Accessibility of Brainstorming Sessions for Blind People

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Abstract. Today, research focuses on the accessibility of explicit information for blind users. This gives only partly access to the information flow in brainstorming sessions, since non-verbal communication is not supported. Advances in ICT however allow capturing implicit information like hand gestures as important part of non-verbal communication. Thus, we describe a system that al-lows integrating blind people into a brainstorming session using a mind map.

Keywords: Accessibility, Mind map, Non-verbal Communication Elements.

1 Introduction

In brainstormings, coordinative, collaborative and communicative elements exist [1] in the 'level of artifacts' and the 'level of non-verbal communication' (Fig. 1).

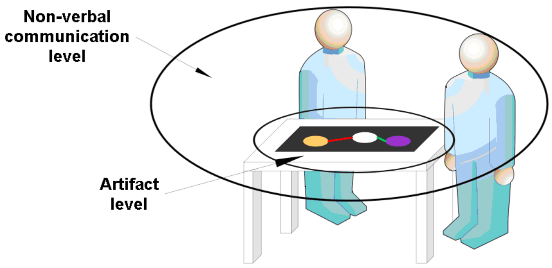

Fig. 1. Brainstorming integrates non-verbal communication and artifact level elements [2]

Within these levels, a number of challenges arise when blind and sighted persons collaborate. The challenges come from fundamentally different (and often incompatible) ways of perception and expression that cannot be easily overcome. This could bring blind people in an unwanted role, which could result in an unintended or unconscious exclusion from such a brainstorming session. In case of a brainstorming session using a mind map, the origin of the problems is twofold: they could either come from

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the generated elements on the artifact level, or from the non-verbal communication level. Both levels are highly interdependent, since many times non-verbal communication elements, such as deictic gestures, refer to elements on the artifact level.

1.1 Level of Artifacts

Although blind and sighted people can access the same digital information of documents by rendering it on screen/print or in Braille/audio, the way of perception leads to considerable differences in accessing or generating this information. The visual channel allows for fast and parallel perception of information, while Braille or audio could be compared to a serial perception. This difference is in particular salient for the perception of graphical elements like those of a mind map. Hence, blind people need more time for sensing the content of artifacts. This becomes even more critical when the artifacts are edited during the meeting. Moreover, jointly working on artifacts requires that each participant is aware about the state and the content of the artifacts. Due to these limitations, current tools and technologies cannot support a joint group of sighted and blind people to create and edit artifacts in a brainstorming meeting.

1.2 Level of Non-verbal Communication

A large amount of information during a meeting is transferred non-verbally by gestures, postures, facial expressions, etc., which rely on the visual channel only. Consequently, blind people are excluded from this information. Not only gestures and facial expressions are required for establishing interpersonal relationship [3], but are also important to coordinate discussions during a brainstorming, e.g. for turn-taking [4,5]. As a workaround for engaging blind people in such meetings, the implicit non-verbal communication is made explicit by verbalizing it. This evokes new problems, since non-verbal communication is parallel and thus has to be serialized in order to communicate it verbally. Moreover, non-verbal communication is done unconsciously, but it has to be consciously translated or articulated by the sighted participants. Both problems mentioned in the above slow down the whole brainstorming session.

The mentioned problems show the difficulties for the participants of a meeting to transfer information and to synchronize the individual mental models. Meetings are significantly more complicated as they have to be consciously prepared and conducted. This imposes a higher cognitive load on the participants. Consequently, such meetings tend to progress more slowly, are less effective and less intuitive. Finally, some activities are even impossible, such as intensely working on a shared document.

2 Related Work

For the chosen scenario of integrating blind people into a collocated mind map brainstorming session, we need to study the research literature on two different levels: the artifact level, and the non-verbal communication level.

2.1 Artifact Level

A vast body of research in the field of HCI (Human Computer Interaction) tackles the problem of more intuitive interaction with digital content. A major approach relies on natural user interfaces (NUIs), which enhance (or in some case, replace) a graphical user interface (GUI), buy providing technologies such as touchscreens, motions trackers, and tangible user interfaces (TUIs) [6,7,8,9] . While these interfaces are helpful for sighted persons to access and alter artifacts in an intuitive way, they support the blind users in a very limited manner.

Window Eyes [10] could output textual information to Braille displays, or audio speakers. A lot of research has been done for making graphical information accessible to the blind, both in terms of providing equivalent descriptive text alternatives [11], or using tactile and/or audio methods [12,13,14,15]. All these approaches focus on linear text and static graphics, but not on dynamically changing artifacts such as a mind map. This requires the development of systems for tracking, analyzing and displaying information and thereby tackling the problem of information overflow. Only a few approaches towards access to dynamic content exist [16,17]. Here, the user interacts with a tangible and sonic representation of a line chart. In another approach, Ferres et al. [18] translate the chart into a textual representation, which can then be accessed by conventional reading devices such as Braille displays.

