2D Presentation Techniques of Mind-maps for Blind Meeting Participants

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Abstract. Mind-maps, used as ideation technique in co-located meetings (e.g. in brainstorming sessions), which meet with increased importance in business and education, show considerably accessibility challenges for blind meeting participants. Besides an overview of general aspects of accessibility issues in co-located meetings, this paper focuses on the design and development of alternative non-visual presentation techniques for mind-maps. The different aspects of serialized presentation techniques (e.g. treeview) for Braille and audio rendering and two dimensional presentation techniques (e.g. tactile two dimensional array matrix and edge-projection method [1]) are discussed based on the user feedback gathered in intermediate tests following a user centered design approach.

Keywords. Blind-users, co-located Meetings, Mind-map, Tactile Display

1. Introduction

The authors presented the key activities, challenges of accessibility issues and the basic layers of an infrastructure to increase accessibility of co-located meeting as well as parts of presentation techniques for mind-maps in [2]. Whereas in [2] the main focus was in the field of proposing a concept for a tactile user interface the main focus here lies on summarizing the results of first user test.

The design of the mind-map user interface for the blind meeting participant is based on an infrastructure giving access to three basic layers defined in [2] which form the key activities for active participation:

- **Changing the Focus of Interest**: Verbal- (for instance mentioning the place of an artifact) or nonverbal (for instance pointing to artifacts) cues are used to move the focus to another object of interest.
- **Discussion about the Focused Artifacts**: Verbal- but also nonverbal (e.g. nodding to agree or disagree to a statement) cues play an important role in ongoing discussions.
- **Manipulation of the Mind-map**: During the co-located meeting the mind-map will be manipulated, e.g. sub-artifacts (ideas) are added or deleted; the position of an artifact in the structure is changed.

Based on this the system architecture defined and implemented can be summarized as:

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1. **Tracking System**: To allow better supported or automated access, verbal (speech recognition) and nonverbal communication cues have to be tracked and detected.

2. **Reasoning and Integration** of Information: To make tracked cues and objects useful and usable for the blind meeting participant they have to be accurate, have to avoid false alerts and in particular have to be selective towards the actual contexts to avoid an information overflow. Reasoning is needed to make sense out of verbal and nonverbal information by combining the different information channels and analyzing the context and to allow a meaningful and supportive presentation.

3. **Synchronization** of Information: Considering that blind and sighted participants use different views of artifacts, all changes made in a mind-map have to be synchronized between the visual and non-visual views. In addition the traced and recognized non-verbal communication cues have to be integrated into the non-visual presentation for blind users and synchronized with the ongoing discussions.

The defined layers of the system infrastructure and synchronization mainly impact on the general functional design of the user interface (e.g. considering an alerting system to inform the blind user on occurring non-verbal communications elements or on artifact manipulations). The specific design of the accessible mind-map itself is especially influenced by the accessibility challenges due to the pure visual and spatial nature of the ideation tool mind-map for structuring and organizing ideas in collaborative meetings, e.g.

- Using hierarchical relations as well as cross relations of the artifacts to structure ideas,
- Using hierarchical and at a second level spatial grouped clusters to put similar or related artifacts together,
- Using layout elements like colors, bold face, underline and symbols to highlight or group artifacts.

Sighted people process such information at a glance in parallel to focusing/reading/manipulating artifacts. Blind participants do need an efficient alternative view to artifacts and the mentioned display of relations.

All aspects have to seamlessly integrate into the working environment a blind person uses. All these aspects are addressed in the DACH project which has been presented and described in detail in [6].

### 2. Presentation Technique

#### 2.1. Serializing of Information

[4] presents a system architecture and a user interface for blind meeting participants to synchronize the mind-map view of sighted meeting participant with the mind-map view of the blind users based on Braille or audio access. The system architecture is designed to include also the handling of nonverbal communication elements (detection, reasoning and presentation to blind user). For the level of artifacts a tree-structure of the mind-map is presented to the blind meeting participant via an accessible .Net c#
tree view. The core advantage and idea of using a tree-structure is that most blind persons are familiar with such tree-structures. They are known from many functions in operating systems and applications. Blind people explore them with their standard AT in a hierarchical and sequential manner. This way of accessing information can be seen as a basic cultural technique of the user group. Further on standard shortcuts to open “search windows” or to copy and paste bubbles can be used and don’t have be explicitly learned and trained by the blind meeting participant. The familiarity of the commands also contributes that blind meeting participants can browse and manipulate the mind-map in a reasonable amount of time. Blind meeting participant have further the possibility to select different alerting possibilities when non-verbal communication elements are detected or changes of artifacts occur. So far the blind user can select between simple beep, up to speech information and message boxes. The combination of the different alerting strategies is possible. In this way interacting with mind-maps seamlessly integrates into the standard Human-Computer Interaction (HCI) of blind users established over the last decades.

The drawback of using a .Net c#-Treeview is that spatial information is lost which plays an important role for clustering as well as in communication (For instance a spoken sentence can refer to geographical information: “Please can you add that artefact in the left upper corner, besides the red artefact). Making all such information explicit supports accessibility but tends to reduce usability for blind participants. New ways of presentation, besides reasoning as mentioned above, should help to convey such important elements of information.

2.2. 2D Presentation Techniques: Edge Projection [1]

The DACH project experiments with new interaction methods for blind people intending to provide alternative access to structural and spatial information in mind-maps. In [1] different methods are presented to improve understanding of geographical layouts and to improve accessibility of touch based user interfaces. The presented edge-projection method, which is used to explore geographical maps, can be adopted to explore mind-maps. The basic concept of edge-projection [1] is to allow the blind user to find artefacts by moving his/her finger along two orthogonal borders of the display. The borders can be seen as a coordinate system. If an artefact is in the range of the touched coordinates the blind user is informed.

