Workshop Proceedings

Supporting Human Memory with Interactive Systems

Workshop at the 2007 British HCI Conference
September 4th, Lancaster, UK

Organized by

Denis Lalanne
DIVA group
Department of Informatics
University of Fribourg
denis.lalanne@unifr.ch

Elise van den Hoven
User-Centered Engineering Group
Industrial Design Department
Eindhoven University of Technology
e.v.d.hoven@tue.nl

The depicted memory game photograph, also named concentration, comes from http://www.flickr.com/photos/smil/19829388

Workshop
Supporting Human Memory with Interactive Systems

Workshop at the 2007 British HCI Conference
September 4th, Lancaster, UK

Abstract

The major goal of this workshop is to explore how interactive systems can support human memory, using novel technologies and innovative human/machine interaction paradigms, such as tangible interaction. We believe this is important since memory and attention are becoming critical resources for our wellness, e.g. with regard to a continuously increasing information overload. The goal of this workshop is not only to support personal information management but also daily life activities, e.g. adapted to user preferences and specific contexts. Where current multimedia search engines are designed for large user communities and their applications, this workshop targets the support of individual's personal memory in everyday life.

Table of contents

Workshop Schedule

09:00 - 09:15 Introduction to workshop

09:15 - 10:00 Position paper presentations - The Ageing Memory

Caprani, N., Porter, N., Greaney, J.
Methods Used to Predict Older Adult Use of Technology Mediated Memory Aids

Hunter, A., Sayers, H., McDaid, L.
An Evolvable Computer Interface for Elderly Users

Wilkes, J., Schneider, N., Grandt, M., Schlick, C.M.
Investigation of Memory-Supporting Design Approaches to the Age-Differentiated Adaptation of Human-Computer Interfaces

10:00 - 10:30 Position paper presentations - Technologies supporting Memory

Kalnikaitė, V., Whittaker, S.
Does Taking Notes Help You Remember Better? Exploring What Note Taking Patterns Lead to Better Organic Memory

Lustig, C., Novatchkov, H., Dunne, L.E., McHugh, M., Coyle, L.
Using Colocation to Support Human Memory

10:30 - 11:00 Break

11:00 - 11:30 Position paper presentations - Digital Memories

Kelly, L., Jones, G.J.F.
Venturing into the Labyrinth: the information retrieval challenge of Human Digital Memories

Evequoz, F., Lalanne, D.
Indexing and visualizing digital memories through personal email archive

11:30 - 12:15 Position paper presentations - Memory & Context Awareness

Bisht, M., Swords, D., Quigley, A.J., Gaudin, B., Bennett, M.
Context-Coded Memories: "Who, What, Where, When, Why?"

Schweer, A., Hinze, A.
The Digital Parrot: Combining Context-Awareness and Semantics to Augment Memory

Gheel, J., Anderson, T.
Activity metadata for enhancing Web document retrieval

12:15 - 01:15 Lunch

01:15 - 01:30 Introduction to afternoon brainstorming and discussion

01:30 - 03:30 Brainstorming in break-out groups

03:30 - 04:00 Break

04:00 - 05:00 Regroup and discuss break-out results

05:00 - 05:30 Wrap-up and future directions

Author Index

Anderson, T.	University of Ulster	tj.anderson@ulster.ac.uk
Bennett, M.	University College Dublin	mike.bennett@ucd.ie
Bisht, M.	University College Dublin	mukulc@gmail.com
Caprani, N.	IADT Dún Laoghaire	niamh.caprani@iadt.ie
Coyle, L.	University College Dublin	lorcan.coyle@ucd.ie
Dunne, L.E.	University College Dublin	lucy.dunne@ucd.ie
Evequoz, F.	University of Fribourg	florian.evequoz@unifr.ch
Gaudin, B.	University College Dublin	benoit.gaudin@ucd.ie
Gheel, J.	University of Ulster	j.gheel@ulster.ac.uk
Grandt, M.	RWTH Aachen University	m.grandt@iaw.rwth-aachen.de
Greaney, J.	IADT Dún Laoghaire	john.greaney@iadt.ie
Hinze, A.	The University of Waikato	hinze@cs.waikato.ac.nz
Hoven, E.v.d.	Eindhoven University of Technology	e.v.d.hoven@tue.nl
Hunter, A.	University of Ulster	hunter-a5@ulster.ac.uk
Jones, G.J.F.	Dublin City University	gareth.jones@computing.dcu.ie
Kalnikaitė, V.	University of Sheffield	v.kalnikaite@sheffield.ac.uk
Kelly, L.	Dublin City University	liadh.kelly@computing.dcu.ie
Lalanne, D.	University of Fribourg	denis.lalanne@unifr.ch
Lustig, C.	University College Dublin	celustig@cs.washington.edu
McDaid, L.	University of Ulster	lj.mcdaid@ulster.ac.uk
McHugh, M.	Dublin City University	mmchugh@computing.dcu.ie
Novatchkov, H.	Dublin City University	ico@novatchkov.org
Porter, N.	IADT Dún Laoghaire	nicola.porter@iadt.ie
Quigley, A.J.	University College Dublin	aquigley@ucd.ie
Sayers, H.	University of Ulster	hm.sayers@ulster.ac.uk
Schlick, C.M.	RWTH Aachen University	c.schlick@iaw.rwth-aachen.de
Schneider, N.	RWTH Aachen University	n.schneider@iaw.rwth-aachen.de
Schweer, A.	The University of Waikato	schweer@cs.waikato.ac.nz
Swords, D.	University College Dublin	davidswordster@gmail.com
Whittaker, S.	University of Sheffield	s.whittaker@sheffield.ac.uk
Wilkes, J.	RWTH Aachen University	j.wilkes@iaw.rwth-aachen.de

Supporting Human Memory with Interactive Systems

Denis Lalanne
DIVA group
Department of Informatics
University of Fribourg,
Fribourg, Switzerland
denis.lalanne@unifr.ch

Elise van den Hoven
User-Centered Engineering Group
Industrial Design Department
Eindhoven University of Technology
The Netherlands
e.v.d.hoven@tue.nl

ABSTRACT
The major goal of this workshop is to explore how interactive systems can support human memory, using novel technologies and innovative human/machine interaction paradigms, such as tangible interaction. We believe this is important since memory and attention are becoming critical resources for our wellness, e.g. with regard to a continuously increasing information overload. The goal of this workshop is not only to support personal information management but also daily life activities, e.g. adapted to user preferences and specific contexts. Where current multimedia search engines are designed for large user communities and their applications, this workshop targets the support of individual's personal memory in everyday life.

1. MOTIVATION
Human memory is central in our daily life activities, not only to build relationships with friends, create our identity or reminisce about the past (Cohen, 1996) but also to drive our attention towards the most important tasks to perform and to manage our lives (Baddeley, 1997). Information overload, memory and attention lacks are crucial challenges to solve, not only for elderly people but also for the rest of the society.

Numerous elderly have memory and attention problems, without speaking about Alzheimer disease (Morris, 2005, Rusted, 2002), which hinder their daily lives. Not only do they have difficulties remembering appointments and tasks that need to be done, such as buying bread or milk twice the same day, they might lose their glasses, they have trouble remembering people and places, which can result in insecurity, unsafe situations and melancholic feelings.

Younger people also face memory problems, especially with the constant increase of information a person owns and handles. Not only the information amount is growing fast, it is dematerializing and thus, people are often experiencing the "lost-in-infospace" effect. Our documents are multiplying in very large file hierarchies, our pictures are no longer stored in photo-albums, our music CDs are taking the form of mp3 files, movies are stored on hard-drives. Google and Microsoft recently tried to solve the "lost-in-infospace" issue by providing, respectively, a desktop search engine and a powerful email search engine, in attempt to minimize the effort needed by people to organize their documents and access them later by browsing. However, in order to find a file, one still has to remember a set of keywords or at least remember its "virtual" existence. If one does not remember having a certain document, browsing could be helpful, since it can reveal related keywords and documents. Those, in turn, can help you remember by association, like our human memory does (Baddeley, 1997, Rigamonti et al., 2005).

The process of "remembering" usually starts with a sensory cue which gives you access to an associated memory. For example, we may see a picture of a place visited in our childhood and the image cues recollections associated to the content of the picture and trigger an emotional reaction simultaneously. This information is generally easier to retrieve if it is associated to a strong emotional experience (Ochsner & Schacter, 2003) or when it is rehearsed often which can be facilitated by having physical objects related to memories, such as souvenirs or photographs (Hoven, 2004). Therefore tangible interaction systems seem to have potential for supporting everyday human memory (e.g. Glos & Cassell, 1997, Hoven & Eggen, 2004, Ullmer & Ishii, 2000). Furthermore, it appears that humans easily access and retrieve information when it is linked to other related information or objects (Lamming & Flynn, 1994, Whittaker et al., 2006), either information or sounds, smells, images, etc. which supports the idea of cross-modal indexing (Lalanne et al. 2005).

This workshop proposes to explore possible ways to support memory, by means of interactive systems, to improve the wellness of people suffering from memory or attention lacks or just everyday people in everyday situations.

2. AIM OF THE WORKSHOP
The aim of the workshop is to bring people together to discuss ongoing studies on human memory, both user centred and technology driven, and to address some of the following questions:

Human Memory: What human memory knowledge is needed to create optimal memory support? What are the known drawbacks of our memory?

Target group: Which groups of people could benefit most from human memory support? Can we support people suffering from Alzheimer and dementia? How can potential users be involved in the analysis, design, implementation and evaluation process?

Evaluation: How do we evaluate memory support from the perspective of the target group, interaction or interface design and supporting technologies? What has been done in terms of evaluation thus far and what did the results teach us?

Supporting Technologies: Which kind of technologies can be used to support human memory? Which multimodal technology

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

can help best supporting memory? For which tasks and target group? And what is the context of use?

Tangible Interaction: Why is tangibility important? How can we assess tangibility? What kinds of tangible objects are suitable for supporting remembering, i.e. how does tangible object design relate to human memory? Are personal tangibles more suitable than generic tangible objects for the memory field?

Emotion-oriented interfaces: How can emotion-oriented computing help supporting memory? How can a machine detect emotions and link it with related information? How can a machine generate emotions and recall memories? Can we use the knowledge that memories and emotions are closely linked?

Personal Information Management and Visualization: Which novel information mining and retrieval strategies are necessary to index and retrieve memories? How to adapt and extend multimedia search engines to handle personal memories? How to deal with the cross-modal nature of personal memories and information?

3. PARTICIPANTS

We aim at a mix of researchers and practitioners working on (including but not limited to) tangible user interfaces, multimodal interfaces, system designers, sensing technologies, cognitive sciences, personal information management or information visualization. These participants could be originating from diverse fields, including HCI, computer science, (interaction) design, psychology, sociology and ethnography.

4. WORKSHOP PROCEDURE

In case you are interested in participating in this workshop you should submit a 4-page position paper on any of the above-mentioned or related topics using the ACM-template (http://www.acm.org/sigs/pubs/proceed/template.html). Papers will be selected based on the quality, the relevance and on the diversity, since we are aiming at discussing work from different backgrounds, such as HCI, computer science, cognitive science. We will have to limit the number of presentations to no more than 15, due to time limitations. The total number of participants is limited to 25 to keep the workshop interactive.

The full-day workshop will consist of a morning program including an introduction and position paper presentations (of approximately 10 minutes each). We want to divide the participants in the afternoon session according to the themes mentioned in the previous section. These themes and the related questions raised in the workshop will be used to start discussions and brainstorms in small discussion groups. Later these groups will present their results to the other workshop participants. We would like to end the workshop with a group discussion on possible future directions. This is a rough first schedule of the day:

9	Welcome & Intro	14-14.30	Brainstorming intro
9-12	Position papers	14.30-16	Brainstorming in groups
12-13	Lunch break	16-17	Group presentations
13-14	Position papers	17-17.30	Wrap up & future

5. FUTURE PLANS

Plans for publishing the workshop proceedings with Springer-Verlag or electronically on ACM Digital Library will be studied in advance. However, we also want to discuss the follow-up possibilities during the workshop: a forum, a wiki, a mailing list, a book or a special issue in an international journal. In addition we are confident that this workshop will facilitate future collaboration and continuing discussions.

6. REFERENCES

[1] Baddeley, A. (1997). Human Memory: Theory and Practice, Psychology Press (UK).

[2] Cohen, G. (1996). Memory in the real world, Hove, UK: Psychology Press.

[3] Dourish, P. (2001). Where the Action is: the Foundations of Embodied Interaction, Cambridge, Massachusetts: MIT Press.

[4] Glos, J.W. and Cassell, J. (1997b). Rosebud: A Place for Interaction Between Memory, Story, and Self, Proceedings of the 2nd International Conference on Cognitive Technology (CT'97), 88.

[5] Hoven, E.A.W.H. van den (2004). Graspable Cues for Everyday Recollecting, Ph.D.-thesis at the Department of Industrial Design, Eindhoven University of Technology, The Netherlands.

[6] Hoven, E. van den, and Eggen, B. (2004). Tangible Computing in Everyday Life: Extending Current Frameworks for Tangible User Interfaces with Personal Objects, Markopoulos et al. (Eds), proceedings of EUSAI 2004, LNCS 3295, Nov 8-10, Eindhoven, The Netherlands, pp. 230-242.

[7] Lalanne, D. and Ingold, R. (2005). "Structuring Multimedia Archives With Static Documents." In ERCIM News: "Multimedia Informatics", vol. 62, n° 62, July 2005, pp. 19-20.

[8] Lamming, M. and Flynn, M. Forget-me-not: intimate computing in support of human memory. In: FRIEND21: International symposium on next generation human interface, Meguro Gajoen, Japan, 1994, 125–128.

[9] Morris, M.E. (2005). Early Detection of Cognitive Decline with Embedded Assessment. Alzheimer's and Dementia, Volume 1, Issue 1, Supplement 1, July 2005, p. 107.

[10] Ochsner, K.N. and Schacter, D.L. (2003). Remembering emotional events: A social cognitive neuroscience approach. In: Handbook of Affective Sciences, R. J. Davidson et al. eds., Oxford University Press, pp 643-660.

[11] Rigamonti, M., Lalanne, D., Evéquoz,, F. and Ingold, R. (2005). "Browsing Multimedia Archives Through Intra- and Multimodal Cross-Documents Links." In Renals S. & Bengio S., eds., Machine Learning for Multimodal Interaction II, LNCS 3869, Springer, pp. 114-125.

[12] Rusted, J.M. and Sheppard, L.M. (2002). Action-based memory in people with dementia: A longitudinal look at tea-making. Neurocase, 8, 111-126.

[13] Ullmer, B., Ishii, H. (2000). Emerging frameworks for tangible user interfaces, IBM Systems Journal, 39, 915-931.

[14] Whittaker, S. Bellotti, V. and Gwizdka, J. (2006). Email in Perso nal Information Management. In Communications of the ACM, 49(1), 68-73.

About the organizers

Denis Lalanne

Denis Lalanne is a senior researcher in the DIVA group of the University of Fribourg, Switzerland, where he gives a course on multimodal interfaces (diuf.unifr.ch/courses/05-06/mmi/). Previously, he was usability officer in Iconomic systems, a Swiss startup, assistant professor in the University of Avignon, and researcher in the USER group of IBM Almaden, USA. In 1998, he obtained a PhD from the Swiss Federal Institute of Technology in the domains of AI and HCI. Denis is currently coordinating scientifically several HCI projects among which: MeModules (www.memodules.ch) which aims at building and evaluating tangible reminders, supporting memory and facilitating the control of devices in everyday life and information access; and Total Recall aiming at supporting humans' memory in their professional life, and more specifically to support humans in remembering information or documents exchanged during meetings, tasks to do, or for preparing their presentations for a following meeting.

Elise van den Hoven

Elise van den Hoven is an assistant professor in the User-Centered Engineering group at the department of Industrial Design of the Eindhoven University of Technology, the Netherlands, currently working on tangible interaction in different application areas, including gaming and well-being. She has a background in user-system interaction. Her PhD-project took place at the Philips Research Eindhoven Laboratories and centered around two major themes: recollecting memories and tangible interaction. Her work focuses on designing, building and evaluating Tangible Interaction systems, which is user-centered and it is inspired by Dourish's Embodied Interaction (2001).

Context-Coded Memories: "Who, What, Where, When, Why?"

Mukul Bisht
ODCSSS:Online Dublin Computer Science Summer School
School of Computer Science and Informatics
University College Dublin, Ireland
mukulc@gmail.com

David Swords
ODCSSS:Online Dublin Computer Science Summer School
School of Computer Science and Informatics
University College Dublin, Ireland
davidswordster@gmail.com

Aaron J. Quigley
Systems Research Group
School of Computer Science and Informatics
University College Dublin, Ireland
aquigley@ucd.ie

Benoit Gaudin
Systems Research Group
School of Computer Science and Informatics
University College Dublin, Ireland
Benoit.Gaudin@ucd.ie

Mike Bennett
Systems Research Group
School of Computer Science and Informatics
University College Dublin, Ireland
Mike.Bennett@ucd.ie

1. INTRODUCTION

Human memory is a powerful yet clearly fragile construct. Research in cognition and the psychology of memory suggests different kinds of memory from short to longterm, or working to iconic [2]. Regardless of the type of memory, we each suffer from difficulties in both retaining and recalling specific memories. We can remember the address and phone number of a friend from 15 years ago but we cannot remember where we left our car keys! Technology is developed to help us in our work and study, so why not strive to develop systems which augment our natural memory? [5, 10].

Of particular interest for our work is technological support for episodic memory to aid people in *story telling* or *reminisce activities*. Episodic memory refers to the memory of an experience, time, place or an event. A challenge when dealing with episodic memory is that, with time the fine details tend to decline or become more difficult to recall. Our approach is to explore the use of different recording mediums to capture digital artefacts which we annotate with "context-coded" details. For our purposes, we are interested in the "context" of the individual (entity) who is capturing the digital artefact (eg. a photograph). *Context* is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and application themselves [3] . Hence, a *context-coded* digital artefacts is a data item (such as a photograph) with the addition of context metadata collected during the data item capture, inferred from subsequent data analysis. Regardless of what the context is determined as it is stored with the data item and is hence context-coded.

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

Providing user access to these context-coded artefacts allows people to have a reference back to the context in which the artefact was created, which we aim to show allows them to remember the past more clearly and with greater fidelity ([10]). For the purposes of this paper we focus on context-coded photographic collections although our techniques can apply to any digital artefact. In [12], one issue in associating location context data to pictures is that it often requires the user to do it manually. Some web sites like Flickr.com offer a convenient way to do it: just drag the picture and drop it on a map where it has been taken. We describe in this paper a simple method to automatically embed location data into a picture. This method only requires that after uploading on a computer her pictures and a file containing data location from a GPS device, the user executes a program which automatically synchronizes location and time information.

The broader motivation for this work stems from our past ethnographic research [9] and TableTop photo sharing studies such as [7] and [1] with elders. This work has suggested the social engagement achieved when sharing printed or digital photographs acts as a natural pathway for the exploration of episodic memories. Digital photography has changed the nature of story telling and reminisce activities in ways which are not yet well understood. A danger in the transition from physical to digital photography is that we will loose the rich story telling medium which the physical photographic artefacts provide.

Some people continue to print the majority of their digital photos which allows them to pass around a pile of their lat-

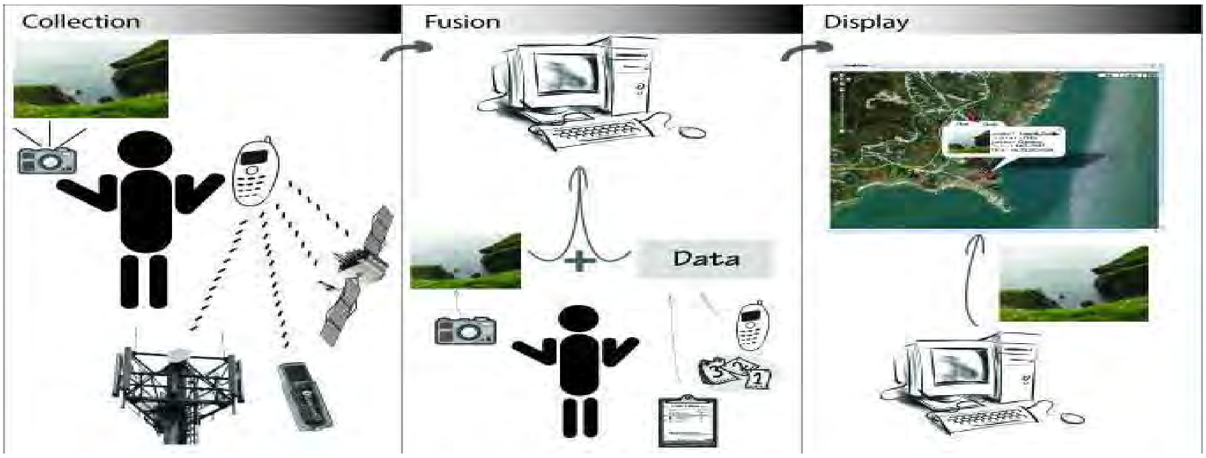

Figure 1: Context-Coding Process: Collection, Processing and Display

est holiday snaps with friends and family and to store them in a physical albums. However, many people are now transitioning to a world with thousands to tens of thousands of digital photographs stored on large hard disks. While this transition brings with it many possibilities in terms of copying, editing, publishing and printing it also brings challenges in terms of presentation, viewing and sharing photographs [1]. Consider for example one person aged 40 with a collection of 32,000 images. Spending ten seconds per image on a screen show, 1 hour per day would take this person 3 months to see all their pictures, just once. Further consider the 5.5 million photos available on a site such a flickr.com and the same process would see them complete a slide show around their 82 birthday. Clearly, people need methods to structure their use, exploration and access to large collections of digital artefacts. However, many of the digital artefacts we each collect form a very limited record of our life experience and are often only annotated with just time stamp data (which may be inaccurate) and cryptic names such as DSC00019.jpg as metadata. It's clear we wish to use, share and keep such collections for our own and others use. The problem is then, how can we provide access to such large collections while supporting episodic memory recall in the face of limited metadata and linear views of such data sets. Our approach here is to place such media in its correct context by processing the media itself and by correlating it with sensor, environmental data and data collected from each person's computational state (email, calendars). By combing these data sources one can offer recall technologies that assist people's memories in both the short and long term.

2. PHOTOS AS A SUPPORT FOR MEMORY

Pictures represent a very interesting means of remembering events or locations. Thanks to digital photo technology, many people take lots of pictures over the course of their lives. People possess hundreds and even thousands of pictures. Digital pictures can be stored as files with extra information (metadata) embedded (place and date the picture was taken, name of the people in the picture, etc). Because of the huge amount of pictures, it is not practically realistic for people to manually annotate each image with such extra information. Lots of metadata is automatically embedded in digital pictures but this default metadata is generally not relevant to common users, as it commonly refers to the make of the camera, the focal length, etc.

2.1 Context Coding Digital Artifacts

Our goal is to provide an approach we call context-coding which enables the automatic embedding of metadata (context) that is relevant to users. Context includes information from the environment (environmental state) and computational environment (computational state) that can be provided to alter an applications behavior, or is an application state which is of interest to the user. Context includes, though is not limited to, spatial information (location, speed), identity (users and others in vicinity), user model (profile, preferences), temporal (time of day or year), environmental (noise, light), social (meeting, party), resources (printers, fax, wireless access), computing (network bandwidth, login), physiological (hearing, heart rate), activity (supervision, interview), schedules and agendas.

Looking at pictures of places we were or people we know is clearly a good way to remember events. People's memories of photographed events can be improved by associating information with the pictures such as date, location, name of the people in the picture, etc. In this section we describe our approach to associating the collected information with the photographs. To achieve our goal, the person taking pictures not only carries a digital camera but also other devices: a GPS device and a mobile phone both embedding BlueTooth facilities. These assumptions seem realistic since digital cameras and mobile phones are common devices. Moreover, it is now possible to acquire a GPS device with no memory storage but with BlueTooth facilities for less than a 100 euros. All together, those devices allow the collection of pictures with associated date and location information. The principle is illustrated in Figure 1 and is described in the following paragraph.

Images are taken with an ordinary camera. The camera saves the images tagging them with a date and time[1]. Meanwhile, the mobile phone receives location coordinates from the GSM device and appends them to a file. It also keeps

[1] This is a usual feature of digital cameras.

