Associative Information Spaces

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ABSTRACT

We present the concept of associative information spaces and their use for group collaboration in interactive spaces. This concept is based on the associative network, which we have shown to be beneficial to the user in the domain of personal information management. We propose to extend this network to allow connections between multiple information spaces, to allow seamless information sharing and discovery. Here, the interactive space should act as a mediator between clients in its presence. We conclude the paper with a list of research questions of broader scope, which we hope will encourage the active development of the proposed concept.

1. INTRODUCTION

People collect information at all times. This information, be it a handwritten grocery list, a print-out of an interesting paper, or an email from the boss, makes up the user's information space. Information spaces are usually strictly delimited from each other and for good reason: privacy. However, when people meet at a physical location to collaborate, they often want to share part of their information space with one other. Groth and Eklundh confirm this claim in a study in [7].

For thoughts and physical information, it is common to augment the environment in collaborative spaces with services that enhance sharing. Examples are a whiteboard in a meeting room for illustrating, thus effectively sharing thoughts or a conveniently located copying-machine for distributing paper-based information. These services can be used seamlessly, i.e. without prior configuration on the client side.

Digital information, on the other hand, is usually shared by either translating it to a different information channel, e.g. by using a projector or a printer, or by sharing it through a physical artifact, like a memory stick or a CD. We blame this mainly on information sharing services not working seamlessly in collaborative environments. After all, if the person I want to give a piece of information to is sitting right next to me, why would I have to ask that person for an email address?

In this paper, we present preliminary research towards a new and seamless way of sharing digital information, by enabling the environment to mediate between individual clients. In our vision, the information space of each individual is organized as an associative network. Such networks are interconnected, much like social networks, where links to colleagues and friends can contain links to their respective networks. To allow seamless collaboration of people, who have not met before but are located inside the same interactive space, we propose that such spaces should also be represented by an information space, which then can mediate between its inhabitants.

2. BACKGROUND

Associations are mental connections between ideas or things. They are used in a popular model of human memory: the semantic model [4]. Here, humans remember new thoughts by creating associations between them and existing knowledge.

In an associative network, information is organized in a similar way. Information is stored as nodes of the network, which can be connected to any other nodes present in the network. These connections represent semantic associations between related information items. To find information, the network can either be traversed by its associations or searched by selecting the desired item from a subset of items related to specific search items. E.g. to find meeting nodes for a certain project, the user can first identify the project node and the meeting node and then select the appropriate item from the few items related to both nodes. In section 3, we present two prototypes, we have built and evaluated, which show the feasibility and acceptance of this approach.

The entirety of this associative network makes up our personal information space. In this space, we might have a node representing another person. If this person organizes his/her information in an associative network as well, we can connect the person with his/her space and extend our network seamlessly with everything the other person is willing to share. In section 4, we discuss possibilities of connecting information spaces and how to manage what information is to be shared.

Similar to people, interactive spaces could also have information spaces, which contain all information relevant to the space, e.g. a list of services present, the space administrator's contact, or

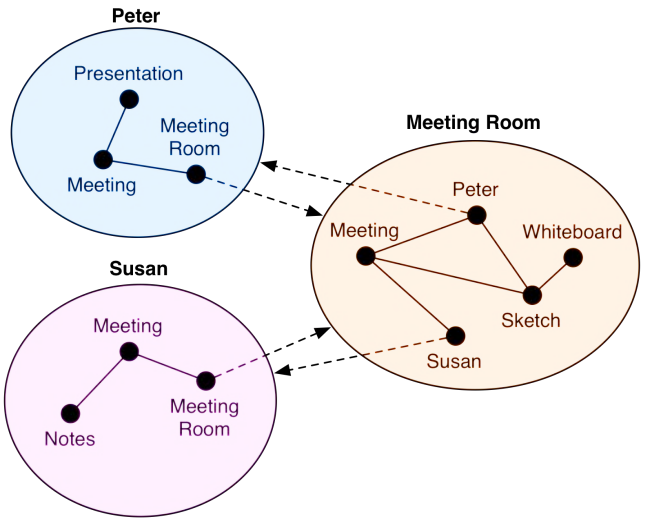

Figure 1. Example of interconnected information spaces

appointments taking place in the room. If the space can also track participants present for an appointment, this information can be used to mediate between the participants. For instance, if there was a presentation last week and you want to access the presenter's slides and any notes that were taken by any of the participants, your system could query the room to gather this information for you by relying the request to the appropriate sources. The presenter and participants can then decide appropriately whether to share the requested information with you. We discuss this in more detail in section 4.

