Co-located games created by children with visual impairments

Charlotte Magnusson
Bitte Rydeman
Certec
Department of Design Sciences
Lund University
Sweden
charlotte@certec.lth.se
bitte.rydeman@certec.lth.se

Sara Finocchietti
Giulia Cappagli
Lope Ben Porquis
Gabriel Baud-Bovy
Monica Gori
Italian Institute of Technology
Italy
sara.finocchietti@iit.it
giulia.cappagli@iit.it
lope.porquis@iit.it
gabriel.baud-bovy@iit.it
monica.gori@iit.it

MobileHCI '15 Adjunct, August 25-28, 2015, Copenhagen, Denmark
ACM 978-1-4503-3653-6/15/08.
http://dx.doi.org/10.1145/2786567.2794350.

Abstract
The present paper reports on a games workshop within the ABBI EU project involving children with visual impairments as co-creators. The created games show that it is possible to create fun, rich and social co-located games with wearable technology employing very simple interactivity. Having a device that makes a sound when you move allows for the creation of finding and avoiding games but also for "sneaking" games where the goal is to avoid activating the sound. Natural sounds were seen to enhance the playfulness of the activity.

Author Keywords
Wearable, play, game, sound, visual impairment, co-creation

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

Introduction
This paper presents work done in the framework of the ABBI (Audio Bracelet for Blind Interaction) EU project. ABBI is a project aimed at developing new wearable technology (an audio bracelet) to improve sensory-motor rehabilitation for children with visual impairment. Visuo-motor feedback is fundamental to calibrate our

Figure 1. ABBI bracelet together with a mobile device. By default the ABBI is quiet when it is stationary, and only makes sounds when it is moved.

body and space perception [1] and it has been verified that hearing can be used to substitute vision in this process [2]. To support this process, the ABBI bracelet has been developed. The ABBI bracelet allows a person who is unable to see the location of their own body to listen to it instead, by using their spatial hearing and auditory knowledge to locate the position of the sound source.

Initial studies in the ABBI project on sound preferences [3] showed that these preferences were indeed quite varied, but also that the participating children appreciated the inclusion of natural sounds (in addition to the synthetic sound initially available). This led to the development of an updated version of the ABBI bracelet which included the possibility to modify the synthesized feedback as well as the option to select between a set of natural sounds using a smartphone app.

So far, the ABBI device has been tested in ad-hoc individual rehabilitation but this type of device also holds potential for more social and playful activities. In order to explore how the ABBI device could be used in social games and play, we organized a workshop together with a group of children with visual impairments at the Chiossone Institute in Italy. The present paper reports initial results from this activity.

The ABBI bracelet

The ABBI bracelet is based on a small custom designed circuit (24 x 25 mm), which includes a powerful processor (ARM Cortex M3), an 9-axis Inertial Measurement Unit (IMU), 16 MB Flash memory, a Smart Bluetooth module and a sound amplifier. The circuit fits with the battery (120 mA) and speaker in an robust enclosure (55 x 35 x 25 mm), which can be fixed on a wrist band (figure 1). The device goes into sleep mode when at rest and automatically wakes up when moved. The processor can synthetize sound in real-time and play back sound stored Flash memory. The sound can be triggered or modulated by the IMU. The Bluetooth link is used to control ABBI settings from a smartphone or computer. In this game workshop, the ABBI device was configured to play back sounds when the velocity was above an adjustable threshold.

