Making Brainstorming Meetings Accessible for Blind Users

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Abstract. Co-located meetings, as a fundamental part of our professional and educational lives heavily rely on visual information. In such meetings visual information consists of a) the artifact or "content" part (as for instance in brainstorming meetings the mind maps) and b) of nonverbal communication elements (like deictic gestures and gazes). Blind persons to a large extent do not have access to these important aspects of information and communication which are only available via the visual channel. Personal support is considered to be the only viable solution, but can only be made available in exceptional cases. This puts blind people at a disadvantage. This paper presents first research results focusing on tracking, analyzing and representing non-visual information and communication elements to blind people to allow more independent access and participation in communication. We present a general system architecture as well as a prototype implementation presenting visual information also to blind users, so that the information gap between sighted and blind participants is reduced in co-located meetings. These activities form the basis for our future research activities on access to non-verbal communication for blind people.

Keywords. Multimodality, Mind Map, Blind Users, Accessibility

Introduction

In our ongoing work a brainstorming meeting using a touch table to display the artifacts as a mind map is selected as an example for co-located meetings, because brainstorming meetings include high dynamics in the communication. They include changes of speakers, changes of non verbal communication elements as for instance deictic gestures and gaze and dynamic changes of the artifact at focus during a meeting. In this paper we will focus especially on this artifact level in co-located meetings, how we could provide better access to mind maps. Besides that, research has been started on how to track and represent non-verbal communication cues.

1. State of the Art Analysis and R&D Principles

In this section we will present the results of an in-depth state of the art research related both to a) access and accessibility of software and tools used in co-located meetings, in

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particular mind mapping tools and b) access to non-verbal communication beyond personal support. The result of this literature research shows that very few has been done so far to support blind people in these settings. Reasons are most probably due to the obvious need to prioritize other domains of accessibility (e.g. text, STEM, video and other graphical elements) and due to the restrictions in technical possibilities of tracking and analyzing non-verbal communication cues. This has changed considerably over the last years, in particular regarding the availability of tracking and analyzing tools for non-verbal communication elements. We will present an overview of the basic approaches allowing independent access of blind people to non verbal communication.

In the field of access for blind users to artifacts in co-located meetings, in particular mind maps, approaches are mostly employing two dimensional haptic dynamic displays [1] which are so far not available on the market and tend to be very expensive. In addition to that, two dimensional representations may cause a blind user to become disoriented and overlooking dynamically changing elements. Two dimensional representations do not substitute the need for systematic search besides linear or linked browsing of the information provided. If used as the only tool for both blind and sighted people in the meeting, blind users would disturb the other users while reading with their hands. As mentioned above, dynamically changing elements have a high risk to disorient the blind user which is worthy of mention in comparison to geographical maps, where several efforts have been made during the past years to make them accessible to blind users [2]. The research showed that far no viable solution for using mind maps in co-located meetings by the sighted and blind user at the same time are available.

It was therefore agreed as a fundamental principle of our research approach, that we must not interfere with the visual representation and interaction. This holds true for a PC as well as modern devices like the Microsoft Pixelsense (http://www.microsoft.com/en-us/pixelsense). We therefore extended the existing mind mapping tool to provide a synchronized and structured representation on state of the art technology for blind people (Braille display and speech output) similar to [3]. Here Kamel and Linday suggest using dedicated input and output devices for the blind at cost of high synchronization needs rather than trying to hook blind users into the view of the sighted users. Moreover we decided that this representation (e.g. tree view) should support well known functionalities as e.g. searching, collapse and expand of levels and cross-linking, but also adding, deleting, changing and moving elements to allow contributing to the co-located activities. The following issues have been identified as essential for any solution for access to mind-map sessions:

- Access by blind people must not interfere with other users.
- Representations, i.e. the visual and the non visual one, always have to be synchronized.
- Blind users have to have the same options as other users (e.g. adding, deleting, moving, grouping, highlighting, linking, …)
- The blind user has to be made aware of any changes done and the system has to allow tracking the changes.

State of the art research on non-verbal communication came up with a similar result. However they are mostly restricted to the domains of a) analysis and importance of non-verbal communication [4] and b) gesture tracking and recognition, e.g. sign and sign language recognition [5]. Very few has been done regarding access to non-verbal communication.