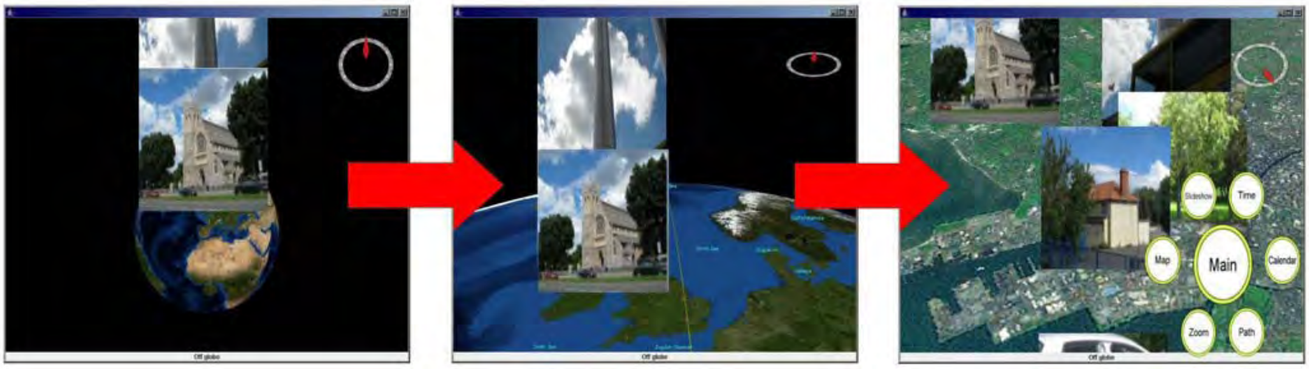

Figure 2: Visualization of pictures

track of the date and time the information location is saved[2]. All these features have been implemented via a mobile phone application. The mobile application can also access and save the calendar details and profile of the mobile phone. This provides information about the people you are with at a given time (colleagues for a meeting, family on holidays, friends at a birthday party, etc). The application uses a BlueTooth scan to determine the BlueTooth devices (and so people's phones) that are around it at any particular time. Note that the previously mentioned application can run in the background without affecting the users' normal interaction with the phone.

For our approach, the pictures with date information are stored in the camera and date and location information are stored in the phone. Data files can be uploaded from the mobile phone to a PC. The images can also be uploaded to the PC. We implemented an application to retrieve and synchronize the collected information. The synchronization is performed with respect to the time. The application considers the photos, the time they were taken at and then looks for the GPS and BlueTooth information that coincides with the closest time to the time the image was taken. The matching results are stored in the photo as metadata. Metadata is stored in the picture itself using the Exchangeable Image File Format (EXIF). If due to some unavoidable circumstances, (like the inability of the GPS device to connect to the satellite or mobile phone) it is not possible to collect data between two points A and B, then extrapolation techniques are used. Also, the frequency for collecting location information adapts to the speed with which the user moves at. For instance, if the user does not change her position for a while, then the frequency location information is collected at is reduced. In the same way, the frequency increases if the user moves very fast.

2.2 Visualizing data

Adding metadata to picture in order to help users' memory is only the first step of the process. To be relevant, the approach has to provide a meaningful way to use the information. Since we focused here on time and location information, we sought to provide the user with an insight into her memory through that information. For that reason, both spatial and temporal criteria are important for the design of an interface for browsing a users' photographs. This approach leads us to provide the user with a map and a time scale. She can then select a location and access all the pictures that were taken at that location. She can also select a time or a period and then access all the pictures taken during that period. Both parameters can be combined to help the user answer questions such as "Was Auntie Helen with us in mum's house in Dublin at Christmas two years ago?". The interface was implemented using the WorldWind software[3], which is a GoogleEarth like application. With the web application Flickr.com you can place pictures on maps to indicate where they were taken. Unlike Flickr, our application does not require any human intervention to place the picture. It uses the embedded location information instead.

The visual interface is a 3D representation of the Earth (see Figure 2). The user is able to select a location with this representation. Time is also a factor that is presented by an artifact resembling a clock which the user rotates to go back and forth through time. As they do this the images relating to the time appear on the surface of the Earth. To start the interface loads photos from the information in a the text file, then the user is presented with a calendar structure within which they can select time periods of interest. The calendar is scalable to show the days, weeks, months and years. When selected the Earth is shown with the relevant photos. The photos on the Earth can be selected and manipulated (e.g. resized or placed aside for future use).

3. CONCLUSIONS AND FUTURE WORK

The systems developed to date for the Context-Coded Memories support rudimentary contextual data collection and processing along with a map and globe based display. Natural extensions for this work include support for indoor location awareness, for example through the use of Ubisense technology to detect position coordinates, where the GPS is not able to receive sufficient coverage from the GPS satellites. In addition, we can add context details from our computer calendar and Google calendar to our images along with inferring activity from emails, documents, SMS and tele-

[2]Note that in some cases, GPS devices are not necessary to get some location information. Mobile phones can indeed save the nearest GSM cell tower id. This gives a rough idea of the location of the phone.

[3]WorldWind is a world map browser software developed by NASA, http://worldwind.arc.nasa.gov/

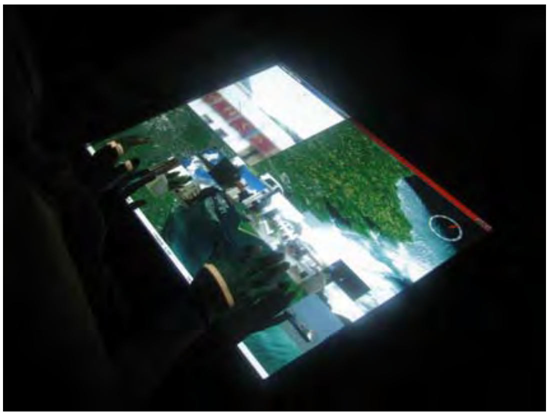

Figure 3: Interface running on a TableTop

phone calls. Image recognition technology can also be used to detect certain faces in your image collection coupled with the BlueTooth device names you were proximate to while you took the photo, which are stored in the images. Our planned future work will explore all of these options along with a visual interface which will be displayed on a multi-touch device such as the DiamondTouch[4], this will provide a gateway to more collaborative aspects of photographic memory aids.

People do not interact the same way with digital pictures as with physical ones. Physical pictures are more adapted to social sharing. For example, it is common that people who were on a trip together meet afterwards to look at the physical pictures they took and talk about them. In this social sharing, the discussion about the pictures leads to memories sharing and each person's memory can help in other ones to be refreshed as memories around photos are discussed. Unfortunately, this habit is disappearing with the use of digital pictures. It is now really easy to share pictures by publishing them on a web site for example. It would then seem interesting to explore retaining the physical tactical nature of pictures as a means of enabling people to socially reminisce. While also gaining important advantages by using digital photographs, easy automatic reorganization, etc. Finally, to provide a tangible link to your digital artefact's a link can be made between physical artifacts and the images displayed, such as souvenirs collected from a holiday. These souvenirs can have RFID tags attached. When a tag is read, the images related to the souvenir would be displayed providing a gateway to this source of information. Our current work seeks to address the need for support for episodic memory through context coded media and subsequent work will provide evaluations of our approach.

4. REFERENCES

[1] Trent Apted, Judy Kay, and Aaron Quigley. Tabletop sharing of digital photographs for the elderly. In *CHI '06: Proceedings of the SIGCHI conference on Human Factors in computing systems*, pages 781–790, New York, NY, USA, 2006. ACM Press.

[2] Alan David Baddeley. *Human Memory: Theory and Practice, Revised Edition*. Lawrence Erlbaum Associates, Publishers, Hove, 1997.

[3] Anind K. Dey. Understanding and using context. *Personal Ubiquitous Comput.*, 5(1):4–7, 2001.

[4] A. Esenther, C. Forlines, K. Ryall, and S. Shipman. Diamondtouch sdk: Support for multi-user, multi-touch applications. In *ACM Conference on Computer Supported Cooperative Work (CSCW)*, New Orleans, Louisiana, USA, November 2002.

[5] Steve Hodges, Lyndsay Williams, Emma Berry, Shahram Izadi, James Srinivasan, Alex Butler, Gavin Smyth, Narinder Kapur, and Ken Wood. Sensecam: a retrospective memory aid. In *Proceedings of UbiComp 2006, The 8th International Conference on Ubicomp*, pages 177–193, Orange County, California, USA, Sept 16-19 2006.

[6] Caitlin Lustig, Hristo Novatchkov, Lucy Dunne, Mike McHugh, and Lorcan Coyle. Using colocation to support human memory. In *MeMos 2007: Supporting Human Memory with Interactive Systems. Workshop at the 2007 British HCI International Conference*, September 2007. To Appear.

[7] M.R. Morris, A.M. Piper, A. Cassanego, A. Huang, A. Paepcke, and T. Winograd. Mediating group dynamics through tabletop interface design. *IEEE Computer Graphics and Applications*, pages 65–73, Sept/Oct 2006.

[8] Jenny Preece and Yvonne Rogers. *Interaction Design: Beyond Human-Computer Interaction*. Wiley, 2002.

[9] Peter Risborg and Aaron Quigley. Nightingale: Reminiscence and technology – from a user perspective. In *Proceedings of the 2003 Australian Web Accessibility Initiative, OZe-WAI*, pages 1–8, La Trobe University, Bundoora, Victoria, Australia, 2003.

[10] Abigail J. Sellen, Andrew Fogg, Mike Aitken, Steve Hodges, Carsten Rother, and Ken Wood. Do life-logging technologies support memory for the past?: an experimental study using sensecam. In *Proceedings of CHI2007*, pages 81–90, San Jose, California, USA, May 28 - May 3 2007.

[11] C. Shen, F.D. Vernier, C. Forlines, and M Ringel. Diamondspin: An extensible toolkit for around-the-table interaction. In *ACM Conference on Human Factors in Computing Systems (CHI)*, pages 167–174, Vienna, Austria, January 2004.

[12] C. Torniai, S.Battle, and S. Cayzer. Sharing, discovering and browsing photo collections through rdf geo-metadata. In *Semantic Web Applications and Perspectives, 3rd Italian Semantic Web Workshop*, December 2006.

[13] Edward Tse, Saul Greenberg, and Chia Shen. Gsi demo: Multiuser gesture/speech interaction over digital tables by wrapping single user applications. In *Proceedings of the 8th international conference on Multimodal interfaces*, pages 76–83, Banff, Alberta, Canada, 2006.

[14] Mike Wu and Ravin Balakrishnan. Multi-finger and whole hand gestural interaction techniques for multi-user tabletop displays. In *Proceedings of the 16th annual ACM symposium on User interface software and technology*, pages 193–202, Vancouver, Canada, 2003.

[4]DiamondTouch is a TableTop technology developed by Mitsubishi, http://www.merl.com/projects/DiamondTouch/

Methods Used to Predict Older Adult Use of Technology Mediated Memory Aids

Niamh Caprani
niamh.caprani@iadt.ie

Nicola Porter
IADT Dún Laoghaire
Kill Avenue, Co. Dublin
Ireland
00353 12144600
nicola.porter@iadt.ie

John Greaney
john.greaney@iadt.ie

ABSTRACT
Prospective memory, or remembering to do things in the future, is an important aspect of daily living. However, research studies have shown that prospective memory tasks display an age-related decline. The current study is part of a longer-term project to design a technology mediated prospective memory aid for older adults. In this paper, the methodologies used to investigate the lifestyles of older adults in terms of their use of memory strategies and technology will be described. From this research several themes emerged to predict the factors that are important to older adults and to the design of a memory aid, including memory ageing, physical ageing, social network and activity and ageing attitude. The findings from these methods will be used to support the design of a new interactive memory aid, MultiMinder.

Categories and Subject Descriptors
H.1.2 [**Models and Principles**]: User/Machine Systems – *software psychology.*

General Terms
Design

Keywords
Prospective memory, memory aids, older adults.

1. INTRODUCTION
Prospective memory (PM) is remembering at some point in the future that something has to be done, without any prompting (Maylor, 1998). PM is pervasive in everyday living and failures in PM can result in a range of consequences, from missing appointments to forgetting to take medication (Groot, Wilson, Evans, & Watson, 2002).

Research into PM is gradually growing, specifically concerning the area of older adults. There have also been recent developments in prospective memory aids for older adults however many of these initially concentrated on designs for cognitively impaired individuals (Neuropage; Hearsh & Treadgold, 1992, Memojog; Szymkowiak et al., 2004). These devices have been shown to support the memory function of the users, more so than traditional methods (Caprani, Greaney, & Porter, 2006).

The current study aims to design a prospective memory aid that can be used by cognitively healthy older adults to support their day-to-day lifestyles. The lifestyle of this group was explored through multiple methodologies to gain an insight into whether such a device is needed and what features are necessary to fit in with the older users' preferences and requirements.

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

2. BACKGROUND

2.1 Prospective Memory in Older Adults
Prospective memory is one area of cognition which is affected by the ageing process (Maylor, 1993). Einstein and McDaniel, (1990) distinguished PM into event- and time-based PM. Event-based PM involves remembering to perform a particular behaviour when prompted by an external cue, such as remembering to phone a friend when you see a picture of her. Time-based PM involves remembering to perform a particular behaviour at a specific time or after a certain amount of time has passed, for example taking medication ten minutes after eating. Time-based PM is believed to be more sensitive to ageing compared to event-based PM, as it is believed to rely more on internal control mechanisms and self-initiated mental activities, such as time monitoring (Henry, McLeod, Phillips, & Crawford, 2004).

Initial studies examining age difference in PM found no significant age-related deficit (Einstein & McDaniel, 1990). However more recent studies have produced outcomes with older adults displaying poorer performance compared to younger counterparts (McDaniel, Einstein, Stout, & Morgan, 2003). One explanation for this decline is that PM is a complex cognitively demanding task which comprises of a number of different processes (McDaniel & Einstein, 1992).

Several frameworks have been developed to try to explain what processes are involved in PM. Dobbs and Reeves (1996) for example claimed that there are six components of PM. These are: meta-knowledge, planning, monitoring, content recall, compliance, and output monitoring. It is suggested that altering the nature of the PM task could consequently alter the components necessary to complete the task (e.g. setting an alarm would eliminate the necessity of monitoring stage). This model highlights how cognitively demanding prospective memory is, as is requires many levels of remembering throughout the process. An interactive reminder system could reduce this memory load by remembering for the user. For example, a reminder system could help organize or plan the task with the older adult, remember the time the task needs to be done, what the tasks do be done are and also, presuming the user accepts the reminder, provide feedback concerning whether the task was completed.

2.2 Current Memory Aids
An external memory aid is defined as any device that facilitates memory in some way (Intons-Peterson & Newsome, 1992).

Research has shown that older adults report to use at least one external aid regularly with the most popular aids being calendars, address books, paper notes and alarm clocks (Cohen-Mansfield, Creedon, Malone, Kirkpatrick, Dutra, & Herman, 2005).

Although the proposed memory aid is aimed at cognitively healthy older adults, previously designed PM aids have commonly targeted cognitively impaired users. This may be because PM decline is more pronounced compared to healthy older adults. Some designs such as MEMOS, a mobile interactive memory aid, have recognized the potential of PM aids for healthy older users and are now adapting their current designs to accommodate for this user group (Thöne-Otto, & Schulze, 2003).

One of the earliest PM aids was Neuropage, a portable paging system for brain injured individuals (Hearsh & Treadgold, 1994). Neuropage was renowned for its simplicity, making it very usable for both cognitive and physical impairments. The users schedule is inputted via a paging company and reminder alerts are sent to the user through the pager at appropriate times. The user only has to press a button to accept the reminder.

More recent developments such as Memojog (Szymkowiak, Morrison, Shah, Gregor, Evans, Newall et al., 2004) have taken into account not only the cognitive and physical needs of cognitively impaired users, but also the social needs surrounding them and their carers. Memojog was designed as a reminder system built on a PDA platform for brain injured and cognitively impaired older users. The user's schedule is inputted by the user, carer or care professional and reminders are issued to the user. The user can accept, postpone or ignore the reminder, in which case the carer is alerted. Memojog is also equipped to store personal information for the user, an aspect that was found to be popular in its evaluation.

Evaluations of these devices have yielded positive effects on memory performance with the help of the aid (e.g., participants were more likely to remember to take medication and meet appointments on time with the help of an electronic aid compared to without an aid). This supports previous research which found that younger as well as older adults benefit from the use of external aids (Einstein & McDaniel, 1990). The success of these electronic devices could be attributed to their compatibility with their target user, supporting prospective memory and in particular time-based PM, which, as previously mentioned is believed to be particularly sensitive to ageing.

3. QUALITATIVE DATA GATHERING

3.1 Methodology

To gather information about older adult's needs and preferences in relation to PM and technology, multiple methods were used to validate each other in the form of methodological triangulation. These data gathering methods included interviews (with professionals and older adults), observations (of older adults' daily activities) and focus groups (of older adults' technology needs). The information that was obtained from these methods was used in the conceptual and physical design of MultiMinder. The older adults that participated in the research were aged 60 years and over, were cognitively healthy and lived relatively independently (i.e., may rely on others to drive them or do heavy lifting etc.). Apart from the focus group method, home visits were organized prior to the research method to help the participants become familiarized with the researcher's presence.

3.1.1 Interviews

Interviews were conducted with 10 older adults and 3 professionals working with older adults. The older participants were questioned about their lifestyles, physical and memory abilities, the memory strategies that they use and the positive and negative features of these strategies. The professional participants were asked similar questions in relation to the older adults that they work with.

3.1.2 Observations

The observations were carried out with 4 older adults in their home. The purpose of the observations was to observe the participants as they carried out daily tasks, such as cooking, preparing and eating lunch, cleaning or doing errands, paying particular attention to cognitive, physical and psychosocial issues. Participants were asked to do the daily activities that they had previously planned or would have done on a standard day.

3.1.3 Focus Groups

Focus groups were carried out to discuss the cognitive, physical and psychosocial needs and preferences of older adults in terms of technology design and to obtain feedback on conceptual design ideas. Two groups of older adults from the Active Retirement Association (ARA) participated, 6 people in one and 4 people in the second group. ARA is an organisation set up as a social outlet to facilitate the pursuit of hobbies, leisure activities and education for people after retirement.

3.2 Inductive Qualitative Analysis

The method used to analyse the research data was the approach known as inductive thematic analysis. An inductive approach concentrates on identifying themes that are linked to the data themselves (Braun & Clarke, 2006). As a hypothesis was not already formed prior to interviewing, this approach allowed for the themes to emerge from the interview transcripts.

According to Thomas (2003) the purposes underlying the development of the general inductive approach are to reduce the raw data into a brief format, to establish links between the research objectives and the summary findings and to develop a model about the underlying processes evident in the raw data. Thomas claims that the inductive approach is intended to aid an understanding of the meaning in complex data through the development of summary themes or categories from the raw data. This is a more straightforward approach to qualitative analysis compared to other traditional approaches (Thomas, 2003).

The process of the inductive approach follows the transcription of the raw data, multiple readings of the text, coding and categorising the data, identifying themes, using diagrams to display the data and making conclusions about the findings.

3.2.1 Emerging Themes

Four themes were identified to represent the important issues in older adults' lifestyles in terms of their daily needs and preferences. The themes were divided into four main themes, each containing three sub-themes. These are displayed in Table 1 below. These themes will be used as guidelines for the design of a technology mediated memory aid so that the system features will be relevant to the older user's needs and preferences and fit into the their daily lifestyle.

Table 1. Summary of themes and sub-themes identified in the lifestyles of older adults

	Themes			
	Memory Ageing	**Physical Ageing**	**Ageing Attitude**	**Social Network & Activity**
Sub-Themes	Reminder strategies	Physical problems	Expected problems	Providing/receiv-ing support
	Perceived problems/ abilities	Assistive technology	Negative attitude from internal/exte rnal sources	Social activity with family/friends/ community
	Learning	Affect on task performance	Positive Attitude	Influence of social network on technology use

3.2.2 Key Findings

Throughout the data gathering process many interesting information was gathered that is key to the development of an interactive memory aid.

From the interviews it was found that all of the participants used three or more memory strategies frequently with the majority of those being used in the home (e.g. calendars, diaries, paper notes, putting objects in conspicuous places etc.). Although the participants identified many positive features of these strategies, many negative features were also identified. The most common responses given when asked the positive features of the memory strategies used were; that the memory aid reminded them to do a task, was easy to display, it was handy or easy to use, it could be thrown away or kept if needed, and it helped them to organise their time. The most common responses given when asked the negative features were that; the reminder might fail to remind them, looks messy if not thrown away, difficult to display, take up too much space to save and they might lose it.

Participants reported to experiencing age-related physical problems; however they felt that these problems had less of an impact on their lifestyles compared to non-age related problems (e.g., knee replacement after a fall).

The observations supported the information found from the interviews. The participants were observed using external memory aids whilst carrying out their daily tasks, such as using an oven timer when baking and using the calendar when filling in a form. Age-related physical problems were not observed to greatly impact how the participant carried out their tasks. However, noticeably age-related changes to behaviour included wearing glasses to read or holding written text at a distance to read. One participant suffering from hip problems adapted to her condition by using the furniture to lean on when doing tasks and a walking stick when moving from room to room.

Findings from the focus group consisted of older adults experiences with different technologies, such as different devices (mobile phones, digital television etc.) and different styles of input (touch screens). Although older adults initially doubted their experience, they gradually realized that their experience was quite diverse. The majority of the participants used mobile phones, however many only used the call features. Other types of technology that the participants reported using included; digital cameras, the Internet, ticket machines at the airport or train station. All of the older adults said that they found touch screens “terribly easy to use, usually straightforward and if you do something wrong you can cancel it”. They said that it was important for them that a device is simple to use and learn, allows the user to return from errors made, has a help option and does what it is supposed to do in only a few steps. It was also thought that technology should accommodate for sensory and fine motor problems, for example, it should have a large screen with large text, (“the bigger the better”), have audio output that can be adjusted to the users hearing ability, and have buttons or an input device that are easy to manipulate.

The focus group participants were also asked to give feedback about computer icons in relation to which ones best represented their purpose. The older adults strongly agreed about which icons they preferred. A common thread that was evident was that the icons that were chosen were not the icons that are used by computer software packages. The groups were more likely to choose real world images to represent a function, such as an image of an ear to display the volume option rather than an image of a speaker. As one participant put it, “that means nothing to me”.

The information that was obtained from these research methods was used for the conceptual design of a reminder system.

4. DESIGN AND DEVELOPMENT

4.1 Conceptual Design

The conceptual design that was developed to accommodate for older adults needs and preferences as identified from the research methods was a multiple reminder system, named MultiMinder.

The data gathering methods showed that the majority of the older participants lead active lifestyles. The idea behind MultiMinder is that it will be a PM aid to assist the older user to organise their time and to remind them of things they have to do in the future. From the interviews it was found that older adults use three or more memory aids in their home with the calendar, diary and paper notes being the most common. Following this, the reminder system will include a digital calendar section, a memos section, a contacts section and a digital timer section (see Figure 1).

The advantage of this design over other memory aids will be that it will contain features suitable for older adults’ sensory and physical abilities, while also accommodating for cognitive (e.g. will require limited input or learning effort, will support time and event based prospective memory) and psychosocial needs (e.g. assist the user to organise their social activities, and support the older user without marking them out as different or old). The system will use a touch-screen pen (on a Tablet PC platform) that will allow the user to manipulate the memory aid in the same way that they used traditional memory aids (writing their message on the screen as opposed to typing it). The purpose of MultiMinder will be to act as a reminder system, displayed in the home, which can be referred to when needed and which will alert the user to appointments they have made.

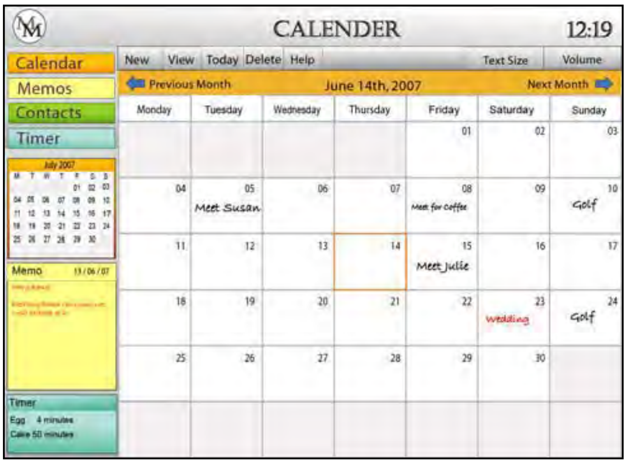

Figure 1. MultiMinder calendar screen

4.2 Future Work

The next stage of this research will be to design a low-fidelity prototype of the reminder system to test on the older user. This prototype will be redesigned and tested until a suitable prototype design is developed.

