HCI Design for People with Visual Disability in Social Interaction

Shi Qiu[1(✉)], Ting Han[2], Hirotaka Osawa[3], Matthias Rauterberg[1], and Jun Hu[1]

[1] Department of Industrial Design, Eindhoven University of Technology, Eindhoven, The Netherlands
{SQIU,G.W.M.Rauterberg,J.Hu}@tue.nl
[2] Department of Design, Shanghai Jiao Tong University, Shanghai, China
hanting@sjtu.edu.cn
[3] Faculty of Engineering, Information and Systems, University of Tsukuba, Tsukuba, Japan
osawa@iit.tsukuba.ac.jp

Abstract. In the Human Computer Interaction (HCI) field, it has been a long tradition of concern of accessing computer systems by people with visual impairments. It is important to develop high quality user interfaces, accessible, usable, and desirable for these people. In this paper, we first report a preliminary background review about HCI design for people with visual disability. The review of the problems in social interaction the blind people may encounter, are also presented. Further, we narrow down our research scope and focus on gaze and eye contact, which have important social meaning in face-to-face communication. We then identify our research objective that is to design gaze simulation for people with visual impairments. Finally, we report the prototypes of our research project and the progress made so far. AQ1 AQ2

Keywords: Social interaction · Eye contact · Visual impairments Face-to-face communication

1 Introduction

According to the information from the World Health Organization (WHO) in 2014, there are 285 million people estimated to be visually impaired worldwide: 39 million are blind and 246 have low vision [1]. The loss of vision often indicates loss of independence, lack of communication and human contact, which increase the limitations in mobility and social interaction. In the Human Computer Interaction (HCI) field, it has been a long tradition of concern of accessing computer systems by people with visual impairments [2]. In web design, they meet the problems include the issue of screen design, the font size, color, patterns in screen background that make the text difficult to read and too many graphics. These features designed to be attractive to the sighted user, may make website inaccessible to a visually impaired user [3]. It is important to develop high quality user interfaces, accessible and usable by blind people with different skills, requirements and preferences, in a variety of contexts of use, and through a variety of different technologies [4]. In recent days, access for blind and visually impaired users

N. Streitz and S. Konomi (Eds.): DAPI 2018, LNCS 10921, pp. 124-134, 2018.
https://doi.org/10.1007/978-3-319-91125-0_10

to computer systems is gradually improving. Some of the obstacles that impeded blind people to have access to computer systems are solved by using screen reader software, voice synthesis, speech recognition, Braille and tactile displays etc. [5].

2 HCI Design for Blind People

In this section, a preliminary background review about HCI design for blind people is presented. We conducted this review for the general understanding of the current assistive technologies and applications for blind people in HCI field. A search on Google Scholar was conducted in March. 2014, using the following key terms: "HCI design", "assistive technology", "accessibility", and "blind people". This search returned 46 results, on which we carried out ancestor and descendent search trying to identify related papers introducing assistive technologies for people with visual impairments. Based on the abstracts, eventually 15 papers [6–20] were selected. We use hearing and touch senses (two of the five senses of human), to categorize and report relevant assistive applications based on the user interfaces. There are two categories: (a) the auditory assistive systems to help blind people in navigation, social networking, photography, and others. [6–13]; (b) help blind people in the areas of tactile navigation, Braille, and touch graphics [14–20]. We paid particular attention to three perspectives of these papers: motivation, system implementation, and evaluation.

2.1 Auditory Assistive Systems

Papers in this category report on the auditory assistive systems to help blind people in navigation, social networking, photography, and others. Table 1 summarizes auditory assistive systems reviewed in this section.

Table 1. Auditory assistive systems.

