Presenting Non-verbal Communication to Blind Users in Brainstorming Sessions

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Abstract. In co-located meetings, which are part of our professional and educational lives, information exchange relies not only on information exchange using artifacts like bubbles in mind-maps or equations presented on electronic whiteboards in classrooms, but also to a large extent on non-verbal communication. In the past much effort was done to make the artifact level accessible but also non-verbal communication heavily relies on the visual channel to which blind people do not have access. Thereby co-located meetings are seen as first domain to research accessibility of non-verbal communication, which are well defined and should lead to more general research on access to non-verbal communication. We present a first prototypical system which allows experimenting with access to non-verbal communication elements by blind people using both the input from a "human" transcriber or automatic tracking and recognition of non-verbal communication cues.

Keywords: Co-located meetings, Non-verbal Communication, Blind User.

1 Introduction

Non-verbal communication plays an important role in social interaction [1,2]. Such communication heavily relies on the visual channel. Examples are nodding of the head to agree or disagree with the current speaker, pointing at artifacts (as for instance bubbles of a mind-map in brainstorming meetings), smiling or gazing to other persons. Further speaker regulation is influenced by non-verbal communication. Non-verbal behavior can include hints of a listener's interest on an ongoing discussion or talk. Blind people do not have access to such information and therefore not only miss information exchange done by an inaccessible artifact layer, but also miss information exchange, which is done by visual non-verbal communication.

This paper presents a tool, which can be used to present non-verbal communication elements to blind people. At the moment, the tool is especially designed for brainstorming sessions based on mind-maps as described in [3]. Such a tool allows investigating the importance of different non-verbal communication elements to blind people, and if the presentation of non-verbal communication elements to blind users could ease the participation of blind persons in co-located meetings.

This work on the presentation layer of non-verbal communication for blind people is embedded in a larger research project which focuses on the access to non-verbal communication in a more general sense.

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2 State of the Art in Tracking and Reasoning for Non-verbal Communication and Research Questions

Much effort has been done during the last years to make the artifact level of communication accessible for blind persons, as for instance mathematical equations, graphs and pictures (examples are [4,5,6]). But also non-verbal communication heavily relies on the visual channel to which blind people don't have access. So far topics as

1. the importance of occurring visual non-verbal communication for blind participants in co-located and also distance meetings,
2. the feasibility of transcribing or tracking and automatic translation of non-verbal communication and
3. the usefulness or added value, restrictions and requirements of such transcript

are not well studied. Especially point 2 and 3, the importance and usefulness, of non-verbal communication will depend also on the way how the non-verbal information is presented to the blind user. Which leads to further research questions how much information can be reasonably presented to the blind user and how to present the information to the blind user? Is it better and feasible to present the gathered information via haptic devices, vibrations, audio cues, non-speech sounds or any other thinkable modalities?

Hardware for tracking movements (e.g. video cameras or sensors which give also 3D data as the Leap Motion (`https://www.leapmotion.com`) and the Microsoft Kinect (`http://www.xbox.com/kinect`) becomes more affordable. Further, sensors attached to the body (e.g. acceleration sensors, MyoTM sensor (`https://www.thalmic.com/en/myo/`)) can be used to track motions. All such devices can be integrated in the described scenario, of course still restricted to settings as being in front of a background for good contrast. They all show potential for a better access to non-verbal communication for blind people and a more detailed description of tracking in co-located meeting can be found in [7], which was prepared in the same project.

However, despite the fact that tracking devices become more accurate and many well-defined scenarios can be found, in which tracking works fine, tracking of the whole occurring non-verbal communication of all persons who are participating in a co-located meeting is not yet possible today. But not only limitation of hardware accuracy is responsible for the limitation of non-verbal communication tracking but also the reasoning algorithms to interpret humans' movements are limited. The interpretation of non-verbal communication by human being is not only done by analyzing the data of one single channel (visual), but much more by the combination of different channels (acoustic, visual and tactile). A human being interprets the occurrence of a stretched finger in the combination with a spoken sentence "Look at this" as a pointing gesture. In most situations human being can interpret gestures with similar appearance but with different meanings easily and sensibly. So tracking and reasoning of non-verbal communication today done by a machine is far away from the interpretation capabilities of non-verbal communication by human beings.

