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A Note from the Editor

Dear SIGACCESS member:

Welcome to the January issue of the SIGACCESS newsletter. This issue highlights the ACM ASSETS 2013 Conference. The first article written by Dr. Richard Ladner and Dr. Clayton Lewis provides an overview of the conference. A report on the first ASSETS captioning challenge was contributed by Dr. Raja Kushalnagar. The remaining ten articles highlight the research work of the students who attended the ASSETS 2013 doctoral consortium.

Jinjuan Heidi Feng

Newsletter editor

SIGACCESS Officers and Information

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Andrew Sears
Information Systems Dept.
UMBC
1000 Hilltop Circle
Baltimore, MD 21250, USA.
+1-410-455-3883 (work)
chair_SIGACCESS@acm.org

Vice-chairperson

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Dept. of Computer Science and
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University of Colorado
Boulder, CO 80309, USA.
vc_SIGACCESS@acm.org

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Hawthorne, NY 10532, USA.
treasurer_SIGACCESS@acm.org

Newsletter Editor

Jinjuan Heidi Feng
Computer and Information Sciences Dept.
Towson University
7800 York Road
Towson MD 21252, USA
+1 410 704 3463
editors_SIGACCESS@acm.org

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Report on ASSETS 2013

Richard E. Ladner
Program Chair, University of Washington
ladner@cs.washington.edu
Clayton Lewis
General Chair, University of Colorado
claytong@colorado.edu

The 15th ACM SIGACCESS International Conference on Computers and Accessibility was held in Bellevue, Washington, USA on Monday – Wednesday, October 21-23, 2013.

The conference began with a welcome by us and the presentation of the first SIGACCESS Impact Award ever given. The award goes to the authors of an ASSETS conference paper presented ten or more years prior which has had a significant impact on computing and information technology that addresses the needs of persons with disabilities. The 2013 award went to Chieko Asakawa and Takashi Itoh for their seminal 1998 ASSETS paper titled "User Interface of a Home Page Reader." Dr. Asakawa was in attendance to receive the award which came with a beautiful bronze plaque that included embossed Braille.

The heart of the conference included 27 technical papers, 2 experience reports, 40 posters, and 8 demonstrations that were selected after a rigorous peer review by a distinguished international program committee. The acceptance rated were 28/98 (29%) for technical papers, 2/4 (50%) for experience reports and 48/78 (62%) for posters and demos. One technical paper that was accepted was not presented at the conference. There were an additional 16 posters presented at the two poster sessions from participants in the doctoral consortium, student research competition, and student travel grant recipients.

The keynote address was given by Ron Baecker from the Technologies for Aging Gracefully Lab at the University of Toronto. The talk "Frontiers of Accessibility: From the Body to the Mind, the Heart and the Soul" used as a foundation the levels of human needs characterized by Abraham Maslow: physiological, safety, love/belonging, esteem, and self-actualization (the need for meaning in one's life). He described a number of projects from his lab that target the various human needs for individuals who lose some physical or mental abilities through the aging process.

The experience reports were a new feature of the conference. Their intention was for conference attendees to hear first-hand accounts of users experiences with technology intended for them. One report by Torsten Felzer and Stephan Rinderknecht about how the first author accesses a computer with very limited mobility. Dr. Felzer gave the talk and an informal demonstration of the technology at the close of the conference. The other report by Christian Vogler, Paula Tucker, and Norman Williams on technology for remote conferences that include hearing, deaf, and deaf-blind participants. The talk, given in sign language by Dr. Vogler, described early unsuccessful attempts to smoothly include conference participants using audio and video teleconference technology, real-time captioning, and sign language interpretation.   He then described a successful approach highlighting all the components need to make the remote meeting accessible.

Another new feature of the conference was a user experience panel moderated by Annalu Waller of three individuals with disabilities, Kristin Rytter founder of Unique Perspective, Peggy Martinez, Accessibility Manager at the Lighthouse for the Blind, Inc., and Angela Theriault, Executive Director for the Deaf-Blind Service Center, all three from Seattle, Washington. Dr. Rytter is a user of augmentative and alternative communication (AAC) devices and has very limited mobility. She used her AAC device with eye-tracking during the panel session. She described her most pressing issue to be the slow speed of communication using AAC devices. Ms. Martinez described her use of refreshable Braille devices and the importance of Braille generally. Ms. Theriault, who used a close-by-seated sign language interpreter, described how a deaf-blind person can use a video relay service along with a "communication facilitator" to make a phone call to anyone, hearing or deaf. A communication facilitator is a tactile sign language interpreter who copies the signs of the video relay operator for incoming information. The deaf-blind person signs for themself for outgoing information.   Ms. Theriault also emphasized the importance of Braille, especially for people who are both blind and deaf. The user experience panel was a big hit as evidenced by the rapt attention of the audience listening intently to every word of the panelists.

Another interesting feature of the conference was the captioning challenge organized by Raja Kushalnagar. The captioning challenge goal was to compare research and industry approaches to increase availability, accuracy and coverage, and to reduce cost of generating real-time transcripts for lectures. Current computer powered automatic speech recognition (ASR) cannot yet handle real-world lecture speeches, and therefore practical, real-time lecture transcription requires human powered transcription, whether from a single professional captioner or from the crowd to caption or correct. Two research teams and a professional captionist participated in the challenge. The first team used crowdsourced typists, led by Jeff Bigham from Carnegie Mellon University. The second team used crowdsourced listeners to correct a real-time transcript, either from the professional captionist or Google ASR, and was led by Gregg Vanderheiden from University of Wisconsin.   The crowd in both cases consisted of members of the ASSETS audience. The professional captionist used a shorthand-based keyboard and software to achieve high coverage and accuracy. The challenge was set for the first day, but technical glitches came up so the challenge was held on the second day.   Dr. Kushalnagar will describe the challenge and announce the challenge outcomes in a separate article in this newsletter.

