A Tactile Presentation Method of Mind maps in co-located Meetings

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ABSTRACT
This paper proposes a concept to use a 2D tactile mind map tool for a better integration of blind people into co-located meetings with the goal of structuring and organizing ideas during ideation. We mainly focus on presentation techniques to present mind maps to blind users. We discuss problems of existing analogue and digital tools, which support structuring and organizing ideas, for blind meeting participants. Further we outline the concept of a sequential method for presenting mind maps [1]. Finally the design of 2D presentation technique using the “touch-sensitive tablet display for blind and partially sighted users” (HyperBraille - Project http://hyperbraille.de) is presented.

Categories and Subject Descriptors
H.5.2 [**User Interfaces**]: Haptic I/O

General Terms
Performance, Design

Keywords
Mind map, Accessibility, Blind Users, Non-Verbal Communication

1. INTRODUCTION
In business life methods for ideation, concept development and other forms of “creative thinking” are often done in co-located meetings using tools like mind maps for structuring processes and results. Taking a closer look at co-located meetings the following sub-processes can be found which also define the basic functionalities tools like mind maps have to support:

1. **Changing the focus to an object of interest**: Changing focus and highlighting new artifacts of interests can be done in several ways. Non-verbal behavior, for instance pointing at the artifacts, or verbal expressions, for instance mentioning the place of the object or its content, can be used to put an object into focus. Often a combination of verbal and non-verbal cues is used.
2. **Discussion about the focused object**: The discussion can be in verbal form but also non-verbal cues are used to communicate ones opinion, for instance by nodding/shaking one’s head to agree/disagree to a statement or raising ones hand to point out that one likes to add something to the ongoing discussion.
3. **Manipulation of the focused object**: The object in discussion might be manipulated following the discussion. Examples are: sub-artifacts (ideas) are added or deleted; the position of artifact in the structure is changed; names and descriptive information might be added, deleted or changed.

Tools like mind maps or metaplan software are used to support this process of creating, discussing, organizing, displaying and saving ideas. Analogue techniques, for instance big white papers (“flip-charts”) and felt-pens have been used for this purpose. Today several computer based tools exist to support such creative and constructive sessions (e.g. Fremind (http://freemind. sourceforge.net/wiki/index.php/Main_Page)). Most of these tools are developed for single use. Some provide features for networked collaboration over distance. Such tools would allow parallel and synchronized manipulation of the mind map by several users but still the use of mind map tools in co-located meetings is rare. The more and more popular use of touch sensitive devices including large table-tops raises interest in such software tools and leads to related research and development activities e.g. [2].

Using digital alternatives to the so far analogue tools (“flip-chart”) shows potential to also increase accessibility of tools and processes and thereby to allow better participation of blind users (and other groups of people with disabilities, what is not discussed here) into collocated meetings. When talking about inclusion soon the discussion goes beyond the tool itself and provokes challenging research questions as including the mentioned aspects of non-verbal communication, which play a key role in co-located meetings. For better access we need:

1. **A Tracking System**: To allow better supported or automated access, verbal (speech recognition) and nonverbal communication cues have to be detected.
2. **Reasoning and Translation of Information**: To be useful the presentation of non-verbal cues has to be accurate, has to avoid false alerts and has to be selective to avoid an information overflow. Reasoning

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is needed to make sense out of verbal and non-verbal information and to make the presentation selective and useful. For example the combinations of the spoken sentence “look at this bubble” and a stretched finger allows recognizing that a pointing gesture occurred. Tracking could allow to identify what “this bubble” meant and allow the blind user accessing the information when thought it is necessary or of interest. Reasoning for human being is mostly done with no explicit effort, but machine reasoning in the needed scenario is a complex and demanding task.

3. **Synchronization of information:** Considering that blind and sighted participant use different views of the artifacts, the following points have to be considered:

   a. Presentation of Objects: Changes by sighted meeting participants have to be made available in the view for the blind user. An approach of a synchronized UI is presented in [1] where the blind user can browse through the objects in a tree structure which they are used to cope with. Another possibility to presents artifacts to blind meeting participants is to use 2D presentation techniques as for instance 2 dimensional haptic output devices like the 2D tactile device of the HyperBraille project (http://hyperbraille.de; further referred as HyperBraille device).Technical specifications of the HyperBraille device can be found at http://web.metec-ag.de/graphik%20display.html.

   b. Presentation of nonverbal communication elements (NVCs) to blind meeting participants: Presenting NVCs to blind participant has to be selective, as mentioned. Information overload would make the system more disturbing than useful, in particular when the acoustic channel is used. Also connections between NVCs and artifacts have to be established (for instance pointing to an artifact, as above). In [4] a simulation tool to investigate important factors of presentation nonverbal communication to blind meeting participants in collocated meetings is presented.

   c. Manipulation of Objects: Also the blind meeting participant should have the possibility to manipulate objects (e.g. add, delete, rename, move bubbles of a mind map), where two issues have to be considered: First the UI must provide an accessible interaction modality. Second the synchronization process between the view for sighted persons and blind meeting participants has to work bidirectional.