5. CONCLUSIONS

It was important when setting out to research the design of a reminder system that the cognitive, physical and psychosocial needs of the older user were identified, both in their day-to-day routines and in terms of their use of memory aids and technology.

The data gathering methods supported the idea that a PM aid would be of benefit to the older user. It was found that older adults frequently use memory aids in their home and although they find these methods satisfactory, many disadvantages were reported concerning the memory aids that they use. The intention for the current design study is to design a reminder system to contain all of the features that older adults find beneficial about the memory aids that they use and they technology that they use and to eliminate the negative aspects.

6. ACKNOWLEDGMENTS

Our thanks to all the people who participated in the research and to the Active Retirement Association for accommodating us. This research is supported by the Irish Institutes of Technology's Council of Directors "Strand 1" Scheme.

7. REFERENCES

[1] Braun, V. & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*, 77-101.

[2] Caprani, N., Greaney, J., & Porter, N. (2006). A Review of Memory Aid Devices for an Ageing Population. *PsychNology Journal, 4*(3), 205 – 243.

[3] Cohen-Mansfield J., Creedon M. A., Malone T. B., Kirkpatrick M. J., Dutra L. A., & Herman R. P. (2005). Electronic memory aids for community dwelling elderly persons: Attitudes, preferences and potential utilization. *Journal of Applied Gerontology, 24,* 3-20.

[4] Dobbs, A. R., & Reeves, M. B. (1996). Prospective Memory: More than Memory. In M. Brandimonte, G. O. Einstein, & M. A. McDaniel (Eds.), *Prospective memory: Theories and applications* (pp. 199-226). Mahwah, NJ: Lawrence Erlbaum.

[5] Einstein, G. O., & McDaniel, M. A. (1990). Normal aging and prospective memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition, 16*, 717–726.

[6] Hearsh, N., & Treadgold, L. (1994). Neuropage: The rehabilitation of memory dysfunction by prosthetic memory aid cueing. *Neurorehabilitation, 4*, 187-197.

[7] Intones- Peterson, M. J., & Newsome, G. L. III. (1992). External memory aids: effects and effectiveness. In D. Herrmann, H. Weingartner, A. Searleman & C. McEvoy (Eds.) *Memory Improvement: Implications for Memory Theory*. New York: Springer-Verlag.

[8] Maylor, E. A. (1993). Minimised prospective memory loss in old age. In J. Carella, J. Rybash, W. Hoyer, & M. Commons (Eds.), Adult information processing: Limits or loss (pp. 529-551). California: Academic Press, Inc.

[9] Maylor, E. A. (1998). Changes in event-based prospective memory across adulthood. *Aging, Neuropsychology, and Cognition, 5,* 107-128.

[10] McDaniel, M. A., & Einstein, G. O. (1992). Aging and prospective memory: Basic findings and practical applications. *Advances in Learning and Behavioral Disabilities, 7*, 87-103.

[11] McDaniel, M. A., Einstein, G. O., Stout, A. C., & Morgan, Z. (2003). Aging and maintaining intentions over delays: Do it or lose it. *Psychology and Aging, 18*(4), 823-835.

[12] Szymkowiak, A., Morrison, K., Inglis, E. A., Gregor, P., Shah, P., Evans, J. J., et al. (2004). Memojog - an interactive memory aid with remote communication. *Paper presented at the Workshop on Universal Access and Assistive Technology (CWUAAT)*, Cambridge, UK. Retrieved April 05, 2006, from http://rehab-www.eng.cam.ac.uk/cwuaat/04/03-memojog-cwuaat04.pdf.

[13] Thomas, D.R. (2003). A general inductive approach for qualitative data analysis. Retrieved July 01, 2007, from http://www.health.auckland.ac.nz/hrmas/resources/qualdatanalysis.html#Purposes.

[14] Thöne-Otto, A. J., & Schulze, H. (2003). *MEMOS: Mobile Extensible Memory & Orientation System*. Retrieved May 25, 2006, from http://www.memos-online.de/contact_en.html

Indexing and visualizing digital memories through personal email archive

Florian Evequoz
Departement of Computer Science
Bd de Perolles 90
CH-1700 Fribourg, Switzerland
florian.evequoz@unifr.ch

Denis Lalanne
Departement of Computer Science
Bd de Perolles 90
CH-1700 Fribourg, Switzerland
denis.lalanne@unifr.ch

ABSTRACT
The research work presented in this paper tackles the personal information overload phenomenon. Our purpose is to offer a set of interactive visualization techniques allowing one's personal digital memory to be organized and overviewed. This system will provide easy browsing, guiding towards the wanted piece of information and allow a free exploration of the personal information space. Three main axis of research are involved: (1) emails clustering to organize personal information, (2) cross-media alignments to connect clustered emails with personal information, and (3) information visualization techniques, to provide interactive means to navigate through personal information. As an alternative to the presented state-of-the-art works, our approach to these challenges takes the personal email archive as entry point into the personal information space. We finally present the work done during the first year of this research and the roadmap for the future.

Keywords
Personal information management, information visualization, emails, memory associations

1. INTRODUCTION
With all types of media becoming digital and storage devices regularly increasing in capacity, we tend to accumulate a growing amount of information that becomes "personal" as soon as we decide to keep it. However, this personal information (PI) grows very fast, challenging our natural wish for order and the capacity of our memory. Thus, e-mails, pictures, videos, music, personal documents and every other pieces of information creating our individual digital memory are often stored anarchically and become hard to retrieve or correlate. Even when we try to keep it organized, the rigid hierarchy of filesystems or mail archives forces us to take decisions on classification schemes that may not be relevant in the long-term, eventually leading to frustration if we fail to retrieve a piece of information that we know for sure is in our collection. We may then feel overwhelmed and have the feeling of losing control over our personal digital memory.

The very hierarchy of file storage system is the main reason for this failure. Indeed, as Bush pointed out in [3], our mind works by association rather than by following the rules of a static hierarchy. An email from a friend may remind us of the holidays we spent together, the places we saw and of which we took the pictures and the music we used to listen to at the time. Gathering this information at once would require painful search in crowded data repositories. However with current systems, no explicit links connect heterogeneous pieces of information about the same topic, related to the same people or having another characteristic in common. This implies that we often have to perform repetitive searching tasks using several different applications in order to gather the obviously correlated information we look for. All in all, the inherent or instinctive structure of our personal information is hidden, and the current searching mechanisms do not put it into evidence. It remains obscure also because we cannot get an overall view of it.

The purpose of the research work presented in this paper is to investigate means for restructuring and visualizing the personal information space interactively. The focus will be put on browsing capabilities, taking advantage of the structure of the personal information and the various links existing between different pieces of information, e.g. thematic, temporal or social links. We will use the personal email archive as the main source for generating a personal information structure. Other personal information (texts, pictures, music) will then be aligned with this structure and integrated together into an interactive visualization tool.

In the following sections, we present a state-of-the-art of personal information management (PIM) and email management and visualization systems. Section 3 is devoted to a more concrete presentation of the work envisioned for our research project. Section 4 present the use cases and applications of the project. Finally, section 5 present the work achieved during the first year of the project and the future plans.

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

2. STATE OF THE ART
PIM research has been receiving a growing interest in the recent years, leading to the developement of several tools and methodologies. We present here some innovative works that motivated our approach. *Stuff I've Seen* [8] is a search

system providing a unified view over all types of PI (files, emails, web pages, etc.) and enabling both queries and filters based on available metadata like date, author or type of document. The search results are presented as a textual list that can be (automatically) ranked by relevance or sorted chronologically. The study conducted at the end of the project notes the importance of people and time for retrieving information. MyLifeBits [9] is a database of resources and links. Links represent either user-created collections of resources or so-called transclusion, that happen when a resource cites or uses another one (e.g. a picture included in a Powerpoint presentation). This work also recalls the need for annotation on non-text media. Results of queries in MyLifeBits can be viewed using traditional detailed or thumbnail view, or using more original and flexible time-based visualizations. FacetMap [18], built on top of MyLifeBits data store, offers a query-refinement mechanism based on facets and therefore allows to browse the data instead of searching. Other works, described in particular in [21] focus on the semantic aspect of personal information. A most interesting user-study of personal information management strategies has been conducted in 2004 by Boardman [2]. Among other conclusions, Boardman notes that users generally prefer to browse than to search their PI and that the email archive has a potential for being integrated with the files, as similarities are strong between files and filed emails. We want to explore the direction he suggests and try to structure the PI around the email archive's own structure. Finally, an interesting research work dating back to 1994 presented in [15] suggests to exploit the human episodic memory, i.e. the ability we have to associate things to a context, in particular places and people, in our memory. [17] also tries to replace information in context, specifically in their temporal context. Following this latter idea, our work tries to recover the natural context of information, focusing on finding similarities between different pieces of data, exploiting the social temporal and thematic dimensions.

In the particular domain of email management, recent works introduce visualization techniques to tackle the issues raised by email overload. Some works use visualizations to help handle the current inbox and keep a synthetic view of tasks. Thread Arcs [12] for example, presents a novel visual approach that helps to understand threads of messages. The works of Dredze [7] or Cselle [6] use machine-learning methods to classify emails into activities, helping to keep trace of current (but also possibly past) tasks. The visualization of activities relies on color schemes. Nevertheless, few works really address the problem of managing and exploring an individual's whole email archive. In [19] the authors propose to visualize the "conversational history" between the mailbox owner and a chosen contact during a certain period of time. While this is an invaluable tool for a psychological self-analysis, it does not provide an overall view of the email archive. Similarily [16] explores relationships through past emails, but consists in an analytical tool rather than an exploration tool. Our system will try to provide a synthetic view of the whole personal email archive that can then be extended to include other types of connected PI.

3. PROJECT OVERVIEW

The PIM works presented in the previous section consider all types of PI equally important with respect to indexing. We chose one as being prominent. As suggested by [2] the email archive has the potential of being taken as a core around which other PI gets connected. Therefore, in order to generate metadata on PI, we use the personal email archive as main source of metadata. Email is indeed a rich subset of PI [20]. A single email inherently connects together people, topics and time. Therefore, a whole personal email archive contains invaluable thematic, temporal and social metadata that would be hard to obtain with other types of PI: people knowing each other usually appear together as recipents of a message, some topics are related to particular groups of contacts, topics and relations are closely related to time periods, etc. Our purpose is to gather this metadata and retrieve clusters pertaining to the social, thematic and temporal dimensions. These three dimensions are preferred by users looking for documents, according to the study in [17]. In the next step of analysis, the remaining PI will be aligned with the dimensional structures extracted from emails, following the approach successfully used in [13] to align multimedia data with textual documents.

Once the metadata is available, relevant visualization techniques will be applied in order to allow browsing the whole PI. As we will not use data-driven classification of PI which requires a training set of already classified data, but statistical analysis, the role of the personal information visualization will be particularly emphasized. We plan to present the user with several visualizations simultaneously, in order to enable visual query refinement using known interaction methods such as on-demand filtering, link & brush, etc. Each of the visualizations proposed will focus on one of the aforementioned dimensions, or a combination of two of them (e.g. variation of themes over time, using a technique similar to ThemeRiver [10]). We believe that the combination and synchronization of several visualization types applied to different dimensions will help the user browse instinctively through her/his PI. Therefore, a goal of this research work will be to confirm or invalidate our hypothesis that a good use of visualization can be efficient for handling PIM, without using any semantic modelling. More specifically, the following steps need to be performed by our email-centric PIM system in order to fulfill its goals:

1. Features or metadata extraction from emails
2. Clustering according to social, thematic and temporal dimensions, based on similarity computations
3. Alignment of the structure extracted from emails with the remaining PI
4. Visualization of the PI, based on the structure and taking advantage of similarity links

4. USE CASES AND APPLICATIONS

The primary use case regards the outcome of this project as a memory association facilitator. In the context of Hasler Stiftung's Memodules [1] project, tangible objects serve as shortcuts to digital information. A user can tag a "real" physical holidays souvenir, associate it to digital pictures, sounds, etc. and use it later to retrieve the images and other data of her/his vacation. One of the main issues raised by this approach is the actual association between digital information and the physical object, in particular the work needed to gather all the pertaining digital information that one want to associate to a specific object. This is where our system comes into play. Indeed, the views of PI it provides, exhibiting a meaningful PI structure, may be used to facilitate the association task. If the emails, documents, pictures and other information about a holiday are gathered and presented together, associating the whole episode to a physical object becomes easier. In addition, physical objects already associated to digital information may serve as query parameters to retrieve correlated pieces of PI. A combination of two physical objects may be used to retrieve the PI pertaining to both objects' associations.

The secondary use case handles professional data access. NCCR IM2 project deals with multimodal information management, and in particular meeting data management (documents, emails, audio/video recording of meetings, slideshows, etc.). Our project comes within the scope of IM2.HMI, of which a specific goal is to develop methods for accessing recorded meetings data. The benefit of our project in this context is to be found in the assistance it can provide for browsing huge amounts of professional data. Indeed, the extracted PI structure may serve as a filter to help navigate through such professional data, and to assist in finding information thanks to similarity links that can be drawn between personal and professional information [14]. Fig. 1 summarizes our approach and the link to both applications.

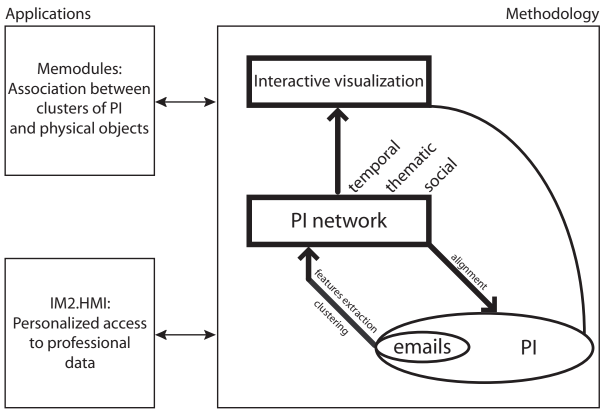

Figure 1: A PI network based on social, temporal and thematic dimensions is extracted from emails and aligned with the remaining PI. Interactive visualization techniques take benefit of this network to help browsing personal information. Two chosen applications are shown on the left.

5. ACHIEVED WORK

The first research efforts were centered on emails. In a first phase, we collected personal data. It consists of (a) a personal email archive containing around 6000 emails and 3500 addresses, (b) the Enron public email archive [5] and (c) the AMI meeting corpus [4], that contains textual, audio, video and email data. A user requirements questionnaire was set up, focusing on the relationship between personal and professional information and the preferred way of accessing them. We then developed a tool for extracting email data from IMAP servers and local archives into a database and perform statistical analysis on textual content and addresses to gather relevant features. More specifically, textual similarities were computed using a cosine similarity measure on tf.idf values. With this method, the similarity between two messages is proportional to the number of words they have in common, and depends on the discriminancy of each word (a rare word, like "Cappadoce" has more weight than a very common word like "meeting"). Likewise, the similarity between two contact's addresses is proportional to the number of times they appear together in the headers of emails. Using the similarity based on the co-occurrences of words in the subjects and contents of emails, a simple hierarchical clustering was performed, which aims at finding a thematic organisation of emails. As well, a social network was built based on similarity measures between email addresses. For the information visualization part, simple views of the email archive were implemented with the help of the prefuse toolkit [11]. The result of thematical clustering was fed into a treemap-visualization, while the result of the social analysis is visualized as a social network graph (see Fig. 2) using a spring layout algorithm to separate main clusters from one another. Even if the two visualizations still need refinement and have not been synchronized yet, limiting the possibilities of visual querying, they show interesting trends that would not have been highlighted by traditional mail clients.

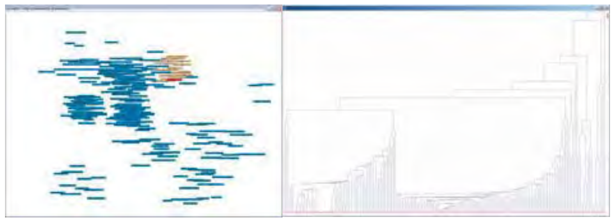

Figure 2: The implemented views of a personal email archive. The left window presents the social-network graph and the right one shows the thematic hierarchical clustering of emails.

6. CONCLUSION AND FUTURE WORKS

In this paper we have presented our approach of personal information management using information visualization. Taking into account the previous work in the field, we compute similarities between differences pieces of data to build a network of PI, in an attempt to gather memory episodes the same way our human memory does. The personal email archive is used as the main source for metadata on PI, allowing to generate thematic, social and temporal links between pieces of information. Our plan is to align the structure extracted from emails with the remaining PI and use this structure as an entry point into the PI. Achieved work covered the phases of data collection and metadata extraction using statistical analysis and clustering methods. We also developed visualizations of the email archive based on the social and thematic dimensions. In the near future, we plan to synchronize the different email archive views to enable more advanced visualization techniques such as link & brush, details-on-demand, filtering, etc. Indeed, we believe that these visualization techniques build upon the similarity links extracted from the data can enhance the PI browsing experience. Further, the alignment of email archives with the rest of the PI will be considered, and various email-centric PI browsers will be implemented through our two use-cases: ego-centric meeting browsing and tangible access to PI. In a final phase, user-evaluations will be conducted, comparing our set of tool with standard mail clients and desktop managers.

7. REFERENCES

[1] Memodules homepage. `http://www.memodules.ch/`.

[2] R. Boardman and M. A. Sasse. "stuff goes into the computer and doesn't come out": a cross-tool study of personal information management. In *CHI '04: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 583–590, New York, NY, USA, 2004. ACM Press.

[3] V. Bush. As we may think. *The Atlantic Monthly*, 176(1):101–108, 1945.

[4] J. Carletta, S. Ashby, S. Bourban, M. Flynn, M. Guillemot, T. Hain, J. Kadlec, V. Karaiskos, W. Kraaij, M. Kronenthal, G. Lathoud, M. Lincoln, A. Lisowska, I. A. McCowan, W. Post, D. Reidsma, and P. Wellner. The ami meeting corpus: A pre-announcement. In S. Renals and S. Bengio, editors, *MLMI'05: Proceedings of the Workshop on Machine Learning for Multimodal Interaction*, number 3869 in LNCS, pages 28–39. Springer-Verlag, 2005.

[5] W. Cohen. Enron email dataset. Retrieved May 5, 2005, from `http://www.cs.cmu.edu/~enron/`, 2005.

[6] G. Cselle, K. Albrecht, and R. Wattenhofer. Buzztrack: topic detection and tracking in email. In *IUI '07: Proceedings of the 12th international conference on Intelligent user interfaces*, pages 190–197, New York, NY, USA, 2007. ACM Press.

[7] M. Dredze, T. Lau, and N. Kushmerick. Automatically classifying emails into activities. In *IUI '06: Proceedings of the 11th international conference on Intelligent user interfaces*, pages 70–77, New York, NY, USA, 2006. ACM Press.

[8] S. Dumais, E. Cutrell, J. Cadiz, G. Jancke, R. Sarin, and D. C. Robbins. Stuff i've seen: a system for personal information retrieval and re-use. In *SIGIR '03: Proceedings of the 26th annual international ACM SIGIR conference on Research and development in informaion retrieval*, pages 72–79, New York, NY, USA, 2003. ACM Press.

[9] J. Gemmell, G. Bell, R. Lueder, S. Drucker, and C. Wong. Mylifebits: fulfilling the memex vision. In *MULTIMEDIA '02: Proceedings of the tenth ACM international conference on Multimedia*, pages 235–238, New York, NY, USA, 2002. ACM Press.

[10] S. Havre, B. Hetzler, and L. Nowell. Themeriver: Visualizing theme changes over time. In *INFOVIS '00: Proceedings of the IEEE Symposium on Information Vizualization 2000*, page 115, Washington, DC, USA, 2000. IEEE Computer Society.

[11] J. Heer, S. K. Card, and J. A. Landay. prefuse: a toolkit for interactive information visualization. In *CHI '05: Proceedings of the SIGCHI conference on Human factors in computing systems*, pages 421–430, New York, NY, USA, 2005. ACM Press.

[12] B. Kerr. Thread arcs: an email thread visualization. In *IEEE Symposium on Information Visualization (INFOVIS)*, pages 211–218, 2003.

[13] D. Lalanne, R. Ingold, D. von Rotz, A. Behera, D. Mekhaldi, and A. Popescu-Belis. Using static documents as structured and thematic interfaces to multimedia meeting archives. In *MLMI'04: Proceedings of the Workshop on Machine Learning for Multimodal Interaction*, LNCS, pages 87–100. Springer-Verlag, 2004.

[14] D. Lalanne, M. Rigamonti, F. Evequoz, B. Dumas, and R. Ingold. An ego-centric and tangible approach to meeting indexing and browsing. In *Machine Learning for Multimodal Interaction (MLMI' 07)*, 2007. Accepted for publication.

[15] M. Lamming and M. Flynn. Forget-me-not: intimate computing in support of human memory. In *Proceedings FRIEND21 Symposium on Next Generation Human Interfaces*, 1994.

[16] A. Perer, B. Shneiderman, and D. W. Oard. Using rhythms of relationships to understand e-mail archives. *J. Am. Soc. Inf. Sci. Technol.*, 57(14):1936–1948, 2006.

[17] M. Ringel, E. Cutrell, S. T. Dumais, and E. Horvitz. Milestones in time: The value of landmarks in retrieving information from personal stores. In M. Rauterberg, M. Menozzi, and J. Wesson, editors, *INTERACT*, pages 184 – 191, Zurich (Switzerland), 1 -5 September 2003. IOS Press.

[18] G. Smith, M. Czerwinski, B. Meyers, D. Robbins, G. Robertson, and D. S. Tan. Facetmap: A scalable search and browse visualization. *IEEE Transactions on Visualization and Computer Graphics*, 12(5):797–804, 2006.

[19] F. B. Viegas, S. Golder, and J. Donath. Visualizing email content: portraying relationships from conversational histories. In *CHI '06: Proceedings of the SIGCHI conference on Human Factors in computing systems*, pages 979–988, New York, NY, USA, 2006. ACM Press.

[20] S. Whittaker, V. Bellotti, and J. Gwizdka. Email in personal information management. *Commun. ACM*, 49(1):68–73, 2006.

[21] H. Xiao and I. F. Cruz. A multi-ontology approach for personal information management. In *ISWC 2005: Proceedings of the Semantic Desktop Workshop*, 2005.

Activity metadata for enhancing Web document retrieval

James Gheel
Institute of Lifelong Learning, University of Ulster
Newtownabbey
Co. Antrim, Northern Ireland
+44 (0)28 90 368658
j.gheel@ulster.ac.uk

Prof. Terry Anderson
School of Computing and Maths, University of Ulster
Newtownabbey
Co. Antrim, Northern Ireland
+44 (0)28 90 366903
tj.anderson@ulster.ac.uk

ABSTRACT
Web users frequently revisit pages that are of particular relevance to them. They also tend to have these documents on-screen and interact with them for longer periods than other pages. By recording document access frequency and activity metadata, which is based on transient user interactions within the browser, it is possible to infer the importance the user attaches to a given page. Activity metadata, access history metadata and document content can be stored in a locally held repository. This repository will help the user remember and quickly retrieve high interest documents they have accessed in the past.

This paper discusses the nature of activity metadata generated and recorded during Web document use, how it relates to the document, and how it can be gathered, stored, represented and visualized for subsequent retrieval. Selected prototype implementation issues are also presented.

Keywords
Metadata, user activity, document retrieval, document representation, document visualization.

1. INTRODUCTION
The number of documents available on the Web continues to increase enormously each year. As Lyman and Varian state [1], it has become "the information medium of first resort for its users". The great benefit of information availability through the Web is reduced as users struggle with information overload and loss of potential productivity.

Traditional mechanisms such as databases have been able to cope with vast increases in information due to their scalable design and techniques such as clustering. Several improvements have been made to assist users in searching for unknown information in unstructured repositories by learning from their searching habits and by cross-referencing the context of a user's search from existing documents [9].

The arguably unparalleled success of Web search engines such as Google and Yahoo, is largely based on content indexing and sophisticated use of information in page links. Highly effective algorithms have been devised to assess the level of importance the Web collectively attaches to a particular site or page. However, comparatively little research has been focused on the importance a particular site or page has for an individual user, often only to predict future pages of interest [3, 14], or to allow keyword searching of previously view pages [15]. In fact, there is strong evidence that Web page revisitation is a prevalent behaviour [12].