On the Sunday prior to the conference Gregory Abowd from Georgia Tech University led the doctoral consortium for 10 PhD students.   Students were mentored by a team of senior faculty members from various institutions. Students presented their dissertation ideas in short talks and practiced "elevator pitches" for their work.   They broke into smaller groups to receive more detailed feedback from their mentors.   Finally, they presented their work in the poster session on Tuesday.

On Tuesday afternoon the conference moved from the hotel to the Microsoft Research building about five miles away.   The afternoon started with an hour-long round table session on topics that were suggested the day before by attendees. Those who suggested topics were table leaders who moderated the conversation at the tables. Table topics included 3D printing, designing AT in line with disability law, accessible games, getting more work at ASSETS on learning disabilities, scaling up accessibility research studies, interventions for caregivers and families, and ten more topics. Following the round table session was the late afternoon poster session and reception. The poster session and reception were open to members of the University of Washington's DUB community that sponsored the event.

The meeting closed with the presentation of the best paper awards that went to:

- The best paper was "Improving Public Transit Accessibility for Blind Riders by Crowdsourcing Bus Stop Landmark Locations with Google Street View" by Kotaro Hara, Shiri Azenkot, Megan Campbell, Cynthia L. Bennett, Vicki Li, Sean Pannella, Robert Moore, Kelly Minckler, Rochelle H. Ng, Jon E. Froehlich. This paper was a joint effort of researchers from the Universities of Maryland and Washington,
- The best student paper was "Wheelchair-based Game Design for Older Adults" by Kathrin M. Gerling, Michael R. Kalyn, Regan L. Mandryk all from the University of Saskatchewan.

The General Chair for ASSETS 2014, Sri Kurniawan, then gave a short presentation about the conference site in Rochester, NY.

Overall, the conference was a great success. There were 155 registered attendees with even more at the open events on Tuesday afternoon at Microsoft Research. It was a welcome sight to see so many people with disabilities participate as attendees and speakers. Sign language interpretation was available throughout the conference and real-time captions were available intermittently, depending on the captioning competition activities. The vast majority of the talks were given in an accessible manner. We were disappointed that one speaker did not show up to give their talk. That paper will not appear in the proceedings. The ACM sponsored Student Research Competition was cancelled because of the small number of submissions. However, the best two of these submissions, and the five student grant awardees, presented at the first poster session. The new features of the conference, experience reports, user experience panel, and round table discussions, added a new richness the conference that seemed to be appreciated by most everyone.

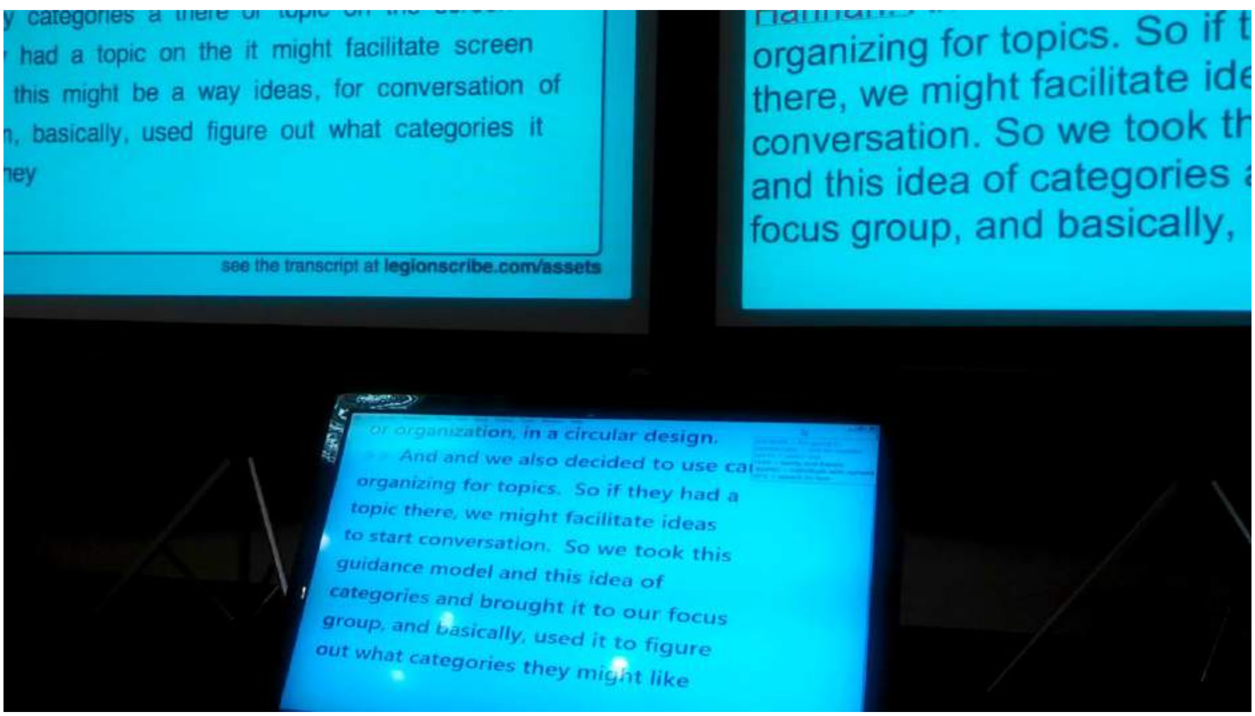
Finally, we would like to thank the sponsors of the conference: Microsoft Research (for the student research competition), DUB at the University of Washington (for the reception at Microsoft Research), and the National Science Foundation (for the Doctoral Consortium). We thank the members of the conference organizing committee and technical program committee for their volunteer support of the conference. Additional thanks goes to Jonathan Lazar, Shari Trewin, and Annalu Waller who served as Associate Program Chairs who helped with the distribution of papers to reviewers, final decisions, organization of the program, and selection of the best papers.