Function	Application	Evaluation
Auditory navigation	Cross watch [6]	Usability evaluation (N = 2)
	Travel aid [7]	Usability evaluation (N = 4)
Social networking	Facebook [8]	Usability evaluation (N = 15)
	Vizwiz social [9]	Field experiment (N = 23)
Photography	Easy snap [10]	Usability evaluation (N = 6)
	Portrait frame [10]	Usability evaluation (N = 15)
Others	Conversation [11]	No evaluation
	Mathematics [12]	Usability evaluation (N = 5)
	Museum guide [13]	No evaluation
	Shopping products [13]	No evaluation

Auditory Navigation

Urban intersections are dangerous for the blind people's travel. They need to enter the crosswalk in the right direction and avoid walking outside of it, which becomes a difficult task for them. In order to solve this problem, a "Crosswatch" system was developed by Ivanchenko et al. [6], using computer vision to provide information about the location and orientation of the crosswalks to the blind users. When a blind user holds a camera phone to walk through the intersection, the system can detect the crosswalks and send an audio tone to her immediately. In the usability evaluation, two blind participants demonstrated the feasibility of the system by comparing two experimental conditions: the system with and without audio feedback. They were better able to use the "Crosswatch" system provided the audio feedback.

Dunai et al. [7] developed a system as a travel aid for the blind users. It consists of two stereo cameras mounted in a helmet and a portable computer for processing the environmental information (Fig. 1). The system can detect the static and dynamic objects from surroundings and transform them into acoustical signals. Four totally blind participants participated in the user experiment to evaluate the usability of this system. Two experimental settings were proposed: the first was blind participants asked to stay in a static position, and the second was to follow the moving object. Experimental results demonstrated that the blind participants were able to control and navigate the system in both familiar and unfamiliar environments. Better results were obtained when the subject was static and the objects were moving around in the area within a diameter of 30 cm.

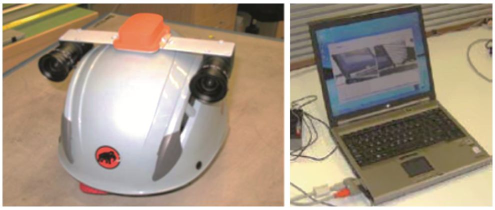

Fig. 1. Real-time assistance prototype [7].

Social Networking

The increasing awareness and concern for accessibility has motivated HCI researchers and developers to claim that mobile user interface should be simpler and more accessible to blind users used screen readers. However, it is reported that blind users still have difficulties to access Facebook and seldom empirical data demonstrate this problem. In response to this, Wentz and Lazar [8] collected empirical data from fifteen blind participants, who participated in the evaluation of "Facebook Desktop" and "Facebook Mobile". Five usability tasks were compared between "Facebook Desktop" and "Facebook Mobile" (e.g. opening and logging into a Facebook account and uploading a picture to a Facebook account). The results indicated that although the user interface of "Facebook Mobile" was missing some features and not consisted with the user interface of "Facebook Desktop", it was more usable than "Facebook Desktop".

Generally, the blind people seek information by the assistance of their family members or friends. If they ask visual questions to their social networks, they can increase the feelings of independence and security. Based on this research motivation, Brady et al. [9] implemented VizWiz Social, an iPhone app, to enable blind users to ask questions to either the crowd or friends. Twenty three blind participants participated in the field experiment to identify the potentiality of using VizWiz Social. The comments from the participants indicated that they were reluctant to bother their social networks with questions, possibly due to the reason that they were not willing to give an impression of being helpless.

Photography

Based on an online survey with 118 blind people, Jayant et al. [10] demonstrated that blind people took photographs for the same reasons as sighted people (e.g. record important events and share experiences). Based on these findings, Jayant et al. [10] introduced an application namely EasySnap, to provide audio feedback to help blind users take pictures of objects and people. Six blind participants participated in the usability test to explore the effectiveness of EasySnap. Most of them agreed that EasySnap helped their photography and found it was easy to use.

Furthermore, a group portrait application namely PortraitFramer was designed based on the Android platform [10]. The blind user can be told how many faces are in the camera's sight (Fig. 2). Fifteen blind and low-vision participants participated in an in-depth study and demonstrated that they could understand how to successfully use the application in a short time.