While bookmarks are simple and highly effective, they can be somewhat cumbersome to manage and keep up-to-date [11, 12]. Address-bar histories and auto-complete functions perform a similar function, but have the advantage (and sometimes disadvantage) of being automatically maintained by the browser. They make effective use of the metadata of past browsing behaviour. However, we will argue that there is much more metadata that can be recorded and used to help users revisit documents, a process that often involves recalling the context of use when the document was last seen [2].

This paper takes the concept of Web document metadata further and suggests that documents should be linked with metadata derived from the user's interactions. It is human nature to repetitively organise our life and carry out our lives in much the same way each day, week, month, etc. This also applies to our use of Web documents. How we have previously used the documents can support their future retrieval. If we solely rely on a particular search engine to find the same information, often we won't enter the same keywords and may have a tedious and frustrating task in re-finding a document.

2. DOCUMENT STORAGE AND RETRIEVAL
A user selects and views a document because of its relevance to their task. Our local file storage typically contains documents we have already seen. But in the case of Web-based documents, if no bookmark or entry in favourites has been set, or if it is a significant period since it was visited, there is likely to be no trace either in the browser history or cache. The only trace is in the user's memory as a page location (URL), title or some fragment of content. But low frequency of access does not imply that it is unimportant. Such access may be vital, for example, to lower-priority research topics, annual financial guidance or work-related manual.

There are several problems with bookmarks and browser histories [11]. Firstly, bookmarking mechanisms revert to the same hierarchical file and folder metaphor that exists for our local storage, implying that we will organise information from different

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

locations into different categories suitably structured. Gemmell et al. for example [6] argue several valid points in their justification for a non-hierarchically organised (and unlimited capacity storage system). They point to several studies that show filing objects into a single hierarchy is too restraining, that items usually belong in several categories anyway and that users would rather not have to categorise items at all. Secondly, an historical list of our previously accessed documents doesn't incorporate any contextual information about the document we viewed. That is, how long did the user spend reading the document, what was its key topic, author, etc? Thirdly, the document the user once viewed may have been deleted, replaced or modified by the time they revisit a bookmark - to a large extent resulting in lost information and knowledge for the user.

In the case of Web documents, navigation is much less structured than for a locally held file. After using a search engine, even if exactly the same keywords are entered as were originally used, a user might follow a different set of links, taking them further from the document they were looking for and perhaps even away from the topic they were browsing [4].

The next section discusses the potential of using the document contents, structure and implicit information in how we browse, retrieve and use documents to assist us further in the retrieval and use of these and related documents.

3. DOCUMENT-INFLUENCED USER ACTIVITY

The number of times we view or open a document is a valuable indicator of its importance to a user – perhaps its perceived authority on some topic, or as a highly reliable source of information. However, if the time spent on a page is usually very brief, then it is probably only a link to a more useful page [12]. Recalling even approximately the day or time we last accessed a document is often a major part of how we remember and relocate a document.

Some browser history facilities now track the number of times the user accesses a Web page document. However, they tend to be quite short term, such as a matter of days, and cannot assist in refinding material over a long period.

The size of a document will influence the amount of time required to read it, in the same way that more text in a document and fewer images will require the user to read more. On a library shelf this is obvious perhaps by the size of a book in conjunction with the size of the characters used on the pages.

When we revisit a Web page, being able to tell automatically if it has changed and even the changes that were made is beneficial for a user in the time taken to review a document. Subsequently, this can be used as an indicator of past change frequency and quantity.

A user may scroll repeatedly in a Web document, indicating to the user's attentiveness to a document [7]. Similarly, in a browser with a tabbed user interface, repeatedly flicking to a certain tab indicates a high level of relevance to a task or subject of interest. With a physical book, research paper or magazine, this would show as marks on the pages, a change in the colour at the edge of the pages, or generally a degradation of paper quality increasing over time.

The duration of a document being open, taking into account whether it is in focus or not, directly reflects the importance it has to our task and perhaps the quality of the content – in the same way that a document on a user's desk is important, but not as important as one in the centre of the desk.

Additionally, if a user noticeably takes information from a document, i.e. copying and pasting elsewhere, this points towards another level of the document's relevance. Conversely, if a user is required to enter information into a Web form, for example in an information request or on a forum, being able to recall this text and interaction with the Web page could help relocate it.

Finally, usage of hyperlinks is of key importance. For example, the main value of a 'hub' page is a set of pointers to a chosen topic. The number of times links are clicked in a document therefore indicates something of that page's worth to the user. The short duration on screen of a sequence of documents may suggest relevance to a target document in that succession of links. Being able to recreate the steps made in a browsing trail and visually showing this at another point in time can mimic the path in a user's long-term memory, thereby rekindling their ability to remember and find a particular document and related documents [5].

3.1 Activity Metadata

In addition to the metadata that occurs as part of the document itself and its contents [10], the user's interaction with a Web document can provide guidance to usage as important as that with printed documents and books in their aging and signs of usage.

This document metadata can be further clarified and classified to assist in collecting, analysing and representing to a user for document retrieval.

Table 1. Web Document Activity Metadata

Higher level user-document activity	**Lower level user-document activity**
Number of accesses	Mouse movement over document
Date/Time of last access	Scrolling required to view document
Duration of document onscreen – focused	Link selection/click count on document
Duration of document onscreen – unfocused	Quantity of data entry
	Text selected/copied

Table 1 shows the two different types of Web document activity metadata. In the first instance, the document itself as a whole influences or initiates the activity performed i.e. higher level user-document activity. Secondly, the user influences the activity performed on the document or parts of it, i.e. lower level user-document activity.

4. REPRESENTING WEB DOCUMENT ACTIVITY

The resulting goal of gathering and generating activity metadata is to assist the user in subsequent retrieval of documents they have already encountered – a time consuming task, particularly as the number of documents a person has accessed increases over time and as the length of time since the document was last seen reduces memory retrieval capability.

To this end, we have undertaken to derive information from users' browsing habits when using the Firefox Web browser and the design of a system, called MetaReminder [13], that leads to a way of visualising the results.

Custom browser code is invoked in a Firefox extension when a page is loaded in the Browser. This code stores the currently viewed Web page document exactly as it has been downloaded to the browser. The HTML document is checked for malformed HTML and then re-formatted to allow for Document Object Model (DOM) parsing. Non-activity metadata that is relevant to the document, is extracted such as: title, description, number of links and size [10] and creates (or initiates creation of) the higher level user-document activity metadata as defined in column one of Table 1. Activity metadata is stored as the result of user interaction with the page.

The activity metadata is combined in one complete XML document and maps as a one-to-one relationship to the original HTML document. Keeping both parts separate ensures flexible access to information, i.e. quick display of the original HTML Web page document and manipulation of the metadata, for example in a search.

When a user wishes to retrieve a previously viewed Web page, they activate a button from the browser toolbar and a locally stored Web page containing Java applets is displayed within the browser. This shows visual representations of document history navigation, based on the activity of the user when engaged with the Web page document, in addition to embedded document metadata and browser generated metadata.

4.1 Visual Representation

In order to properly support the task of retrieving previously viewed Web page documents, using a user's activity metadata on those documents as previously described, a suitable visual representation of the metadata needs to be provided to the user.

Our approach to this in MetaReminder is 3-fold. Firstly, a time-based arrangement of documents is employed (Figure 1), such as that in Lifestreams [8], where the ordering of a list of Web page documents by time allows other temporal related metadata (such as link succession and document usage duration) to be incorporated in the visual arrangement of those documents. Secondly, a flexible query mechanism allows users to dynamically determine the metadata values of a desired document, either individually or in a compound manner, to eventually narrow down the pool of available documents that match the selected metadata criteria. Lastly, a free-text search allows the user to search for any keyword in their repository of browsed documents, either in the Web document itself or in the annotated comments they have added during Web browsing.

5. RESULTS AND CONCLUSION

Firstly, it has been found that a large number of the Web pages that users read are visited very infrequently – in this instance, 72% were visited only once and 96% visited 5 times or less. This has confirmed and justified the purpose of this research and the necessity in helping users remember and retrieve previously viewed Web page documents – particularly those that are less likely to remain in a user's long term memory either by lack of relevance at the time, or due to a long period of time since last seen. In addition, the results have shown that as the number of times the user visits a page, the activity performed on that Web page document as a result increases proportionately. Also, users tend to visit a large number of pages with relatively small values of metadata, for example, with a small size and a small number of links, thereby supporting the theory that users need support in remembering a combination of metadata items in order to distinguish documents from each other when finding and reminding.

The overall use of the MetaReminder tool has been successful, with an 84% success rate from a group of evaluators in finding documents last used over a range of increasing time spans and that have been used infrequently.

The evaluation users have shown in the use of MetaReminder that they prefer the flexibility in being able to match the metadata they remember to their Web document management tasks, without being restricted for example by a narrowly focused tool or facility such as a Web browser history or bookmark function. This was explicitly evident in the use of the Metadata Dynamic Query facility of MetaReminder. This flexibility was confirmed in the feedback gathered from open answered questions.

An important finding was that the MetaReminder tool had a significant impact on what users felt was important in terms of metadata in helping them in their Web document management tasks once exposed to new types of metadata. A comparison of the rating of each of the metadata items used in MetaReminder by the evaluation users and a group of people who didn't use it, showed that those who weren't exposed to MetaReminder were more likely to find traditional items useful such as title of page, location of page, subject and description.

This is in contrast to the evaluation users of MetaReminder who were more likely to find the activity metadata of date and time of access and number of accesses (non-transient metadata), followed by subject, description and annotated comments as useful. In addition it has been discovered that that the users had formed a particular mental process of what they found useful in helping them in their task, i.e. they look for significant overall document activity first (date, time, access count), followed by an overall summary of the document from document metadata (subject, description and comments). This was evident in both the results from the use of the Browsed Document Stream facility in MetaReminder and by the rating of the metadata items in the questionnaire.

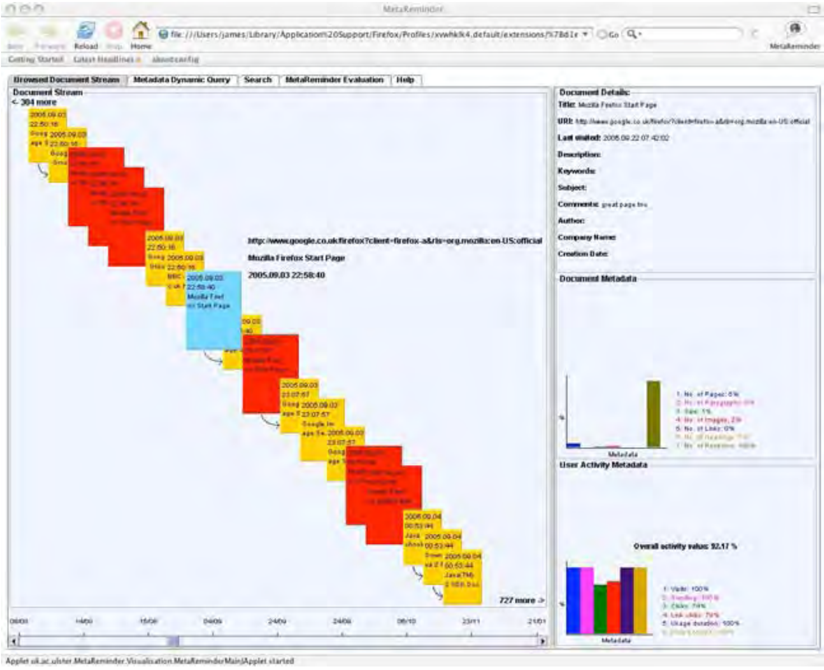

Figure 1. The MetaReminder Browsed Document Stream.

6. ACKNOWLEDGMENTS

This work was partly funded by the Centre for Software Process Technologies at the University of Ulster which is supported by the EU Programme For Peace And Reconciliation in Northern Ireland and The Border Region Of Ireland (PEACE II).

7. REFERENCES

[1] Lyman, Peter and Hal R. Varian, *"How Much Information"*, 2003. Available from: http://www.sims.berkeley.edu/how-much-info-2003.

[2] Villa, Robert and Chalmers, Matthew, *"A framework for implicitly tracking data"*, Proceedings of the Second DELOS Network of Excellence Workshop on Personalisation and Recommender Systems in Digital Libraries, Dublin City University, Ireland, 18 - 20 June 2001.

[3] Shavlik, Jude and Goecks, Jeremy, *"Estimating Users' Interest in Web Pages by Unobtrusively Monitoring Users' Normal Behavior"*, Proceedings of the 2000 AAAI Spring Symposium on Adaptive User Interfaces.

[4] Levene M. and Loizou G., *"Web interaction and the navigation problem in hypertext",* Encyclopedia of Microcomputers, 28(7):381-398, Marcel Dekker, NY, 2001.

[5] Chalmers, M., Rodden, K. and Brodbeck, D.: *"The order of things: activity-centred information access"*; Computer Networks and ISDN Systems, 30 (1998), 359–367.

[6] Gemmell, J., Bell, G. and Lueder, R., *"MyLifeBits: a personal database for everything"*, in Communications of the ACM, vol. 49, Issue 1 (Jan 2006), pp. 88.95.

[7] Claypool, Mark, Le, Phong, Waseda, Makoto and Brown, David, *"Implicit Interest Indicators"*, In Proceedings of ACM Intelligent User Interfaces Conference (IUI), Santa Fe, New Mexico, USA, January 14-17, 2001.

[8] Freeman, E. and Fertig, S., *"Lifestreams: Organizing your Electronic Life"*, AAAI Fall Symposium: AI Applications in Knowledge Navigation and Retrieval, November 1995, Cambridge, MA.

[9] Lawrence, S., *"Context in Web Search"*. IEEE Data Engineering Bulletin. Volume 23, Number 3, pp. 25-32, 2000.

[10] Gheel, J., and Anderson, T., *"Data and Metadata for Finding and Reminding"*, In Proceedings of 1999 IEEE International Conference on Information Visualisation, July 14 - 16, 1999, London, England.

[11] Abrams, David, Baecker, Ron and Chignell, Mark, *"Information Archiving with Bookmarks: Personal Web Space Construction and Organization"*, In Proceedings of CHI '98.

[12] Cockburn, Andy and McKenzie, Bruce, *"What do Web users do? An empirical analysis of Web use"*, in International Journal of Human-Computer Studies, 54(6), 903-922, 2001.

[13] Gheel, J., *"MetaReminder"*, Available from:

http://homepage.mac.com/james.gheel/MetaReminder/

[14] Goecks, Jeremy, Shavlik, Jude, *"Automatically Labeling Web Pages Based on Normal User Actions",* Proceedings of the Workshop on Machine Learning for Information Filtering, 1999 International Joint Conference on Artificial Intelligence (IJCAI), Stockholm, Sweden, 1999.

[15] Google Inc., *"Google Web History"*, Available from:

http://www.google.com/psearch

An Evolvable Computer Interface for Elderly Users

Audrey Hunter
School of Computing and Intelligent Systems
University of Ulster, Magee Campus
Northland Road, Derry, BT48 7JL
0044(0)2871 375167
hunter-a5@ulster.ac.uk

Heather Sayers
School of Computing and Intelligent Systems
University of Ulster, Magee Campus
Northland Road, Derry, BT48 7JL
0044(0)2871 375148
hm.sayers@ulster.ac.uk

Liam McDaid
School of Computing and Intelligent Systems
University of Ulster, Magee Campus
Northland Road, Derry, BT48 7JL
0044(0)2871 375452
lj.mcdaid@ulster.ac.uk

ABSTRACT
This research focuses on developing an intelligent, dynamically evolvable help facility which will offer appropriate assistance to the user while he/she is browsing the Internet.

Categories and Subject Descriptors
H.5.2 [**Information Interfaces and Presentation**]: User Interfaces – *graphical user interfaces (GUI), screen design (e.g., text, graphics, colour), user-centred design*

General Terms.
Design, Human Factors.

Keywords
Elderly, Internet, human-computer interaction, interaction patterns, intelligent techniques.

1. INTRODUCTION
Elderly people encompass a large and increasing section of the population. In the UK, the Office for National Statistics, General Register Office for Scotland and Northern Ireland Statistics and Research Agency (2006) report that, over the last 30 years, the proportion of the population aged 65 and over has increased while the proportion below the age of 16 has decreased [20]. Within the population aged 65 and over, the proportion of people aged 85 and over has increased from 7% in mid-1971 to 12% in mid-2004. However, it is estimated that the number of elderly people is projected to exceed the number of children from 2023 onwards [21]. A study carried out in Ireland by the National Council on Ageing and Older People (2002), has shown that the Internet offers elderly people the potential to participate in the new economy, gain access to information relevant to them, share experiences and overcome geographic isolation [1]. Compared to younger people, however, elderly people are less comfortable with computers and perceive less efficacy and control in computer use [6]. Elderly people can experience computer anxiety which generally increases in line with less experience [9]. One of the key obstacles that prevent elderly people from using computers is the ageing process itself [2]. Despite these difficulties there is a need for elderly users to integrate computer usage into their everyday lives in order to be able to participate fully in society [15]. Computer technologies are a promising method of increasing the quality of life of elderly people providing that the systems designed accommodate the specific needs of these users [5]. Recent research has shown that although elderly people experience more difficulties with technology than younger people, their performance is improved if the system design is changed to meet their requirements [5].

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

Research in the area of evolvable interfaces focuses on user initiated changes, where the user must specify any required changes, i.e. the changes are not dynamic. Although there is much ongoing research on evolvable interfaces, there is very little published research on measuring and adapting dynamically to change in people's behaviour in usage of computing applications. This is the central challenge of the work proposed in this research. Our aim is to develop an intelligent, evolvable help facility specifically for the Internet, where the system can log and monitor user activities continually over time, recognise when assistance is required and dynamically offer assistance to the user to suit current needs. The core of the evolvable help facility will use intelligent techniques to learn user specific interaction patterns and subsequently identify changes in these patterns thereby triggering the appropriate level of assistance to be offered to the user. As a user interacts with the Internet, his or her behaviour can be logged and analysed [4; 17].

2. THE AGEING PROCESS
It is impossible to put together a simple profile or to identify a single stereotypical elderly PC user because there is a great deal of diversity within the user group. Each elderly individual is unique and therefore requires different specifications for different applications and interfaces. A person's ability can vary widely through time depending on factors like fatigue and illness [10]. Dickinson et al. (2005) suggests that poorly designed interfaces are a fundamental obstacle to digital inclusion and that elderly adults find it more difficult than their younger counterparts to use standard interfaces [8]. By designing technology to include the elderly, they can remain living in their own homes longer, keeping in contact with the outside world through, for example, Internet banking, shopping and email, and thus increase their sense of well-being and security. Browne [3] reports that short-term memory does not decline much with age, but working

memory (the ability to make use of items in short term memory), does show impairment with increasing age [13]. Zajicek (2001) has reported that exploratory learning is vital for building conceptual models of the operation of a PC interface where the user must remember a sequence of actions and reason about them [23]. However, Age Associated Memory Impairment (AAMI) in elderly people has a detrimental effect on exploratory learning where their ability to create a mental model of the operation of an interface is reduced [23]. Attention span, hearing, vision, memory and reasoning capability are also shown to degrade naturally with age [23]. Other research has shown that elderly people have difficulty remembering and navigating routes and particularly struggle to select the correct order of landmarks on a route [22]. According to Zajicek (2001), the navigational structure of information on the Internet is quite similar to the way in which landmarks and special features of a physical route are organised [23]. Hence, elderly people encounter the same navigational difficulties while using the Internet due to their deficiency in remembering routes [23]. Haimov (2006) reports on studies which have shown that the foremost impairment which affects the cognitive performance of an elderly person is deterioration in memory [11].

3. EVOLVABLE INTERFACES

An evolvable interface is any interface which changes over time to suit the needs of users. Research has been carried out on evolvable interfaces for the Internet, but has tended to focus on user-initiated changes.

3.1 Internet Interfaces

IBM have developed Web Adaptation Technology as part of the accessibilityWorks project which adapts webpages to suit the preferences of the user, such as magnifying pages or adapting mouse and keyboard settings [12]. In September 2006, the European Union agreed to fund the €3million DIADEM (Delivering Inclusive Access for Disabled and Elderly Members of the community) Project, coordinated by Brunel University, London [7]. This three year project aims to develop an expert system that will monitor user activities, evaluate user interactions with online forms and then develop a system that will adapt the computer interface to suit the needs of the individual user [16]. Gregor et al. (2002) have reviewed a talking web browser, BrookesTalk, developed at Oxford Brookes University [10]. The talking web browser was designed to enable visually impaired users to easily access the Internet. It was developed using standard user centred design and its review highlighted the weakness of this approach and suggested that a user sensitive inclusive design methodology would have produced a more successful outcome where designers are encouraged to seek out diversity among the intended users of a system in order to design a more appropriate system. This view is also shared by Newell and Dickinson (2006) who report on a prototype email, web search and navigation system for users over 60 years who had no experience in using computers and who had never used the Internet [19].

Current help facilities on webpages are not dynamic and do not offer help to the user unless the user specifies that he/she needs assistance. In order to provide dynamic help to a user while browsing the Internet, this research will develop an intelligent help facility which will offer assistance to a user as they need it – without the user having to ask for it. The system will be aware of which user is currently using the system and will recognise when a user needs help to complete a specific task by referring to previous instances where the user successfully completed the task.

4. PROPOSED RESEARCH AND PRELIMINARY WORK

This research focuses on elderly users that have a reasonable proficiency in the use of computers. Our aim is to implement an intelligent help facility to dynamically offer assistance when it is recognised that a user may be experiencing difficulties. To do this, the authors have carried out some preliminary work to demonstrate that monitoring browser interaction patterns can be effectively achieved and that Artificial Neural Networks (ANNs) can be utilised to identify interaction patterns for individual users.

4.1 Using Intelligent Techniques

Initial experiments by the authors have established the usefulness of an ANN to categorise users' browsing tasks [14]. Data was gathered from 20 volunteers. Each participant was asked to complete two web browsing tasks, Task A and Task B. Each task consisted of five small subtasks where the subject was asked to find a specific piece of information by using the links on the webpage specified. The aim was to identify which task a user completed. An event logger (free software created by the Mozilla project) was utilised to log participants' activity as each task was conducted [18] including the title and URL of the current webpage, the time taken to complete the task and whether the left or right key had been pressed on the mouse. A log was created in the form of an XML document. A parser program was used to extract the relevant data from the XML file. The information from each logged event was stored in an Access database where the data was analysed. After the data was gathered and analysed, half of the data (seen data) was used to train the ANN. The experiment was repeated ten times and after each repetition the classification accuracy (CA) of the output was examined to calculate the performance of the network. This was done by analysing the number of correct classifications over the two tasks. Once the accuracy of each training procedure had been established the average was calculated and the overall CA determined. This was repeated for different network architectures and once the optimum network architecture (number of neurons in the hidden layer) had been determined, the accuracy of the trained network was tested by applying the remaining half of the data (unseen data) to the network. Again, the process was repeated ten times, the average obtained and the overall CA calculated. The overall CA obtained was 96% when the ANN was tested using unseen data. This preliminary work shows that ANNs can be successfully utilised to monitor users' browsing interaction patterns and thus identify which task the user completed.

4.2 Monitoring Interaction Patterns

The initial step towards developing an evolvable interface is the accurate identification of users' browsing interaction patterns. Initial studies have been carried out with users aged between 54 and 86 to establish typical interaction patterns when using the

Internet. Data was gathered from a controlled study group of elderly computer users and care was taken to select elderly people with similar computer experience and age. Before the data gathering process, the elderly participants were asked to complete a questionnaire about their computer experience and the study group was chosen based on the results obtained. Results from the questionnaire established that the most common sites used by the age group are shopping, hobby and email sites which help them to keep in contact with the outside world. Common tasks carried out on these types of websites were identified. Each task consisted of a number of subtasks which required participants to navigate through the website specified and therefore enabled the interaction patterns of older users carrying out these tasks to be collected. These preliminary experiments logged factors such as time taken and the navigation pathways. The University of the Third Age (U3A) has facilitated access to a wide population of older people who are familiar with computers but who still require assistance when accessing the Internet. The data gathered from the study group will be interpreted to offer a level of assistance that will suit individual needs. In addition, the elderly participants were asked about any difficulties they encountered while using the Internet. The most prominent answer was that they had difficulty remembering how they had completed certain tasks, such as opening emails, on previous occasions. The elderly participants found that they could remember how to complete a task when they were given individual assistance with small prompts to jog their memory and help them to complete the task.