ASSETS 2013 Captioning Challenge

Raja S. Kushalnagar
Rochester Institute of Technology
rskics@rit.edu

The 15th ACM SIGACCESS International Conference on Computers and Accessibility (ASSETS 2013) held a Captioning Challenge. The goal of the challenge was to compare research and industry approaches for live captioning and transcription of conference presentations. We compared the availability, accuracy and readability of each approach. We also also compared the overall cost of generating real-time transcripts for lectures.

The competition featured two research teams and a professional captionist. The first team (Collaborative Crowd Captioning - Scribe) led by Jeff Bigham from Carnegie Mellon University generated a real-time transcript by utilizing crowd-sourced listeners and typists who typed parts of what they heard. The second team (Crowd Caption Correction - CCC) led by Gregg Vanderheiden from University of Wisconsin, used crowd-sourced listeners and correctors, who read a real-time transcript that is being generated either from the professional captioner or Google ASR. The crowd in both cases consisted of members of the ASSETS audience. The professional captionist used a shorthand-based keyboard and software to achieve high coverage and accuracy. The challenge was set for the first day, but technical glitches came up so the challenge was held on the second day.



Scribe (Upper left), CCC with CART (Upper right), and CART (Lower center)

Need for Captioning

Worldwide, about 2% of the population have hearing loss such that they cannot understand everyday speech without visual accommodations. Additionally, everyone has faced temporary or "situational disabilities" such as watching TV in a noisy sports bar, adapting to unfamiliar speech accents, or studying in a quiet area such as a library. Moreover, captions, i.e., the translation of audio to text enhances accessibility for computers that do not currently have the capability of understanding audio. The translation opens up new vistas to harness the power of the cloud.

Need for Captioning Challenge

Current real-time captioning for conferences and other public events is provided by specialists who need to be booked in advance and are expensive. The reason for inflexible booking times and high costs is that real-time captioners are in short supply due to the need for extensive training with specialized computer solutions.

A pure human powered typist cannot keep up with natural speaking rates. A single professional typist using a standard qwerty keyboard averages around 50 to 80 words per minute as compared to the average speaker who utters around 2 to 3 words per second, i.e., around 120-180 words per minute. On the other hand, a human can listen and understand a speaker with high accuracy in most environments, including a conference environment.

A pure computer powered approach cannot listen and understand with high accuracy. The high error rates occur because ASR software usually cannot handle unrestricted domains where there speaker accents, noise background and vocabulary vary widely, unlike human listeners. The generated captions often have high latency and error rates that render the captions unusable by human readers.On the other hand, given enough processing power, most automatic speech recognition (ASR) programs can keep up with speakers.

As such, real time captions cannot be addressed solely by human powered transcription or by computer powered transcription. In order to keep up with the average speaking rate and have high accuracy, a combination of human and computer powered transcription is required. Current professional real-time transcription uses either of the following: (1) stenocaptioning, which is based on the stenographic shorthand used by court reporters. The stenocaptioner listens to the presenter and enters what they hear in a stenographic shorthand code which is then translated by a computer into closed captions; or (2) automatic speech recognition through through re-speaking, whereby a professional re-speaker voices over any dialogue they hear into their ASR to transcribe it in real-time. Use of a re-speaker eliminates many factors that reduce accuracy, such as multiple speakers and variability in audio quality and speaker enunciation. For human powered captioning, the limited availability of stenographers or re-speakers means that on-demand captioning for lectures or presentations is expensive, and often simply not available. Conversely, computer powered captioning can be provided on-demand and is cheap, but is simply not accurate enough for use in unrestricted audio domains like conference presentations. Most deaf viewers do not have the luxury of splitting time between the captions and the presentation view, so the captions have to be near-perfect and not be presented faster than their reading speed. For many Deaf people, English is a second language, so if errors occur too often or if the captions are too fast, the readers will not be able to follow it. Readability means more than just delivering all words accurately.

Research Teams

Scribe: Legion Scribe is a crowd-sourced system that enables a small group of people who can hear and type to jointly transcribe what they hear. Each person types fragments of what they hear; Scribe automatically stitches all partial captions together to form a complete caption stream. Previous studies have shown that the accuracy of Scribe captions approaches that of a professional stenographer, while its cost is dramatically lower. In addition, a different set of workers can correct the stitched captions. Unlike a professional captioner, Scribe can be started on-demand by audience members or crowd workers. It can be far cheaper than other human powered approaches.