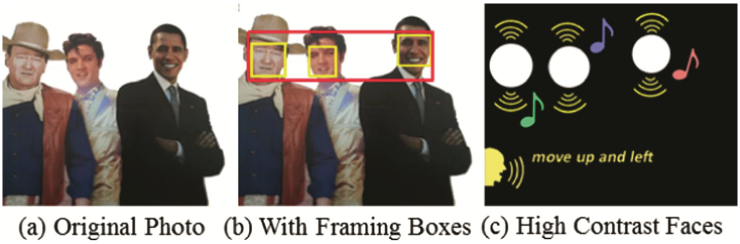

Fig. 2. Steps of PortraitFramer application: (a) Photo taken; (b) Faces found; (c) Announces the number of faces [10].

Others

Nishimoto and Watanabe [11] implemented a lunch delivery web system for blind people. To decrease their mental workload for selection, researchers observed the effective communication for ordering from the menu between two blind people. Based on the analysis of their dialogue, a prototype system was developed, which consists of three steps by speech: rough selection, selection of favorites, and final selection.

Bernareggi and Brigatti [12] introduced a speech input technique to enable the blind users to write mathematical documents. The system was tested by five blind participants and each of them was asked to complete four tasks of inserting mathematical expressions. All tasks were completed by typing on a keyboard and later by speech input. The results demonstrated that the execution time for speech input was faster than typing with complex short-cut keys.

A barcode-based system was implemented to help blind users identify objects in the environment [13]. The QR code (two-dimensional barcode) is affixed to the object that the blind user wants to know more information about. A camera phone with QR reader software decodes the barcode to a URL and directs the phone's browser to get an audio file from the website, containing a verbal description of the object. Two potential scenarios were identified to get benefits from the system: museum and shopping, where it could provide auditory guide for blind people.

2.2 Tactile Assistive Systems

In this category, the papers report on tactile assistive systems that help blind people in the areas of tactile navigation, Braille, and touch graphics. Table 2 summarizes tactile assistive systems reviewed in this section.

Table 2. Tactile assistive systems.

Function	Application	Evaluation
Tactile navigation	Vibrotactile helmet [14]	No evaluation
	Virtual environment [15]	Usability evaluation (N = 5)
Braille	Braille window system [16]	Usability evaluation (N = 8)
	V-Braille [17]	No evaluation
Touch graphics	System of tactile photo/portrait [18]	No evaluation
	Haptic gray scale image [19]	Usability evaluation by 20 blind and blindfolded participants
	Fingertip Guiding Manipulator [20]	Usability evaluation by 18 blindfolded and 2 blind participants

Tactile Navigation

To avoid for blind people's collision, and for workers in low-light environments, Mann et al. [14] presented a navigation system, using a range camera and an array of vibration actuators built into a helmet (Fig. 3). The blind person wears the Kinect range camera on the helmet and the camera can be kept in motion rather than stationary. Six vibration actuators of the helmet are positioned along that person's forehead to provide the corresponding haptic feedbacks. From varying degrees of the haptic feedbacks from the vibration actuators, the blind user can clearly understand the depth in the surroundings.

Spatial information is not accessible for blind people, so some learning tools are provided as a preparation for navigation before going out to the real environment. In response to this research context, Huang [15] presented a learning tool of simulating a real-world environment by using 3D virtual simulation technology, to assist blind people to access non-visual spatial information. A 3D virtual environment in Stockholm was simulated by haptic and audio cues for the experimental study. Five blind participants explored the building in 3D virtual environment to find different locations. The qualitative analysis of the experiment indicated that the virtual environment with both haptic and audio cues was easiest to learn, then the condition with haptic and the last one was the condition with audio.

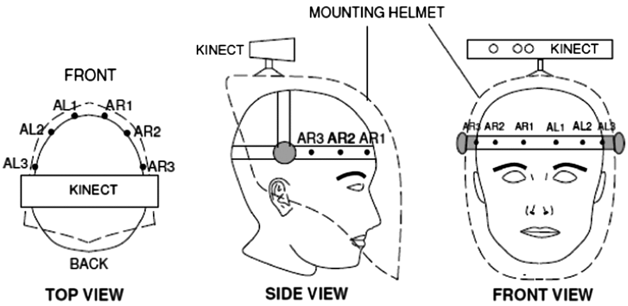

Fig. 3. Kinect range camera and six vibration actuators on a helmet [14].

