An Accessible Environment to Integrate Blind Participants into Brainstorming Sessions

User Studies

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Abstract. This paper presents user studies done for a system supporting blind people to take part in co-located brainstorming meetings. For supporting blind people, visual information exchange has to be made accessible to them. This visual information exchange takes place in two ways (a) by using artefacts to hold and share visual information (e.g. text on blackboards, content of mind-map nodes) (b) by non-verbal communication exchange (e.g. nodding to agree to someone's arguments, pointing to highlight some important artefacts). The presented prototype uses Leap Motion to detect pointing gestures as a representative example for non-verbal communication elements, while for the artefact layer a mind-map is used. A so-called "blind user interface" serializes the star structure of this min-map and allows accessing it by the blind user through a regular screen reader.

Keywords: Co-located meeting · Brainstorming session · Mind–map · Blind user · User studies

1 Introduction

Co-located meetings play an important role in our professional lives. To overcome barriers and to establish a better integration of blind people in such meetings, visual information exchange has to be made accessible to blind meeting participants. Two main layers of visual information exchange were identified: (a) artefacts like text on a blackboard, nodes on a mind-map, etc. (b) non-verbal communication elements like for instance pointing gestures to highlight an artifact during an ongoing discussion, or nodding to agree to someone's arguments.

Ongoing research shows a high effort to make the artefacts layer accessible to blind meeting participants. Accessibility issues of artefacts are for instance researched in many fields. In the fields of mathematics for example, Archambault et al. [1] developed a mathematical conversion library for a better accessibility of equations. For making graphical elements accessible to blind users, Ramloll et al. [2] developed a sonification

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for haptic line graphs. For representing more complex diagrams such as UML to the blind user, King et al. [3] developed the TeDUB system.

However, the possibilities to improve information accessibility in co-located meetings, the difficulties in tracking and representation of non-verbal communication to the blind user, as well as the helpfulness for blind people to follow an ongoing discussion by considering the layer of non-verbal communication are not well studied so far. First aspects are researched by Pölzer and Miesenberger [4], who developed a user interface for the serialized representation of the mind-map's content and giving the possibility to blind user to also edit and enter nodes to the mind-map. This work was then combined with a prototype for a co-located team meeting, which was developed by Kunz et al. [10]. Within this prototype, the pointing gesture was taken as a representative example of a non-verbal communication element. It allowed including blind meeting participants into co-located brainstorming sessions, using a mind-map and pointing gestures. The used mind-map application was not based on a large sheet of paper, but in digital form on an interactive table, which is a fundamental requirement to allow blind-meeting participants to interact with it. In the following, the paper summarizes the conducted user studies.

2 System Design

The concept of the overall system architecture and different user interfaces were already presented earlier. Pölzer & Miesenberger discussed various user interfaces for the mind-map presentation [5], while a virtual Braille keyboard on an interactive surface was described by Zaim et al. [6]. Finally, the software design for the prototype was described by Pölzer et al. [7]. The implemented prototype for the user tests consists of a user interface for the sighted meeting participant, a separate user interface for the blind meeting participant (displayed on an interactive table Microsoft Pixelsense), and a LEAP-based tracking system to track the occurring pointing gestures (the non-verbal communication elements).

2.1 User Interface for Sighted Meeting Participants

The mind-map for the sighted users was displayed on a Microsoft Pixelsense interactive table, which allowed the sighted users to modify and edit the mind-map by using touch gestures and a virtual keyboard. Since mind-map software typically is not de-signed for collaborative multiuser interaction, it offers only a correct perspective view to one of the users around the table, while the other sighted users only can see nodes from the sides or even upside-down. Since this would significantly impact the efficiency of a brainstorming session, a new software "CoME" was developed which allows editing nodes in any orientation and later correct alignment with the rest of the mind-map. Further functionalities of the software are adding, deleting, cutting, copying and pasting nodes as well as to modifying their content (see Fig. 1). The software can be found on sourceforge.net [11].

Fig. 1. Overview on the system

2.2 User Interface for Blind Meeting Participants

A detailed description of the user interface for the blind meeting participant is given by Pölzer et al. [7]. This blind user interface mainly consists of a tree-view representation of the mind-map on the Pixelsense table, which is presented to the blind user on a separate PC (see Fig. 1). The blind user interface, which allows manipulating of and navigating through the mind-map, can be managed by the blind user by the help of standard AT (Braille Displays, speech output). The blind user interface's functionality for basic operations (e.g. adding, deleting or modifying a bubble) is identical with the functionalities of the user interface of the sighted users.