Related work

The ABBI concept as such is novel, and has been published at [2], [4], [5]. For users with visual impairments there are few wearable or mobile games – one of the few mobile games designed for this group is NIVINAVI [6], an inclusive mobile game making mobility training more fun. Wearables can take the form of headworn displays, glasses (recently Google glass), smart textiles, shoes, armbands, jewellery etc [7] – basically anything interactive somehow worn on the body. While not specifically designed for persons with visual impairments, such devices with their potential for eyes-free interaction hold promise also for persons with visual impairments [8]. Although not explicitly designed for children with visual impairments, there are examples of interactive technologies that could benefit this group. The bracelet presented in [9] is designed to support playing by enhancing RFID tagged objects by playing sounds and showing lights. Sounds are also used in “SoundTag” [10] where interactive tags were designed to be worn during the game “tag”: when a chaser hits a tag placed on a runner the tag emits a sound. OnObject [11] is a small device worn on the hand which allows you to program an object to respond to gestural triggers by playing

Figure 2. Trying to find your partner (initial exercise).

recorded speech. Tagaboo [12] uses a specially designed glove that can respond (by playing sounds) to tags placed in pockets or similar. Exergames are games designed for physical activity and given that the ABBI is designed for being used while moving, guidelines for the design of exergames are potentially relevant [13].

The difference between the above mentioned designs and ABBI lies both in the focus and simple design. In ABBI most of the processing relies on the human sensory-motor system – in a sense it is the human that responds to the technology, instead of the technology adding a lot of interactivity to objects and environments. From an interactive perspective this makes the ABBI design quite simple: the device plays a sound when it is moving and keeps quiet when it is still. The original design is intended to support sensory-motor rehabilitation, but the device can potentially also be used in more social settings – and the presented work is aimed at exploring how.

Workshop activity

An explorative workshop was organized at the Chiossone institute in Italy together with nine children with visual impairments. The children were split into two groups – one containing seven children with low vision and one group with two blind children. To get a baseline for how you can find someone based on sound alone, the activity started with an exercise where the participants were assigned to pairs and told the names of their partner. They were then distributed along the walls of the room where the workshop was held and told to find each other by calling out the names of their partner. Participants who had some residual vision were blindfolded.

After this the same exercise using ABBI devices was performed. This time the persons in each pair had ABBIs with the same sound, and the task was to team up with the other person having the same sound. This exercise was done both with synthetic "ping" type sounds (different frequencies for different pairs; 600, 800, 1000 and 1200Hz) and natural sounds (each pair selected which sound they wanted). Trainers and researchers also participated in these initial exercises to make the numbers even when forming pairs, and to make the soundscape more similar in the two groups.

After these initial exercises, the children were split into groups and asked to design games that made use of the ABBI device. Finally, the resulting games presented by their designers.

Results

The initial exercises were mostly intended to familiarize the children with the use of ABBI in a social setting, but some observations were made. The first observation was that it appeared quite easy to locate a person calling your name. Even making the task harder by asking people to turn around on the spot before setting out to locate their partner did not stop the participants from finding their partners quickly. Using the ABBI sounds appeared harder – although all participants found their partner eventually, there was more searching around and the exercise overall took longer. There was hardly any difference between the synthetic ping sounds and the natural sounds – all pairs finding their partners in the low vision group took around 1 minute and 20 seconds. In contrast, using speech took around 20 seconds (including the time to turn around on the spot). Since the blind group only included one pair of children with a blindfolded sighted pair to

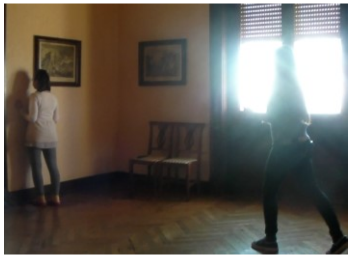

Figure 3. Playing the game "Statues".

provide distraction, times for this group are not comparable – although it is interesting to note that the blind children did team up first.

The sounds selected by the four pairs in the first group were short explosion, bubbling water, mosquito and a rhythmic synthetic "drops" sound. The pair in the second group started off selecting an elephant sound. To have one more pair a blindfolded trainer/researcher pair also participated. This pair used the bubbling sound. The blind children in this group disliked having the same sound, and asked to have different sounds instead. The sounds they selected were the elephant and the "drops" sound (the trainer pair used bubbling water and short explosion).

