Augmented Memory for Conference Attendees

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Abstract. Human memory at its best can perform astonishing feats – the tiniest snippet of information can trigger whole chains of associations, ending at an item long-believed forgotten. While modern information systems excel at systematic manipulation of structured or semi-structured information or even vast repositories of unstructured textual information, they are still far from these capabilities.
Unfortunately, human memory is also prone to failure. Thus, a personal information system that augments human memory through suitable means to store and access information could have huge benefits.
In this paper, we introduce a problem domain for research on such a system: researchers who attend academic conferences and need to remember names, affiliations and research interests of fellow conference attendees and many other types of information. Academic interest in wearable, context-aware systems for information display and capture has strongly increased in the last few years. We present an overview of existing systems and point out unresolved issues. We show that resolving these issues will not only make it possible to build improved augmented memory systems but will also contribute to research in a wider context. Finally, we outline our agenda for research in this area.

Keywords: Context-Awareness, Personal Information Management, Mobile Information Systems, Wearable Computing

1 Introduction

The idea of using computers to augment a person's memory capabilities – to increase the amount of information that can be kept in one's memory and recalled at will – is almost as old as computers themselves.

In 1945, Vannevar Bush envisioned how technology could support researchers in managing their documents, notes and other information [1]. One component of his vision was a storage device built into a researcher's desk that would hold all documents encountered by the researcher. The user of this system would be able to easily add new documents and retrieve those he or she has already seen. In addition to that, the system would allow for the creation of connections between documents. This part of Bush's vision has partially come true in modern hypertext systems.

Another component of Bush's vision was a wearable device, wirelessly connected to the main system. This device would record photographs, voice comments and timestamps while the researcher is working in the field or in the laboratory. Today, it is possible to build such a device at reasonable costs. However, there are still many open issues that need to be resolved to make the device valuable for its users.

This paper outlines research on some of these issues and shows how research on such a device can contribute to more general research areas in Computer Science.

Section 2 introduces the problem domain we are concentrating on in this paper: researchers who visit academic conferences. Section 3 first gives an overview of related work and then points out a number of issues that are still unresolved. Section 4 describes how we intend to address these issues and places this research in a wider context. This includes background information about our project, our research questions, the current status and future steps. Section 5 summarises the contributions of this paper.

2 Attending an Academic Conference

This section describes an application domain for augmented memory systems: supporting researchers who attend academic conferences. The focus lies on the activities that occur during the conference (Sect. 2.1), on the kinds of information that are typically acquired and recalled during or after participating in a conference (Sect. 2.2) and on existing, low-tech memory aids that might be used to improve recall (Sect. 2.3).

2.1 Activities

When a researcher attends an academic conference, this typically includes most of these activities:

- travelling to and from the conference city.
- commuting between the hotel and the conference venue.
- checking in at the conference reception.
- meeting other conference attendees – some of them for the first time.
- attending presentations, demonstrations, keynotes, panel discussions, poster sessions and other events scheduled in the conference programme – alone or as part of a group.
- talking to other conference attendees about a wide range of topics, for example discussions about professional and social events at the conference, research ideas, other professional topics, plans for the evening, travel advice for the conference city and its surroundings, or other personal topics.
- taking part in excursions or social events with other conference attendees.
- exploring the conference city, alone or with other conference attendees.

2.2 Information

After or during the conference, the researcher might want to remember certain information related to his or her experiences at the conference. Here are some example questions that the researcher might ask him- or herself:

- At which place/time/event did I meet this person?
- Which topics have I talked about with this person (at all/last time we met/at a given event/...)?
- Who was it I talked to (about a given topic/at a given event)?
- What happened in February 2006?
- What did I do in Paris?
- Who did I tell about this place/person/conversation?
- Who was it a given colleague introduced me to at a given event?
- At the conference lunch on Thursday of this given conference, there was someone sitting at my table, two seats to my right. Who was that?

From these example questions, a number of information types can be identified (see Fig. 1). Primary entities in these questions are *persons*, *places* and *time intervals*. *Events* are combinations of one or more places, one or more time intervals and a sense of purpose: "While I was attending NZ CSRSC 2007" is not the same as "While I was in Hamilton from 10 until 13 April 2007". Persons have a wide range of possible attributes – from their name and contact details over their research interests to the colour of the clothes they wore at a specific time/event. *Conversations* are links between two or more persons; they occur at a specific time interval and at a specific (set of) place(s). Each conversation has one or more *topics* – which may in turn be related to persons, places, time intervals, events or conversations. Places, time intervals, events and conversations can be seen as hierarchical. For example, the conference opening is part of the first day of NZ CSRSC 2007 which is part of the whole conference.