However, these approaches do not investigate the dynamics of changing graphics in real-time, and they also do not include non-verbal communication elements.

2.2 Non-verbal Communication Level

While meeting support for blind people is still a largely underrepresented research area as stated by Winberg et al. [19], distributed meetings for sighted persons are well addressed in literature. Providing awareness of eye-contacts or of other gestures such as pointing or nodding supports the social presence and coordinates the teamwork [5], [4], [20]. Work presented by Ba et al. [21] provides a proximity approach to identify the visual focus of attention of a user. Morency et al. [22] show that nodding and other head movements can be successfully captured by visual tracking systems.

Deictic gestures bridge between the level of non-verbal communication and the level of artifacts. They are used by sighted people to easily refer to artifacts during a meeting. Within the very little work conducted for blind people, Oliveira et al. [23] address how to translate deictic gestures made on a whiteboard containing static content into a haptic representation. Thereby, the blind person wears a glove which guides his hand to the position on the artifact level the sighted user is pointing to. However, there is no work for deictic gestures on dynamic content.

To summarize, the integration of blind people into brainstorming sessions is still very limited. This is mainly because of the following reasons:

- Deictic gestures are not reliably captured and assigned to artifacts on the interactive surface.
- Translation of the "parallel" content of the artifact level to the serial perception of the blind user and vice versa is not well investigated.
- Lack of interfaces for blind users to interact with the artifacts

This paper thus introduces a system that allows integrating blind users in a mind map brainstorming meeting, which addresses the challenges mentioned in the above.

3 Contribution

To address the above challenges, we realized the concept of an automatic real-time translation as core of the overall system. This translation process is threefold: (1) capturing artifacts and non-verbal communication elements with dedicated sensors; (2) semantic modeling of artifacts and activities; and (3) making the information available to all participants in an appropriate and accessible representation (Fig. 2).

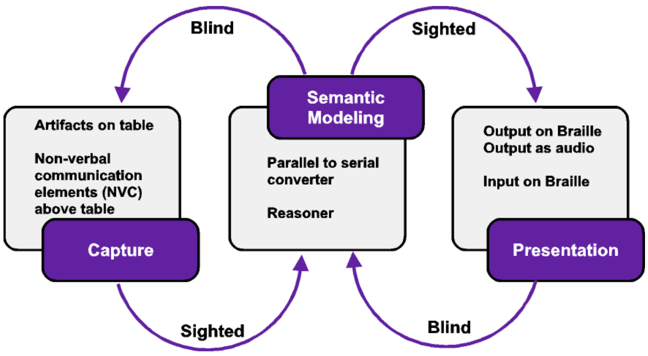

Fig. 2. General overview of the realized system

The system is realized in a multi-layer architecture, consisting of 4 layers.

3.1 Persistence Layer

The persistence layer only contains the mind map model. Although many graph-based mind map tools exist, we implemented our mind map in a tree structure. Within a tree structure, every element n the mind map represents a node in the tree model, thus having a unique path to the root. This path is made accessible to the blind users. In comparison to alternative screen exploring techniques for blind users as presented by Kane et al. [24], a tree structure can be easily navigated, interpreted and manipulated by a blind user in a way she is already familiar with.

3.2 Controller Layer

The Model Update Controller updates the persistence layer. The controller will also report changes of the model to the application layer. The model update controller also provides information to the semantic reasoner in order to properly infer the relation between deictic and other pointing gestures and artifacts.

3.3 Application Layer

The main components of the application layer are the mind map software, the reasoner, and an accessible mind map (blind user interface).

The reasoner receives the tracking information from the sensors and compares the calculated pointing direction intersection point with the positions of the artifacts on the screen in order to highlight the corresponding component. This information is given to the mind map and the accessible mind map applications, where the corresponding object is highlighted.

The mind map application is shown in Fig. 3. It currently allows adding and deleting elements, adding text to an element and freely moving it around. It is also possible to rotate an element, which is important since the sighted persons sit around the table.

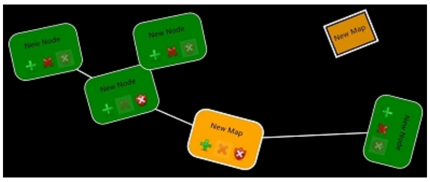

Fig. 3. Collaborative mind map Editor "CoME"

Sighted persons can move, zoom, and rotate objects by using the touch input capabilities of Microsoft PixelSense tabletop computer. All structure and content information is transferred to the blind user interface (see Fig. 4). This is in principle a serialized representation of the parallel information in the mind map. When the mind map is updated, the structure of the tree in the blind user interface is altered. The interface also offers possibilities to modify the mind map on the table, such as adding, modifying, or deleting a node in the tree. Moreover, cut and paste functionalities are available, as well as a search function or a button for further details of a node. Any modification will immediately be transferred to the mind map visualization on the PixelSense.