Figure 1 shows an example of interconnected information spaces. Peter and Susan have both attended a meeting in the meeting room. Peter has held a presentation and Susan has taken some notes, which are both stored in their respective information spaces. In addition, Peter has done a sketch on a whiteboard in the meeting room, which was captured and stored in the room's information space. Even though Peter and Susan are not directly connected, Susan may access Peter's presentation by asking the room to mediate between the information spaces, because the room has stored a link to both Peter and Susan.

Creating common information spaces for group collaboration is a known research goal in the field of computer-supported collaborative work. Rolland et al., however, argue in [9] that creating such a common information space can have inherent disadvantages in many situations. Our approach avoids the discussed problems, because it does not explicitly define a common information space but instead offers each client seamless integration of other's information spaces into their own.

For distributed systems a similar concept called Tuple Spaces (coined by D. Gelernter in [6]) already exists, which allows seamless interaction of different networked services. Using, e.g., the event heap (see [8]) small hardware or software components can send and receive events in tuple form. These events are then mediated to other services either directly or through a patch panel application (see [1] for an example). For Associative Information Spaces, the interactive space takes over the role of the patch field and the clients communicate with each other through it while relying on a unified information structure, which in our case is the associative network instead of tuples.

3. PREVIOUS WORK

The Associative PDA [3] is a mobile system for personal information management (PIM) relying on an associative network to represent and organize the user's information. Each information item is defined by a custom type and can be associated with any other items. Finding information can be achieved by moving along associations, or by searching the shared neighborhoods of any number of items.

The prototype was realized as a web prototype (see figure 2) and tested with over 30 participants in multiple user studies. The

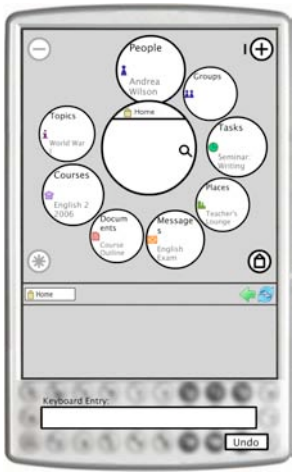

Figure 2. The Associative PDA Flash Prototype.

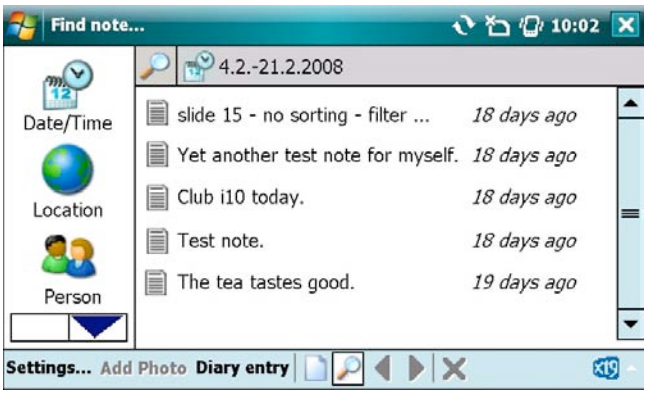

Figure 3. Search screen of the Associative PDA 2.0.

results confirmed our hypothesis, that the use of associations for organizing information is highly intuitive and generally understood.

In the Associative PDA 2.0 [5] we wanted to test the design in a more realistic situation. We wanted to deploy a usable system and evaluate its long-term use on the go. To keep the implementation effort within acceptable limits, we restricted the design to note taking as a representative activity of PIM.