These aspects are addressed in the DACH project which is presented in [3]. This paper focuses on alternative ways of presenting the mind map. Based on an analysis of missing features of mind map tools it will briefly discuss sequential methods of accessing mind maps and finally it presents ideas how to use new 2D techniques to present mind maps to blind meeting participants. The main focus lies within the concept of using a 2D tactile device for the mind map presentation.

2. TYPICAL PROBLEMS OF IDEATION TOOLS FOR BLIND PEOPLE

This section summarizes the main accessibility problems of tools supporting structuring and organizing ideas during ideation processes.

Originally, ideation tools have been developed to “visualize” and to allow better memorizing and manipulating the process and the results. Such tools provide methods for structuring and organizing ideas e.g.:

- Hierarchical relations as well as cross relations of artifacts
- Geographical clusters to put similar artifacts together and using colors and other cues to highlight aspects as relations, attributes and properties.

Sighted people process these relations at a short glance in parallel to focusing/reading the artifacts itself. For blind participants it is impossible to access these attributes in the same short amount of time without adaption of the views for blind meeting participants. They use a sequential approach (e.g. audio or haptic) and building an efficient mental map in a fast manner is of crucial importance for participation. The mentioned hierarchical structuring for traditional access helps and with NVC tracking and reasoning for selective presentation the situation can improve. But in addition alternative presentation methods would help in developing a mental map for better “coming and staying in the discussion”.

Artifacts and their attributes form already a long sequential or hierarchical list which blind persons have to navigate and manage. More challenging are the high dynamical changes of the artifacts and attributes making it hard to follow. Artifacts and their attributes are subject to change during the structuring and organizing process, and most often the more they change, the better the process. For sighted people most changes of artifacts (for instance if a cluster was moved from the left upper corner to the right bottom corner) are recognized at a short glance whereas for blind participants finding changes, without explicitly telling them such changes, is a much more complex process. They have to search through the artefacts to figure out which of the artifacts have been changed. As a consequence it is important to give blind meeting participants the possibility to get informed when artefacts are changed.

3. SEQUENTIAL PRESENTATION TECHNIQUES

[1] presents a system architecture to synchronize the mind map view of sighted meeting participant with the mind map view of the blind users. This includes also the handling of nonverbal communication elements (detection, reasoning and presentation to blind user). In [1] a user interface for presenting the mindmap to the blind meeting participant is presented. The main idea is to allow only a tree - structure as mindmap architecture. The tree - structure is presented to the blind meeting participant via an accessible .Net c# Treeview. The advantage of using a tree-structure is that many blind persons are already familiar with tree - structures for instance from operating systems which they explore with their standard AT in a hierarchical and sequential manner. Functionalities to browse through the artifacts and to manipulate the artifacts like expand and collapse sub-trees, cut and paste,

modify and add artifacts (mind map bubbles) do not need much learning.

As mentioned in section 2 it is important to inform the blind user of changes of mindmap bubbles. In [1] this is solved via message boxes. After appearing of a message the blind user has the possibility to get the focus on the mind-map item which was changed or to keep his/her focus where it was before with a parallel alert or only by adding information to the history.

The drawback of using a tree - structure and an accessible .Net c# user-interface is that the blind meeting participant can explore the mind map only sequential and that geographical information of the artifacts are lost, meaning that they have to be made explicit adding additional information to an already long list. The blind participant has no clue where the artifacts are positioned on the view of the sighted user. Without geographical information the blind user has limited access to information-clusters based on geographical information. With no mental map equal to the geographical mindmap blind participants are soon lost or depend on help to follow verbal information cues based on geographical information. Example phrases are: “Please can you place this artefact to the left upper corner?”, “What is written on the artefact next to another artifact?”, “Can we put this artefact in the middle of the left upper corner?” Such phrases are common between sighted users, but can’t be handled by blind meeting participants without a geographical understanding of the arrangement of the artifacts.