All information types, as well as their attributes or other information associated with them, can be used for the subject and for the object of a question.

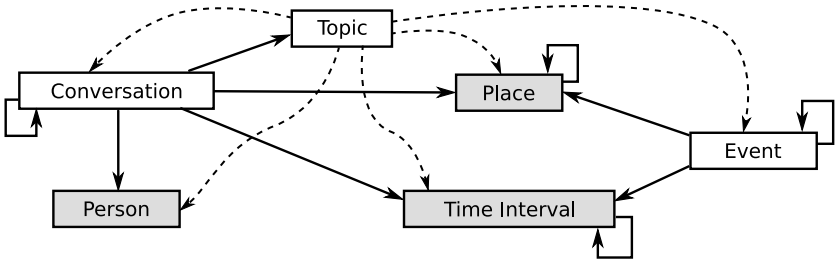

Fig. 1. Information types and their relationships. Primary types are highlighted in grey. Solid arrows stand for the possibility of has-a relationships between entities of the source and target types, dashed arrows for the possibility of is-a relationships. Attributes and relationship cardinalities have been omitted.

2.3 Low-Tech Memory Aids

Without the use of dedicated hardware and software, questions like those presented in Sect. 2.2 can only be answered by referring to one's memory or, in case that fails, by

- looking through the printed or electronic conference programme and proceedings to help remember names and affiliations of persons, presentations, the temporal order of events, etc.
- using business cards collected at the conference to remember names and affiliations of persons.
- using handwritten or electronic notes taken while at the conference or just afterwards to recall persons met there, topics that were discussed, etc.
- looking at photographs to remember persons, events and places.

None of these easily allow for associations between the entities. For example, each business card has to be explicitly annotated with the event at which it was received for this information to be associated with the card. Another drawback is that as most of these memory aids are paper-based, they are not easily portable in large amounts.

3 Existing Systems

This section gives an overview of existing memory aid systems and identifies a number of open questions in this area.

In the Forget-me-not project [2], a PDA was used to collect information about its user's activities (e. g., location of the user, encounters with other people, workstation usage) throughout the day. This information was presented to the user as a biographical log to enable the user to remember details about events.

Jimminy [3, 4], also called the Wearable Remembrance Agent, is an extension of the Emacs text-editor running on a wearable computer with chorded keyboard and heads-up display. It is a note-based system that automatically suggests relevant notes based on the text of the currently edited note and also, if available, on the physical context of the wearer.

Dey et al. developed a dedicated system for the conference domain: Their conference assistant [5] is a portable system that relies on a central conference server to provide conference attendees with information about the conference programme, activities of colleagues at the conference and other conference-related information.

All systems described so far belong to the research area of context-aware computing. According to a commonly-used classification, context-aware applications can either passively display context or actively adapt their behaviour according to the user's current context [6], with the second type being the more common by far. Thus, in these applications context is usually not seen as interesting in its own right. Instead, it is mostly used as metadata for the actual information.

In the last few years, several research projects have been started that aim to use multimedia and possibly dedicated context data recorded through wearable devices during most of the wearer's daily activities.

Arguably the most well-known of these projects is MyLifeBits [7]. Its goal is to store all of a person's digital media, from documents on his/her computer to video recordings of everyday experiences.

The iRemember system [8] is a wearable device that records conversations. To help its user when his/her memory fails, the system makes the recorded data available for searching and browsing through automated speech recognition. This system is typical for a whole range of projects that use machine learning techniques to make recorded multimedia data available for later retrieval (compare [9]).

3.1 Open Questions

Even though augmented memory systems are of interest to an increasing number of researchers, there are still many open questions in this area.

Decreasing size and costs for computer parts, especially storage, make it ever more feasible to build small, powerful wearable devices that capture sensor data and make multimedia recordings of a user's experiences. However, the more important part of augmented memory – improved recall of previously encountered information – still remains difficult. Most existing systems use relational databases with relatively simple data types (timestamps, location, textual data). Associations between items are generally established based on proximity of their timestamps. It is an open question whether data models dedicated to the problem domain can lead to more powerful systems. These specialised data models would require the development of suitable storage models, query languages and retrieval mechanisms. This makes augmented memory systems an interesting field for research in information systems.

Storing new and retrieving previously seen information are the only operations supported by most systems. Especially with highly associative data, the user might find it helpful to edit and reorganise stored information as his or her understanding of a field evolves. To the best of our knowledge, this issue has not been addressed in research on augmented memory systems.

