Cognitive Prostheses for Elderly People

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Abstract

The proportion of the elderly population in many countries is increasing sharply. The number of elderly people who have dementia or have other difficulties and are in need of support in their daily life will correspondingly increase. Appropriately designed technology can help us to meet this challenge by providing cognitive assistance. For healthy elderly people who want to find creative and engaging ways to share their reminiscences, we have been working on systems which allow them to make use of the internet to collect and build their own personalised reminiscence website. For people who are quite severely affected by dementia, with no functioning short-term memory, we have been developing ways in which they could still enjoy speaking about the past, assisted by a multi-media system. For people with dementia who are still in their own homes we have been developing the elements needed for a 24-hour computer-based prompting system.

Keywords
Elderly people, rehabilitation, cognitive prostheses, multi-media, artificial intelligence.

1 Introduction

The numbers of people in the UK over the age of 65 are predicted to increase from 9.25 million in 1996 to 12 million in 2021. The number of people aged over 75 will have doubled and the number over 90 will have more than tripled. In the USA, the Census Bureau states that the chances of having a disability increases with age, and more than half those who are 65 or over have a disability [1]. People over 65 accounted for 12% of the US population, but accounted for 34% of those with disabilities and 43% of those with severe disabilities. A significant proportion of these disabilities are cognitive disabilities; currently one in four of those over 80 have dementia, for example. In Japan, in 1996, the average life expectancy was 77 years for Japanese men and 84 years for Japanese women, giving the people of Japan the world's greatest longevity. As a result of the increase in the average life expectancy and the decline in the live birthrate, population ageing in Japan has been progressing rapidly. The percentage of the population aged 65 and over, which was 10% in 1985, is expected to reach 17% by 2001 and 27% by 2025.

Along with social and economic challenges this brings, the number of elderly people who have dementia or have other difficulties and are in need of support in...
their daily life will sharply increase. One cause is the increase in the number of older elderly people due to the improvements in average life expectancy. Another cause is an increase in the number of people whose lives have been saved (particularly stroke victims) as a result of advances in medical care.

Appropriate computer-based systems have the potential [8] to enhance the quality of life and independence of elderly people within the community. Such systems could compensate for reductions in cognitive performance in older people, thus allowing them to retain a high level of independence and control over their lives, and keep them intellectually active for much longer. Recent changes in technology, particularly the convergence of personal computing, internet, television, and mobile phone technologies provide many potential opportunities for supporting older people in an effective and efficient way.

A range of systems are possible, extending from help for healthy elderly people who want increased contact with family and friends, and more opportunities for enjoyable activities, to systems for people with memory problems which can prompt and cue them for important daily activities, and stimulation techniques and exercises for maintaining cognitive function, such as reminiscence therapy. Multi-media and multi-modal systems provide a richness of interaction which is particularly appropriate for those elderly people with reducing sensory and intellectual capabilities.

We have begun to develop prototype systems to enable us to explore the best way to provide a range of technical assistance for elderly people. For healthy elderly people who want to find creative and engaging ways to share their reminiscences, we have been working on systems which allow them to make use of the World Wide Web to collect and build their own personalised reminiscence website. For people who are quite severely affected by dementia, with no functioning short-term memory, computer-aided reminiscence can act as an aid to conversation with their families and caregivers. We have been developing ways in which this type of system could be made effective and easy to use. For people who are having memory problems, but are still in their own homes, and want to remain there as long as possible, we have been developing the elements needed for a 24-hour computer-based prompting system in the home, that could give the person prompts for daily activities in an acceptable and effective way.

2 A reminiscence website

Reminiscence is a natural and valuable form of interaction for elderly people. It can give them “a dignity, a sense of purpose, in going back over their lives and handing on valuable information to a younger generation” [2]. The intention of this project was to develop a tool which elderly people could use to create their own reminiscence website, based on both publicly available and personal material. In order to elicit personal material easily, the system used a combination of pre-stored publicly available material, such as news cuttings, recipes and graphics, and interviewed the user about their own personal recollections and views related to the material they were presented with. The system then combined the person’s own material with the pre-stored material, and automatically arranged it into an attractive and easy to navigate website.

The prototype system provided users with three choices of topic: events from the past in the form of newspaper cuttings, photographs of scenes from the past, and traditional recipes. In the newspaper and photograph sections, the users were able to select newspaper cuttings or photographs, and then add their own recollections related to these cuttings or photographs. In the recipe section, they could select favourite recipes for traditional dishes, and also give their own versions of the recipes.