Braille

Recent window systems present lavish information in a graphic layout. Thus, the text-only access of a standard Braille device is no longer sufficient to enable the blind people to access the window systems. Prescher et al. [16] presented a two-dimension Braille Window System (BWS) based on a tactile display. This tactile display consists of a pin-matrix of six separate regions, to enable the blind person to receive different types of information simultaneously. The primary region among six can be shown in text- or graphics-based manners through four different views. In user experiment, eight blind participants aimed at examining the intuitiveness of operating BWS, and the usability of the system. They confirmed the concept of the Braille windows, regions and views and demonstrated that it provided an efficient way for the interaction.

Braille devices play an important role to enable blind people to access information from the computer systems. Völkel et al. [17] implemented a Braille pin-matrix device, which allows presenting tactile graphics on a matrix of 60 times 120 pins. The pin-matrix device is made up of vertical Braille modules and each of them is equipped with a separate sensor and a separate actuator electronic, capable of detecting multiple points of contact.

Graphics

Although face photos/portraits information is very important in emotional lives, such information is almost inaccessible to blind people. Li et al. [18] proposed a prototypical system namely TactileFace, aiming at enabling blind people to access facial images by automatically creating the corresponding tactile graphics. Two important features were introduced for the desired TactileFace system: (1) Blind people were capable of accessing the system independently; (2) Tactile facial images could be created by the system in a real time.

Nikolakis et al. [19] proposed to develop an interactive system, converting gray images into the haptic representation. Twenty blind and blindfolded participants evaluated the system and the results demonstrated that they could distinguish dark and light areas in the gray images and understand the simple shapes.

Yusoh et al. [20] developed a haptic graphic system, aiming at helping blind people create mental images of line drawings. The system is made of a fingertip guiding manipulator (FGM) with two-mode functions: the passive mode and the active mode. In the active mode, the blind user's fingertip is pulled by the FGM along line drawings. In the passive mode, the blind user can freely move the fingertip in the only direction of the line drawings. In the user experiment, the blindfolded and blind participants evaluated the time consumed for the active mode and the passive mode. The results demonstrated that FGM was a helpful tool for teaching and perceiving the line drawings.

3 Problems in Social Interaction

In the literature review, we gain the overview knowledge of available HCI designs for blind people. Many useful devices and systems are created to solve the practical problems that blind people encounter in their daily lives. However, HCI designs which aim to solve problems in social interaction for blind people are seldom mentioned. In face-to-face communication, blind people are more introverted, submissive, and less confident due to the sighted control. They have the poor social adaption [21]. The impatience, discomfort, or intolerance of the sighted is the other important factor in determining the level of the involvement for the blind person [22].

Kemp [23] investigated social interaction of blind people by controlled, experimental methods. In the experiment, 30 blind and 30 sighted participants were formed into three groups: 10 blind-blind pairs, 10 blind-sighted pairs, and 10 sighted-sighted pairs. Each pair was videotaped while participating in 15-min discussion sessions. Subsequent ratings were made on such dimensions as style, synchrony, and content of interchanges. The impression formation questionnaire was adopted before and after discussions on the accuracy, confidence, and quality of impression.

Several differences were found between blind and sighted people's social behaviors. For example, frequency of interruptions in blind pairs was twice as great as sighted pairs. Blind participants tended to report feelings less confident in their responses. Fewer physical gestures were observed in blind participants. Blind participants turned toward their conversation partner less often than did the sighted.

In social skills training with visually impaired people, particular interest has been the improvement of eye contact [22]. The basis for these effort has been social psychology studies, which documented the significance of visual cues in social communication [24, 25]. Lack of eye contact may cause sighted people to feel that they are not fully in communication [24]. In training, the blind person was asked to simply "look" in the direction towards a sighted person who is talking to her. However, gaze signals among sighted people are far from a simple and unnatural "look". For example, a sighted speaker consciously or unconsciously uses gaze or eye contact to communicate with the conversation partner in face-to-face communication. Through the conversation partner's eyes, she can sense interest, engagement, happiness etc.