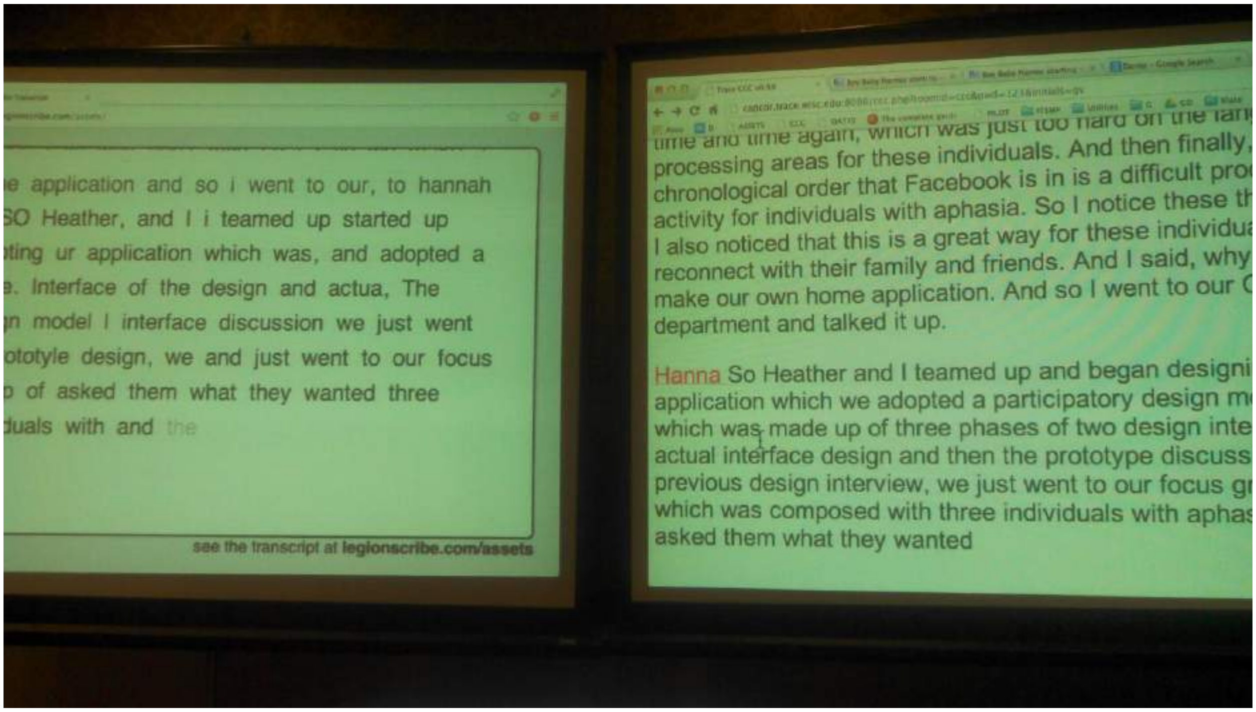
CCC: Crowd Caption Correction (CCC) is a system that enables listeners with an opportunity to correct errors in captions. The need for real-time caption correction is that real-time captions inevitably have errors due to several factors. First, the listener (captioner or re-speaker) has a limited temporal window to clarify ambiguities in the audio stream. This limited temporal window limits the opportunity of the captioner or typist to repair false guesses. Second, all captioning approaches often make typographical errors occur due to the larger vocabulary and unique spelling or pronunciation of technical or scientific terms in the presentation. Third, there is an inevitable processing delay of a few seconds to collect sufficient audio data to process, transform and display the words, making accurate meeting content more accessible to persons who rely on captions and providing a more accurate transcript of meeting content to all users.

Stenographer: Stenography is currently the most reliable transcription service in terms of comprehensiveness and accuracy. The stenographer presses multiple keys in parallel on a specialized stenograph (short-hand system) keyboard. As a result, certified stenographers can sustain 225 WPM, which is fast enough to transcribe all words in a presentation in real-time. However, due to the lack of availability and their cost, the number of captioners in higher education remains tiny in comparison with other forms of visual accessibility for deaf and hard of hearing consumers, including sign language interpreters. At the end of 2012, according to the online database managed by the Registry of Interpreters for the Deaf (RID) online database, there are 9,611 certified interpreters in the United States. According to the online database maintained by the National Court Reporters Association (NCRA), there are 316 certified CART providers offering services in higher education in the United States.

Caption Challenge

Most presentation rooms prioritize acoustic coverage over visuals. The ASSETS conference was not an exception. As the room was very wide and shallow, the line of sight and readablity to all three caption comparison screens was limited to one third of the conference room. An announcement was made to encourage members to switch seats between sessions so that more people in the audience could watch and compare the captions.

The captioning challenge was conducted over two morning sessions on Tuesday, Oct 22 from 8:30 am to 11:45 am. There were a total of six 15-minute presentations.



Scribe (left), CCC with CART (right)

Metrics:

There are many dimensions to the usability of captions. The most widely used metrics are accuracy, coverage, delay and flow. For instance, the readability and usability of captions goes down as the number of errors in capturing and presenting words goes up. The same is true for delay; in general real-time captions are expected to have less than 4 to 5 second delay from the time they were originally spoken. If the delay is more, the consumers cannot effectively interact. Similarly, the captions should cover (capture) all spoken information; if too few are captured, the consumer misses too much information. Finally, flow refers to how word and translation errors are presented at the sentence level - often human powered captioning errors are easier to parse and ignore than computer powered captioning errors.

Each session presentation was about 15 minutes long. Each presenter's average speaking rate ranged from about 110 to 190 words per minute as shown in Figure 1 below.

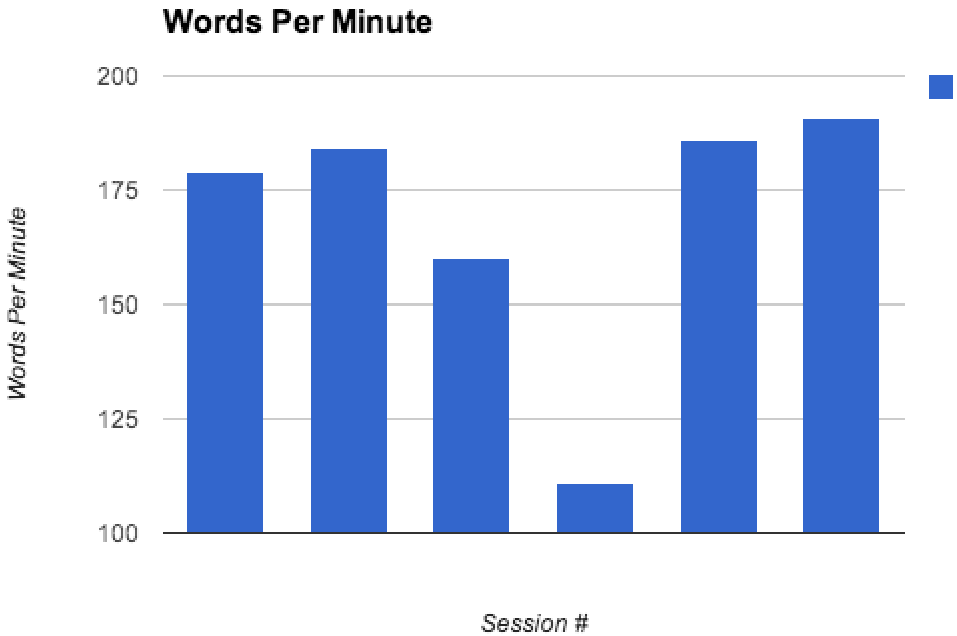


Figure 1

The presentations discussed original research to other researchers, and as a result, the ratio of unique words to all words was high even by lecture standards. The unique to total words ratio for the conference presentations averaged approximately 0.3, which is higher than the average undergraduate lecture ratio of 0.2, and is more than double the average ratio on television entertainment programs. The large number of unique words (dictionary size) is challenging for all captioning approaches, whether human or computer powered.