As it comes to gesture recognition and tracking, there is an ongoing trend to utilize the availability of affordable technologies as for instance the Microsoft Kinect (www.xbox.com/kinect) as well as the upcoming Leap Motion (https://www.leapmotion.com). This technology can be also employed for complex settings like co-located meetings, as a basic source for non-verbal communication cues. However, no information was found on approaches for testing and experimenting with these tools for making non verbal communication accessible to blind users.

This in-depth state of the art analysis and intensive workshops and discussions led to first concepts and design ideas for better access to non-verbal communication and artifacts like mind maps frequently used in co-located meetings.

2. A Software Tool to Represent Mind Maps to Blind Users

In this section an overview of the implemented tool for presenting the mind map to the sighted user as well as to the blind user will be given. The tool overcomes predictable problems for the blind user as for instance positions of elements on the display, colors of elements and dynamical changes of the mind map by rebuilding the layout of the mind map and including an alert system which informs the blind user when a change occurred to the mind map.

2.1. System Architecture

The architecture consists of four layers as shown in figure 1. Based on our experiences when developing application in smart spaces [6] we employ the pub/sub paradigm. Here, communication among components happens via subscriptions to channels identified by a name. The underlying network is transparent and the involved components can even be distributed over multiple computers. In our case, this allows us to easily add and remove further components, such as additional input and output devices or further preprocessing components to infer higher-level information.

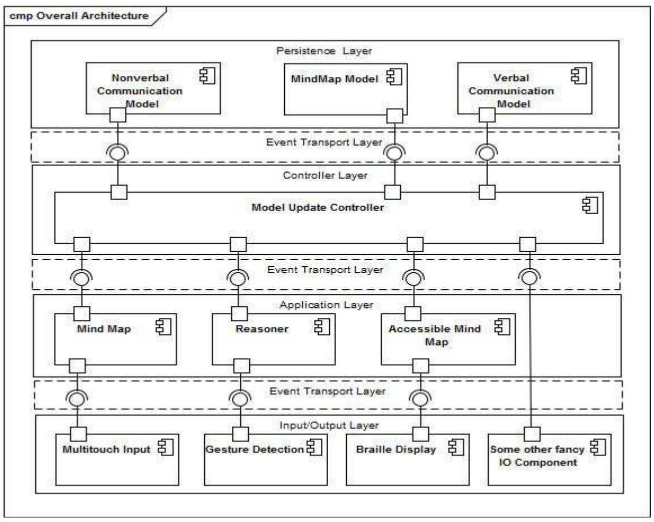

Figure 1: Architectural overview of the system

The actual model is stored in the Persistence Layer. For now, only the MindMap Model is implemented.

Following the MVC pattern, updates to the Persistence Layer are made by the Model Update Controller in the Controller Layer. Vice-versa it will also report changes of the model. Different representations to cope with individual presentation needs are thus synchronized as suggested in [7]. In future iterations we will extend this to also include reasoning e.g. to give rendering hints for particular devices. We expect model changes to occur frequently. Hence, we foresee a filtering mechanism to keep the cognitive load for blind users as low as possible.

The actual implementations of the mind mapping software for blind and sighted users reside in the Application Layer. Both are described in more detail in the following section.

Finally, the Input/Output Layer will contain the various input and output devices, such as the Microsoft Pixelsense, the Microsoft Kinect and a Braille display.

2.2. Model Structure for Holding the Mind Map

Despite the fact that today mind mapping tools exist, which allow for a graph structure between the nodes of the mind map, the basic structure of the implemented MindMap Model is a tree. Comparing tree structures to graphs, trees are beneficial since they feature a unique path to any element. In comparison to alternative exploring techniques of a screen by a blind user, as they were presented in [8], a tree structure has the big advantage that it can be navigated, interpreted and manipulated by a blind user in a way the blind user is already familiar with from other software environments as for instance the Windows explorer. Furthermore using a tree structure and a Braille display accompanies a small risk of overlooking elements by the blind user.

In further iterations the tree structure can be extended by using a second different type of link between the nodes. This gives the possibility to still have a clear tree structure but also represent further correlations between the bubbles. In case a node has a second link, this link can be presented to the blind user as extra information.