The project had a number of aspects. It was an exploration of ways to help elderly people to use technology easily, and in a way which they found rewarding and relevant. It was also an investigation of ways to use multi-media to present reminiscence material in an engaging and interesting way.

The system was developed with the involvement of a group of older people who met at a Community Information Service to learn about using computers. This group, as well as guiding the development of the software, acted as evaluators of the final result.

The material was assembled with the help of a structured dialogue with the user which incorporated computer interviewing techniques, giving an interactive question and answer session that evoked memories whilst allowing users the freedom to answer in their own words [3]. Providing hypertext links enhanced the reminiscence experience. If users’ memories were triggered by text or image they could follow that text or image to pursue that topic. In this way the hypertext links offered options that mimic human thought and communication processes [4].

The process of iterative design was successful, not only as the key to meeting the objectives of designing a usable web site, but also in involving people in the presentation of community history and creating a sense of their ownership of that history.

The first stage of user evaluation was undertaken with a group of older men and women who were using the community-based computing facilities to familiarise themselves with computer technology. A wide range of skill sets was represented from absolute beginners to

The final user evaluation was undertaken with three people at this centre who had been involved in earlier site testing and one person who was a first time user. The evaluation followed an informal social psychology approach primarily to measure user satisfaction. The researcher observed the users’ interaction with the site, particularly to see what navigation difficulties were encountered, and whether reminiscence was evoked.

The user group was asked: “Would you recommend this site to your friends?” All replied positively. They were asked “Will you come back and make another web page?” Two replied “Yes”, one said, “Yes, if there were new topics” and one said they would like to look at the web site again but not to make a page. The question “What improvements would you suggest?” received recommendations on adding to site content, particularly more photographs with more explanatory text and different newspaper headlines. One person said the site was good for cooks and liked the idea of a web site to collect recipes.

Comments were largely positive. It was seen to be a “Better way to present photographs as it brings life to them”. The immediacy of the result appealed to users: “People will like seeing the web page they’ve built, particularly because it’s all completed in one session”. It was noted that there was enough content for two or three short sessions.

We concluded that presenting a tool specifically designed for older people, and one which they have a good motivation for using, can help older people with few computing skills to learn to use the new technology. As well as participating in an enjoyable reminiscence session older people were learning about computers and the World Wide Web. Creating a personal page brought about a sense of achievement in ‘mastering’ new technology.

3 A multi-media reminiscence experience as a conversation prosthesis

Dementia, which involves the loss of short-term memory in elderly people is a very serious problem for the person and for their family and carers. It can rule out most social activities and interactions, since these depend on a working short-term memory for effective participation. This includes even the essential ability to communicate.

As well as being valuable with all older people, reminiscence is an important tool used to help elderly people who have dementia [5, 6]. This is because, while their short-term memory may be impaired, their long-term memory is usually more or less intact [7]. The difficulty is accessing these long-term memories without the capability of keeping a conversation going, which depends on short-term memory. What can help are activities that do not require patients to keep a conversation topic active, for instance looking at photographs. This can provide a structure for meaningful interactions.

The tools used in such reminiscence work include photographs, videos, sound, music and written materials. However, these are all in separate media, and it can be very time consuming searching for a particular photograph, sound recording or film clip. Bringing all these media together into a multi-media scrapbook could mean a more structured framework for a reminiscence session and it could save valuable time. The intention of this project was to begin to develop a system that can act as a ‘conversation prosthesis’, giving the user the support needed to carry out a satisfying conversation about the past.

An investigation was undertaken to determine which aspects of multi-media would be most helpful for such a reminiscence experience, and the best way to present them.

A number of prototype interfaces were developed for a multi-media scrapbook in order to address the following questions:

1. Is it better for the display to use the metaphor of a real-life scrapbook or a standard computer screen?
2. How should the scrapbook material be organised – by subject or by medium?
3. How do the individual media add to the reminiscence process, what effects are produced by the various media – sounds, pictures, videos, music?

A number of prototype interfaces for a multi-media reminiscence experience were developed. These included text, photographs, videos and songs from the past life of the city. The materials were collected with the assistance of Dundee University and Dundee City archives and library, and the Dundee Heritage Project. The prototypes were demonstrated for evaluation for people with dementia and staff at a day centre run by Alzheimer Scotland: Action on Dementia. The following conclusions were drawn from these evaluation sessions.