The audience rated the professional captions first in terms of accuracy and coverage. Scribe was rated second in terms of accuracy and coverage, and the automatic speech recognition software (Google) did not yield readable or usable captions. The audience liked using the Crowd Caption Correction system in conjunction with the professional captions. The audience was unable to test CCC with Scribe as the systems were not compatible. The audience members used CCC to identify speakers during questions and answers, and in clarifying diagrams and locations. This was needed as the professional captioner did not know the audience and could not identify, nor could the captioner understand the content context and clarify diagrams or locations. The audience members were more engaged in reading as they listened and clarified ambiguities as they occurred. Many audience members re-read to clarify and corrected words that had been uttered several seconds earlier.

The lack of professional captioner scheduling flexibility (on-demand) resulted in a large gap in visual accommodation coverage. The professional captioner was booked only for the captioning challenge and sign language interpreters were provided for the entire conference. On the evening of the second day, a conference attendee's hearing aids broke, and this person was temporarily disabled. This person asked for captioning, as the person did not know sign language and could not use the sign language interpreters. The conference organizers called multiple captioning agencies to procure captioners for the next morning. None of them could provide available captioners on short notice, either local or remote. Finally, a couple of hours later, an agency was able to find and book a captioner to provide service several hours after the start of the morning session. During this time when professional captions were not available, the Scribe team stepped in and provided captions for the temporarily disabled audience attendee for free. At the end of the third day, another attendee told us that he had trouble adjusting to the variety of accents (situational disability) and was missed out much of the presentation without the aid of captions. The Scribe team can hire online workers on-demand for a much lower net cost compared to professional captioners who are also not normally available on-demand.

The ASSETS 2013 Caption Challenge compared the accuracy, availability and cost between the professional captioners, Google Automatic Speech Recognition, Scribe and Crowd Caption Correction. Scribe and Crowd Caption Correction

In terms of caption generation, Scribe had the lowest on-demand availability time and overall cost. Scribe was "the most useful" solution.

In terms of caption accuracy, the Crowd Caption Correction system, which can work with any caption source, yielded the most accurate transcript when used with professional captions. Crowd Caption Correction was "the most accurate" solution.

A Blind-Friendly Photography Application for Smartphones

Dustin Adams, Sri Kurniawan
University of California, Santa Cruz
1156 High St. Santa Cruz, CA 95060
{duwadams, skurnia}@ucsc.edu

Abstract

Photography is a visual way to capture a moment in time. Photos can be used for artistic expression, and to remember significant events. Because photo taking, organizing and sharing traditionally requires visual information, those with no or limited sight often have problems with these activities. Previous work has made photo capturing without sight easier, however, there is little work that makes photo browsing and sharing blind-accessible. My dissertation research aims at facilitating independence for blind persons to take, organize and share photos through user-centered development of a smartphone application that can be used without sight. The work starts with an investigation of current practices of blind persons in these activities, continued with a review of existing applications, and finally the design and long-term evaluation of the application.

Introduction/Motivation

Photography is an enjoyed pastime of many blind and visually impaired people [1,2,3], however, due to the visually oriented nature of photography, photographs taken by blind people often are lacking, sometimes missing the photo subject entirely [6]. Furthermore, it is difficult for blind people to independently organize and identify a photo after it has been taken [4]. Due to the proliferation of digital photography and the Internet, online photo sharing is becoming increasingly popular [5]. The advent and ubiquity of smartphones provide a customizable framework that can help blind people capture, organize, and share photos. My dissertation research involves building an application for smartphones to assist blind users in capturing, organizing, and sharing photographs.

Proposed Solution

For understanding the requirements of blind and visually impaired people taking, organizing, and sharing photos, we must involve the blind and visually impaired population directly, as well as people who are congenitally and adventitiously blind. The hypotheses of this work are:

H1: By enhancing the photo with audio and time, date, and location metadata, the user will retrieve photos with more accuracy.

H2: Congenitally blind people would prefer and perform better with linear organization, while adventitiously blind people would prefer and perform better with hierarchical organization. Once the first version of the system has been developed and implemented, usability and accessibility testing will be performed to make sure it is usable by blind and visually impaired people. Getting feedback from the participants on the current system will be necessary for improvement. Testing this system on at least 20 participants in a controlled study will provide useful feedback into how well it functions. The prototype application will be revised and retested until the system allows all participants in the testing phase to take, organize, and share photos. The remainder of this project consists of four distinct phases, for which I am involving people who are legally and totally blind, and congenitally and adventitiously blind. Each phase contributes to a prototype system which will be tested with at least 10 blind users and redesigned and tested based on user testing results.

Phase 1 seeks to assist blind people with aiming and capturing a photo, which involves computer vision algorithms to identify what is in the camera frame and provides feedback to the user of how to improve that frame (e.g., center an object).

Phase 2 seeks to develop a system to assist blind people to organize a photo library and successfully identify desired photos using the aforementioned non-visual cues to assist in identification via accessibility features available for Apple (VoiceOver [8]) and Android (TalkBack [9]).

Phase 3 seeks to develop a system to assist blind people to share photos online.

Phase 4 will bring all three phases together into a smartphone app that allows the user to capture, organize, and share photos all in one environment.