2.3. View for Sighted User

The mind mapping tool is running as a .net (http://www.microsoft.com/net) application on a Microsoft Pixelsense. Here, the sighted participants are able to collaborate on the map. Modifications of a standard mind mapping tool are limited to forwarding changes to the Model Update Controller and to update the view if changes have been made by blind participants.

2.4. View for Blind User

The presentation for blind users is running as well as a .net application in which all elements have to be accessible by a screen reader. In figure 2 a screenshot of the blind user view is shown.

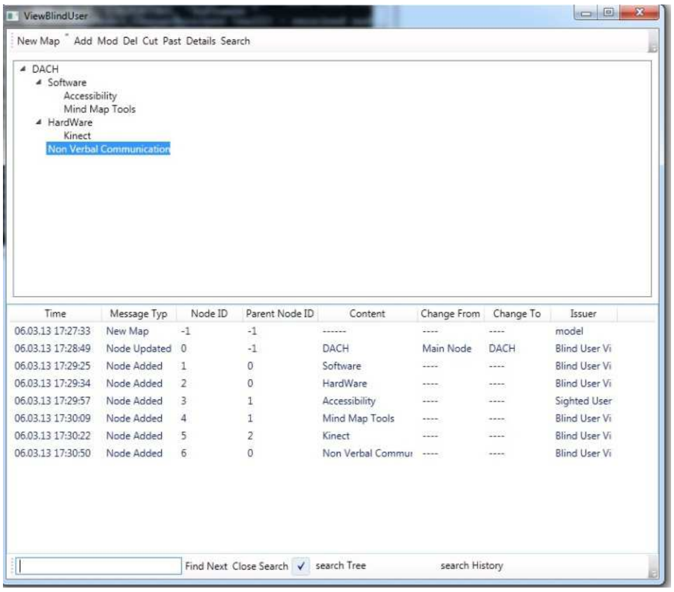

Figure 2: Blind User View

The view mainly consists of 4 parts. The first one is the menu bar for the buttons that includes the functionality for the blind user as for instance add or delete a node. The second part is the TreeView which represents the mind map as a tree which can be navigated by a blind user in a way he/she is already familiar with from other software environments. The third part is a ListView which includes the history of the modifications of the mind map, which gives the blind users the possibility to look up modifications later on. Finally, the fourth part is a menu bar to enable search functionality, giving the user the possibility to search the tree as well as the history for special content. To allow the blind user for an easier overview and a faster handling of the tool the search-bar can also be closed.

The presentation for blind user also includes notifications via a message box in reply to changes of the mind map. It is also used to offer shifting the focus to the modified element in the tree.

2.5. First User Tests

The prototype of the system (excluding the part of the non verbal communication) was tested in two short sessions between a sighted and a blind person. The two blind users were running different screen readers.

Despite the fact that the different screen readers showed different behavior about the accessibility of the blind user view, the view was generally accessible for both users. Only a few improvements considering the accessibility were suggested. Both blind users appreciated the intention to present the mind maps to different user groups with different views. Also the inclusion of an alert system to inform the blind user about modification of the view and give them the possibility to jump to the modification or to stay at the node where they had been before the modification happened, was judged by both user as a good solution for the synchronization of the different views. Both users positively mentioned the possibility to have a history, which can be used as a fall back strategy if they have missed some changes in the mind map.

From the perspective of the sighted participant the sudden appearance of new nodes was not considered to be disturbing. Reasons may be found in the verbal communication between the sighted and the blind user which included hints about the next steps of the communication partners.

3. Conclusions and Outlooks

In the first prototype only the artifact level of co-located meetings was considered from a brainstorming meeting. Making that level accessible and thereby not excluding blind people form relevant information as well as to give them the possibility to actively manipulate the artifacts considerably improved the integration of blind people into co-located meetings. Nevertheless blind people should not only have access to the artifact level but also to the non verbal communication level. Therefore we aim to include the non verbal communication model into the prototype as the next steps in our research.

Later on we will also extend our prototype to utilize other methods for input and output allowing access to non-verbal communication in parallel to explicit (verbal, written, graphical) information. We will also continue with evaluating tracking technology which we plan to apply for making non-verbal communication elements accessible.

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