3 Tool for Simulating Non-verbal Communication Elements

3.1 General Description of the Simulating Tool

Considering the fact that an automatic tracking of non-verbal communication today is still very limited, transcribing by a human being is the only reasonable way to do research and considering a service for better access to important aspects of non-verbal communication. The tool provides an UI (see figure 1) for fast entering information on gestures and other non-verbal elements a transcriber identifies during a brainstorming session. A second possibility is to use time protocols and video recordings. In the second case, a co-located meeting has to be recorded, the video has to be analyzed and a time protocol has to be designed. Afterwards the video and the defined gestures can be presented to the blind user. Both possibilities are included in the system architecture of the mind-map tool presented in [3]. In the current version, the blind user is informed via a message box about the transcribed gesture. In a later stage, automatic import of recognized gestures and other non-verbal cues can be supported.

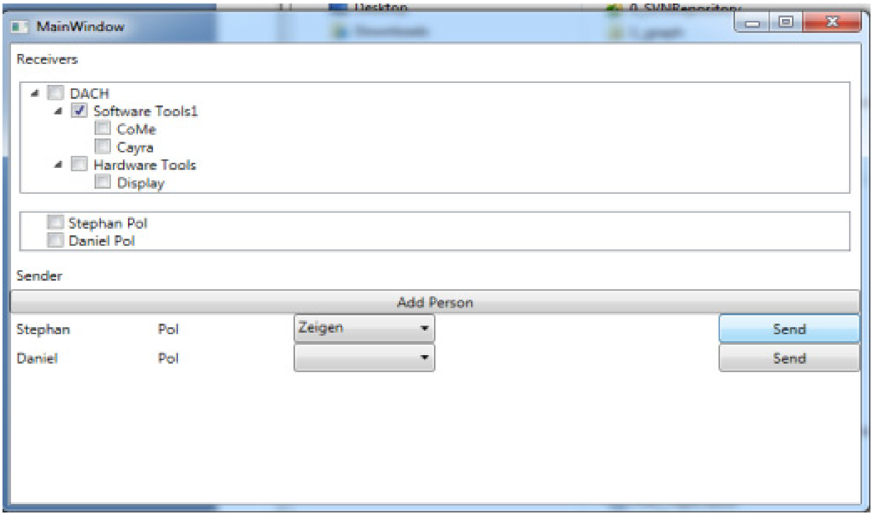

Fig. 1. UI for transcribing gestures in a real brainstorming session: The transcriber can select the gesture from a predefined list (here "zeigen (pointing)"), and the originator as well as a receiver by selecting it with a tick. At the moment possible receivers are bubbles of the mind-map and persons taking part in the meeting, who have to be added at the beginning of the session via the "add Persons" button.

For the presentation of the non-verbal communication elements to the blind user with standard AT, a machine readable format has to be defined. The structure used at the moment is described by the following attributes:

- Sender: Is the originator of a message
- Message Type: can be for instance pointing, gaze or smiling

- Receiver: The "object" the originator is interacting with, can be another person or a mind-map bubble
- Timestamp: Time when the non-verbal communication element occurred

These attributes are highly related to an information exchange in a typical conversation, in which a sender generates a message and interacts with a receiver. The timestamp is not immediately presented to the blind user but can be used afterwards to allow chronologically looking up gestures in a history view. For the beginning, it seems that the fields selected are satisfying. However if important fields are missing as for instance repetition, duration or starting- and end time they can be added easily.