To start research on possibilities for exploring two dimensional presentations the edge-projection method [1] was implemented at the institute for the presentation of the mind-map on Android devices. The accessibility of the application was achieved by speech output using the screen reader Talkback. During developing and intermediate testing (based on a simple min-map with only a few bubbles the blind user has to find a specific bubble as well as specific clusters and to get a spatial understanding of the mind-map) it turned out that on touch devices with no tangible edges like most of the existing touchpads and smartphones, a feedback system (vibration, audio cues) can support the blind users to find the position of artifacts. Besides vibrating feedback also the size of the virtual edges can be increased. All in all early user feedback of edge-projection in conjunction with mind-maps shows that this method can help to understand spatial information but in general finding artifacts is still quite tricky and is a time consuming task.
2.3. 2D Presentation Techniques: HyperBraille-Display

In [2] we propose a concept to present and manipulate the mind-map using the HyperBraille-Device (HyperBraille - Project http://hyperbraille.de). A two dimensional 60x120 pin matrix which allows giving the user a tangible feedback on shapes and forms. Further the device provides a touch sensitive surface. We implemented functionalities allowing navigation (e.g. exploring, zooming) and input (adding, deleting, shifting…) by using touch gestures on the touch sensitive tactile device. Based on the Graphical-Braille-Window System [7], [8] a set of tactile arrays can be defined on the HyperBraille device (see e.g. Figure 1). The mind-map can be presented in the upper left corner, whereby the text content of mind-map artifacts and additional information about them can be presented in the bottom area. The right upper corner (together with short acoustic signals) can be used to inform the blind user of changes of the mind-map generated in the synchronized visual view. Using such a splitting of the user interface has the advantage that the focus of the blind user has not to be changed automatically. Blind users can decide if they are interested in modifications in the mind-map or not and when it is best for them to explore. The powerful Graphical-Braille-Window System and the Braille-IO framework [9] efficiently support integrating basic functionalities as shifting and zooming.

![Figure 1: A possible adjustment of information on the HyperBraille-Device based on the Braille-Windowing-System](image)

At the moment we experiment with the presentation and navigation of the mind-map by blind meeting participants via the HyperBraille device. Manipulation and integration of the presentation of non-verbal communication is seen as a further step. For the intermediate user evaluation we only used two areas in the view. The structure of the mind-map is presented in the upper view range with the whole width of the pin Matrix. The mind-map bubbles are presented to the blind user with filled circles using 4 pins per diameter at a standard zoom level of 1. The lines have a thickness of 1 pin. So far the additional information in the bottom view range only contains the bubble content in Braille letters (Figure 2) but it can easily enriched with further information as bubble color or path relations in case of a tree structure. Based on the current touch position in the mind-map area during exploration of the mind-map structure the presented additional information (bubble content) is updated.
For the intermediate user feedback, which is gained in parallel to the developing process, a simple tree based mind-map was used. In general a positive feedback was gathered. Especially in the understanding of spatial information it turned out that the user gets a fast understanding of clusters what efficiently supports following and contributing to a brainstorming session. The tactile method also supports the understanding of sentences like “a bubble is located in the upper right corner”. Also the hierarchy of bubbles was understood by the meeting participant in a fast and easy way, and the tree structure was gathered by the blind meeting participant without much extra effort. User feedback suggested to present not only content when you are on a bubble but also presenting start and target bubble when on a connection line for a faster understanding of parent-child relation.

3. Summary

Comparing two dimensional presentation techniques with sequential methods, the second has the big advantage that standard AT can be used and the effort to learn and train new AT and interaction patterns is kept very low. Shortcuts and navigation patterns can be designed in a way so that the blind user can use standard shortcuts, which allows a fast navigation in the tree view. Also the time to explore the mind-map via sequential presentation technique is reasonable. Using sequential presentation techniques has the core disadvantage that all spatial information is lost.

Two dimensional methods have the advantage that the geographical information is presented to the blind meeting participant. The presented edge-projection algorithm in particular was described as a time-consuming and complex method in the intermediate tests. The tactile feedback method using the HyperBraille device shows potential to reduce and to overcome this time consuming effort of finding bubbles and understanding the structure of the mind-map. The drawback of the 2d tactile method is that blind meeting participants have to get used to a totally new device, and new interaction techniques have to be trained. Also the costs are very high and only a few prototype devices do exist. Such devices are so far only available in research domains and still much too expensive for being used as mainstream AT.
4. Outlook

Based on the intermediate user feedback further research will focus on 2D presentation techniques for better support of access to complex and dynamic information structures.

Besides the accessibility of artifacts also the access to non-verbal communication elements plays an important role to reduce the information gap between sighted and blind meeting participants in co-located meetings. Therefore a clear understanding of the importance of non-verbal communication in a general communication process and especially for blind meeting participants has to be gained. Further appropriate presentation methods have to be found to provide the right amount of information in an efficient way not to overload blind users with information he/she is not able to cope with. Fundamental research on presenting non-verbal communication elements to blind meeting participants is going on in [5] using a simulation tool.

Acknowledgments

This work has been partially supported by the FWF (Austrian Science Found) with the regional project number I867-N25 and it has been produced out of the D-A-CH project. The D-A-CH project is a joined project between TUD, the ETH and JKU with the respective funding organizations DFG (German Research Foundation), SNF (Swiss National Science Foundation) and FWF (Austrian Science Found).

This paper and participation in the conference has been supported by “Stiftung Aktion Österreich-Ungarn”, project number: 91ôu6 (Conference participation AAATE2015 - ICCCP2016).

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