Stage of Research

Based on my literature survey, I argue that if I am to develop a blind-friendly application that can facilitate photography (taking pictures, recognizing them and sharing them through mainstream social networking tools) for those without or with limited sight, I need to first understand the photography habits, needs and preferences of blind persons. I ran an online survey among those who are totally blind, with light perception, and legally blind on Survey Monkey for a month in September 2012. I received 54 valid responses. Respondents ranged from 18 to 78 years old of age (mean = 47.6, S.D. = 18.79 years). There were 37 females and 17 males. Thirty-three were legally blind, nine with light perception, and ten were totally blind. I wanted to answer the questions "Are blind people interested in taking photos?", "Is a smartphone app a good choice to assist blind photography?", "What are the problems blind persons currently have with photo taking, sharing, and organizing?" and "Why aren't blind photographers sharing their pictures extensively?" I found that there is a significant interest in being able to take their own pictures. The survey also revealed that 31 out of all 54 participants (57%) in the survey use a smartphone to take photos, which suggests designing a smartphone application to assist with blind photography is a good choice. We asked participants to list problems they generally face with photography in order to inform the design of the application, for which 38 responses were received. Below is the summary of needs:

- Photo Taking: Aiming, focusing, positioning, and framing; Easy way to get sighted help; Accessible device; Improving photo quality.
- Photo Organizing and Editing: Identifying what's in the picture; Labeling the pictures; Manipulating pictures
- Photo Sharing: Easy way to get sighted help; Accessible photo sharing method.

To further inform useful features to meet additional needs by blind photographers, I designed an interview targeted to the blind photography community investigating current photography habits. The interview was completed by 11 people who have taken photos without sighted help and ranged from being legally blind to totally blind. Several features to accompany the previously mentioned iPhone application to assist with blind photography were extracted using open-coding qualitative analysis performed on the interviews. The following are the proposed additional features: Search function – annotates photos and audio files, user querie for keywords.

- Photo weeder – the user snaps many photos, and the best is chosen using computer-vision and machine-learning.
- Blur detection – the user is notified whether the frame is blurry, out of focus, or has poor lighting.

I and two other researchers analyzed the forum posts of a Flickr group "Blind Photographers" to further understand what kind of obstacles and solutions blind photographers encounter [10]. Some of the common obstacles observed with this group are: getting the right focus, inaccessible editing software and cameras/equipment, framing, and determining photo quality. We found some of the strategies blind photographers use to capture "good" photographs with this group are: taking lots of photos then weeding out low quality photos, just point and shoot, and take pictures of what is "visible" (i.e. something known in the environment).

Based on analyzing survey responses and the forum posts of the Flickr "Blind Photographers" group, I developed a prototype iPhone application to assist with photo capturing and retrieval for blind users, the details of which can be found here [5]. The application records ambient audio while the user is framing the camera, and the user can give an optional voice memo. The application also captures time, date and location metadata; these data serve the purpose of assisting the user in identifying their photos later. The application was tested with five people with low vision (ranging from legally blind to totally blind). Participants were pleased with being able to locate photos more quickly, due to the application, share stories of the photos and relive those experiences.

Envisioned Contributions

This research will provide an understanding of how blind people currently capture, organize and share photos. To my knowledge, only two studies have sought to understand how blind people are capturing photos [6,7], and none investigates how blind persons organize or share photos. This research will also seek an alternative to capturing a moment in time for blind persons. This system will provide a novel approach for aiming a camera using computer vision that can be provided to other research topics.

The technological value of my research work lays in the novel methods for i) computer vision algorithm to improve photo taking without sight; ii) audio life-logging to retrieve large amount of audio data. My work will also provide a deep understanding of how blind people take, organize and share pictures. This research will produce a technological artifact that turns a smartphone into a photo-taking aid without sight.

References

[1] UCR/California Museum of Photography. Sight Unseen. http://www.cmp.ucr.edu/exhibitions/sightunseen/

[2] Time Magazine - Photos by Blind Photographers, http://www.time.com/time/photogallery/0,29307,1897093_1883579,00.html

[3] Seeing Beyond Sight. http://www.seeingbeyondsight.org/home/

[4] Adams, D., Morales, L., Kurniawan, S. A Qualitative Study to Support a Blind Photography Mobile Application. Proc. PETRA 2013, ACM (2013).

[5] Harada, S., Sato, D., Adams, D., Kurniawan, S., Takagi, H., Asakawa, C. 2012. Enhancing the Photo Sharing Experience for the Blind. In Proc. Of CHI '13. Awaiting Publication.

[6] Jayant, C., Ji, H., White, S., Bigham, J.P. 2011. Supporting blind photography. In Proc. Of ASSETS '11. ACM (2011), 203-210.

[7] Vázquez, M. and Steinfeld, A. Helping visually impaired users properly aim a camera. In Proc. Of ASSETS '12. ACM (2012), 95-102.

[8] Apple - Accessibility - VoiceOver - In Depth. http://www.apple.com/accessibility/voiceover/.

[9] TalkBack – Android. https://play.google.com.

[10] Flickr. http://www.flickr.com.

About the Author:

Dustin Adams is a third year PhD student in Computer Science at the University of California, Santa Cruz. His research focuses on technology to assist people with visual impairment access photos via smartphone.

Sri Kurniawan is an Associate Professor in Computer Engineering at the University of California, Santa Cruz. Her research focuses on the design and evaluation of interactive systems that help people with special needs.

Enhancing Situational Awareness of Indoor Orientation for the Visually Impaired

Abdulrhman A. Alkhanifer
Rochester Institute of Technology (RIT), B. Thomas Golisano College of Computing and Information Sciences
Rochester, New York 14623 USA
akhnaifer@mail.rit.edu

Abstract

This research is to design a user interface dedicated for visually impaired users to assist them when orienting themselves to unfamiliar indoor environments. Current orientation and navigation systems research focuses on providing feasible solutions to assist users, however less focus is given to the user interface level and how it enhances user's understanding of the surrounding environment. Our proposal is to apply the Situation Awareness Oriented design approach to enhance the user interface of the current indoor navigation systems for the visually impaired.

1. Problem and Motivation

User interface (UI) that supports user's situation awareness (SA) can help in user' understanding of the surrounding environment and its changing factors [1]. Visually impaired (VI) users rely on their hearing sense to orient themselves in unfamiliar indoor environments. This includes their understanding of landmarks around them, and their direction in relation to these landmarks. When using navigation systems, VI users rely on system feedback to understand and adjust to new environments. Thus, indoor navigation system feedback plays a major role in users' SA. There are three goals for this work: enhancing user performance while navigating unfamiliar indoor environments, reducing user errors, and increasing user orientation and awareness of important surrounding landmarks.

