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.

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**]

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 system, the Digital Parrot, 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. We end the paper with a brief overview of our project.

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 remains significant after the

*A slightly modified version of this paper has been previously published as: A. Schweer and A. Hinze. The Digital Parrot: Combining Context-Awareness and Semantics to Augment Memory. In Proceedings of the Workshop on Supporting Human Memory with Interactive Systems, 2007 British HCI International Conference, September 2007.

NZCSRSC 2008, April 2008, Christchurch, New Zealand.

conference, for example when following up on conversations.

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. An 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.

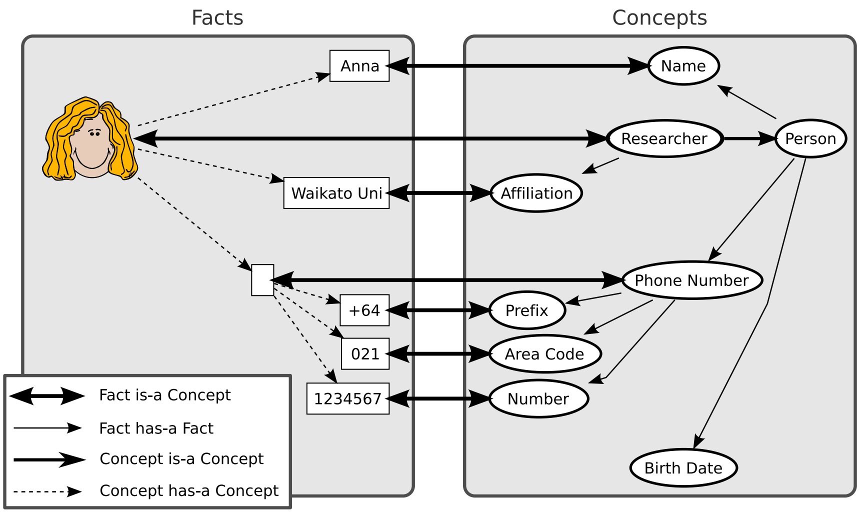

Figure 1: Data Model: Example Facts (Rectangles), Concepts (Ovals) and Relationships (Arrows)

Following the generic architecture, the our 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.

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 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 human long-term memory.

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

The research described in this paper is part of the first author's PhD project. The project started in September 2006 and we expect it to be completed in the second half of 2009.

The main focus of this project is on investigating suitable data models, storage mechanisms, visualisations and access paradigms to help humans recall their own past experiences. In the course of our project, we will also investigate methods to evaluate the performance of augmented memory systems.

We have built up a small collection of sample data and are currently developing a prototype system to inform the following steps. We will then design user studies to evaluate our system, extend the prototype as much as required to conduct the studies and finally conduct the user studies to evaluate our approach.

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

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 *Proc. iiWAS 2004*, 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 *Proc. CARPE '04*, pages 22–31, 2004.

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

[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 *Proc. Workshop on The What, Who, Where, When, and How of Context-Awareness*, 2000.

[6] A. K. Dey, D. Salber, G. D. Abowd, and M. Futakawa. The conference assistant: Combining context-awareness with wearable computing. In *Proc. ISWC 1999*, pages 21–28, 1999.

[7] X. L. Dong and A. Halevy. A platform for personal information management and integration. In *Proc. CIDR '05*, 2005.

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

[9] R. Jain. Experiential computing. *Commun. 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 *Proc. CIDR '05*, 2005.

[11] P. Kim, M. Podlaseck, and G. Pingali. Personal chronicling tools for enhancing information archival and collaboration in enterprises. In *Proc. CARPE '04*, pages 56–65, 2004.

[12] M. Lamming and M. Flynn. "Forget-me-not": Intimate computing in support of human memory. In *Proc. FRIEND21*, 1994.

[13] J. C. C. Pinzon and R. Singh. Designing an experiential annotation system for personal multimedia information management. In *Proc. IASTED-HCI*, pages 234–239, 2005.

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

[15] A. Schweer and A. Hinze. Augmented memory for conference attendees. In *Proc. NZCSRSC '07*, 2007.

[16] A. Schweer and A. Hinze. Challenges in interface and interaction design for context-aware augmented memory systems. In *Proc. CHINZ 2007*, 2007.

[17] S. Vemuri, C. Schmandt, and W. Bender. iRemember: a personal, long-term memory prosthesis. In *Proc. CARPE '06*, pages 65–74, 2006.