4 Research Implementation

Based on the social problem of blind people, we narrow down our research scope and focus on gaze and eye contact, which have important social meaning in face-to-face communication. Our research objective is to design an assistive system, which can simulate natural gaze for the blind person, to improve the conversation quality between the sighted and blind people in face-to-face communication.

The system is expected to have three primary functions (Fig. 4):

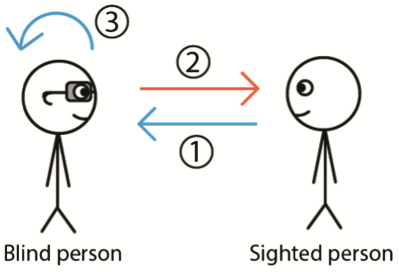

Fig. 4. Three functions of gaze simulation between blind and sighted people: (1) Feel eye gaze; (2) Send "eye gaze"; (3) Feel eye contact.

Feel eye gaze: By converting the gaze (visual cues) to corresponding tactile signals, the blind person can perceive eye gaze from the sighted in face-to-face communication.

Send "eye gaze": A wearable glasses device is proposed to simulate the natural "eye gaze" for the blind person as a visual reaction to the sighted interlocutor.

Feel eye contact: After simulating natural gaze for the blind person, more precise eye-to-eye communication (eye contact) can be established between the sighted and blind people. The blind person can feel corresponding tactile signals when the "eye contact" happens.

Early in our research project, a qualitative study was conducted on nonverbal signals (gaze, facial expressions, body gestures etc.) for blind people in face-to-face communication and problems they had due to the lack of visual signals [25]. Based on the literature review and preliminary investigations, the research scope was narrowed down and focused on gaze signals. A conceptual design of E-Gaze glasses was proposed, aiming at creating gaze communication between the sighted and blind people in face-to-face conversations. Twenty totally blind and low vision participants were interviewed to evaluate and envision four design features of the E-Gaze [25].

In order to make gaze signals accessible to the blind person, we developed a prototype, namely Tactile Band. The tactile feedback enabled the blind person to feel attention (gaze signals) from the sighted and tried to enhance the level of engagement in face-to-face communication [26]. To simulate natural gaze for blind people, we implemented a working prototype, E-Gaze glasses, an assistive device based on eye tracking. E-Gaze established the "eye contact" between the sighted and blind people in face-to-face conversations [27]. We refined gaze behaviors of the E-Gaze and designed a gaze model that combined the eye-contact mechanism with a turn-taking strategy, which linked the eye gaze animation with the conversation flow. We further proposed an experimental design to test the E-Gaze and hypothesize that the model-driven gaze simulation can enhance the conversation quality between the sighted and blind people in the face-to-face communication [28].

In our latest E-Gaze system, we let the blind person wear both E-Gaze glasses and Tactile Wristband in the experiment, not only to enable the blind person to feel the "eye contact" from the sighted, but also to send the "e-gaze" to the sighted in a dyadic conversation. If the gaze signal from the sighted is detected to hit the eye area of the blind person, a slight vibration from the Tactile Wristband is triggered by the vibration motor. So the blind person knows that the sighted is looking at her. The overview of E-Gaze system is shown in Fig. 5.