4.3 The Proposed System

The system proposed in this research is outlined in Figure 1. It is envisaged that the intelligent system will be a hybrid of a number of intelligent techniques since it requires learning, classifying and reasoning capabilities that can detect if the user is having difficulties completing a specific task. It will do this by referencing the original pathways (the sequence of user actions required to achieve a task) and actions the user employed to complete a specific browsing task. At this stage of the research the intelligent techniques which are likely to be utilised during the research include Rule-Based Reasoning (RBR), Case-Based Reasoning (CBR) and Artificial Neural Networks (ANNs).

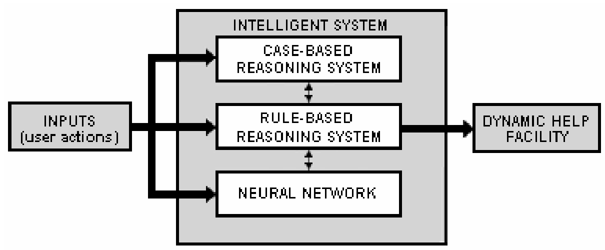

Figure 1: Overview of System Architecture

It is envisaged that the intelligent system will consist of three components which interact as follows. The RBS will continually monitor user activities and make a decision on whether the intelligent system intervenes to provide help. For example, if the user has not interacted with the computer for a specified period of time, then the system may initiate help through a rule of the form:

IF interaction = 0 **AND** time >T **THEN** output help from the help facility

The RBS may communicate with the CBR system to ascertain if there was a previous occasion where the same situation occurred and if so what was the outcome, i.e. what assistance was given to the user and did the user successfully complete the task. The RBS will then make the decision on whether to offer the user the same assistance or to adapt the level of help to the current situation. The ANN will identify user patterns to provide more detail regarding user interaction which will provide useful information for the RBS. By utilising all the information from the CBR system and the ANN, the RBS can make a decision on the appropriate (initial) level of help to offer the user.

It is proposed that the output from the help facility will be in the form of a pop-up window where the user will have the choice of a number of possible options. These options will be tailored to the specific user depending on how they have been categorised by the system, for example, experienced or novice users. By choosing the appropriate option the user will assist the dynamic help facility in determining the level of help required. The help facility will then provide the steps the user requires to complete the task, where the detail contained in the steps will be relevant to the level of help the user requires. Once the user has chosen an option, the RBS then makes further decisions using this additional information. For example, a user may indicate that he/she cannot remember the next step needed to complete a task. Therefore, the dynamic help facility might offer navigational help to the user in the form of a tutorial detailing the steps involved. In addition, if the user wishes to refuse the help they can simply choose to close the help facility. The interaction between the user and the RBS will be an interactive process and the outcome will be a solution to the problem that satisfies user needs. This problem/solution case will be stored in the CBR system to be retrieved later when similar problems are experienced by the user. The intelligent system will be trained on the data gathered from the elderly (see section 4.2). The rule base and problem/solution cases will be initialised using this data.

4.4 Evaluating the System

It is expected that some of the people in the study group will experience more problems than others when using computers and therefore allow the system to be fully evaluated. The development of the system will be an iterative process and therefore the system will be subject to frequent testing and evaluation by the target user group. After the initial prototype of the system has been developed a full evaluation of system will take place. During this evaluation the elderly people will be asked to assess the system on the appropriateness of the help and the suitability of the level of help that was offered to them. They will be asked about the aesthetics of the pop-up screens, i.e. could they read the instructions easily, was the text too small or too large, was the language used easy to understand, was the colour scheme suitable? They will be asked for suggestions on how to improve the system and these will be incorporated into the system design and subsequently evaluated again after the suggested changes have been made. The results of the evaluation sessions will be analysed and subsequently modifications will be implemented in the system. This process ensures that the final prototype will be capable of offering the user the appropriate level of help, should they require it. Further work needs to be carried out with the target user group in order to ascertain the most acceptable and useful methods of presenting help to the user. During the design process suggestions made by the user group will be incorporated into the prototype design which will be tested and evaluated by target users.

5. CONCLUSIONS

This paper presents a review of evolvable interfaces and factors which hinder elderly people's ability to use a computer interface effectively. Currently, research on evolvable interfaces concentrates mainly on user-initiated changes where the user must specify any required changes to the interface. This paper has presented initial work in the development of an intelligent evolvable help facility that will dynamically offer individualised assistance to elderly users while accessing the Internet.

6. REFERENCES

[1] ICT and older people in Ireland: evidence from a study by the National Council on ageing and older people 2002. Retrieved 20 April, 2007, from National Council on Ageing and Older People, Ireland: http://www.mwhb.ie/conferences/itandelderly/conference/presentations/presentations/jheuston2.pdf

[2] Arnott, J.L., et al. E-mail interfaces for older people. In *Proceedings of the IEEE International Conference on Systems, Man & Cybernetics* (The Hague, Netherlands, October 10-13, 2004). IEEE Conference Proceedings, 2004, 111-117.

[3] Browne, H. Accessibility and usability of information technology by the elderly. Retrieved 2 May 2007, from Department of Computer Science, University of Maryland: http://www.otal.umd.edu/UUGuide/hbrowne/

[4] Clark, L., Ting, I., Kimble, C., Wright, P., and Kudenko, D. Combining ethnographic and clickstream data to identify user web browsing strategies. *Information Research, 11, 2* (January 2006), paper 249 [Available at http://InformationR.net/ir/11-2/paper249.html]

[5] Czaja, S.J. and Lee C.C. The impact of aging on access to technology. *Universal Access in the Information Society (UAIS*), *5, 4,* (March 2007), 341-349.

[6] Czaja, S.J. and Sharit, J. Age differences in attitudes towards computers. *The Journals of Gerontology, series B, Psychological Sciences and Social Sciences*, *53, 5,* (Nov. 1998), 329-340.

[7] Press Release: European Union Backs €3m Project To Develop Assistive Technology for Elderly and Disabled (DIADEM). Retrieved 13 April, 2006, from Brunel University, West London: http://www.brunel.ac.uk/3/Press%20Releases/DIADEMFINAL.doc

[8] Dickinson, A., Newell, A.F., Smith, M.J. and Hill R.L. Introducing the Internet to the over-60s: developing an email system for older novice computer users, *Interacting with Computers*, *17, 6,* (Dec. 2005) 621-642.

[9] Ellis, D. and Allaire, J.C. Modelling computer interest in older adults: the role of age, education, computer knowledge, and computer anxiety. *Human Factors, 41, 3,* (Sept. 1999) 345-355.

[10] Gregor, P., Newell, A.F. and Zajicek, M. Designing for dynamic diversity – interfaces for older people. In *Proceedings of the 5th International ACM SIGCAPH Conference on Assistive Technologies (ASSETS 2002)* (Edinburgh, Scotland, July 8-10, 2002). ACM Press, New York, NY, USA, 151-156.

[11] Haimov, I. Association between memory impairment and insomnia among older adults. *European Journal of Ageing, 3, 2* (May 2006), 107-115.

[12] Hanson, V.L. et al. Improving web accessibility through an enhanced open-source browser. *IBM Systems Journal*, *44, 3* (Aug. 2005), 573-588.

[13] Hawthorn D. Possible implications of aging for interface designers. *Interacting with Computers*, *12, 5* (April 2000), 507-528.

[14] Hunter, A., Sayers, H.M., Mulvenna, M. and McDaid, L. PC User Activity Classification Using Intelligent Techniques. Accepted for publication in *Proceedings of the Irish Signals and Systems Conference (ISSC)* (Derry, Northern Ireland, September 13-14, 2007).

[15] Kaspar, R. Technology and loneliness in old age. *Gerontechnology, 3, 1* (June 2004), 42-48.

[16] Lines, L. et al. Online form design for older adults: introducing web-automated personalisation. In *Proceedings of HCI, the Web and the Older Population, workshop at HCI 2006*, (London, England, Sept. 12, 2006).

[17] Montgomery, A.L. et al. Modelling online browsing and path analysis using clickstream data. *Marketing Science,* 23, 4 (Fall 2004), 579–595.

[18] Mozilla, Home Page: Mozilla.org, Retrieved 15 February, 2007: http://www.mozilla.org/

[19] Newell, A.F. and Dickinson, A. Designing a portal for older users: a case study of an industrial/academic collaboration. *ACM Transactions on Computer-Human Interaction*, 13, 3 (Sept. 2006) 347-375.

[20] Population (Ageing). Retrieved November 27, 2006, from the Office for National Statistics, General Register Office for Scotland and Northern Ireland Statistics and Research Agency: http://www.statistics.gov.uk/cci/nugget.asp?id=949

[21] Statistics Press Notice 2005. Retrieved May 24, 2007, from Northern Ireland Statistics and Research Agency: http://www.nisra.gov.uk/archive/demography/publications/pop_project_pr_2004.pdf

[22] Wilkniss, S.M. et al. Age-related differences in an ecologically based study of route learning. *Psychology and Aging, 12, 2* (June 1997), 372-375.

[23] Zajicek M. Special interface requirements for older adults. In Proceedings of the WUAUC'01, 2001 EC/NSF Workshop on Universal Accessibility of Ubiquitous Computing: Providing for the Elderly, (Alcácer do Sal, Portugal, May 22 - 25, 2001). ACM Press, New York, NY, USA, 2001, 60-65.

Does Taking Notes Help You Remember Better? Exploring How Note Taking Relates to Memory

Vaiva Kalnikaitė & Steve Whittaker
The University of Sheffield
Regent Court, 211 Portobello Street
Sheffield, S1 4DP, UK.
00 44 (0)114 222 2630 {v.kalnikaite, s.whittaker}@sheffield.ac.uk

ABSTRACT

People are aware of the fact that their memories are fallible and as a result they spend significant amounts of time preparing for subsequent memory challenges, e.g. by taking notes about information they think they will later have to remember. There has been extensive research into note taking and whether it is effective as a memory aid, but most of this has concerned pen and paper rather than digital notes. We conducted an experiment investigating the relationship between note-taking behaviors (whether digital or paper based) and subsequent recall. We gave people two systems: a note-taking device called ChittyChatty (CC) that combines digital notes with an audio record – Fig 1; and conventional Pen & Paper (PP) – Fig 2. We observed the note taking patterns that occurred in digital CC notes and paper based PP notes. We then examined whether the quality and quantity of those notes related to subsequent organic memory (OM) – i.e. human memory without any external aids. We also explored people's perceptions of the accuracy of their OM, in relation to the quality and quantity of their CC and PP notes, to see whether people who believed they had bad memories took more notes.

Overall, we found that taking high quality notes helped OM, but taking large volumes of notes didn't. This disconfirms the Distraction hypothesis which claims that the act of taking notes leads people to remember less using OM at recall. We also found a close correspondence between digital and pen and paper notes. Finally people who are unconfident about OM tend to take more notes, suggesting that these people may overcompensate when taking notes, because of their perception of their poor OM quality.

Categories and Subject Descriptors

D.m [**Software**]: Software Psychology.

General Terms

Performance, Design, Experimentation, Human Factors.

Keywords

Memory, Prosthetic Memory, Digital Memory, Notes, Handwritten Notes, Speech Retrieval, Speech Browsing, Remembering.

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

1. INTRODUCTION AND MAIN QUESTIONS

In our everyday lives we are aware of the fallibility of our memories. To prepare for future retrieval we carry notepads, diaries and other writing devices to help us remember information that we may need to recall in the future. In this paper we refer to the use of such prosthetic devices as prosthetic memory (PM), and natural unaided memory as organic memory (OM). However, there is much that we don't know about the utility of PM devices: are digital notes similar ways to pen/paper notes? Do people who think they can't remember tend to take more notes? And does note taking distract us from remembering using OM?

Figure 1. ChittyChatty (CC) Interface – temporal co-indexing of notes and audio.

Note taking to most of us is a conventional way of life. We think we know how to take notes, and we believe that it's one of the oldest and most efficient external human memory aids known to mankind [1]. But do such PM notes aid our OM in general and in the longer-term? Some research studies suggest that notes are only effective as a short-term memory aid [7].

Research into note taking has been extensive [7, 6, 8, 4], however, most of this work has focused on when and why people take *paper* notes. And another crucial issue that has not been systematically explored is the relationship between the quality and quantity of digital notes that people take and how it influences our organic memory (OM).

Here we describe a study investigating the effects of note taking patterns on OM. In particular, does note *quality* or *quantity* affect our ability to recall information more accurately using OM? And how do notes help us remember? Do they promote better OM, or do they help us prosthetically by providing a record of the information that we need to know?

Figure 2. Pen & Paper (PP)

We describe a laboratory study investigating two general note taking attributes relating to OM and PM: (a) *Quality* of PM notes; (b) *Quantity* of PM notes; looking at how these relate to (c) *Memory Performance* (whether using OM, or PM) and (d) *Confidence* in OM. We had four main research questions: first, what is the relationship between digital and pen/paper notes? Second, do people who take high *Quality* or *Quantity* notes, perform better at OM recall, or does note taking generally distract them? Third, when people take high *Quality* or *Quantity* notes, does that help remembering with PM? Fourth, what is the relationship between *User Confidence* in their own OM and note *Quality/Quantity*?

Specific questions we address are:

1. Are digital and paper notes similar or different?
2. Does the act of taking notes distract people from focusing on important information - preventing them from later remembering unaided?
3. Does note-taking help people by successfully recording information they need later thus improving PM recall?
4. How does the quality and quantity of individual notes relate to people's perception of the accuracy of their OM? E.g. do people who are confident about their OM take fewer notes?

2. EXPERIMENTAL METHOD

The data for this paper was collected during an experiment investigating relationships between OM and PM [3]. This paper presents further results examining how the *quality* and *quantity* of collected notes affects OM. We applied the following procedure.

Briefly in our within subjects experiment people were given memory tasks where they heard a conversation, and were given a specific memory prosthesis. This PM was either traditional pen-and-paper (PP) or digital ChittyChatty (CC) – a device that coindexes a speech recording and digital notes. People could use this prosthetic device to take notes while they listened to the conversation.

They were later asked to remember details of that conversation, and given access to the original notes they had taken when they first heard the story. Of course some users could remember parts of what had been said without needing to refer to their notes, and users were free to choose whether to use their unaided OM or PM notes to answer questions. We also recorded users' confidence in their OM, by asking them before each retrieval question, how sure they were that they would be able to remember information unaided, i.e. without recourse to the PM device they had been given.

We also recorded the preparations that they made for future retrieval by analysing the notes they made either on paper or using CC.

2.1 Users

In total we had twenty five users who took part (14 women and 11 men, aged 23-55). Users were volunteers consisting of university researchers, administrative and management staff, as well as other professionals from public and private sectors. Users had no prior knowledge of the project or our experimental hypotheses. None of the users had prior experience of using CC, but obviously all had extensive experience both OM and PP.

2.2 Procedure

The experiments were run using a custom built website. Users were first given a general description of the experiment, and the conversations. We then gave them a brief web-based, hands-on tutorial providing detailed descriptions of each memory prosthesis and procedures for the experiment. Users were allowed to proceed to the actual experiment only if (a) they felt confident with each PM and (b) they had successfully completed all practice tasks.

The experiment ran across 3 sessions: same day, 7 days later and 30 days later. On the first day, users took notes and had to recall information they just heard. 7 and 30 days later, users were asked to retrieve information they heard on the first day. They were allowed to use their notes to answer questions, but they could also choose to rely for memory on their OM alone. Thus at retrieval we had some data for when people used OM only and other data for when they relied on PM (whether this was PP or CC notes).

2.3 Stories and Test Questions

The conversational stories were intended to simulate real-life conversations between two old friends who had just bumped into one another after a period of several years. The stories contained a mixture of facts and fiction equally distributed within each story. We conducted extensive pilots with the stories, to ensure they could be easily understood; they did not contain any unfamiliar or unusual terms. User comments indicated that they were enjoyable to listen to, as well as achieving their objective of simulating real-life conversational experiences. The average story time was 3.20 minutes.

An example fragment of one story was the following:

"Oh, do you remember my older brother, Dave? Let me tell you how he got here. He has loved Def Leppard ever since he was 15 years old and saw them play at the Sheffield Show, Hillsborough Park in 1978. The hair, the tight trousers, the heavy guitars, the thunder of the drums and the screaming vocals. He was particularly entranced with their Yorkshire lyrics."

We read users a story and gave them either CC or PP depending on the experimental condition. To control for story/retrieval method confounds, we counterbalanced the order in which users received stories, and the PM they were given. Users answered questions on web based forms.

In all conditions we recorded the *retrieval accuracy*, scored by two independent judges against a formal marking scheme. People could choose to answer questions using their PM notes or unaided OM, and we recorded whether users relied on OM or PM to answer the question.

The *quality* of notes was scored in the following way. We first generated an evaluation metric for the quality of the notes, by having two coders blind to the experimental hypotheses. They agreed a set of ideal notes. We then scored notes against the target. Quality scores ranged from 0-5 depending on how much of the target notes the user generated. If the note contained all the target keywords (or their synonyms) and context, it received a maximum score of 5. Partial scores for quality were defined as either (a) containing all keywords, but not enough or inaccurate context, or (b) accurate context, but incomplete set of keywords. Scoring was carried out independently by the two scorers and disagreements were referred to a third scorer for resolution.

The *quantity* of notes was scored on the basis of the number of words written on the screen or paper. This count captured all the words written down, but excluded articles and other non-meaningful words. Fig 3 & 4 illustrate the difference between high and low quantity of notes taken with CC.

3. HYPOTHESES AND RESULTS

The results are organised as follows:

- H1 – Equivalence Hypothesis – people will take similar *Quality* and *Quantity* notes with CC and (PP).
- H2 - Distraction Hypothesis – the act of taking notes distracts - causing people who take detailed notes to remember less using OM.
- H3 – PM Capture Hypothesis – notes provide an important resource for memory, and detailed notes will result in better PM retrieval.
- H4 – Confidence Hypothesis – people who are confident about own memory take less notes.

3.1 Measures and Variables

We collected and report the following data:

- Note *Quality* for CC and PP
- *Quantity* of notes for CC and PP
- User *Confidence* in their ability to remember unaided
- *Accuracy* of answers and whether these are generated using OM or PM

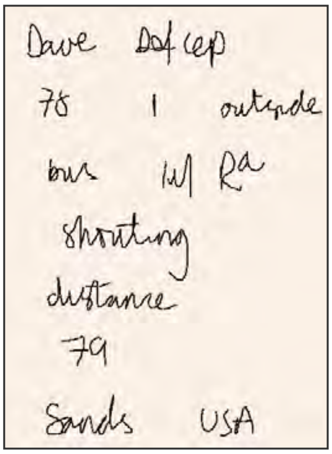

Figure 3. Low Quantity of CC Notes.

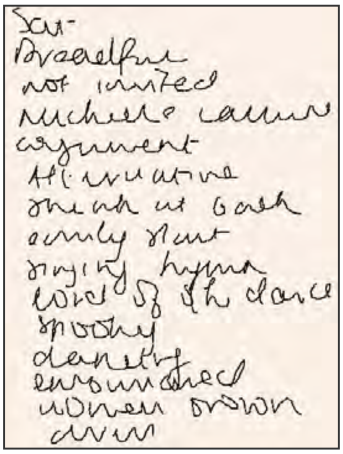

Figure 4. High Quantity of CC Notes.

3.2 Equivalence Hypothesis

Are CC and PP notes similar or different?

We were interested in how people took notes digitally compared with pen and paper notes. For instance, when people used CC, did they take more or less notes, in comparison to when they used PP?

We found that notes were consistent in *Quality,* digitally and on paper. There was a strong correlation between the *Quality* of digital notes on CC and PP notes (r (1, 24) = 0.4, p< 0.01).

The *Quantity* of CC & PP notes was also consistent. There was a strong correlation between the *Quantity* of both types of notes (r (1, 24) = 0.6, p< 0.01).

Furthermore, we examined normalised *Quality* and *Quantity* results, where we calculated the number of high *Quality* notes as a function of the number of notes taken. Again we found a strong correlation between *CC* normalised note scores and *PP* normalised note scores (r (1, 24) = 0.5, p< 0.01).

Given this similarity between digital and PP notes, we therefore combine them in the following analyses.

3.3 Distraction Hypothesis

Do high Quality and Quantity notes help OM?

We first evaluate the objective benefits of *Quality* and *Quantity* notes on the *Accuracy* of user answers using OM.

We correlated OM *Accuracy* scores (when people chose to use their OM to answer questions) with overall *Quality* of CC & PP notes combined. We found a positive correlation (r (1,24) = 0.4, p<0.01). Thus, people who take higher *Quality* notes, generally have better OM. So contrary to the Distraction hypothesis, taking high quality notes doesn't distract people from OM remembering. Instead, if they take good notes they tend to remember better. This suggests that notes may function to reinforce information being committed to OM, by helping people to focus on what is important to remember.

There was no correlation between the *Quantity* of combined CC & PP notes and OM *Accuracy* (r (1, 24) = 0.07, p>0.1). Thus the sheer volume of notes is unrelated to OM.

3.4 PM Capture Hypothesis

Do more detailed notes increase PM accuracy?

We next tested whether more detailed notes help people to retrieve information more accurately when they use PM. We looked at the correlation between the *Quantity* of PM notes and *Accuracy* when people answered questions using PM. There was no correlation between PM note *Quantity* and PM *Accuracy* scores (r (1,24) = 0.1, p>0.1). Thus people who take more detailed notes, do not do better at PM recall. This may be because notes become hard to interpret especially at longer retention intervals of a week or month [3].

3.5 Confidence Hypothesis

Does high user Confidence result in low Quantity of notes?

Overall people can remember the amount of notes they generated in a short-term, e.g. during the same session. A week or a month later, people may be unable to remember details of notes that they generated during the first session. We therefore conducted analysis of user confidence during the first session alone.

We found a strong negative correlation between the *Quantity* of PM notes and user *Confidence* score during the first session (r (1, 24) = -0.5, p<0.05). This suggests that people take more notes if they are not confident that they can remember using their OM.

4. CONCLUSIONS

There is some controversy surrounding PP notes. Some researchers have argued that PP notes are little use as a memory aid [4, 8], while others suggest they are useful [6]. We examined whether there are any specific features of PP (and also CC) notes that influence OM.

One of the most popular theories expounded to disprove the effectiveness of notes is the Distraction Hypothesis [2,7] which claims that people miss (and therefore forget) vital information because they are busy writing what was being said. Our research results don't support this hypothesis, showing instead that high quality notes *help* OM. This may be because taking good notes helps people to focus on what is important. However we also found that note-taking was motivated by people's evaluation of their OM. People take more notes when they are less confident about their OM, suggesting that they may be concerned about being distracted, and overcompensate for this.

We expected users with more notes to be able to overcome potential OM weakness by 'reading off' the answers from their notes. Somewhat surprisingly we did not find a relationship between note quantity and PM accuracy. This may be because at longer retention intervals the cryptic nature of most notes and the fact that they do not capture information such as emotions, background setting or context, makes them increasingly hard to interpret.

In addition we observed consistency between digital and paper based notes. Generally, when a user generates a lot of notes with PP, they will also tend to generate a lot of notes with CC. Similarly with quality, users who generate high quality notes on PP also tend to generate high quality notes with CC.

However it may be that if people used CC more regularly and over longer periods of time, this strong overlap between CC and PP notes may decrease. Another independent analysis of long term note taking with CC, suggests people shift to more minimal ways of note taking relying on speech for retrieval.

5. ACKNOWLEDGMENTS

We thank our participants for their time and in sharing their stories, memories and ideas.

6. REFERENCES

[1] Barnett J., Di Vesta F., Rogozinski J. What is learnt in note taking? Journal of Educational Psychology (1981), 23(2), 181-192.

[2] Benton S., Kiewra K., Whitfill J., Dennison R. Encoding and external-storage effects on writing responses. *Journal of Educational Psychology* (1993), 85. 267-280.

[3] Kalnikaite, V., and Whittaker, S. (2007). Software or Wetware? Discovering When and Why People Use Digital Prosthetic Memory. In *Proc. CHI07*, ACM Press (2007), 71-80.

[4] Kidd A. The marks are on the knowledge worker. *In Proc. CHI94*, ACM Press (1994), 186-191.

[5] Kiewra K., Mayer R., Christensen M., Kim S., Risch N. Effects of repetition on recall and note-taking: Strategies for learning from lectures. *Journal of Educational Psychology*, (1991) 83. 120-123.

[6] Landay J.A., Kaugmann T.R. User Interface Issues in Mobile Computing. *In Proc. WWOS-IV 1993*, IEEE Press (1993), 40-47.