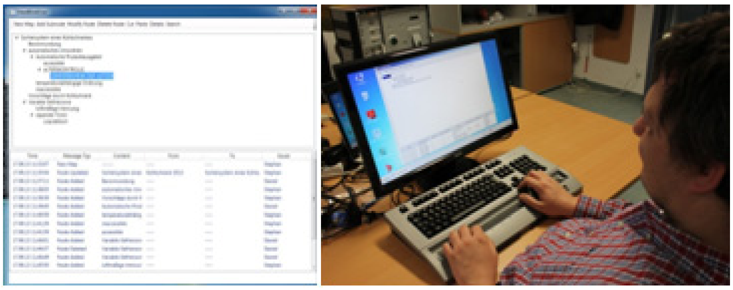

Fig. 4. Blind user interface and blind user testing the blind user interface

The blind user interface also contains a tree structure representing the content of the mind map. The blind user can browse this tree in a way he is already familiar with from other environments. The interface also includes a list view with the mind map's history of modifications. This allows the blind user to view modifications also in an asynchronous way. Finally, a search functionality allows searching the history as well as the tree. A message box will further notify the blind user when changes are made to the mind map or when pointing gestures highlight a certain artifact (node). All the elements can be accessed by the blind user with the Braille display (see Fig. 4).

3.4 Input/Output Layer

As described above, artifacts as well as NVCs have to be captured by the system. For our realized prototype, we choose a scenario (but are not limited to) with three sighted users and one blind user who gather around PixelSense as shown in Fig. 5.

Fig. 5. Overall physical setup

Since PixelSense is an interactive screen, any touch input for modifying the artifacts can be sensed, while text is currently still entered via the keyboard. For detecting deictic gestures as the most important representative for NVCs, three LEAP Motion sensors are used. They are placed on the PixelSense's frame to detect deictic gestures from the sighted users (see Fig. 5). The sensors are oriented in such a way that the lower boundary of the sensor's field of view is parallel to the table's surface.

4 Preliminary User Tests

The blind user interface together with the mind map editor CoME were evaluated in first trial runs. The blind users accessed the interface with a Braille display which was connected to a screen reader. Using different screen readers, the blind user interface was in general accessible, although different readers showed different performance.

In general, the blind users appreciated to present mind maps to different user groups with different adapted views. It was further seen as a good solution for the synchronization between blind and sighted users within a mind map session that there is an alert system which informs the blind user about any modification done on the mind map. Also the history of the blind user interface was very much appreciated, since it could be used if blind users missed some changes made in the mind map.

The expected irritations of sighted users by suddenly appearing nodes in the mind map – being entered via the blind user interface – were not confirmed during our first trail runs. The reason for this could be found in the fact that there was still an audio synchronization between all the team members, from which cues about the next possible interaction of the blind user could be derived.

5 Conclusion and Outlook

We introduced a system that supports a mind map brainstorming meeting between blind and sighted users. The system gives access for blind users to the generated arti-facts, and also captures and transfers non-verbal communication elements. This allows a deep integration of a blind user into a brainstorming meeting.

Our work will continue with in-depth user studies with the built system. We will then continue to integrate other NVC elements into the system, such as nodding or shrugging. For integrating these NVC elements, we will extend our current system by additional sensors. Moreover, more sophisticated filtering algorithms will be developed to avoid false interpretations and thus wrong notifications to the blind user.