We have two motivations for this work. First, most of the developed orientation and navigation systems focus on providing feasible assistive technologies for the VI in indoor environments; however, less focus is given to the UI interaction level and how it fits user needs to enhance their performance. Second, the orientation task in unfamiliar indoor buildings involves critical thinking and decision making, which makes it a good candidate for SA oriented design.

2. Research Questions

RQ1. *How can we enhance visually impaired users' situation awareness during orientation in unfamiliar buildings?*

RQ2. *What is an efficient and easy to learn user interface that supports visually impaired orientation and mobility in unfamiliar indoor environments?*

RQ3. *How can we enhance the safe performance of visually impaired users orientation in unfamiliar indoor environments?*

3. Literature Review

Recent research, has been developed to provide indoor navigation systems dedicated to the VI. Most research focuses on providing feasible navigation and orientation assistance; however, less focus was given to the UI level that enhances user performance. Fallah, et al. [4] developed a mobile-based indoor navigation system that provides one-by-one voice directions to a user's destination. Their UI was voice command input and voice output. Kulyukin and Nicholson [5] developed a way-finding robot that navigates indoors to guide VI users. Keypad and voice commands were their input UI. Voice was the output UI. Both of these systems provide only specific directional instructions to the users. This, however, does not help in enhancing a user's SA about the surrounding environment, and thus building a better mental map. Our focus is different from previous work. We aim to enhance the user understanding of the surrounding indoor environment to help them in building their mental map, and therefore perform better.

4. Solution

SA can be divided into three levels [3]: perception, comprehension, and projection. Having all three levels will incorporate a good SA for users. In 2003, Endsley et al. [1] introduced SA oriented approach as a user-centered design approach that focuses on the dynamics between information presented on the UI and user goals. This type of design focuses on assisting users to maintain a good SA level. SA oriented design consists of three steps: requirements stage, design, and SA evaluation. The requirement stage focuses on eliciting SA requirements which represents the information needed to perform user goals. The design stage is where UI prototype is conducted. Endsley et al. [1] provided 50 design principles to be taken into account when designing for SA. After finishing the design, the evaluation stage can be conducted to ensure that our UI enhanced users' SA.

Our proposed work can be divided into three steps: user studies, design stage, and evaluation stage.

For the first step, we started by conducting an initial user study for the domain understanding. We intend to conduct a follow-up study to elicit system and SA requirements. We will use our initial study feedback to tailor our follow-up one. Using our results, we will conduct SA requirements analysis where we identify every SA requirement and its related UI information.

The second step is the design. We intend to use the participatory design approach [6], which provides high involvement by users in the design process. This involvement helps in identifying user needs, and validating the design iteratively. We aim to recruit four VI users to be involved in our design stage. Users will participate in and validate every step of the design. Additionally, recruits will initially test the UI usability. As for the prototype, we intend to use a hands-free orientation device that can be used in addition to a user's white cane. Our device can assist users when entering unfamiliar indoor environments. The reason for our consideration is that VI users are advised to keep their other hand free when navigating to be able to protect themselves in case they fall.

The final step of our research is the experimental work. Experiments are intended to test and validate our design. Two types of tests that we use: usability, and experiments. Usability tests assess our UI usability. Experiments are intended to validate that our design enhanced user's SA. Unlike SA experiments that are conducted in simulators, we will conduct our experiments in a controlled realistic environment, such as our college building. Pilot experiments will be conducted with fewer participants than the final experiment to ensure that experiment variables are well controlled. For our final test, we aim to recruit 15-20 VI. Participants' criteria are VI cane users, with no mobility issues, ability to hear, and have no prior experience in the test building. The reason we focus on cane users is that we found through our previous user study that cane users have greater needs for orientation assistance than guide dog users. Participants will be placed in two groups. Group A will navigate the building with their canes and our prototype, while group B will navigate only using their canes. We are currently reviewing SA measures to be used for our experimental setup. We are considering the use of SA direct objective measures such as SA Global Assessment Technique (SAGAT) [2]. In SAGAT, randomly within the orientation and navigation tasks, users can be asked by a tester to pause and answer questions about their SA. Each SAGAT question represents an SA requirement. In addition to the SA metrics, we are reviewing other navigation metrics that can help in inferring user performance, such as time to perform task, number of navigation errors (e.g., missing a turn), and path length in feet.

5. Stage

We are still in the early stages of this work where we're creating the domain understanding and initial user studies. As a first step of this work, we have conducted an initial user study to understand the orientation problems that persist with VI users in indoor environments. We conducted semi-structural interviews with 24 VI users from five different countries. Our results show different orientation needs for VI when entering unfamiliar buildings. Needs vary from abstract basic information about the indoor environment to more detailed information about the path and surrounding landmarks. Clock positioning was reported as the preferred way to explain positions around users.

6. Contribution

The key contribution of this work is to enhance user performance by applying the SA design theory to indoor navigation systems dedicated to the VI.

References

[1] Endsley, M.R. 2011. Designing for Situation Awareness: An Approach to User-Centered Design, Second Edition. CRC Press Inc., Boca Raton, FL, USA.

[2] Endsley, M.R. 1988. Situation awareness global assessment technique (SAGAT). In proceedings of the IEEE National Aerospace and Electronics Conference, (Dayton, OH, USA, May 23-27, 1988). NAECON 1988. 789–795 vol.3.

[3] Endsley, M.R. and Garland, D.J. eds. 2000. Situation Awareness Analysis and Measurement. Lawrence Erlbaum Associates, Mahwah, NJ, USA.

[4] Fallah, N., Apostolopoulos, I., Bekris, K. and Folmer, E. 2012. The user as a sensor: navigating users with visual impairments in indoor spaces using tactile landmarks. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (New York, NY, USA, 2012), 425– 432.