Our final prototype was realized on a Windows Mobile Pocket PC (see figure 3) and provided the same functionality as the previous prototype in terms of defining and searching the associative network. For our evaluation, we gave the prototype to 11 test users for the duration of 4 weeks and encouraged them to use the system extensively. The results showed that the number of search terms used does not increase with the amount of information items in the system, which indicates a very high search efficiency for large data sets that is certainly not true for hierarchical systems.

4. PROPOSED RESEARCH

We want to create an associative environment with multiple clients, to test the usefulness of connecting spaces and clients. To do so, we want to extend our Media Space [2], a next generation meeting room, with an associative information space and distribute associative clients among some of the researchers of the group. We hope to show through informal interviews and observations that the use of the shared information space is beneficial for group collaboration and does not raise privacy concerns.

The first important challenge is to create a process for the initial pairing of two information spaces. This pairing should be universal, such that it can be recreated through the Internet at any place and time. Further it should be seamless and not place any additional burden on the users, like having to pick a name from a list when the other person is standing right in front of me. Close range RFID or directed IR technology could be a feasible solution: pairing two mobile phones by holding their IR ports next to each other is a very natural interaction (if there was not the tedious menu configuration). The simplest way to allow universal pairing is to create a client-server architecture, similar to instant messenger architectures, where clients log into a central server which relays all requests. Pushing the authentication to the clients instead of the server could provide additional security.

When two information spaces are somehow connected, we need to think about how we can seamlessly access the information of the

other space without invading that person's privacy. Since we assume both systems to be associative, their organization of information is compatible and the remote network can simply be considered as an extension of the local network. Therefore, all search instructions will also work, just as they work in our own information space. However, for performance reasons the search on the remote network should be executed by the remote client. The challenge here lies in how to combine the search results of two systems on a wider search that concerns both networks.

Another related challenge is how to identify duplicate information items between different information spaces, like the meeting item from the example in figure 1. Here, pattern-matching algorithms might be able to positively support the user in identifying these relationships or even provide an automated mapping.

Further, the search results should always be restricted to a subset of the remote information space that its owner considers appropriate for the requesting client. We want to keep the owner of the information space in control of what to share while avoiding the unnecessary burden of complex access rights systems. One approach could be to flag associations as public, which can then be traversed by anybody who can reach them. This way, the information space owner can indicate all connections between another person and the information that person is allowed to see. By moving through multiple nodes, like project nodes, complex access rights systems can be simulated in a very natural way.

Finally, we want to explore how the interactive space, or rather its information space, can assist the collaboration of the people in its presence. We see particular benefit in the mediation between its clients and the provision of a history of use. Here, the main challenges are how to design and integrate an information space that does not have an explicit owner, and how to seamlessly hop over multiple information spaces to retrieve the requested information. In addition, the room needs to be able to detect its inhabitants and collaborate with the organizer's information space to create the required links between the ongoing event and its participants. This way, the environment instead of the people could initiate the initial pairing necessary to connect information spaces. Further, through the use of the history, delayed retrieval of information is enabled, because the original context can be reconstructed.

5. GOALS FOR THE WORKSHOP

We believe that the use of individual information spaces for interactive spaces has the potential for a much broader impact on how we interact with the physical world than what we propose here as our research goal. The following list of key questions summarizes the direction of research we imagine:

- How can interconnected information spaces be used to detect and configure environmental services in a natural way? How can we foster non-disturbing automation?
- What impact does it have to keep a history of all events taking place at an interactive space? Will its users accept this level of tracking if discretion is guaranteed? How can collaborators benefit from having a history?
- How can interactions with the physical world benefit from the knowledge captured in the shared information spaces? Can the shared personal information provide more clarity about the situation? Is it feasible to anticipate and learn the user's customs and habits?
- What challenges are involved in pushing information services into the information space? Is it feasible to replace all holding devices, like computers, memory sticks, or DVD players with a unified information space?

Our main goals for the workshop are to raise interest in the use of associative information spaces for interactive spaces, to get feedback on our ideas, and to discuss further research directions. We believe this fits very well with the innovative scope of your workshop topic, and a discussion with experts in the field of mobile interaction with the real world could lead to very interesting new ideas. If the results appear compelling, we would be very interested in contributing to a subsequent publication at a major journal or conference.

6. ACKNOWLEDGMENTS

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