Display Metaphor

1. Is it better for the display to use the metaphor of a real-life scrapbook or a standard computer screen?

Six of the staff members preferred the book presentation, three preferred the screen and two had no preference. This was almost a reversal of the preference shown by the group of people who had dementia, the
majority preferring the screen presentation. This preference for the screen presentation could have been due to reduced cognitive ability. The book presentation may give the person with dementia more information to process than they are comfortably able to cope with. They would first have to see the book and recognise it as such before moving on to seeing the picture.

The safest conclusion for the moment, however, based on the small sample number, is that some people prefer the metaphor of a real-life scrapbook, so presentation is a matter of personal choice. Most of the evaluators recognised that some people could prefer either presentation and said it would be of benefit to be able to select the presentation type for each session.

Organisation of material

2. How should the scrapbook material be organised – by subject or by medium?

The majority of the staff evaluators preferred the arrangement by subject saying it was more logical. Some were unsure, however, although no-one showed a preference for the arrangement by media. The clients with dementia reflected these findings. Despite preferring arrangement by subject the majority of evaluators could see benefits from having access to both methods of arrangements.

It was concluded that for basic reminiscence sessions the arrangement by subject is preferable, but access to arrangement by medium should be an option, in order to make the software available for use in other ways.

Effects of individual media

3. How does each individual medium add to the reminiscence process, and what effects are produced by the various media – sounds, pictures, videos, music?

It was found that with videos the clients were only able to strongly identify with them when they triggered off specific personal memories, whereas songs and photographs were more generally appreciated. Most of the videos and photographs and all of the songs were able to spur conversations, however. Attention stayed longest with the songs, which were particularly enjoyed when played repeatedly with everyone singing along. The staff on the other hand felt that some individual clients enjoyed the videos most.

One general finding was that the multi-media presentation produced a great deal of interest and motivation from the people with dementia with whom we worked. Staff were also very keen to see the idea developed further.

4 Interfaces for a 24-hour prompting system

Elderly people who are in the early stages of dementia are often still able to stay in their own homes with some sort of support. This is valued by most of them, who want to stay in the homes they are familiar with as long as possible. Declining short-term memory means that problems arise through the person needing to have prompts for their daily activities, and to ensure their safety, when involving, for instance, medication or use of the cooker. Having another person with them at all times is normally not possible. One way in which technology might be able to help is by providing some sort of 24-hour prompting presence in the home. The design challenges for such a system is that its purpose must be obvious to the user without any need for training, it must be acceptable to the user, and it must be accepted as authoritative by the user.

We have begun to develop the concept of a screen on the wall which has a human face or figure on it that can give prompts as needed to the occupant of the house. As a first step in the process, we have been investigating the acceptability of a range of computer-generated faces for delivering prompts. This work has been done in conjunction with a hospital-based day centre for people with dementia, and in particular with occupational therapy staff and patients there.

A range of computer-generated faces was produced, which varied from very realistic three-dimensional versions to two-dimensional cartoon style presentations. Evaluations indicated that the more cartoon-style faces were more acceptable. The three-dimensional versions were felt by patients (and staff) to suggest untrustworthiness, and even to be a bit threatening. (One patient commented of a face, “He looks like a convict”). They much preferred the cartoon-style faces.

A number of different cartoon personalities were then created and tried out. These included an older male doctor, a middle-aged male doctor, a younger male doctor, and two younger people, not identifiable as doctors, a man and a woman. Patients were asked which faces they liked and also which they would trust. There was some variability, but the men liked the young man or the young women, and the women liked the young man.

Different voices were also tried out, and the favourite which emerged was that of a softly-spoken middle-aged man with a local accent.

A degree of animation was added to the figure, and also a demonstration set-up facility was developed which would allow a care-giver to set up the prompts which would be given through the day. This prototype was demonstrated to occupational therapy staff, and their comments and suggestions were noted. The next
stage of this work will be to develop a fully animated figure, with an accompanying set-up tool.

5 Conclusions

This work has demonstrated that appropriate technology can be of benefit to elderly people, both in pursuing their interests more effectively, and in giving support to people who are coping with memory loss due to ageing. What is needed in future work is a thorough exploration of ways in which this technology can be most effective in helping with the very serious challenges posed by the ageing of the population in many countries.

References