2.3 Tracking System

To track the occurring pointing gestures of a sighted user, the Leap Motion sensor is used. It is placed on the Pixelsense's edge, directly in front of the user. During the user tests, each person was tracked by his/her "own" Leap Motion (see Fig. 1), since the tracking range of one sensor is too small to cover the whole space above the table. A detailed description of the tracking system is given by Alavi & Kunz [8].

3 User Tests and Feedback

The whole design of the user study was based on the main aspects of usability engineering, as described by Nielsen [9]. During the usability engineering cycle, important aspects are: (i) analysis of user needs and user benefits from such systems through experts and target group representatives; (ii) an iterative user centered design process; and (iii) an evaluation process. The evaluation process (test scenario) and the corresponding tasks were clearly defined (see Sect. 3.1). The usability assessment methods were mainly based on the methods of observations, questionnaires and interviews (see Sect. 3.3).

3.1 Experimental Setup

The setup was designed for two sighted and one blind meeting participant. The working space for the blind user, including the required AT (Braille Display) was placed next to the short side of the Microsoft PixelSense on a small table (see Fig. 1). Thus, the blind user was able to acoustically follow the discussion directly without any additional means. The Leap sensors for tracking the pointing gestures of the sighted users were placed in a way so that the one sighted person was standing on a long side of the table and the other one at a short side of the table, each with his own LEAP sensor in front of him. During the design of the experimental setup, special attention was paid on the close integration of the blind participant.

The topics for the brainstorming sessions were defined for each meeting separately within the present group. The following topics were discussed: 'study' ("Studium"), 'holiday' ("Urlaub"), 'restaurant delivery service' ("Lieferservice") and 'Organization of the Institute's 25 Year Anniversary' ("Organisation der 25-jährigen Institutsfeier"). The topics were chosen in such a way that they did not require any previous knowledge or skills to fully participate in the brainstorming session. Within a 15 min brainstorming session, participants were asked to develop ideas to those topics and to integrate these ideas in the mind-map tool to trigger a further discussion.

3.2 User and User Instruction

Four different user studies with four different blind participants were conducted. All four blind participants were already familiar with Braille displays. Two of them were involved in the ongoing user centered design process of the blind user interface. For the other two blind users, the concept and the user interface were totally new. For the blind users not involved in the development process, an extended introduction time was used to get familiar with the concept of mind-maps and the functionalities of the designed user interface.

One sighted participant, who was familiar with the whole experimental setup and therefore able to answer occurring questions, took part in all four sessions. The second sighted participant was different in 3 out of 4 meetings (in one case only one sighted and one blind participant took part in the meeting).

Sighted users are normally familiar with the concept of mind-maps and the user interface was not too complex, which allowed the sighted users directly to start the meeting. Each of the four user tests took around 15 min without introduction time.

3.3 Evaluation and User Feedback

Any tool to improve the accessibility of co-located meetings without imposing additional effort to the blind users can be seen as a progress in accessibility, since such tools are rare or even do not exist. As discussed in the above, this is mainly due to the difficulties in acquiring non-verbal communication elements of the sighted users. Thus, it was decided to develop a questionnaire for the blind participants to evaluate the system based on their personal impression. Special attention was paid to the following aspects:

- General idea and concept of information representation,
- Understanding of the mind-map's content and possibility to follow occurring mind-map changes,
- Importance of non-verbal communication elements (pointing gestures),
- Suggestions for improvements.

General Idea. All blind users evaluated the idea and the system architecture (including the use of synchronized different views for sighted- and blind meeting participant) as suitable. The fact that all blind meeting participants started to add nodes directly after the start of the test scenario showed that they liked and understood the concept. The blind users appreciated that this new interface is not just to output data, but can also be used to modify the content of the mind-map and to active take part in the discussion. For them, it was important that the new tools allow them to participate in the discussion in "real time", thus removing the impression that they slow down the whole team process.

Understanding of the Mind-Map. The generated mind-maps were not perceived as too complex by the sighted users, but also all blind participants stated that they can follow the changes in the mind-map and that they have an understanding of the mind-map's structure. The understanding of the mind-map by the blind participant can also be supported by the fact that they interact and manipulated the mind-map during the ongoing meeting, and that they were fully integrated in the generation of the mind-map's layout.

Importance of Pointing Gestures. All blind participants agreed that the presentation of the pointing gestures and highlighting the related content of the nodes can help them to follow the ongoing discussion. Since the blind users know that non-verbal communication elements such as pointing are an important communication means by the sighted users, they appreciated to have access also to this important communication layer. Having access to this layer allowed the blind users to understand the focus of the discussion much easier, since they do not have to extrapolate this from the spoken word only.