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References

1. Ellis, C.A., Gibbs, S.J., Rein, G.: Groupware: Some Issues and Experiences. Communications of the ACM 34, 39–58 (1991)
2. Kunz, A., Alavi, A., Sinn, P.: Integrating Pointing Gesture Detection for Enhancing Brainstorming Meetings Using Kinect and PixelSense. In: Proc. of the 8th International Conference on Digital Enterprise Technology, ETH-Zürich, Zürich, Switzerland, pp. 1–8 (2014)
3. von Thun, F.S.: Miteinander reden 1 – Störungen und Klärungen. Allgemeine Psychologie der Kommunikation. rororo, Reinbek, Germany (1998)
4. Kendon, A.: Some functions of gaze-direction on social interaction. Acta Psychologica 26, 22–63 (1967)
5. Argyle, M., Cook, M.: Gaze & Mutual Gaze. Cambridge University Press, New York (1976)
6. Ishii, H., Ullmer, B.: Tangible Bits: Toward Seamless Interfaces between People, Bits and Atoms. In: Proc. of the SIGCHI Conference on Human Factors in Computing Systems (CHI 1997), pp. 234–241. ACM, New York (1997)
7. Fitzmaurice, G., Ishii, H., Buxton, W.: Bricks: Laying the Foundation for Graspable User Interfaces. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI 1995), pp. 442–449. ACM, New York (1995)
8. Ganser, C., Steinemann, A., Kunz, A.: InfrActables: Supporting Collocated Groupwork by Combining Pen-based and Tangible Interaction. In: Proceedings of IEEE Tabletop 2007, pp. 1–2. IEEE, Washington (2007)
9. Hofer, R., Kunz, A.: TNT: Touch 'n' Tangibles on LC-displays. In: Natkin, S., Dupire, J. (eds.) ICEC 2009. LNCS, vol. 5709, pp. 222–227. Springer, Heidelberg (2009)
10. Window Eyes by GW Micro, `http://www.gwmicro.com/Window-Eyes`
11. W3C/WAI Guidelines, `http://www.w3.org/WAI/intro/wcag.php`
12. Yayl, L.: Huseby Zoom Maps: A Design Methodology for Tactile Graphics. Journal of Visual Impairment & Blindness 3(5), 270–276 (2009)

13. Manshad, M.S., Manshad, A.S.: Multimodal Vision Glove for Touchscreens. In: Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility, pp. 251–252. ACM, New York (2008)
14. 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)
15. Petrie, H., et al.: TeDUB: A System for Presenting and Exploring Technical Drawings for Blind People. In: Miesenberger, K., Klaus, J., Zagler, W.L. (eds.) ICCHP 2002. LNCS, vol. 2398, pp. 537–539. Springer, Heidelberg (2002)
16. Petit, G., Dufresne, A., Levesque, V., Hayward, V., Trudeau, N.: Refreshable Tactile Graphics Applied to Schoolbook Illustrations for Students with Visual Impairments. In: Proceedings of the 10th International ACM SIGACCESS Conference on Computers and Accessibility (Assets 2008), pp. 89–96. ACM, New York (2008)
17. Landua, S., Welss, L.: Merging Table Sensory Input and Audio Data by Means of the Talking Tactile Tablet. In: Proceedings of Eurohaptics, pp. 414–418. IEEE Computer Society, Washington (2003)
18. Ferres, L., Verkhogliad, P., Lindgaard, G., Boucher, L., Chretien, A., Lachance, M.: Improving Accessibility to Statistical Graphs: The iGraph-Lite System. In: Proceedings of the 9th International SIGACCESS Conference on Computers and Accessibility (Assets 2007), pp. 67–74. ACM, New York (2007)
19. Winberg, F., Bowers, J.: Assembling the Senses: Towards the Design of Cooperative Interfaces for Visually Impaired Users. In: Proceedings of the 2004 ACM Conference on Computer Supported Cooperative Work (CSCW 2004), pp. 332–341. ACM, New York (2004)
20. Kunz, A., Nescher, T., Küchler, M.: CollaBoard: A Novel Interactive Electronic Whiteboard for Remote Collaboration with People on Content. In: Proceedings of the International Conference on Cyberworlds (CW 2010), pp. 430–437. IEEE, Washington (2010)
21. Ba, S.O., Odobez, J.-M.: A Study on Visual Focus of Attention Recognition from Head Pose in a Meeting Room. In: Renals, S., Bengio, S., Fiscus, J.G. (eds.) MLMI 2006. LNCS, vol. 4299, pp. 75–87. Springer, Heidelberg (2006)
22. Morency, L.-P., Quattoni, A., Darrell, T.: Latent-Dynamic Discriminative Models for Continuous Gesture Recognition. In: Proceedings of the 2007 IEEE Conference on Computer Vision and Pattern Recognition (CVPR 2007), pp. 1–8. IEEE, Washington (2007)
23. Oliveira, F., Cowan, H., Faug, B., Quek, F.: Enabling Multimodal Discourse for the Blind. In: Proceedings of the International Conference on Multimodal Interfaces and the Workshop on Machine Learning for Multimodal Interaction (ICMI-MLMI 2010), vol. (18). ACM, New York (2010)
24. Kane, S.K., Morris, M.R., Perkins, A.Z., Wigdor, D., Ladner, R.E., Wobbrock, J.O.: Access Overlays: Improving Non-visual Access to Large Touch screens for Blind Users. In: Proceedings of the 24th Annual ACM Symposium on User Interface Software and Technology (UIST 2011), pp. 273–282. ACM, New York (2011)