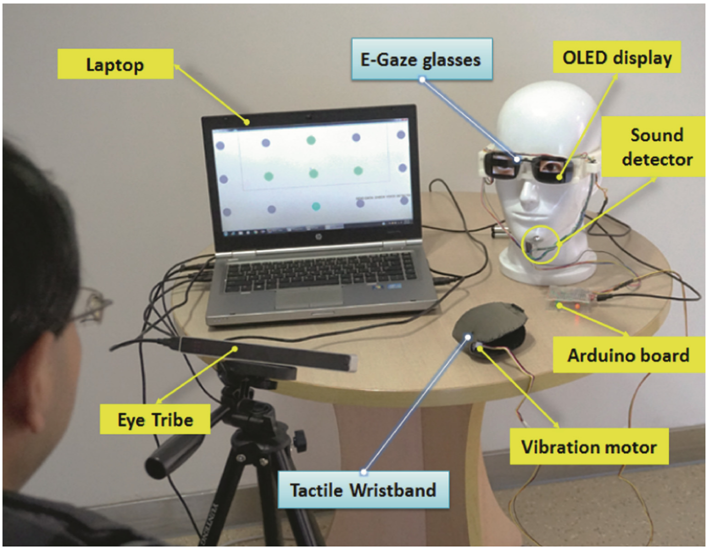

Fig. 5. The overview of the E-Gaze system.

5 Conclusion

In this paper, a preliminary background review about HCI design for blind people is presented. We conduct this review for the general understanding of the current assistive technologies and applications for blind people in the HCI field. Many useful devices and systems are created to solve the practical problems that blind people meet in their daily lives, but the important parts are missing: problems in social interaction, especially in face-to-face communication. The review of social problems for blind people is also presented: due to lack of gaze communication, blind people are more introverted, submissive, and less confident in face-to-face communication with sighted people. Based on the literature review and the primary study, our research objective is to design gaze simulation for people with visual impairments. Finally, we present the iterative prototypes of gaze simulation for blind people in face-to-face communication and report the implementations so far.

Acknowledgments. We thank our colleagues at the Systemic Change research group in Eindhoven University of Technology who offer suggestions and ideas for this project. This research is supported by the China Scholarship Council.

References

1. World Health Organization. Visual impairment and blindness (2014). http://www.who.int/mediacentre/factsheets/fs282/en/. Accessed August 2014
2. Muller, M.J., Wharton, C., McIver Jr., W.J., Laux, L.: Toward an HCI research and practice agenda based on human needs and social responsibility. In: Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, pp. 155–161 (1997)
3. Oppenheim, C., Selby, K.: Access to information on the World Wide Web for blind and visually impaired people. Aslib Proc. **51**(10), 335–345 (1999)
4. Stephanidis, C.: User interfaces for all: new perspectives into human-computer interaction. User Interfaces All-Concepts Methods Tools **1**, 3–17 (2001)
5. Iglesias, R., Casado, S., Gutierrez, T., Barbero, J.I., Avizzano, C.A., Marcheschi, S., Bergamasco, M.: Computer graphics access for blind people through a haptic and audio virtual environment. In: The 3rd IEEE International Workshop on Haptic, Audio and Visual Environments and Their Applications, HAVE 2004, Proceedings, pp. 13–18 (2004)
6. Ivanchenko, V., Coughlan, J., Shen, H.: Crosswatch: a camera phone system for orienting visually impaired pedestrians at traffic intersections. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (eds.) ICCHP 2008. LNCS, vol. 5105, pp. 1122–1128. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-70540-6_168
7. Dunai, L., Fajarnes, G.P., Praderas, V.S., Garcia, B.D., Lengua, I.L.: Real-time assistance prototype—a new navigation aid for blind people. In: IECON 2010-36th Annual Conference on IEEE Industrial Electronics Society, pp. 1173–1178 (2010)
8. Wentz, B., Lazar, J.: Are separate interfaces inherently unequal?: an evaluation with blind users of the usability of two interfaces for a social networking platform. In: Proceedings of the 2011 iConference, pp. 91–97 (2011)
9. Brady, E.L., Zhong, Y., Morris, M.R., Bigham, J.P.: Investigating the appropriateness of social network question asking as a resource for blind users. In: Proceedings of the 2013 Conference on Computer Supported Cooperative Work, pp. 1225–1236 (2013)
10. Jayant, C., Ji, H., White, S., Bigham, J.P.: Supporting blind photography. In: The Proceedings of the 13th International ACM SIGACCESS Conference on Computers and Accessibility, pp. 203–210 (2011)
11. Nishimoto, T., Watanabe, T.: An analysis of human-to-human dialogs and its application to assist visually-impaired people. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (eds.) ICCHP 2008. LNCS, vol. 5105, pp. 809–812. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-70540-6_120
12. Bernareggi, C., Brigatti, V.: Writing mathematics by speech: a case study for visually impaired. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (eds.) ICCHP 2008. LNCS, vol. 5105, pp. 879–882. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-70540-6_131
13. Al-Khalifa, H.S.: Utilizing QR code and mobile phones for blinds and visually impaired people. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (eds.) ICCHP 2008. LNCS, vol. 5105, pp. 1065–1069. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-70540-6_159

