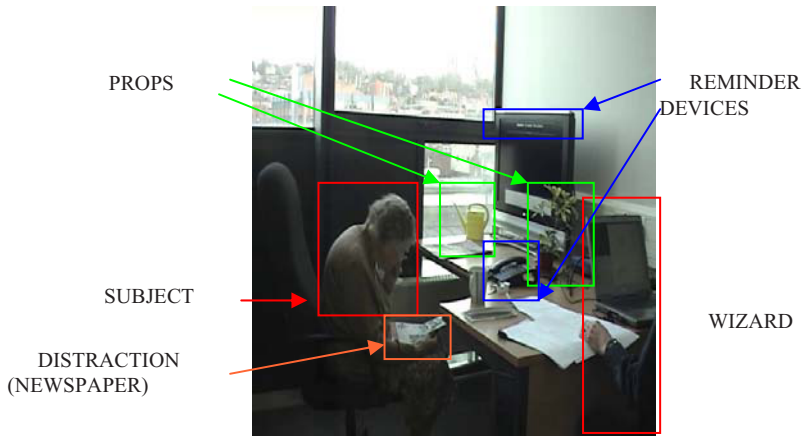


Fig. 3. Participant taking part in WoZ based evaluation of reminder system

Fig 3 shows our prototype system under evaluation. The participant is performing a distraction task, in this case reading a newspaper, intended to simulate everyday routine while they are exposed to various reminders. Unfortunately the Wizard is visible as we lacked a second experimenter to record responses etc; we believe this affected the suspension of disbelief required for effective WoZ evaluation. Two reminder devices can be seen: a telephone and the television; the latter displaying a reminder. Throughout the experiment, the participant is questioned about the reminders shown to them and subjectively rates them based on their persuasiveness, intrusiveness etc. The intention is to discover which reminders work well for each scenario.

5 Results and Conclusions

Our WoZ based experiment revealed that, as expected, participants reacted very differently to reminders depending on the context. Several stated that they would feel annoyed if “phone call” reminder interrupted them for a trivial task but found such reminders persuasive nonetheless. Similarly, most subjects expressed distaste for the synthesized voice when played from speakers but liked the same reminder delivered via the phone. The voicemail reminders confused some subjects. Voicemail had two “alert” modes: the first caused the phone display to flash and the second rang the

phone once. Neither made what was happening clear to the subject, indicating that the well known adage of “discoverable design” [25] must be a priority when implementing such systems.

In general, reminders issued in a different “mode” from the distraction task succeeded, for example receiving a spoken-voice reminder when reading. Focus of attention was also important; for example the on-screen reminder (though non-intrusive) was effective if the user was watching TV as their distraction task. Similarly, users often noticed an active “phone-flashing” reminder only when they interacted with the phone for other reasons despite the phone flashing for some time previously. Differences in reaction between subjects to the same reminder indicate the need for the system to be tailored to particular users and their habits in any future implementation.

The exploratory nature of this study limits the conclusions that may be drawn from our work and the small sample size is an additional drawback. Two priorities are a statistical study to reexamine the interview findings with a statistically valid cohort and further controlled experiments with specific successful reminder modes to determine what makes each mode persuasive and how their efficacy may be improved. Thereafter, a second WoZ, or even real, system can be built and evaluated based on such findings.

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