The following games were designed by the children:

Capture the flag. The children are divided into two teams and each child has an ABBI bracelet with a specific sound that matches the sound of an ABBI in the other team. One person, who is not in any of the teams, is holding a flag. This person calls attention to herself, so the children know where she is. The game starts when one player moves his or her ABBI to create a sound. The two players now move towards the flag in order to catch it. The child who reaches the flag first wins.

Statues. All the children except one are wearing ABBI bracelets. Their aim is to reach the opposite wall where the single child is standing, without making a sound with their ABBIs. If they make their ABBI sound they will get caught.

Circle of ABBIs. The children stand in a circle, each wearing an ABBI with a different sound. One player makes his ABBI sound, moves to another child in the circle and touches her, then he goes back to his place in the circle. The child who was touched now has to find the child who touched her, through recognizing the sound of that child's ABBI.

Find me. This game involves two children. One child is wearing an ABBI and is making it sound while walking around. The other child has to find the child who is making the sound and catch him.

Tag/Hide-and-seek. One child is hiding/trying to avoid being caught and another child is seeking. The child that is seeking is wearing an ABBI and is making it sound, so the one who is hiding will know when the seeker approaches.

Discussion

Although the main purpose with the exercise was the game design, we start with a short discussion on the initial exercise. That humans are good at picking out their own name comes as no surprise (it is even possible to see differences in brain activation between hearing your own name and other names [14]). Another difference between the initial name exercise and the following ABBI exercises was that in the ABBI exercise the persons in the pair had been assigned the same sound in order to help them remember which sound they were looking for. This turned out to be quite confusing since the sounds tended to mix – we had hoped participants would keep their ABBIS still to listen for the other person in the pair, but this turned out to be hard, and a takeaway lesson is that similar sounds on multiple ABBIs should generally be avoided (unless

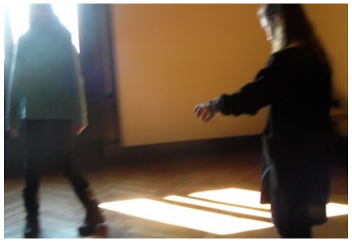

Figure 4. Two blind children playing "tag"/"hide and seek" (possibly for the first time in their lives).

one wants to use this as a specific challenge in an exercise). Our results indicate that it was roughly as easy to locate "ping" sounds as natural sounds. We had expected the natural sounds to possibly be easier, because these sounds would have cognitive associations – but we don't see any indication in this direction. This tentative observation is in agreement with the results in [15] where it was shown that trajectory recreation worked reasonably well for several different sounds. What we did see however, was how much fun the natural sounds added to the exercise. This became even more evident in the game creating activity. We also noted that the selection of sounds confirmed the results from the initial studies [3], which showed the importance not only on nice and pleasurable sounds, but also of unpleasant or drastic ones. Running around "exploding" at every step, sounding like an elephant (or a mosquito) or making rhythmical musical sounds is quite a different experience compared to walking around making a "ping" at each step.

Not surprisingly, many games are of a "find the sound" type. Complementing this is the "avoid the sound". We see both these in the game "hide and seek": the chaser tries to find the sound source, whilst the person being chased tries to avoid the sound of the chaser (this game was designed and played by the two blind participants). An interesting use of the ABBI was to rely on the fact that it was silent when it isn't moved – this way you can create "sneaking" games, where the goal is to avoid being noticed. These kind of games had not been discussed in the ABBI design team prior to the workshop, and it can be noted that "non-activation" does not feature in any of the works cited in the related works section (refs [9 – 12]). It is quite possible that working with technology may potentially bias a designers and developers towards relying on activation of different responses. Thus, our results also provide further evidence of the value of allowing children to participate in the design process as co-creators [16].

Conclusion

The present paper reports on a games workshop involving children with visual impairments. The created games show that it is possible to create fun, rich and social co-located games with wearable technology employing very simple interactivity. Having a device that makes a sound when you move allows for the creation of finding and avoiding games but also for "sneaking" games where the goal is to avoid activating the sound. Making use of natural sounds enhances the playfulness of the activity – and we note that it is important to include both pleasant as well as unpleasant/drastic sounds.