14. Mann, S., Huang, J., Janzen, R., Lo, R., Rampersad, V., Chen, A., Doha, T. : Blind navigation with a wearable range camera and vibrotactile helmet. In: Proceedings of the 19th ACM International Conference on Multimedia, pp. 1325–1328 (2011)
15. Huang, Y.Y.: Exploration in 3D virtual worlds with haptic-audio support for nonvisual spatial recognition. Hum.-Comput. Interact. **332**, 269–272 (2010)
16. Prescher, D., Weber, G., Spindler, M.: A tactile windowing system for blind users. In: Proceedings of the 12th International ACM SIGACCESS Conference on Computers and Accessibility, pp. 91–98 (2010)
17. Völkel, T., Weber, G., Baumann, U.: Tactile graphics revised: the novel BrailleDis 9000 pin-matrix device with multitouch input. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (eds.) ICCHP 2008. LNCS, vol. 5105, pp. 835–842. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-70540-6_124
18. Li, N., Wang, Z., Yuriar, J., Li, B.: TactileFace: a system for enabling access to face photos by visually-impaired people. In: Proceedings of the 16th International Conference on Intelligent User Interfaces, pp. 445–446 (2011)
19. Nikolakis, G., Moustakas, K., Tzovaras, D., Strintzis, M.G.: Haptic representation of images for the blind and the visually impaired. In: Proceedings of the 11th International Conference on Human-Computer Interaction (2005)
20. Yusoh, S.M.N.S., Nomura, Y., Kokubo, N., Sugiura, T., Matsui, H., Kato, N.: Dual mode fingertip guiding manipulator for blind persons enabling passive/active line-drawing explorations. In: Miesenberger, K., Klaus, J., Zagler, W., Karshmer, A. (eds.) ICCHP 2008. LNCS, vol. 5105, pp. 851–858. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-70540-6_126
21. Petrucci, D.: The blind child and his adjustment. New Outlook Blind **47**, 240–246 (1953)
22. Van Hasselt, V.B.: Social adaptation in the blind. Clin. Psychol. Rev. **3**(1), 87–102 (1983)
23. Kemp, N.J.: Social interaction in the blind. Int. J. Rehabil. Res. **3**(1), 87–88 (1980)
24. Argyle, M., Dean, J.: Eye-contact, distance and affiliation. Sociometry **28**, 289–304 (1965)
25. Qiu, S., Hu, J., Rauterberg, M.: Nonverbal signals for face-to-face communication between the blind and the sighted. In: Proceedings of International Conference on Enabling Access for Persons with Visual Impairment (ICEAVPI 2015), pp. 157–165 (2015)
26. Qiu, S., Rauterberg, M., Hu, J.: Designing and evaluating a wearable device for accessing gaze signals from the sighted. In: Antona, M., Stephanidis, C. (eds.) UAHCI 2016. LNCS, vol. 9737, pp. 454–464. Springer, Cham (2016). https://doi.org/10.1007/978-3-319-40250-5_43
27. Qiu, S., Anas, S.A., Osawa, H., Rauterberg, M., Hu, J.: E-gaze glasses: simulating natural gazes for blind people. In: Proceedings of the TEI 2016: Tenth International Conference on Tangible, Embedded, and Embodied Interaction, pp. 563–569 (2016)
28. Qiu, S., Anas, S.A., Osawa, H., Rauterberg, M., Hu, J.: Model-driven gaze simulation for the blind person in face-to-face communication. In: Proceedings of the 4th International Conference on Human-Agent Interaction, pp. 59–62 (2016)