[7] Piolat A., Olive T., Kellog R. Cognitive effect during note taking. Applied Cognitive Psychology (2005), 19:3, 291.

[8] Whittaker S., Hirschberg J. Look or Listen: Discovering Effective Techniques for Accessing Speech Data. *In Proc. CHI98*. Springer-VErlag (2003), 253-269.

Venturing into the Labyrinth: the Information Retrieval Challenge of Human Digital Memories

Liadh Kelly
Centre for Digital Video Processing
Dublin City University, Dublin 9, Ireland
Liadh.Kelly@computing.dcu.ie

Gareth J. F. Jones
Centre for Digital Video Processing
Dublin City University, Dublin 9, Ireland
Gareth.Jones@computing.dcu.ie

ABSTRACT

Advances in digital capture and storage technologies mean that it is now possible to capture and store one's entire life experiences in a Human Digital Memory (HDM). However, these vast personal archives are of little benefit if an individual cannot locate and retrieve significant items from them. While potentially offering exciting opportunities to support a user in their activities by providing access to information stored from previous experiences, we believe that the features of HDM datasets present new research challenges for information retrieval which must be addressed if these possibilities are to be realised. Specifically we postulate that effective retrieval from HDMs must exploit the rich sources of context data which can be captured and associated with items stored within them. User's memories of experiences stored within their memory archive will often be linked to these context features. We suggest how such contextual metadata can be exploited within the retrieval process.

General Terms

Personal Information Management, Human Digital Memories, Context data, Context-based retrieval

1. INTRODUCTION

Vannevar Bush could never have envisaged the impact his 1945 article "As We May Think" [3] would have on computing science and society. His article is largely credited with predicting many recent innovations in computing including the World Wide Web. However, Bush presented a vision encompassing far more than the idea of linking pages of information. He foresaw a world where all information associated with someone's life could be stored and, importantly, retrieved at a later stage.

Advances in digital capture and storage technologies mean that Bush's ideas are now coming to be realized. Vast digital archives of one's personal life experiences (more formally referred to as "Human Digital Memories (HDMs)") can now be generated. Content recorded from someone's life might include: all documents read, written, and downloaded; photographs taken; videos seen; music listened to; details of places visited; details of people met etc. Capturing all this data requires using a range of devices and technologies, at present these include personal computers, mobile phones, cameras, video and audio recorders, GPS devices and Bluetooth sensors. The best known example of a prototype HDM archive is that of Microsoft's Gordon Bell who has dedicated much time in recent years to digital capture of all of his personal data, as part of the *MyLifeBits* project [7]. The wide range of technical and ethical issues raised by HDMs form the basis of the ongoing "Memories for Life" Grand Challenge for Computing in the U.K. [2].

While a person's entire life experiences can now reasonably be stored on a computer, little attention has been given to how the individual (or a descendent of the individual) might access this vast archive. Current information retrieval (IR) techniques, as exemplified by web search engines, are good at retrieving relevant items from formal content archives in response to a user's queries. However, the characteristics of HMDs are quite different to those of the document collections for which current search engines have been developed. Looking into an HDM archive we can imagine seeing a diverse range of item types, incompletely linked into information structures, forming a complex and seemingly unintelligible labyrinth which we have no hope of successfully navigating. Retrieving items from such complex and unpredictable data structures presents great challenges to IR. The iCLIPS project [1] at Dublin City University is focused on the development of new IR strategies suitable for HDMs. We believe memory cues can play a strong role in IR for the HDM domain, within our work we are exploring methods to enable context data to be used for search within HDMs. We are interested in both how context can be used to link and annotate items, and also how it can be used interactively in user interfaces to enable users to explore their HDM.

In the remainder of this paper we look at efforts that have been made towards effective IR in HDMs and suggest directions for future research. In particular we focus on context, memory cues and visualization.

2. THE HDM RETRIEVAL PROBLEM

The characteristics of HDMs mean that they provide a number of challenges for retrieval. Among these features are

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

that: items will often not have formal textual descriptions; many items will be very similar, repeatedly covering common features of the user's life; related items will often not be joined by links; the archive will contain much non-useful data that the user will never wish to retrieve; the user may be unable to describe clearly what they are looking for; and the user may not even be aware that an item was captured and is available for retrieval. New techniques for IR which take these features into account need to be found if we are to successfully provide applications that allow people to browse and search their archives effectively and efficiently.

We can illustrate some of the challenges posed by HDM retrieval using an example. Consider a scenario where someone is looking for a particular photo from her HDM archive. All she remembers about the picture is that last time she viewed it, the sun was glaring in the window and she was talking on the phone to her friend Jack. Conventional IR techniques would not be capable of retrieving the correct photo based on these context criteria which are unrelated to its contents. New approaches to IR using context could enable her to search for pictures viewed while speaking with Jack while the weather was sunny.

2.1 Context in HDM Retrieval

The notion of using context to aid retrieval in this and other domains is not new. Context is a crucial component of memory for recollection of items we wish to re-retrieve from a HDM. As part of our investigation we are examining which forms of context data, or combinations of them, might prove most useful for search. Issues to be explored include whether different item types are associated with different context features, and the extent to which these are personal to individuals or are consistent across groups.

There are examples of use of context in simple ways in existing work. The Microsoft *MyLifeBits* [7] and *Stuff I've Seen (SIS)* [6] systems make use of context data to aid retrieval of personal files. MyLifeBits uses features such as people, location or date. This context data allows for linking of items, for example a photo containing Jack could be linked with an email from Jack. The SIS system similarly uses features such as date and author to enable an individual to search for items. An extension of SIS, PHLAT [5], uses *tagging* as an additional context feature. With tagging the user can add whatever type of text-based annotation they desire to items; these annotations can then be used subsequently in retrieval. A significant disadvantage of these current systems is that much of the burden for annotating items with context features is placed on the user. Users of course are often busy people or sometimes just plain lazy, and very often will not take the time to add annotations to items; but they would still like the benefits of a system enabling them to search using rich annotations derived from context data. Widespread takeup of context based search clearly requires methods for automatic annotation and linking of items with minimal user involvement.

Additionally, we believe that there are many other sources of context which can be integrated to improve retrieval in the personal archive domain. For example, the earlier image search scenario requires integration of photo access with details from the searcher's phone records and records of the weather conditions. A primary focus of our research is the capture of diverse and novel sources of context information, and exploration of the role they can play in retrieval.

Many current technologies, such as timestamps, GPS technology, Bluetooth, and biometric sensors, already enable us capture many sources of context data which can be used directly or used to derive useful context-based search features. Some examples are as follows:

- Timestamps can be useful to infer temporal annotations when a person may recall the time, day, month, season or relative year when an item was created or accessed, e.g. *I remember the photo was taken during the winter time in the past few years.*

- GPS technology can enable users to retrieve an item based on location of item creation or previous access, e.g. *I remember I last looked at that document on my laptop when I was in Boston at a conference.*

- Combining timestamp and GPS information, we can determine such things as the light status and weather conditions at the time of item access or creation [9], e.g. *It was getting dark and very cold when that photograph was taken.*

- Use of Bluetooth networking enables us to monitor other devices present in the nearby vicinity - in today's society many people have Bluetooth technology activated on their mobile phones. Using this information we can maintain a record of who was present when our subject was creating or accessing items from their HDM [4].

- Biometric sensors provide information on a subject's physiological state. In the CDVP at DCU we are exploring the use of two Biometric sensor devices - heart rate monitoring and capture of other features using a BodyMedia SenseWear armband. The BodyMedia SenseWear armband is worn around the upper-arm, and captures physiological data, including Galvanic Skin Response (GSR), a measure of skin conductivity which is affected by sweat from physical activity and emotional stimuli; Heat Flux, which is a measure of the heat being dissipated by the body; Skin Temperature, which is a measure of the body's core temperature; and accelerometers, which is a measure of movement or lack thereof. These measures can be used with heart rate as an indication of different levels of arousal, such as excitement or boredom, which may correlate with more significant events in a person's life.

2.2 Information Linking in HDMs

In addition to annotating items with context metadata, we are also interested in linking related items to support search. This is motivated by the successful exploitation of the link structure of the web by web search engines. Link structure is used in computing to measure page importance. This information has proven an important component in successful ranking of pages in web search, most notably in the *Google* search engine, which uses the PageRank algorithm [10]. The basis of PageRank is to assign an importance factor to each

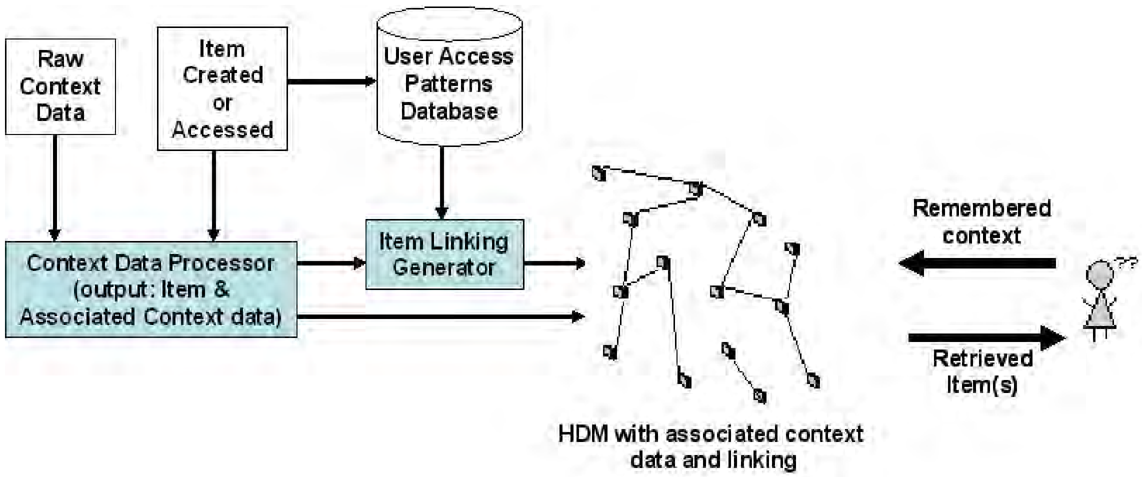

Figure 1: Context-based retrieval from a HDM using memory cues.

web page based on the number and importance of web pages which link to the page.

Items captured within an HDM by contrast are not directly joined together by inter-item links. We believe that building and exploiting such link structures has a valuable role to play in HDM search. Other researchers have also begun to investigate the possibility of using linkage in retrieval from personal archives, thus enabling the use of algorithms such as PageRank to aid the retrieval process. For example, the Connections system [11] retrieves items from a person's personal collection by first forming a relation graph from the personal collection using successor models which reflect user access patterns to files. The system then ranks the results of a text-based search query using PageRank type algorithms. We are similarly interested in exploring different methods of exploiting a user's past information access patterns and past interaction with items in their HDM to form inter-item links. We also plan to explore a broad range of other methods of forming potentially useful links, such as through the use of related context and association based on content similarity. The linking combinations which yield the best search results will then be further investigated. As part of this investigation we will explore how PageRank type algorithms might be extended to help locate interesting items based on the contextual component of user's memories of required items.

Figure 1 demonstrates how context information and linking might tie together to aid retrieval in an HDM. More specifically, this figure shows how a user's HDM can be transformed into a linked graph using user access patterns and context information associated with items. The user can then query this linked structure using recalled context information.

A linkage structure in an HDM could have other uses beyond simply allowing for ranking of retrieved items. A linked HDM could for example allow for the suggestion of items which are closely linked to the item currently being examined or worked on, we return to this topic in the next section.

2.3 Interfaces for HDMs

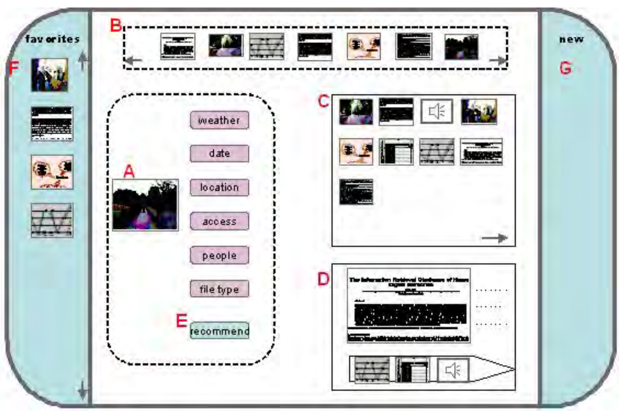

Figure 2: Sample HDM interface.

The complex and heterogeneous nature of an HDM means that simple ranked retrieval is unlikely to support many of the user's information searching tasks. As we imagine gazing into the partially linked labyrinth of an HDM, we can expect to see items related in some way (contextually or topically) to the one that we are currently examining. From the currently viewed item the user may wish to browse to one of these items or use links as a path to navigate to another location in the maze of their HDM. To support this exploratory search activity will require a suitable user interface designed to support the user's search activities. Such an interface should be intuitive, simple to use, and afford the user all the functionality they require.

We anticipate that people's remembering processes can be used as a basis for the design of an effective interface to aid IR in HDMs. A good example of this is [8], where memory cues are used for a meeting video retrieval system. From a user study, they found what types of items people easily remember and easily forget about meetings. "location of the meeting room", "table layout in the room", "seat positions" and "main speaker names" were found to be among the items remembered, while items like date, time, dress and posture were hard to recall. They used this information in the design of an intuitive interface that uses information which can act as memory cues for the retrieval of the desired meeting video.

An interface for an HDM should allow the user to easily explore and search through their archive. This poses obvious problems arising from the potentially vast size of an HDM, its heterogeneity and the diverse needs of the user. Various methods, such as fish-eye views and linking and zooming spaces, have been developed successfully for information visualisation in other domains. In iCLIPS we will investigate the suitability of existing visualisation techniques for the HDM domain, and also explore new ideas, such as those depicted in the interface design shown in Figure 2. Interface design for the complex HDM space is proving a very challenging problem for us due to the fact that an HDM may be vast in size, and a given item may be labelled with many context features and linked to a large number of other items. Added to these problems is the fact that the space is personal to the user, and as such the user has specific memory cues which they may use to recall an item.

The interface design shown in Figure 2 is suggested as a possible solution for both the searching and exploring of an HDM. With this interface users can follow context memory cues E for a given item A, including date, location, people present, to search, and then enter their context search using the 'recommend' button at the bottom of E. This will then display the 'best' links from a given item. The resulting items are displayed in pane C as individual items or 'èvents' combining multiple items. Elements in C can be enlarged and explored in pane D. Pane B shows items previously viewed to allow the user to jump back to these search states if they wish. Panel F allows the user to add items to a list of 'favourites' for future access. Finally the user can drag an item they wish to explore in detail into panel G, this item then becomes the new item A and its associated attributes are displayed allowing the user to browse from this point.

One aspect that we find interesting is the representation of search states in pane F. The volume of items in panes B and F may build up very quickly. In this situation it will be hard for the user to recall the search state associated with each item. Humans generally find it easier to recognize than recall things, with this in mind we plan to display an intuitive summary of the search state when the user hovers over an item in one of these panes. The key challenge here lies in the creation of a summary that effectively reminds a user of the given search state. We will explore techniques which extract key points or attributes from items in the creation of these summaries, however exactly how to do this remains an unsolved problem.

3. CONCLUDING REMARKS

In this paper we argue that if context information is exploited correctly, it can form a valuable component in meeting the challenges of IR for HDMs. We envisage HDM IR systems which respond and adapt to the user; systems which work and evolve with the user's needs and the way they remember information. In the near future it will be hard for people to imagine a world where HDMs did not exist. In the iCLIPS project we are exploring the development of retrieval techniques and interfaces that address the unique retrieval challenges of HDMs, and contribute to the realisation of Bush's original vision of the Memex.

4. ACKNOWLEDGMENTS

This work is funded by CMS023 grant under the Science Foundation Ireland Research Frontiers Programme 2006.

5. REFERENCES

[1] iCLIPS: Integrating Context through Annotation and Linking in Information Retrieval for Personal Information Archives. http://www.cdvp.dcu.ie/iCLIPS/.

[2] Memories for Life, A Grand Challenge for Computing of the United Kingdom Computing Research Committee. http://www.memoriesforlife.org.

[3] V. Bush. As We May Think. *The Atlantic Monthly*, pages 101–108, 1945.

[4] D. Byrne, B. Lavelle, A. Doherty, G. Jones, and A. Smeaton. Using Bluetooth and GPS Metadata to Measure Event Similarity in SenseCam Images. In *IMAI'07 - 5th International Conference on Intelligent Multimedia and Ambient Intelligence*, pages 18–24. Salt Lake City, Utah, USA, July 2007.

[5] E. Cutrell, D. Robbins, S. Dumais, and R. Sarin. Fast, Flexible Filtering with Phlat - Personal Search and Organization Made Easy. In *CHI 2006: Conference Companion on Human Factors in Computing Systems*, pages 261–270, New York, NY, USA, April 2006. Montreal, Quebec, Canada, ACM Press.

[6] S. Dumais, E. Cutrell, J. Cadiz, G. Jancke, R. Sarin, and D. Robbins. Stuff I've Seen: a System for Personal Information Retrieval and Re-use. In *SIGIR '03: The 26th Annual International ACM SIGIR Conference on Research and Development in Informaion Retrieval*, pages 72–79, New York, NY, USA, July 2003. Toronto, Canada, ACM Press.

[7] J. Gemmell, G. Bell, and R. Lueder. MyLifeBits: A Personal Database for Everything. *Communications of the ACM. Personal Information Management*, 49(1):88–95, January 2006.

[8] A. Jaimes, K. Omura, T. Nagamine, and K. Hirata. Memory Cues for Meeting Video Retrieval. In *CARPE'04*, pages 74–85. New York, New York, USA, October 2004.

[9] N. O'Hare, H. Lee, S. Cooray, C. Gurrin, G. Jones, J. Malobabic, N. O'Connor, A. Smeaton, and B. Uscilowski. MediAssist: Using Content-Based Analysis and Context to Manage Personal Photo Collections. In *CIVR2006 - 5th International Conference on Image and Video Retrieval*, pages 529–532. Springer-Verlag, July 2006.

[10] L. Page, S. Brin, R. Motwani, and T. Winograd. The PageRank Citation Ranking: Bringing Order to the Web. Technical report, Computer Science Department, Stanford University, January 1998.

[11] C. Soules and G. Ganger. Connections: Using Context to Enhance File Search. In *20th ACM Symposium on Operating Systems Principles (SOSP'05)*, pages 119–132. Brighton, United Kingdom, 2005.

Using Colocation to Support Human Memory

Caitlin Lustig
ODCSSS Program
University College Dublin
Dublin, Ireland
celustig@cs.washington.edu

Hristo Novatchkov
ODCSSS Program
Dublin City University
Dublin, Ireland
ico@novatchkov.org

Lucy E. Dunne
University College Dublin
Dublin, Ireland
lucy.dunne@ucd.ie

Mike McHugh
Dublin City University
Dublin, Ireland
mmchugh@computing.dcu.ie

Lorcan Coyle
University College Dublin
Dublin, Ireland
lorcan.coyle@ucd.ie

ABSTRACT
The progress of health care in the western world has been marked by an increase in life expectancy. Advances in life expectancy have meant that more people are living with acute health problems, many of which are related to impairment of memory. This paper describes a pair of scenarios that use RFID to assist people who may suffer from memory defects to extend their capability for independent living. We present our implementation of an RFID glove, describe its operation, and show how it enables the application scenarios.

1. INTRODUCTION
Increasing global life expectancies has opened up new issues for society. Many people, faced with the reality of living longer, wish to maintain their accustomed level of independence as they age. The problem is that the health care that allows them to live longer has not managed to conquer many age-related ailments. As a result, there is a need to balance the desire to live independently with the facts of deteriorating health. This paper describes an approach that have the potential to help achieve that balance.

The impetus behind this work are the demographic changes that are a result of the improved health care. On a local level, the 2002 Irish census showed 11.13% of the population are over 65; figures published by the Office for National Statistics in the UK indicate that the equivalent figure was 15.96% of the population in 2003. Many of these people live alone: 28.5% of the over-65s in the 2002 Irish figures. This aging is not an isolated phenomenon, and is reflected throughout the developed world [15].

From a technological point of view, the computing power present in the average home is staggering compared with 50 years ago. How to harness this technological power to assist independent living is a challenge which has been addressed via approaches ranging from the full instrumentation of smart homes [17], to the more individually targeted life-logging and review [8, 5].

Much research on *aides-mémoire* for sufferers of memory loss has been conducted. Oriani *et al.* demonstrate the advantages that electronic memory aids (EMAs) have, as well as the motivation for their use by Alzheimer's patients [13]. Hart *et al.* explore the use of EMAs for a different population, that of people recovering from traumatic head injuries [7]. These studies both comment on the need to reduce the barrier of use of electronic devices. If a prospective user needs to remember complicated procedures or receive specialised training to use the device, they are less likely to want one.

RFID is a commercially available technology, and has proven to be useful in real life applications. Our investigation into the application of RFID to this area indicates that it significantly reduces the complexity of operation exposed to the user since the system makes its observations based on normal every-day activities of the user. Additionally, the user retains ownership of the gathered information – there is no need for it to leave the home.

2. RFID AND COLOCATION
Radio Frequency Identification (RFID) technology has been around since 1948 and has become an integral part of many business processes [11]. On a personal scale, RFID badges are prevalent in many environments (for example, [6]). These types of badges lead to a common scenario, in which the RFID tag is mobile and uniquely identifies an individual, while the associated reader(s) are stationary (for example, [6, 1]). Our application proposes to reverse this structure, and use a mobile reader – which is associated with a unique user – with multiple tags which are relatively immobile.

Our environment is populated with RFID-tagged artifacts. These passive RFID tags uniquely identify each artifact; as the user comes into contact with them the system records the interaction. We have developed an *RFID glove* to gather this information and transmit it to a database. The glove is

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

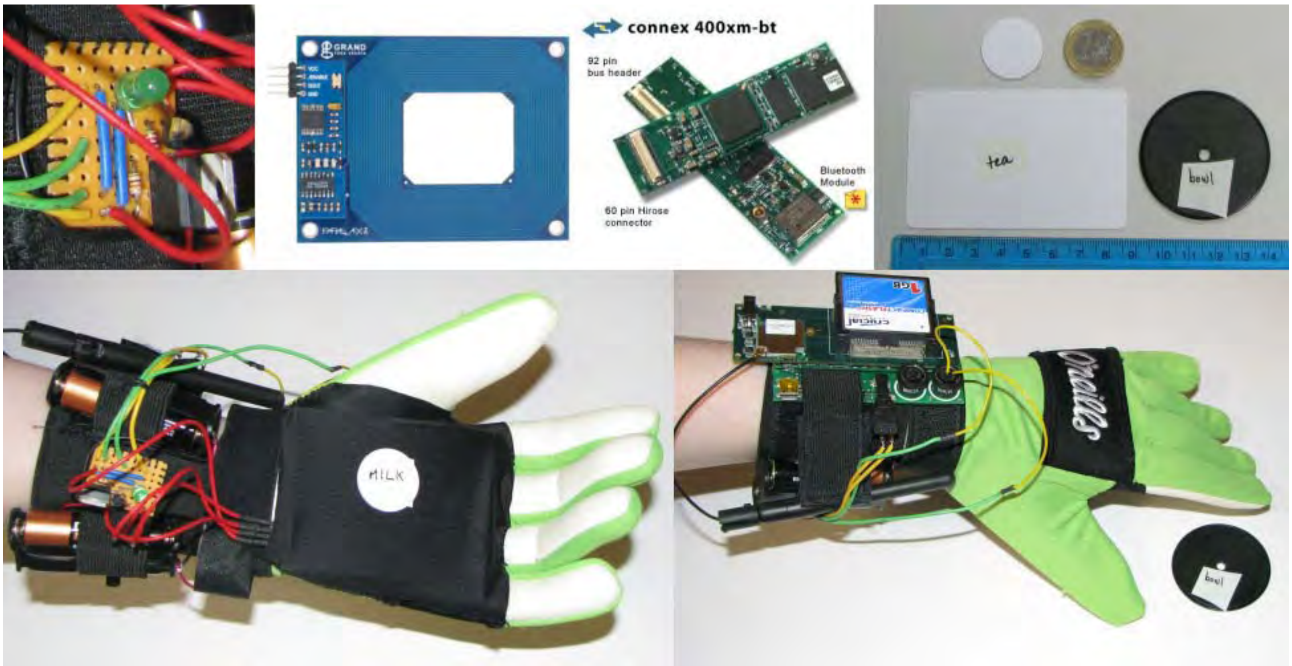

Figure 1: The RFID glove. Clockwise from top left: the circuitry connecting the RFID reader to the Gumstix; the portable RFID reader; the Gumstix motherboard; three types of RFID tags; the front view of the glove – the circuitry and batteries are visible and the RFID reader is in a pouch under the palm; the rear view of the glove – the Gumstix, serial connection, and WiFi antenna are visible.

made up of a portable RFID reader[1], a full function miniature computer system[2], power, and connecting circuitry.