Although these games were created within a project directed at children with visual impairments, the game concepts are not restricted to this group – these kinds of games could potentially be fun for everyone.

Acknowledgements

We thank the EU for supporting the ABBI project. We also thank all the children and trainers involved in the activities.

References

1. Gori, M., Sandini, G., Martinoli, C., and Burr, D. (2010). Poor haptic orientation discrimination in nonsighted children may reflect disruption of cross-sensory calibration. Curr Biol 20, 223-225.

2. Cappagli, G., Baud-Bovy, G., Sandini, G., Gori. M., Auditory-motor training improves audio spatial localization. 9th Forum of Neuroscience, Milan 2014
3. Magnusson, C., Caltenco, H., Finocchietti, S., Cappagli, G., Wilson, G., Gori, M., What do you like? Early design explorations of sound and haptic preferences, Poster submission to MobileHCI'15
4. M. Gori, From the study of multisensory integration to cross-sensory rehabilitation technologies, Congresso Nazionale di Bioingegneria, Pavia 2014.
5. G. Cappagli, E. Cocchi, M. Gori, G. Baud-Bovy, Audio and proprioceptive space perception in sighted and visually impaired children. 15th International Multisensory Integration forum, Amsterdam 2014.
6. Magnusson, C., Waern, A., Rassmus-Gröhn, K., Bjernryd, Å., Bernhardsson, H., Jakobsson, A., Salo, J., Wallon, M., Hedvall, P. O., Navigating the world and learning to like it - mobility training through a pervasive game, Accepted for presentation at MobileHCI 2011, Stockholm, Sweden.
7. Mann, Steve (2014): Wearable Computing. In: Soegaard, Mads and Dam, Rikke Friis (eds.). "The Encyclopedia of Human-Computer Interaction, 2nd Ed.". Aarhus, Denmark: The Interaction Design Foundation. Available online at https://www.interaction-design.org/encyclopedia/wearable_computing.html
8. Hanlu Ye, Meethu Malu, Uran Oh, and Leah Findlater. 2014. Current and future mobile and wearable device use by people with visual impairments. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems (CHI '14). ACM, New York, NY, USA, 3123-3132.
9. Judith Amores, Xavier Benavides, Roger Boldu, and Pattie Maes. 2015. Exploring the Design of a Wearable Device to Turn Everyday Objects into Playful Experiences. In Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems (CHI EA '15). ACM, New York, NY, USA, 2145-2150.
10. Ryoko Ueoka, Hiroki Kobayashi, Michitaka Hirose, SoundTag: RFID based wearable computer play tool for children. Transactions on Edutainment III 2009
11. Chung, K., Shilman, M., Merrill, C., & Ishii, H., OnObject: gestural play with tagged everyday objects. In Proc. UIST 2010, ACM Press (2010) 379-380.
12. Konkel, M., Leung, V., Ullmer, B., & Hu, C., (2003), Tagaboo: a collaborative children's game based upon wearable RFID technology. Personal and Ubiquitous Computing, 8(5), 382-384.
13. Florian Mueller and Katherine Isbister. 2014. Movement-based game guidelines. In Proceedings of the 32nd annual ACM conference on Human factors in computing systems (CHI '14). ACM, New York, NY, USA, 2191-2200.
14. Carmody DP, Lewis M (2006) Brain activation when hearing one's own and others' names. Brain Research 1116: 153-158 doi:10.1016/j.brainres.2006.07.121
15. Wilson, G., Brewster, S., Caltenco, H., Magnusson, C., Finocchietti, S., Baud-Bovy, G. & Gori, M. (2015) "Effects of Sound Type on Recreating the Trajectory of a Moving Source", Proceedings of CHI 2015 Extended Abstracts, Apr 18-23, Seoul, South Korea
16. Druin, A., (2002) The role of children in the design of new technology, Behaviour & Information Technology, 21:1, 1-25, DOI: 10.1080/01449290110108659