Another open question is how to create an augmented memory system that would be acceptable for the average person to use in his/her everyday life. It is still impossible to use a wearable augmented memory system that is completely concealed from everyone but its user. This makes it especially important to consider social norms in the construction of such a system to ensure it can actually be used outside the laboratory.

4 Our Project

The research described in this paper is part of the first author's PhD project as a member of the Information Systems and Databases Group at the Computer

Science Department, University of Waikato, New Zealand. The second author is the chief supervisor of this PhD project.

This section places the previous sections in the wider context of the whole project. We then introduce our research questions and indicate the project's current status and the next steps.

Our project explores new challenges and opportunities for information systems research – information modelling, storage models, query languages and retrieval methods – that arise in mobile, context-aware systems and specifically in augmented memory systems. Thus, we aim to address the first open question pointed out in Sect. 3.1. In augmented memory systems, context can be both metadata for documents and data in its own right. This makes them more interesting and more challenging than context-aware systems that only display context or adapt their behaviour according to the user's context, and also than systems which treat context merely like any other type of metadata.

There are several reasons why we have chosen to initially focus on the conference domain as described in Sect. 2. Firstly, it is of a semi-structured nature with a limited number of primary information entities, see Sect. 2.2. The conference setting also offers a wide range of context and information types (compare [5]), which increases its usefulness as a testbed. We are confident that the results gained from the conference setting will be transferable to other problem domains. Lastly, our choice of problem domain leads to a good availability of domain experts and possible test users.

4.1 Research Questions

We have refined the goal of our project into the following research questions:

How to Model the Problem Domain. The first step in the development of an information system is to determine which data will be dealt with. This includes the identification of information entities, their attributes and their relationships. We have presented a first cut analysis of the conference domain in Sect. 2.2.

The questions given in Sect. 2.2 can be used to validate the domain model, following the use of competency questions in ontology design [10]: If the list of questions is complete in regards to the intended use of the domain model, the domain model is valid if it can be used to answer all questions. This requires that the list of questions, in turn, has been verified in terms of correctness and completeness.

How to Acquire Context and Other Information. The primary activity of the envisioned users of our augmented memory system is something else than using the system. In the conference setting, the users' focus is – and should remain on – the activities described in Sect. 2.1. To minimise interruptions, our device has to automate the capture of context information as much as possible.

The system should also allow its user to add annotations to captured information. Automatic transcription of audio comments is still error-prone and requires

computational resources often not found on wearable devices. Also, users in the conference setting might be reluctant to record audio comments when they can be overheard. For this reason, it is likely that the system will have to allow the user to input written annotations.

How to Store Data. Once the domain model is complete, we will investigate which systems and mechanisms can be used to store the information described by the model. We will evaluate "classical" database paradigms (e. g. relational and object-oriented approaches) as well as recent developments, for example for RDF data.

How to Query and Retrieve Data. Closely tied to the storage system are the means to access the stored information. Classical strategies for information access are searching and browsing – the first allowing the user to find items that match the supplied criteria, the second to navigate along predefined structures (for example, classification hierarchies). We will decide on how best to support the information needs of the users of our system. Given the associative nature of the human memory, one important access mechanism is likely to be navigation between items that are related in some way.

How to Design the Overall System. Most of the existing systems described in Sect. 3 use a centralised system architecture: While information is captured on small, mobile devices, it is eventually stored on one central, more powerful computer. We will investigate whether this also is a suitable architecture for our system or, if not, find one that is.

How to Improve the User Experience. There are a number of smaller issues not central to our project that we will still have to take into account while developing an augmented memory system. Examples for these are suitable user interfaces for information input, display and manipulation; privacy issues; and sharing of information between two or more users of our system.

4.2 Current Status and Next Steps

The project was started in September 2006. The first step in our project was to find a suitable problem domain for our research. This step has been completed: We have decided to concentrate on the domain of researchers who attend academic conferences, for reasons outlined at the start of this section. As a second application domain (not reported on in this paper), we will consider travel diaries that record tourists experiences.

The next steps are to further review the related work and to refine the data model. We will then make the final decision about the project's main focus and start addressing the research questions given in Sect. 4.1. Completion of the project is expected for the second half of 2009.

5 Summary

In this paper, we have motivated research on augmented memory systems. We have defined the conference domain of supporting attendees of academic conferences, presented a first requirements analysis and argued why this domain is suitable for further research. Based on an overview of related work, we have identified several unresolved issues in research on augmented memory systems. We have then introduced our project that has set out to address some of these issues while contributing to more general research topics in information systems.

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