4. 2D PRESENTATION TECHNIQUES

This section presents tow ways (edge-projection [5] and 2D tactile feedback) of 2D presentation technique of mind maps for blind user. The main focus lies on the 2D tactile feedback concept.

4.1 Edge-projection [5]

In [5], different methods are presented to improve understanding of geographical layouts and to improve accessibility of touch based user interfaces. One explored method which allows browsing mind-maps is called edge-projection. The basic idea of edge-projection is to allow the blind user to find elements by moving his/her finger along two orthogonal boarders of the display. The boarders can be seen as a coordinate system. If a bubble is in the range of the touched coordinates the blind user is informed (compare figure 1).

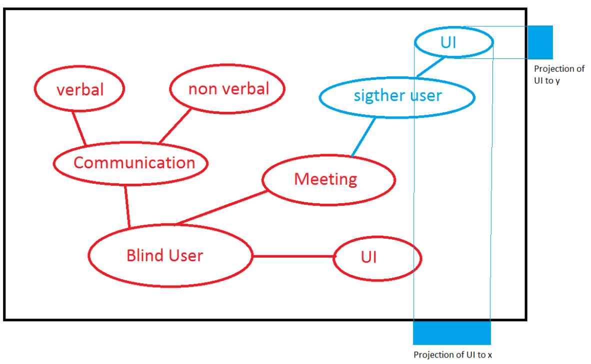

Figure 1: The idea of edge-projection [5] by the example of a mindmap.

User testing with edge-projection [5] in conjunction with mind-maps is done at the moment. A publication with a more detailed description is planned for early next year. The early user feedback points out that this method can help to understand geographical information of the bubble but in general finding bubbles is still quite tricky.

4.2 Two Dimensional Tactile Presentation Technique

4.2.1 Selecting of Hardware

Different tactile 2D presenting techniques for blind persons exist. One possibility is to use tactile graphics as produced by Braille printers. Another possibility would be to use the Graphic Window Professional device (Maple GWP http://handytech.de/produkte.php?produkt=58&lang=de). A third one in consideration has been HyperBraille. Comparing these approaches outlines the advantages of HyperBraille:

a) The resolution of HyperBraille is much higher than other existing graphical tactile devices.

b) Structure and attributes of the artifact are not constant during ideation but change during the ideation process. In comparison to Braille prints HyperBraille allows to adapt immediately to the changes of artefacts during ideation process.

c) The HyperBraille display is also touch sensitive. The touch sensitivity on the one hand can be used to support information presentation for the blind user (information can be presented according to the reading positions of the fingers) and on the other hand it can be used directly as input device to navigate through the artefacts (for instance to zoom in or zoom out in the mind map).

4.2.2 System Architecture

The system architecture is similar to the system architecture presented in [1]. This means that sighted persons work together on a user-interface and the blind meeting participant has his/her own user interface. The system architecture in [1] respects the needs of synchronization process between the different views for sighted and blind users.

4.2.3 Presentation Possibilities

For mind maps the HyperBraille display can be used for a tactile representation of the bubbles but also the interconnection lines between the bubbles can be presented to the blind meeting participant. This means in contrary to the one dimensional Braille displays and the edge-projection method [5], using the tactile feedback gives the blind user the possibility to directly follow interconnection lines in the mind map. The blind participant hasn’t to do a random search on the edges to find a child of one mind map bubble but he/she can follow the interconnection lines.

For the design of the user interface on HyperBraille the following aspects have to be considered.

a) Range of View: The number of bubbles in a mind map can get very huge. It is not possibly to present the whole mind map at once with a reasonable resolution. Therefore zoom in and zoom out functionalities have to be provided. Functionalities for shifting the area in view left, right, up and down have to be provided. For that the existing buttons on the Hyperbraille display can be used. Based on the touch sensitivity of the HyperBraille device special gestures can be defined to allow a direct zooming and shifting of the mind map on the Braille pin matrix array. Reasonable gestures are already defined in [6].

b) Presentation of bubble content: If the blind user is on a bubble the content has to be presented to him. One way is to use speech output. Speech output would be a very fast way to present content to the blind user. However, much speech output in co-located meetings has the big disadvantage to overload the blind user with acoustic information and the blind user is no longer able to follow the ongoing discussion. Another possibility is to use the HyperBraille display itself and present the content via Braille letters to the blind user. This can be done using a separate information bar on the HyperBraille display. This approach is based on the Braille Window System presented in [6] and [7]. In comparison to [6] and [7] only one application (the mind map) has to be considered. Therefore the number of needed areas can be reduces and the HyperBraille display is split up in two areas. The first one presents the structure of the mind map. Compare figure 2. In case of a high zooming level or a complex mind map with a high number of bubbles, scroll bars for horizontal and vertical scrolling have to be included into the main area.