The RFID glove was assembled as follows[3]: We used a sports glove as a scaffold; A pouch was added on the palm to house the RFID reader. A wrist-strap was made with pouches for the batteries that power the glove and a strap for the Gumstix. A circuit board was sewed into the wrist strap; this houses a Voltage regulator, an LED for diagnostics, and a simple circuit that converts the output of the RFID reader into a form that can be consumed by a serial interface. The total cost of components for the RFID glove is approximately $350 and individual tags cost in the region of $1 each. Figure 1 shows some images of the RFID glove in action and some of its constituent parts.

In our system, passive RFID tags that are placed on various artifacts transmit their tag IDs when activated by the RFID reader in the glove. The RFID reader activates the tags, which return their IDs to the reader. The tag IDs are then sent to the Gumstix computer via a serial connection. The tag IDs are processed and sent to a remote database across a WiFi connection. In the database, tag IDs are associated with descriptions of the objects to which they are attached.

[1]From Parallax — `http://www.parallax.com/`

[2]From Gumstix, our computer consists of a connex400 XMBT motherboard, console-st expansion, and wifistix CF (EU) expansion — `http://www.gumstix.com`

[3]More details on the glove assembly are available on the project's wiki — `https://secure.ucd.ie/twiki/bin/view/GumstixRFID/WebHome`

In order to ensure privacy, tag reads are only recorded if the tag ID is already in the database. The database provides the framework on which our scenario applications are developed.

RFID was an attractive technology to use in our system because of its low cost and small size. The small size is particularly important because it allows us to easily attach tags onto objects in our kitchen model in an unobtrusive manner. Our RFID reader has a range of about 3 cm and so the user must be picking up the tagged object or hovering their hand over it in order for the tag to be read. However, RFID comes with many problems: tags cannot be read through the human body since it is mostly composed of water. For this reason, we placed the reader onto the palm of the glove rather than the back, even though this made it more difficult to grasp onto objects. We are currently considering alternative mountings for the reader.

3. APPLICATION SCENARIOS

We chose to implement applications to target two scenarios to assist sufferers of short-term memory loss in the home. The first attempts to assist them to complete routine (but complex) at-home tasks, the second tries to ensure that instructions for taking prescription medication are followed. Both applications use RFID and colocation to attempt to solve the problems at hand.

3.1 Recognising Routine Tasks

Our work is based on earlier work done by Intel in the development of an RFID glove. Their glove could accurately recognise the activities that were being undertaken at any time by examining their interactions with the artifacts in their environment. Our first scenario is an extension of this work. Our application will monitor ongoing routines and alert the user if there is a delay in their completion. This is particularly useful for helping users with short-term memory problems, since they often find it difficult to perform routine tasks if they have too many steps or if they are distracted. This scenario calls for the the development of software for remembering the position or context of tagged artifacts, and the development of a simple task detector that will remind the user when an incomplete task has been abandoned. The initial range of tasks will be a small set of simple routine tasks from the kitchen domain, which was used by Patterson *et al.* to good effect [9].

3.2 Reminding Users to Take Medication

Our second scenario is in some respects the inverse of the first. Rather than be concerned about the completion of tasks undertaken, we aim to recognise situations where tasks are not performed when expected. An example of this would be in routine medication of the potential user. This is a situation where the absence of an activity may have significant impacts on the health of the user, and where a reminder would be useful.

To complete this scenario, we must first recognise the actions associated with taking medicine. To this end, our experiments will involve placing the RFID tags on both the bottle and lid of the container holding the medicine, so that we can automatically capture the individual's interaction with the container. Once we have captured the raw data in the form of time stamped RFID tag detection, we will associate them with events or activities. We must then recognise the absence of those events at significant times. Most medical regimens calls for the ingestion of medicine at fixed times – every 4 hours, or 3 times a day – or at times related to other activities – before eating, for example. Using an activity model generated from the data, we will be able to build up an activity model and infer from it if and when the medicine has been taken by the individual.

4. EVALUATION FRAMEWORK

Our evaluation will take two forms. We will perform evaluations of both scenarios using volunteers to complete two tasks. The first will consist of performing a number of repetitive kitchen tasks in the presence of distractions, the second will involve remembering to perform a simple task (to simulate taking medicine) several times a day over the course of a number of days.

Data will be gathered from users in a number of forms: All interactions between the user and the tagged artifacts will be recorded and time stamped in a database; users will be asked to keep diaries of their behaviour over the trial period; and users will be debriefed with a short interview at the end of the trial period to qualitatively evaluate the system and to perform some quality control over the collected data.

We will perform quantitative evaluations by looking at the improvement in task completion with the reminding functionality turned on versus it being turned off. We will perform qualitative evaluations by issuing questionnaires with questions such as these:

- Did the reminding functionality remind you to complete your tasks appropriately?
- Did you find the glove useful?
- Did you find the glove overly restrictive?

5. RELATED WORK

At the current stage of our work, we are focused on the technical implementation details. This has allowed us to proceed with developing a working system. We are, however, aware that our proposal will be affected by related work in the field. This Section briefly surveys the relevant state of the art.

The earliest work on RFID gloves was done by Schmidt *et al*, who embedded an RFID reader into a work glove [14]. They suggested that tag reads could trigger applications, bookmark to information, and access individualized information. More recent work was done by Kuwamura et al., who developed a prototype system called "Ubiquitous Memories" [10]. Their prototype includes a wrist mounted RFID reader to record and index user experiences based on touch.

Intel Seattle has conducted similar research – they created an RFID glove and later, a more compact bracelet. One system they used to detect activities was learned models using different types of frameworks – Hidden Markov Models and Dynamic Bayes Nets [9]. Another system that they used was a mined model. By using searches on how-to web pages they were able to relate objects to activities and determine their usage probabilities [2]. They were able to determine which words were objects using WordNet. This was found to be slightly less accurate than using the learned models.

Our project is similar in focus to Intel's project and will likely develop one of the models that was developed by Intel for our event detection. However, our future work proposes something novel in that we wish to determine when an event has not taken place or when a user has not finished completing a task. This requires a model that can distinguish between when a task has ended and when a task has been interrupted. Ultimately, we would like a system that not only reminds people with short term memory loss to take their pills until they take them, but also alerts them if they get distracted midway through taking the pills.

Alternative sensing technology to mobile RFID cannot give the granularity of activity that is required for task identification in all cases. For instance, accelerometer data can tell us when the subject is moving, but not what they are moving towards. Stationary RFID readers can inform us when the subject is within their detection radius, but not what they are doing. GPS, Bluetooth and audio sensors can all determine location, but not activity. Environmental sensors could, potentially, notify the monitors of hazardous changes such as the presence of natural gas or carbon dioxide, but would not by themselves identify the cause of such changes.

One potential way to determine activity is to use visual sensors. Using appropriate image analysis, the subjects' activities could be identified, and the system could react appropriately. The issue that arises in this scenario is one of privacy. Elderly people may be averse to being monitored by video [16]. Visual monitoring may be seen as changing what was a private area – the home – into a more public one. The implications of this change are explored by Bohn *et al.* [4], expanding on the idea of personal borders [12] to identify some of the challenges in this area.

6. CONCLUSIONS

RFID has become popular in recent years for all manner of applications. This paper presents an implementation of an RFID-reading glove that is well suited to assisting sufferers of short-term memory loss to live independently in their homes. Two scenarios are presented: the first ensures that ongoing routine kitchen tasks are completed, e.g., if a kettle is boiled, and tea bags are opened, then a cup of tea should be made, even if the user is distracted. The second issues reminders to the user if medication is not taken according to their doctor's instructions. These scenarios are compelling because they fill a clear need and have low cost in terms of infrastructure or cognitive load. The information generated also has the benefit of being owned by the user — no information leaves their home without their permission.

Our research is a work-in-progress; we have completed our hardware implementation, we have outlined the scenarios we intend to tackle, and we have proposed an evaluation framework to test the efficacy of our approach. The next stage of our work is to implement the necessary routine detection algorithms and perform evaluations of our application of the scenarios. This work is part of a larger project on aiding human memory that includes related applications, such as systems for aiding reminiscence activities by groups [3] and portable diary applications.

7. ACKNOWLEDGMENTS

This work is supported by Science Foundation Ireland under grant 03/IN.3/I361 and grant 04/RPI/1544. Caitlin Lustig and Hristo Novatchkov are supported with funding from the Online Dublin Computer Science Summer School (ODCSSS).

8. REFERENCES

[1] The ubiquitous home project. `http://univ.nict.go.jp/past\_pj/disco/eng/research/ubiquitous\_home.html`.

[2] AAAI. *Unsupervised Activity Recognition Using Automatically Mined Common Sense*, July 2005.

[3] M. Bisht, D. Swords, A. Quigley, B. Gaudin, and M. bennett. Context-coded memories: "who, what, where, when, why?". In *MeMos 2007: Supporting Human Memory with Interactive Systems. Workshop at the 2007 British HCI International Conference.*, Sept. 2007. To Appear.

[4] J. Bohn, V. Coroama, M. Langheinrich, F. Mattern, and M. Rohs. Living in a world of smart everyday objects - social, economic, and ethical implications. *Journal of Human and Ecological Risk Assessment*, 10(5):763–786, October 2004.

[5] D. Byrne, C. Gurrin, G. J. Jones, A. F. Smeaton, H. Lee, B. Lavelle, and A. Doherty. Augmenting lifelog data in real-world encounters. In *Proceedings of 6th IEEE International Symposium on Mixed and Augmented Reality*, 2007. To appear.

[6] D. Cox, V. Kindratenko, and D. Pointer. Intellibadge : Towards providing location-aware value-added services at academic conferences. In *UbiComp 2003: Ubiquitous Computing*, pages 264–280, 2003.

[7] T. Hart, R. Buchhofer, and M. Vaccaro. Portable electronic devices as memory and organizational aids after traumatic brain injury: a consumer survey study. *Journal of Head Trauma Rehabilitation*, 19(5):351–365, September/October 2004.

[8] S. Hodges, L. Williams, E. Berry, S. Izadi, J. Srinivasan, A. Butler, G. Smyth, N. Kapur, and K. Wood. Sensecam: A retrospective memory aid. In *Proceedings of the 8th International Conference on Ubicomp*, pages 177–193, 2006.

[9] ISWC. *Fine-Grained Activity Recognition by Aggregating Abstract Object Usage*, October 2005.

[10] T. Kawamura, T. Fukuhara, H. Takeda, Y. Kono, and M. Kidode. Ubiquitous memories: a memory externalization system using physical objects. *Personal Ubiquitous Comput.*, 11(4):287–298, 2007.

[11] J. Landt. The history of RFID. *IEEE Potentials*, 24(4):8–11, October/November 2005.

[12] G. Marx. Murky conceptual waters: The public and the private. *Ethics and Information Technology*, 3(3):157–169, September 2001.

[13] M. Oriani, E. Moniz-Cook, G. Binetti, G. Zanieri, G. Frisoni, C. Geroldi, L. De Vreese, and O. Zanetti. An electronic memory aid to support prospective memory in patients in the early stages of alzheimer's disease: a pilot study. *Aging & Mental Health*, 7(1):22–27, January 2003.

[14] A. Schmidt and C. M. Hans-W. Gellersen. Enabling implicit human computer interaction - a wearable rfid-tag reader. In *Proceedings of the International Symposium on Wearable Computers (ISWC2000)*, pages 193–194, October 2000.

[15] V. Spiezia. The greying population: A wasted human capital or just a social liability? *International Labour Review*, 141(1/2):71–114, 2002.

[16] M. Vacher, D. Istrate, L. Besacier, E. Castelli, and J.-F. Serignat. Smart audio sensor for telemedecine. In *Smart Object Conference, Grenoble, France*, pages 222–225, 15-17 May 2003.

[17] T. Yamazaki. Ubiquitous home: Real-life testbed for home context-aware service. In *First International Conference on Testbeds and Research Infrastructures for the DEvelopment of NeTworks and COMmunities (TRIDENTCOM'05)*, pages 54–59, 2005.

The Digital Parrot: Combining Context-Awareness and Semantics to Augment Memory

Andrea Schweer
Department of Computer Science
The University of Waikato
Hamilton, New Zealand
schweer@cs.waikato.ac.nz

Annika Hinze
Department of Computer Science
The University of Waikato
Hamilton, New Zealand
hinze@cs.waikato.ac.nz

ABSTRACT

People of all ages and backgrounds are prone to forgetting information, even about their personal experiences. Existing systems to support people in remembering such information either continuously record a person's experiences or provide means to store and retrieve clearly defined, isolated pieces of data. We propose a new approach: combining context-awareness with semantic information. We believe this approach to be superior to the existing systems in certain types of situations.

This position paper introduces this approach and our own ongoing project, the Digital Parrot.

Categories and Subject Descriptors

H.5.1 [**Multimedia Information Systems**]: Artificial, augmented, and virtual realities; H.3.m [**Information Storage and Retrieval**]: Miscellaneous; H.5.2 [**User Interfaces**]

General Terms

Human Factors, Design

Keywords

Augmented memory, context-aware systems, wearable systems

1. INTRODUCTION

We all know that people are prone to forget information. While this might be welcome in some situations, it often is a serious inconvenience and negatively influences our well-being and also our performance in the workplace.

A number of software systems have been proposed to improve an individual's long-term memory through various means. Examples are note-taking software or systems that continuously record multimedia data.

Our own approach differs from these existing systems. We believe that a personal, context-aware system which employs a typed, semi-structured data model to support its users is the optimal approach to augmenting memory.

Context-aware systems run on wearable or mobile computing equipment such as cell phones, PDAs or laptop computers by a single user. The systems employ a variety of sensors to detect the user's current context while he or she is interacting with the system. A user's context is everything that characterises his/her current situation [5].

The idea to use a typed, semi-structured data model is inspired by data models used in the Semantic Web [3]. These models consists of information items and connections between those items. Additionally, each information item can be associated with one or more data types. These data types can be used in formulating queries and also to infer properties of information items.

We believe that our approach, the combination of these two fields, more accurately reflects the structure of human memory. The drawback of our approach is that it cannot automatically capture all information but requires interaction from the user. However, this drawback can be overcome by focusing on specific usage scenarios. We will use our Digital Parrot prototype system to refine and test our hypothesis.

In this position paper, we first introduce usage scenarios for the Digital Parrot and examine their common characteristics. From these descriptions, we derive requirements for user interface and interaction design and for the functionality offered by a system to support the memory of individuals in similar situations. We present our initial design for the Digital Parrot and compare it with existing work in this area. Our conclusions are presented as research questions. We end the paper with a brief overview of our approach to address these questions.

2. USAGE SCENARIOS

Early stages of our project examined usage scenarios for the Digital Parrot. The two domains we evaluated in detail are support for conference attendees [15] and travellers [16]. Here we summarise our observations.

Attendees of academic conferences, trade shows and similar events typically interact with a large number of people in a short period of time. Some of these are people they have met before, some are new contacts. In such situations, people typically want to remember names and affiliations of other persons, research interests, topics of previous conversations and under which circumstances they first met someone. Most of this information remain significant after the conference, for example when following up on conversations.

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

Similarly, travellers could benefit from an augmented memory system both during their journey and afterwards. Information here includes the travel itinerary, visited places of interest and topics of conversation with other travellers.

We identified a number of similarities between these two domains.

C1: The user is outside his or her usual environment. This means that they encounter different kinds of information than usual and do not have established routines to deal with this information. The user also cannot rely on their familiar infrastructure.

C2: People in both roles know that they are encountering information which they will want to remember later.

C3: Most or all important activities occur in the "real world", outside the user's imagination.

C4: The situations are semi-structured: Conferences have programmes with formal sessions and informal hallway conversations, journeys follow an itinerary that includes certain activities.

The concepts of our Digital Parrot will be equally beneficial for other domains that share these characteristics. Examples are research field work, museum visits and crime scene investigation.

3. REQUIREMENTS

Based on the usage scenarios presented above, this section identifies a number of requirements for an augmented memory system to support people in similar scenarios.

Support for Multi-Modal Information. People receive information through a variety of senses: hearing, vision, touch, taste and smell. All of these different types of information may want to be remembered. Consequently, to support people best, an augmented memory system should support storage and retrieval for as many of these information types as technically possible.

Combination of Data Sources. In our project, we focus specifically on situations in which the user encounters different information than in his or her day-to-day life (C1) but is aware that he/she will want to remember information about the current situation at a later point in time (C2). However, the user's attention is typically focussed on the actual situation, not on preserving the memories of the current situation. Thus, an augmented memory system should autonomously capture as much information as possible but also allow the user to manually enter information into the system. Automatic capture of information is possible because most interaction happens outside the user's imagination (C3). Capturing information in our target scenarios is easier than for general situations because some information can be inferred from the situation structure (C4).

User Interface for Data Manipulation. An augmented memory system needs to provide its user with means to find and view (listen to, etc.) the stored information. There are several reasons why users should also be able to edit the information in the system. Firstly, information might simply have been stored incorrectly or incompletely. Secondly, a person's understanding of an event might change over time, for example as the person learns additional background information about the event. Thirdly, we see an augmented memory system's task as helping the user, not as working against him/her. Thus, the user, rather than the system, should be in control of the stored memories, even at the cost of accuracy of the stored information as would be judged by an external observer.

Modular System. Since the user cannot rely on his or her familiar infrastructure (C1) but has to use whatever is available to him/her in the specific situation, an augmented memory system should be designed in a modular way. This allows the system to interact with those resources, such as network connection or context sensors, that are available at any given moment.

4. DESIGN

In the previous section, we have identified our requirements for an augmented memory system. We now present the design for our system, the Digital Parrot, that is based on these requirements.

4.1 User Interface and Interaction

The design of the Digital Parrot's user interface and interaction concerns topics such as mode of use, data visualisation and access paradigms.

Mode of Use. The Digital Parrot will run on a small mobile device, for example a PDA (initial experiments will be performed in simulation). Most interaction will be based on stylus or text input, but we can also imagine other interface types (for example speech-based).

Visualisation. The obvious visualisation for information that consists of items and their associations is that of a graph or network. Typically, context-aware systems visualise their data based on time and location. We are investigating how to best combine these approaches.

Access Paradigms. Standard access paradigms in an information system are searching and browsing. In our project, we are also investigating alternative access paradigms like filtering and semantic zooming, following the concepts of experiential computing [9].

More details about the user interface and interaction design for the Digital Parrot can be found in [16].

4.2 Architecture

We have described a service-oriented architecture for a generic context-aware augmented memory system in [16]. The design of the Digital Parrot's architecture is based on this generic architecture.

Following the generic architecture, the Digital Parrot system consists of a core, an interface to external services and a user interface.

The system core is responsible for storing information items and relationships between these items. It also contains a filter engine which can compute subsets of all stored information as specified by search criteria.

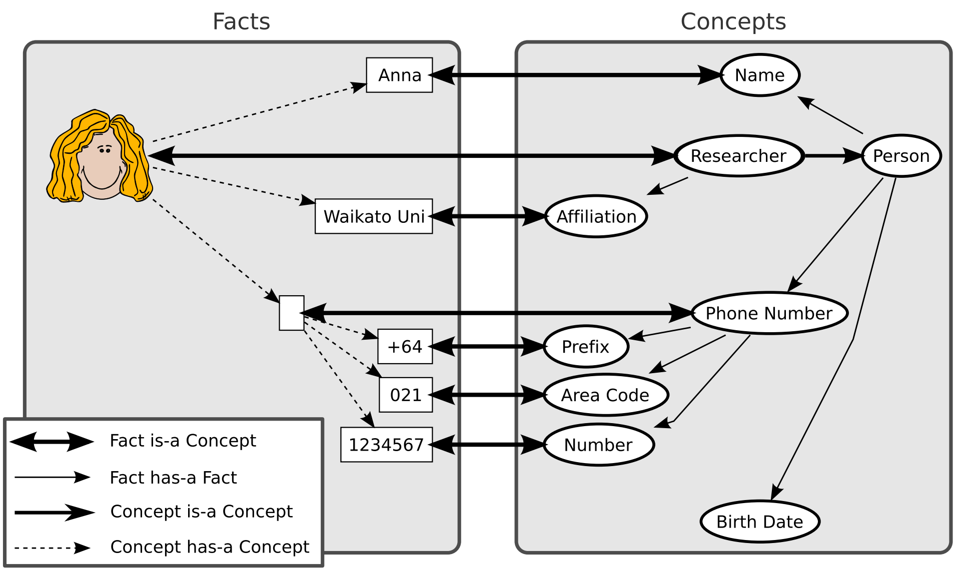

Figure 1: Data Model: Example Facts and Concepts

External services provide information for the system by interacting with context sensors or other data sources. The service-oriented design decouples these services from the system core. Thus, external services can easily be added or removed from the system according to the user's preferences and the availability status of the service.

The user interface layer provides all functionality as discussed in Section 4.1.

4.3 Data Model

We use the example shown in Figure 1 to explain our ideas for the Digital Parrot's underlying data model. We will use a typed data model that enables the system to associate the stored memories with semantic information.

The basic unit of information in our system is a **fact**. The left side of the figure shows facts: someone we know and some information we associate with her. Facts are not stored in isolation; each fact is connected to one or more other facts. For example, we know that "Anna" is not just a random name but the name of this person.

Concepts, shown on the right side of the figure, are used to categorise facts. We know that "Anna" is a name and "+64-21-1234567" is a phone number. Concepts are not mutually exclusive, which means that each fact can belong to more than one concept. Concepts can be hierarchical to allow several layers of detail. For example, a phone number can commonly be separated into a country prefix, an area code, the actual phone number and possibly an extension code. In addition to these part-of hierarchies, concepts can form inheritance relationships. For example, a researcher has all characteristics of a person but usually also an affiliation.

Concepts work like stencils in that they make assumptions about **properties** that certain concepts usually have. For example, we expect that each person we meet does have a name and a birth date, even though we might not actually know some of this information. However, the Digital Parrot's data model needs to be flexible enough to allow deviations from these assumptions. For example, some countries do not use last names.

Connections between facts are not limited to "property of"-style relationships. Just like our memory, the Digital Parrot's data model needs to support arbitrary associations between facts and concepts. We expect that different individuals wish to use different concepts and facts to describe the same situation. The Digital Parrot will allow its users to customise the data model, i. e. the names of concepts and their properties.

The Digital Parrot aims to support people in remembering their own experiences. This adds another facet to our data model; namely, that of the **context** in which a fact has been stored, revised or accessed—in the person's own long-term memory as well as in the Digital Parrot. Context data describes any aspect of the person's internal or external state, such as the current time, geophysical location, social situation or weather conditions.

Facts and context in the Digital Parrot can be supplied directly by the user and obtained from external data sources. We are still investigating how to represent context in our data model.

5. RELATED WORK

The first category of related work are systems to record a person's experiences. This idea was first published in 1945 [4]. The first actual devices were built in the mid-1990s. Due to technical limitations, these early systems ran on purpose-built devices and focused on combining textual information with context data. Examples are Forget-me-not [12], Jimminy [14] and the Conference Assistant [6].

Following the technological progress of ever more powerful wearable systems, the concepts introduced in the early wearable systems have been extended to continuously recorded multimedia data. Examples are MyLifeBits [8], Life logs [2], iRemember [17] and Evitae [13].

All of these systems share a number of limitations. Firstly, they assume that information items are isolated and only linked with their context. Secondly, their philosophy is to record and retrieve – it is not possible to manipulate information stored in these systems, beyond providing annotations. Furthermore, especially the multimedia-oriented systems focus on identifying the "interesting" parts of the recording with machine learning. However, we believe that there is a limit on which information can be captured with this approach as opposed to our approach which enables the user to determine what data to store and at which point.

The data model we have described earlier shares some characteristics with those employed in the Semantic Web, for example RDF[1]. Thus, the second category of related work are programs for semantic personal information management. Examples are Haystack [10], Personal Chronicling Tools [11], SemanticLIFE [1] and Semex [7]. These programs do not take the user's external context into account. We also believe that their data models rely too much on clean and consistent structure—which will not always be present in real-life data.

6. SUMMARY AND OUTLOOK

In this position paper, we have made the case for combining context-awareness and semantics to augment a person's memory. This combination is a very promising approach because it mimics several characteristics of the human long-term memory.