Suggestions for Improvements. An idea came up to show the available elements in a fast way without the structure by presenting only the first letters of each node's content in one line. The blind user normally is involved in the generation of the mind-map and knows the nodes. Based on the presentation of the first letters, the blind user has than a fast way to find and select a node of the mind-map. The fact that letters could appear twice or even more frequently in such a line representation of the mind-map's tree structure was regarded as less disturbing, since the position of the letter in the line gives another important hint on which node is actually meant.

4 Summary and Outlook

The user tests showed us that such a system was accepted by all meeting participants. It did not impose an additional overhead to the sighted users, since they interact with the mind-map in a convenient way. On the other hand, the system allowed the blind users to easily follow the discussion and the actively take part within without decelerating the whole process. Thus, the active participation of all persons showed that such a system can reduce the information gap between sighted- and blind meeting participants. As we have seen in the user studies, not only the accessibility of artefacts can help blind meeting participants to follow an ongoing discussion, but also the presentation of non-verbal communication elements such as pointing gestures. Besides the well-known complexity of tracking and reasoning issues, a deep understanding of the importance for non-verbal communication elements for blind user has to be gained to achieve an adequate, non-overloading and non-disturbing presentation of such elements.

Future work will focus on different state of the art and new presentation techniques which have to be analyzed to find a proper way of presentation. Moreover, the additional filtering algorithms should be further improved by e.g. reasoning procedures to further increase the stability of the system and to better avoid false alerts to the blind user. In addition, future work will also address the fact that information is spatially distributed not only on a tabletop, but also in multiple dimensions in the complete meeting room. This will impose a higher level of complexity to the blind user interface, which have to be mastered in the future.

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References

1. Archambault, D., Fitzpatrick, D., Gupta, G., Karshmer, A.I., Miesenberger, K., Pontelli, E.: Towards a universal maths conversion library. In: Miesenberger, K., Klaus, J., Zagler, W.L., Burger, D. (eds.) ICCHP 2004. LNCS, vol. 3118, pp. 664–669. Springer, Heidelberg (2004)
2. Ramloll, R., Yu, W., Brewster, S., Riedel, B., Burton, M., Dimigen, G.: Constructing sonified haptic line graphs for the blind student: first steps. In: Proceedings of the 4th International ACM Conference on Assistive Technologies (Assets 2000), pp. 17–25 (2000)
3. King, A., Blenkhorn, P., Crombie, D., Dijkstra, S., Evans, G., Wood, J.: Presenting UML software engineering diagrams to blind people. In: Miesenberger, K., Klaus, J., Zagler, W.L., Burger, D. (eds.) ICCHP 2004. LNCS, vol. 3118, pp. 522–529. Springer, Heidelberg (2004)
4. Pölzer, S., Miesenberger, K.: Presenting non-verbal communication to blind users in brainstorming sessions. In: Proceedings of the 14th International Conference on Computers Helping People with Special Needs, pp. 220–225 (2014)
5. Pölzer, S., Miesenberger, K.: 2D presentation techniques of mindmaps for blind meeting participants. In: Proceedings of the 13th AAATE Conference, pp. 533–538 (2015)
6. Zaim, E., Gruber, M., Gaisbauer, G., Heumader, P., Pölzer, S., Miesenberger, K.: Virtual braille-keyboard in co-located meetings. In: Miesenberger, K., Fels, D., Archambault, D., Peňáz, P., Zagler, W. (eds.) ICCHP 2014, Part I. LNCS, vol. 8547, pp. 231–236. Springer, Heidelberg (2014)

7. Pölzer, S., Schnelle-Walka, D., Pöll, D., Heumader, P., Miesenberger, K.: Making brainstorming meetings accessible for blind users. In: Proceedings of the 12th European AAATE Conference, pp. 653–658 (2013)
8. Alavi, A., Kunz, A.: Tracking deictic gestures over large interactive surfaces. J. Comput. Support. Coop. Work (JCSCW) **24**, 109–119 (2015)
9. Nielsen, J.: Usability Engineering. Elsevier, Amsterdam (1994)
10. Kunz, A., Miesenberger, K., Mühlhäuser, M., Alavi, A., Pölzer, S., Pöll, D., Heumader, P., Schnelle-Walka, D.: Accessibility of brainstorming sessions for blind people. In: Miesenberger, K., Fels, D., Archambault, D., Peňáz, P., Zagler, W. (eds.) ICCHP 2014, Part I. LNCS, vol. 8547, pp. 237–244. Springer, Heidelberg (2014)
11. Sourceforge.net, March 2016. http://sourceforge.net/p/come/wiki/CoME%20-%20Collaborative%20Mindmap%20Editor/