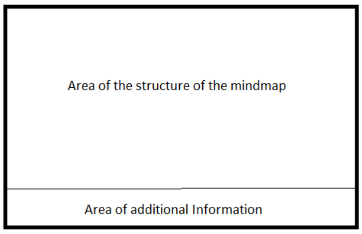

Figure 2: Splitting up the tactile range of the HyperBraille display into one for the structure of the mindmap and one for additional information

c) Presentation of additional supportive information: Besides the content of bubbles it makes sense to present additional information in the area of information (see figure 2). Additional information can include, number of connections to other artefacts, directions of the connections as well as content of connected artefacts.

d) Changes in the mind map by other participants: The blind participant has to be informed if another user made a change in the mind map. One possibility is to use speech output. Again it has to be taken care not to overload the blind user with acoustic information. Also based on the acoustic channel but a much less obtrusive method is just to inform the blind user of the change via a short beep. The specification of the beep (frequency, type of sound) can already include some hints of the modification for instance if a bubble was added, deleted or moved. Besides using the acoustic channel another method to inform blind users about ongoing changes is to use the tactile sense. Vibrating devices as vibrating watches, bracelets or vibrating mobile-phones (for instance placed in the user's trousers pocket) can be used to inform the blind user of occurring changes.

However, as soon as the blind participant has some idea of the structure of the mind map, it makes sense to allow jumping to the change by a simple gesture or a key event, which he has to be triggered. The mind map has to be moved in such a way that the region of the mind map including the last change of the artefacts is always at the same position (for instance left upper corner). A further consideration to be made is to inform the blind person before the update by another person is made on his view that he can finish the task he worked on, provoking issues of synchronization. Another possibility to avoid a permanent change of focus for the blind user is to use the concept of Braille Window System of [6] and [7] to present the last modifications of the mind map in a third area. Compare figure 3.

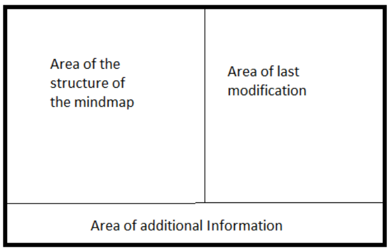

Figure 3: Deviding the HyperBraille device in thre areas to have one are for the modification

e) Focused objects by non-verbal behavior: The idea presented under point d) to move the mind map according to the changed artefacts (in the area of last modification), gives also a possibility to present the blind meeting participant the target of pointing gestures.

4.2.4 Manipulation possibilities

To allow blind users to take part in the structuring and organizing process based on mind maps the user interface has to provide the following manipulation functionalities.

- Focusing elements: A specific gesture executed over the element will put the focus on the element. Focusing elements is important to give the blind user the possibility to select elements he/she wants to modify (for instance deleting).
- Adding bubbles: The blind meeting participant must have the possibility to include bubbles and to place it on the mind map. Therefore a specific gesture detected by the touch sensitivity of the device can be used to specify the place where the bubble should be added. The input of content can be done via a sepparate keyboard or via the Braille – keyboard of HyperBraille. Speech Recognition might be considered, but again might be disturbing in such meetings.
- Removing bubbles: A specific gesture has to be designed for the HypeBraille so that the blind meeting participant can delete bubbles.
- Modifying structure: The blind user must also have the possibility, via defined gestures, to delete and add connections between the mindmap bubbles and to move bubbles.
- Highlighting of bubbles: During an ongoing discussion sighted people have the possibility to illustrate focused object by pointing to them. To give blind users a similar functionality a specific gesture has to be defined to allow highlighting of bubbles. However not only the view for the blind user has to be prepared for the

pointing gesture but also synchronization and visual highlighting of the depicted bubbles in the view for the sighted user have to be established.

Touch gestures either have to be designed in a clever way or have to be executed in combination with a function key to avoid unaware executing of touch gestures during browsing through the mind map. Further it seems to be reasonable that all gestures have keyboard alternative both for blind users and blind users which might have problems with executing gestures.

5. SUMMARY

Comparing two dimensional presentation techniques with the sequential methods using state of the art AT devices like Braille displays and speech output, two dimensional methods have the advantage that the geographical information are presented to the blind meeting participant per se. Based on the conceptual considerations research will be done on how devices like HyperBraille can help to support better access to complex and dynamic information structures and thereby allow to support participation in co-located meeting.

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