We introduced the current design stage of our Digital Parrot prototype and placed it into a wider context of related work.

The next steps are to build a prototype of the Digital Parrot. We take an iterative approach, with user studies to inform and validate our design and implementation.

The main focus of our project is on investigating the following research questions:

- What is a suitable meta-model to express human experiences and their contexts?
- What is a suitable storage mechanism for experience data?
- Which visualisations and access paradigms are best to help humans recall their own past experiences?
- How can we evaluate the performance of context-aware augmented memory systems?

7. REFERENCES

[1] M. Ahmed, H. H. Hoang, S. Karim, S. Khusro, M. Lanzenberger, K. Latif, E. Michlmayr, K. Mustofa, H. T. Nguyen, A. Rauber, A. Schatten, M. N. Tho, and A. M. Tjoa. SemanticLIFE – A framework for managing information of a human lifetime. In *iiWAS2004: Proceedings of 6th International Conference on Information Integration and Web-based Applications & Services*, pages 687–696, 2004.

[2] K. Aizawa, D. Tancharoen, S. Kawasaki, and T. Yamasaki. Efficient retrieval of life log based on context and content. In *CARPE'04: Proceedings of the the 1st ACM workshop on Continuous archival and retrieval of personal experiences*, pages 22–31, 2004.

[3] T. Berners-Lee, J. Hendler, and O. Lassila. The semantic web. *Scientific American*, 2001.

[1]http://www.w3.org/RDF/

[4] V. Bush. As we may think. *The Atlantic Monthly*, 176(1):101–108, 1945.

[5] A. K. Dey and G. D. Abowd. Towards a better understanding of context and context-awareness. In *Workshop on The What, Who, Where, When, and How of Context-Awareness, as part of the 2000 Conference on Human Factors in Computing Systems (CHI 2000)*, 2000.

[6] A. K. Dey, D. Salber, G. D. Abowd, and M. Futakawa. The conference assistant: Combining context-awareness with wearable computing. In *ISWC 1999: Proceedings of the 3rd International Symposium on Wearable Computers*, pages 21–28, 1999.

[7] X. L. Dong and A. Halevy. A platform for personal information management and integration. In *CIDR '05: Proceedings of the Second Biennal Conference on Innovative Data Systems Research*, 2005.

[8] J. Gemmell, G. Bell, and R. Lueder. MyLifeBits: a personal database for everything. *Communications of the ACM*, 49(1):88–95, 2006.

[9] R. Jain. Experiential computing. *Communications of the ACM*, 46(7):48–55, 2003.

[10] D. R. Karger, K. Bakshi, D. Huynh, D. Quan, and V. Sinha. Haystack: A general purpose information management tool for end users of semistructured data. In *CIDR 2005: Proceedings of the Second Biennial Conference on Innovative Data Systems Research*, 2005.

[11] P. Kim, M. Podlaseck, and G. Pingali. Personal chronicling tools for enhancing information archival and collaboration in enterprises. In *CARPE'04: Proceedings of the the 1st ACM workshop on Continuous archival and retrieval of personal experiences*, pages 56–65, 2004.

[12] M. Lamming and M. Flynn. "Forget-me-not": Intimate computing in support of human memory. In *Proceedings of FRIEND21, 1994 International Symposium on Next Generation Human Interface*, 1994.

[13] J. C. C. Pinzon and R. Singh. Designing an experiential annotation system for personal multimedia information management. In *IASTED Conference on Human-Computer Interaction (IASTED-HCI)*, pages 234–239, 2005.

[14] B. Rhodes. Using physical context for just-in-time information retrieval. *IEEE Transactions on Computers*, 52(8):1011–1014, 2003.

[15] A. Schweer and A. Hinze. Augmented memory for conference attendees. In *Proceedings of NZCSRSC '07, the 5th New Zealand Computer Science Research Student Conference*, 2007.

[16] A. Schweer and A. Hinze. Challenges in interface and interaction design for context-aware augmented memory systems. In *Proceedings of the 8th Annual SIGCHI-NZ Conference on Human-Computer Interaction (CHINZ2007)*, 2007.

[17] S. Vemuri, C. Schmandt, and W. Bender. iRemember: a personal, long-term memory prosthesis. In *CARPE '06: Proceedings of the 3rd ACM workshop on Continuous archival and retrival of personal experiences*, pages 65–74, 2006.

Investigation of Memory-Supporting Design Approaches to the Age-Differentiated Adaptation of Human-Computer Interfaces

Janet Wilkes Nicole Schneider Morten Grandt Christopher M. Schlick

Institute of Industrial Engineering and Ergonomics, RWTH Aachen University
Bergdriesch 27, 52062 Aachen, Germany
+49-241-80 99440

{j.wilkes; n.schneider; m.grandt; c.schlick}@iaw.rwth-aachen.de

ABSTRACT

Demographic change promotes new concepts for the support of ageing employees during work with computer monitors. An approach to age-differentiated adaptation of the human-computer interface should allow for the specific capabilities and needs of elderly users during primarily cognitive activities. To determine the factors of consideration during the implementation of the adaptation model, experimental investigation took place. It was explored how various adaptation dimensions affect the performance of users and to what extent related age-specific effects occur. The results justify further investigations of design variants.

Keywords

Demographic change, adaptive human-computer interfaces

1. Introduction

Against the background of demographic change in particular, the changing boundary conditions of the work world - such as the increasingly dynamic nature of business and work organization, the increasing information flow and the rise in work with computers - lead to a significant increase in the demands made on employees' cognitive performance. To effectively and productively counter this aspect, strategies of employee retention, in the sense of measures for the retention of productivity and motivation among elderly employees, will be of even greater significance in the future. Work tasks and tools must be adapted to the needs of ageing employees if the described activities are to be executed by an increasingly elderly proportion of employees in the future. The age-differentiated adaptation of the human-computer interface model described in the following creates an approach to the ergonomic support of interindividual experience and performance profiles. The focus is on design concepts that achieve the support of memory performance through user-centered information provision.

2. Age-specific Changes of Cognition and Performance

Models and approaches that deal with changes in performance of ageing persons range from the deficit model, whose assumptions no longer hold today (cp. Naegele 2004, p. 353), to the disuse model, compensation model or competence model, among others (see Astor et al. 2006, p. 17 et sqq.). Instead of the hypotheses of the deficit model, it is often assumed that a "differential age" exists according to varying developments in the performance and personality areas with an increase in age. However, these differences can vary in strength and can move in different directions (cp. Maintz 2003, p. 50). Consequently, a general decrease in performance with an increase in age cannot be assumed. Instead, a change in performance on cognitive and physical levels can be assumed, meaning that a general decrease in operational performance cannot be assumed either. In fact, investigations show that with an increase in age come interindividually greatly dispersed abilities. However, these can be positively influenced through the targeted promotion and ergonomic design of work tools (cp. Munnichs 1989). A precise allocation of employees to tasks according to performance profiles can thus be a significant factor for the employment of elderly workers. This goal can be achieved through the promotion of learning and measures of organizational design. In the following, an overview of each factor that affects an age-typical change in performance is presented. These factors are particularly important for the ergonomic human-computer interface and an adaptation, and must therefore be taken into careful consideration:

- *Increasing Performances:* Higher stability of vigilance for increasing duration and complexity; crystalline intelligence; abstractive ability
- *Constant Performances:* Motor reaction time; signal detection; long-term memory
- *Decreasing Performances:* Visual acuity; premotoric processing time; speed of information processing; performance during multi-tasking; working memory; fluid intelligence; flexibility; spatial sense

The mentioned performance elements and their temporal allocation indicate that several rise with an increase in age, while others either remain constant or decrease. It must be observed that as many of these performance change elements as possible are taken into consideration during the design of work and learning processes. This is necessary to ensure that areas with decreasing performance are compensated, and increasing performances can continue to be developed (cp. Astor et al. 2006, p. 18). In today's world, great meaning is associated with the use and handling of computer programs. The respective tasks, which are unfamiliar to many elderly persons and which lead to massive amounts of information that must be processed daily, justify an emphasis on the cognitive aspects of age-related performance deficits.

Supporting Human Memory with Interactve Systems, workshop at the HCI 2007 (British HCI conference 2007), September 4th, 2007, Lancaster, UK

The changes of basic cognitive functions, such as psychomotorics, intelligence and attentiveness, as well as learning and memory all change with age and then have an impact on the performance of elderly persons. Park (1992) showed that age-related performance decreases occur in the majority of these cognitive processes; these will be briefly introduced here.

The cognitive processes of psychomotorics affect the processing and integration of received signals in existing structures when incoming signals must be recognized during discrimination tasks. Premotoric processing time increases with age as reactions to different stimulus factors require more time. Motoric reaction time, i.e., the time needed for a movement after a signal is first deciphered, still remains nearly constant (Lehr 2003, p. 109 et sqq.). The cause behind such results is attributed to the delayed information processing of older persons, i.e., these persons require more time to register preceding information of a reaction and then to form an overview of the immediate situation. However, once this has occurred there is no longer a difference in reaction speed compared to that of younger persons.

Often the ability to remain attentive in the long term (vigilance) is more important than reaction speed. Investigations that examined the ability to work under pressure and the precision of psychomotoric reactions during long lasting information offers came to two important conclusions: 1. With an increase in age comes an increase in the stability of performance during longer periods and increased complexity of processes. 2. There are no measurable age-specific performance differences for signal detection (cp. Lehr 2003, p. 110 et sqq.). However, other authors postulate a reduction in attentiveness. Particularly, the ability to divide attention between various elements decreases. This can be attributed to decelerated information processing and reduced working memory capacity (cp. Kullmann / Seidel 2005, p. 42).

The meanwhile rejected assumption of a general performance decrease with an increase in age, as postulated in the deficit model, can be inferred from intelligence research. This research points out that significant interindividual differences exist in intelligence performance. This variability stems from the various social backgrounds of the persons involved, yet occurs more frequently for certain components of intelligence (cp. Lehr 2003, p. 77). Intelligence can be divided into “fluid” and “crystalline” intelligence based on the distinction made by Cattell (1963). Fluid intelligence encompasses basic processes of information processing and problem solving. “Fluid” refers to speed, adaptability and agility of cognitive processes as well as swift orientation in new situations (cp. Kullmann / Seidel 2005, p. 41). This form of intelligence decreases after middle age. Crystalline intelligence, however, involves experience-based knowledge that is acquired throughout the course of one’s life, therefore also continuously increasing into old age (cp. Stöckl et al. 2001, p. 97). For tasks that have an emphasis on speed a decrease in intelligence performance with an increase in age must be noted. Performance for language and knowledge related tasks either remains constant or increases (cp. Benda 1997, p. 290).

It is assumed that performance is greatly dependent on learning ability since the humans of today are constantly faced with the challenge of adapting to changing demands and situations. Thus, learning ability, especially in the occupational context, becomes one of the most important competencies. If elderly persons appear to be slower in their learning behavior it does not necessarily mean that the ageing process alone is to blame. Instead, multicausal explanations may exist. Experimental studies of learning ability in elderly persons produced several results (Astor et al. 2006, p. 24) that are also significant for the ergonomic design of the human-computer interface.

From these results the assumption that elderly persons are generally poorer learners than younger ones cannot be supported. Rather, elderly persons learn in a different manner. Often, external circumstances can cause the poorer learning results of elderly persons. For example, in most organizations a variation in learning behavior different to that of the younger employees is not catered to. There is no doubt, however, regarding the assumption that the speed of information processing decreases with an increase in age (cp. Bruggmann 2000, p. 28). This can be traced back to a changing level of memorization performance. An increase in age results in a reduction in short-term memory capacity of 4% to 28%, especially for visually acquired information (cp. Lehr 2003, p. 96). Short-term memory becomes more sensitive to disturbances during impact procedures of learning material (cp. Thomae / Lehr 1973, p. 27) and is overstrained more quickly by complex learning material. Information transfer to long-term memory also becomes more difficult (cp. Bruggmann 2000, p. 28). Additionally, reproduction of learned material without sufficient prior knowledge of the topic is increasingly challenging for elderly persons. If prior knowledge exists, however, memory performance remains constant even into old age.

Since computers and systems that primarily address cognitive demands are dealt with, the deceleration of information processing and decrease in working memory capacity also have an effect on their usage. The described performance deficits create significant challenges for ergonomic software design intended for various, including elderly, users. Current user interfaces are still not flexible enough to consider and compensate the various cognitive performance prerequisites of different users. The individualization of the human-computer interface presents a promising approach to achieving cognitive performance, and, with the following approaches, will significantly contribute to the support and improvement of memory performance.

3. Model of Age-differentiated Adaptation

The approach to age-differentiated adaptation of the human-computer interface followed here is focused on compensating fluctuations in performance, thereby especially helping elderly persons in their work with computers. This individual adaptation is therefore exemplarily carried out with project management software since work with network plans places coordinative-communicative demands on the user while also requiring complex cognitive processes. The automatic adaptation is based on the methods of Jameson (2001). A distinction is made between three different phases in this approach - afference, inference and efference. In the first phase the typical user characteristics are registered. These are then analyzed in the second phase and conclusions are drawn regarding individualization. In the third phase the individual adaptation to the user interface is performed. For the age-differentiated adaptation model the three phases are adapted accordingly and an evaluation phase is added in which the adaptive software is evaluated by the user and then updated correspondingly. Based on the mentioned specific performance abilities and characteristics of elderly persons, and on the application area of project management, certain individualization dimensions in regard to adaptation of the human-computer interface are of particular interest. These dimensions include font size and presentation form or menu structure, yet particular significance results from the dimension of memory aids. If the previously mentioned cognitive developments and their influence on computer use are implemented as a basis, then cognitive fluctuations in performance could be recognized and caught. These could then be used as memory aids to assist users in the processing of complex tasks in the network plan. Therefore, possible function commands or current status indicators for the task being processed could be shown. The importance of possible memory aids was formed from the results of initial experiments that will be briefly mentioned here.

3.1 First Experiments and Results

In an experiment with 90 subjects (20 to 73 years of age) the influences of font size on recognition and of the layout design of network plans on memorization and interpretation performance were investigated. First, user-specific abilities, experiences and attitudes were determined through various tests. Aside from visual acuity data, cognitive performance, spatial sense, fluid intelligence and memorization ability of the subjects were acquired via standardized questionnaires and tests. The main experiment divided itself into the following three sub-experiments: 1. Microsoft's standard font size and the recommended font size according to DIN was examined regarding suitability for elderly persons, and whether an increase in font size would lead to an improvement in performance. The goal was to determine the optimal individualized adaptation of the font size based on the user's visual acuity. 2. Various network plan layouts (for details see Schneider et al. 2007) were examined to determine whether a vertical or a horizontal orientation would have different effects on the memorization performance of users. Additionally, different spatial spreads, i.e., between activities of a network plan, were analyzed. The goal was to determine a possible age influence, and thereby related cognitive abilities, on memorization performance. 3. Analogous to 2., the influence of layout design on interpretation performance was also examined here. The goal was to determine the influence of layout design on interpretation performance through evaluation of network plans and age-specific influence factors, along with their relation.

An evaluation of the test procedures shows that spatial sense and memorization ability both decrease with an increase in age. The results of the font size experiment for age-differentiated software design show that the commonly preset standard font size (12') is sufficient for all age groups. Whether or not this size is sufficient in occupational practice during long-term visually demanding project management tasks will be examined in follow-up experiments. The results of layout design of network plan show that a distinction between different task types, memorization and interpretation must be made for the adaptation of software. A larger gap between activities is necessary for good memorization performance. Furthermore, a horizontal network plan orientation is more favorable than a vertical one. This outcome supports the visual-spatial memory theory of Winkelholz / Schlick (2006). However, a smaller gap between activities has a more positive effect on the performance of subjects in the interpretation of network plans. This conforms to the proximity compatibility principle (PCP) (Wickens / Carswell, 1995). This theory postulates that the spatial proximity of displays is useful for mental information integration in which a compatibility of cognitive processes is provided, thereby decreasing "information access costs". Regarding layout, the expected positive effects of horizontal orientation could also be confirmed here (cp. Winkelholz / Schlick 2006). The varying task-dependent effect of spatial spread on subjects' performance expresses an interesting trade-off in the layout design of network plans. The layout variant, i.e., which spatial spread between activities is better suited for the processing of project management tasks, will be examined in follow-up investigations.

4. Future Work

Due to the age-related cognitive performance deficits, especially the working memory and spatial sense, the graphical design of network plans presents a particularly promising adaptation dimensions. Based on previously acquired insights, follow-up experiments will involve the investigation of solutions to the described trade-off. In addition, innovative interaction procedures will be examined regarding whether or not they can contribute to the compensation of determined sensorimotor deficits among elderly users. For this purpose, different design variants of network plans and age-specific viewpoints are conceived and empirically analyzed. Three design variants (see below) derived from previous results, which may contribute to the support of spatial sense and compensation of working memory capacity loss, will be empirically tested.

Different design variants of a network plan (Fig.1) are introduced that can compensate the individual age-specific physiological and cognitive performance deficits and can make an "optimal" ergonomic individualization of project management software possible.

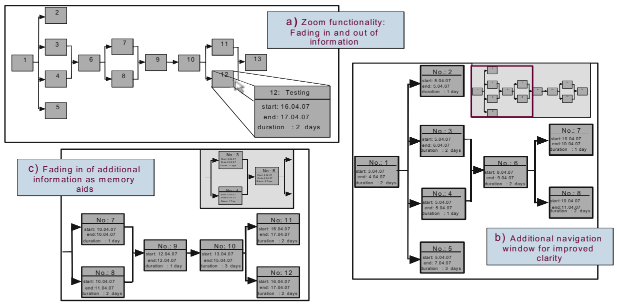

Figure 1: Design Variants for Visualization

The complete and clear presentation of a network plan on a computer screen is often only possible through a reduction of information, i.e., leaving out information within activities. Such a reduced network plan offers a good overview of the entire structure, yet it is not suitable for a precise analysis. This dilemma can perhaps be solved by the zoom function. The dispersed information elements on the screen can be focused on, enlarged, and thus explored in detail through interactive zooming. A variable information density results for which the level of detail can be increased via zooming in and decreased via zooming out. Simultaneously, the display in the lowest zoom level provides an overview of the entire process. Navigation within the information space during zooming can be simplified if a small additional window is faded in beside the desktop. The complete desktop is depicted in smaller form in this case, and the zoomed-in area is graphically highlighted. Investigations of zoom function effectiveness, particularly for various age groups, are not known. The first design variant (Fig.1a) attempts to counteract the trade-off between clarity and the necessary detailed information through the zoom function. A network plan with reduced information, i.e., less required space, is designed in favor of greater clarity. For example, in this network plan only the names of the activities are contained in the network plan nodes. Additional information necessary for the analysis of the network plan can be requested by the user through marking of the activity. The information is then displayed through a zoom function or a layering of display elements (so-called ToolTip function).

If all activities within a network plan are to be displayed with the greatest amount of information possible, a splitting of different screens is required due to the resulting size. This can be realized through a scrolling or paging function. Information is displayed on a long continuous page during scrolling. During paging, however, the information is displayed in smaller units on several pages. Most of the previous investigations against this background were carried out with respect to the internet. According to studies by Schwarz et al. (1983) investigating the effect of paging and scrolling on different task types, a task-dependent effect can be assumed. Paging was generally preferred, and led to improved performance in sorting tasks. No difference in performance was determined between scrolling and paging in the search for connections between elements or for reading tasks. Studies investigating age effects during paging or scrolling do not exist. However, for elderly persons with decreasing spatial sense and memory in particular, difficulties in the navigation of activity graphs can be expected. The second design variant (Fig.1b) is based on a fully labeled network plan. The loss of clarity is to be counteracted and the age-specific performance changes regarding working memory and spatial sense (orientation) are to be compensated by an additional window in which the entire process is scaled down. In this scaled down window the currently displayed section on the screen is also marked.

Due to previous results, it is assumed that both initially mentioned design variants can each only compensate specific age-related performance deficits. However, the goal is to achieve extensive support of all relevant performance areas. A possible solution will be examined in the third design variant which focuses on the use of memory aids for the support of the working memory. So-called ToolTips offer assistance in the sense of memory aids. Temporary faded-in textual information about a focused on object are referred to here. These tips appear when the cursor pauses on an object for a specific amount of time, yet they cannot be explicitly invoked. Bookmarks of websites can also be used as memory aids. No investigations about age-differentiated design of these software support functions are known. The design variant (Fig.1c) includes the following display and usage concept: the user can select a section of a network plan, such as individual nodes, whose information is crucial for further processing. The selected network plan section is then displayed in a separate screen region so that the user can quickly and easily access the information, even if the foundational network plan section is no long visible on the screen (e.g., due to scrolling).

5. ACKNOWLEDGMENTS

Our thanks to the German Research Foundation for supporting this work within SPP 1884 “age-differentiated work systems“.

6. REFERENCES

[1] Astor, M.; Koch, C.; Klose, G.; Reimann, F.; Rochhold, S.; Stemann, M.: Zu alt, um Neues zu lernen? Chancen und Grenzen des gemeinsamen Lernens von älteren und jüngeren Mitarbeitern, In: QUEM-Materialien 77, Hrsg.: AWBF, 2006, 1-165.

[2] Benda, H.v.: Alter. In: Luczak, H.; Volpert, W. (Hrsg.): Handbuch Arbeitswissenschaft. Stuttgart: Schäffer-Poeschel, 1997, 290-295.

[3] Bruggmann, M.: Die Erfahrung älterer Mitarbeiter als Ressource. Wiesbaden: Deutscher Universitäts-Verlag, 2000.

[4] Cattell, R.B.: Theory of Fluid and Crystallized Intelligence: A critical experiment. Journal of Educational Psychology, 54, 1963, 1-22.

[5] Jameson, A.: Systems that Adapt to Their Users: An Integrative Perspective. Saarbrücken: Saarland University, 2001.

[6] Kullmann, H.-M.; Seidel, E.: Lernen und Gedächtnis im Erwachsenenalter. 2. Aufl. Bielefeld: Bertelsmann, 2005.

[7] Lehr, U.: Psychologie des Alterns. 10. Aufl. Wiebelsheim: Quelle und Meyer Verlag, 2003.

[8] Maintz, G.: Leistungsfähigkeit älterer Arbeitnehmer. Abschied vom Defizitmodell. In: Badura, B.; Schellschmidt, H.; Vetter, C. (Hrsg.): Fehlzeiten - Report 2002. Demographischer Wandel. Berlin: Springer-Verlag, 2003, 43-55.

[9] Munnichs, J.M.A.: Intervention: Eine notwendige Strategie für die Bewältigung des Alterns, Erfolgreiches Altern: Bedingungen und Variationen, Bern, 1989, 308-313.

[10] Naegele, G.: Zwischen Arbeit und Rente. Gesellschaftliche Chancen und Risiken älterer Arbeitnehmer. 2. Aufl. Augsburg: Maro Verlag, 2004.

[11] Park, D.C.: Applied cognitive aging research, Handbook of aging and cognition, Hillsdale NJ, Lawrence Erlbaum Associates, 1992, 449-494.

[12] Schneider, N.; Schreiber, S.; Wilkes, J.; Grandt, M.; Schlick, C.: Investigation of Adaptation Dimensions for Age-Differentiated Human-Computer Interfaces, 12th International Conference on HCI Juli 2007, Beijing, S. 1010-1019.

[13] Schwarz, E.; Beldie, I.P.; Pastor, S.: A comparison of paging and scrolling for changing screen contents by inexperienced users. Human Factors, 24, 1983, 279-282.

[14] Stöckl, M.; Spevacek, G.; Straka, G.A.: Alternsgerechte Didaktik. In: Schemme, D. (Hrsg.): Qualifizierung, Personal- und Organisationsentwicklung mit älteren Mitarbeiterinnen und Mitarbeitern: Probleme und Lösungsansätze. Bielefeld: Bertelsmann Verlag, 2001, 89-113.

[15] Thomae, H.; Lehr, U.: Berufliche Leistungsfähigkeit im mittleren und höheren Erwachsenenalter. Eine Analyse des Forschungsstandes. Göttingen: Otto Schwarz & Co., 1973.

[16] Wickens, C.D.; Carswell, M.: The Proximity Compatibility Principle: Its Psychological Foundation and Relevance to Display Design. Human Factors, 37(3), 1995, 473-494.

[17] Winkelholz, C.; Schlick, C.: Modeling human spatial memory within a symbolic architecture of cognition, International Conference Spatial Cognition 2006, Bremen, 2006