3.2 First Experimental Setup

Two different experiment setups were tested. One experiment setup was based on a real time meeting and the graphical user interface for gesture transcription and the second one was based on recording of a brainstorming session which was presented to a blind person afterwards. The blind person, who was taking part in the real time meeting, was also the person, who took part in the video based experiment. In both experiment setups only pointing gestures were considered as a representative of non-verbal communication.

During the first experiment setup in a short meeting, between a sighted and a blind participant, a small mind-map with only a few bubbles was created. The CoME tool (http://sourceforge.net/projects/come/) which is also developed in the same project was used for the presentation of the mind-map to the sighted person and the BlindUserView, which is described in [3] was used for the presentation of the mind-map to the blind user. During the generation of the mind-map the sighted person tried to make a high number of pointing gestures, which were presented to the blind user using the UI for transcribing. The transcribed gestures were presented to the blind user by message boxes. During the generation of pointing gestures, the sighted user consciously avoided spoken hints of the focused targets. Sentences like "can you add a node with the content meeting as a child to this bubble" were used instead of telling the bubble names.

For the second experiment setup a video of a brainstorming session between two sighted persons was prepared. Afterwards a time-protocol including the pointing gestures and the generation of the bubbles was generated. The video was presented to the blind user and in parallel the BlindUserView was used for the representation of the mind-map. Based on the time-protocol the bubbles and the gestures were presented to the blind user at the corresponding times to the video. Again message boxes were used to present the occurrence of pointing gestures. The record was presented twice to the blind user. In the second case the message boxes, which informed the user that a bubble was added, were deactivated. Instead only a beep, which indicated a creation of a bubble, was given as a hint to the blind user that a change of the mind map occurred. The blind user had to figure out where the bubble was added.

From a short discussion with the blind user about the importance of the pointing gestures, it turned out that they might have the possibility to support the blind in brainstorming meetings but it has to be taken care that only important gestures are presented to the blind user and not to overload him/her. Blind users also urged that the output interface has to be designed in a clever way. At the moment the alert messages, which present changes of the mind-map and occurring gestures are judged by the blind user as too time consuming to follow the ongoing discussion. The blind user has also the impression that only generating a beep, when a bubble is added, and to allow him to use the time to search for the changes in the tree instead of reading the message boxes and jumping to the change, gives him a better understanding of the structure of the mind-map (generating only a beep was done during the second time the blind user watched the video).To reduce time effort for the blind user to read message boxes presentation of the gestures via audio might be a good idea. But audio often conflicts with the ongoing discourse. Braille allows more "catching up in parallel". Another way to reduce reading effort is to shorten question by using clever structures and not to ask whole questions. To give an example: In case of a pointing gesture instead of presenting a message box with the content "Person is pointing to bubble. Jump to node?" it might be enough to use a specific beep for an occurring pointing gesture and just present the bubble, where the user is pointing to, on the Braille display. If the blind user likes to put the focus to the bubble he/she just hits the space button on the keyboard.

4 Outlook and Goals

Today, tracking and reasoning of non-verbal communication is only possible for special scenarios and setups as for instance sign recognition. Automatic tracking and reasoning of non-verbal communication cues will only be possible at an experimental level the next years. The presented tool gives a possibility already today to investigate the importance of different non-verbal communication cues for blind persons taking part in co-located meetings and supports research in automatic tracking.

The subjective importance of gestures to a blind user will not only depend on the information benefit which the blind user gets but also on the presentation method. As pointed out above special care has to be given not to overload the blind user by less important gestures in a conversation so he/she is not distracted from the ongoing verbal communication. One important step not to overload but still present as much as possible of information of non-verbal communication to the blind user is to find the right presentation technique.

The next goals are to figure out important gestures in brainstorming session to propose non-verbal communication elements an automatic detection and presentation should focus on. In addition it allows experimenting to the mentioned important step in what way non-verbal communication is presented best to blind users (e.g. audio or message boxes). Finally, it proposes considering new services for important meetings, be it by human or automatic support. Moreover, other co-located or distant meetings in which e.g. a teacher points at artifacts on a white-/blackboard will be analyzed.

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