[5] Kulyukin, V., Gharpure, C., Nicholson, J. and Osborne, G. 2006. Robot-assisted wayfinding for the visually impaired in structured indoor environments. Auton. Robots. 21, 1 (Aug. 2006), 29–41.

[6] Muller M. J. 2002. Participatory design: the third space in HCI. In The human-computer interaction handbook, J. Jacko and A. Sears, Eds. L. Erlbaum Associates Inc., Hillsdale, NJ, USA 1051-1068.

About the Author:

Abdulrhman Alkhanifer is a Ph.D. student in the Computing and Information Science Program at Rochester Institute of Technology (RIT) in Rochester, NY. Abdulrhman is advised by Dr. Stephanie Ludi from the software engineering department. His research focuses on enhancing the user interface of the orientation assistive technology for the blind.

Exergames for children with motor skills problems

Karina Caro
Department of Computer Science, CICESE
Ensenada, Baja California, México
karicaro@cicese.edu.mx

Abstract

Physical therapy helps children with Developmental Coordination Disorder (DCD) generalize motor functions executing different physical exercises through practice, repetition, and guidance. Children find task-repetition boring and guidance could not be provided outside the therapy-room in real life situations. Exergames are good in supporting motor therapeutic interventions as children find them engaging, but little has been said if the practicing of motor skills through exergaming enables skills generalization. The goal of this project is to investigate the impact of using exergames to help children with motor skills problems improve motor coordination and achieve motor skills generalization in real life situations. To date I have completed a contextual study to uncover the type of exercises children with DCD conduct during physical therapy, and inform the design of Froggy Bobby –an exergame supporting the motor skills generalization of children with DCD.

Introduction

Developmental Coordination Disorder (DCD) is a marked or serious impairment in the development of motor function and coordination (American Psychiatric Association, 2000). Children with DCD experience sensory impairments, and problems in gross and fine motor skills (Asonitou et al., 2012). Physical therapy or motor training enables over time motor skills retention and generalization (Hillier, 2007). However, conducting a successful physical therapy is challenging. As it involves task-repetition that children find boring, and the motor exercises practiced during training lack of realism to help children generalize from the therapy-room to other environments when specialists are not at their side to provide step-by-step guidance (Asonitou et al., 2012).

It has been demonstrated that exergames can be a good tool for use with therapeutic proposes for motor functioning (Goh, Ang, & Tan, 2008) and help children to practice motor skills at "anytime and anywhere" (Yim & Graham, 2007). I hypothesized exergames could also serve as a basis to build better evidence-based treatments to improve motor coordination and promote motor skills generalization to support children with DCD.

Related work

In the literature, several projects have investigated how exergames: serve for entertainment [e.g., Dance Dance Revolution (Behrenshausen, 2007)], promote physical activity [Astrojumper (Finkelstein, Nickel, & Suma, 2010)], and support motor rehabilitation [e.g. Arrow Attack (Burke et al., 2009)]. The use of exergames has been explored in support of different populations [e.g., children with cerebral palsy (Hernandez et al., 2012) , older adults (Tsai, Chang et al., 2012) , and stroke patients (Burke et al., 2009)]. For example, Hernandez et al., 2012 presents an exergame that enables children with cerebral palsy to use a rehabilitation bicycle to control an avatar who has to ride a unicycle while carrying a tray full of eggs in each hand. This study shows exergames benefits physical activity, which may have an impact on health (Yim & Graham, 2007) and in motor skills rehabilitation (Burke et al., 2009). However, none of these studies shows the usefulness and feasibility on using exergaming for motor skills generalization.

In light of the related literature, I will investigate the following research question: *What is the user experience and the efficacy of exergames to help children with DCD generalize the motor skills learned in therapy-rooms to real life situations?*

Methodology

I will follow a user-centered methodology using a mixed-method approach including multiple qualitative and quantitative methods to design and evaluate an exergame for motor skills generalization of children with DCD (see Figure 1).

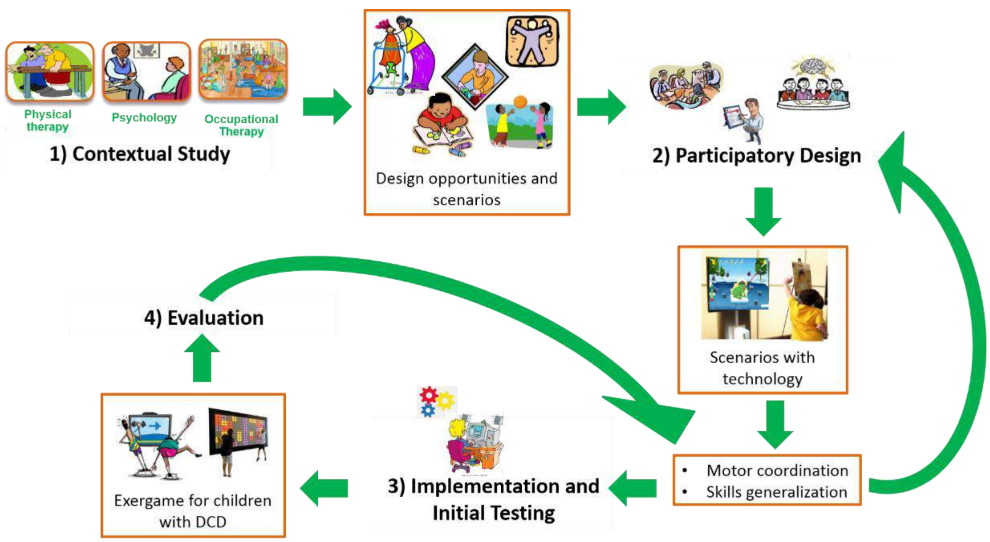


Figure 1: Proposed methodology for the research process.

First, I will conduct a contextual study (1) to identify the motor skills important for skills generalization, understand current activities and exercises students with DCD execute with trained specialists during physical therapies, and envision a set of realistic scenarios showing the potential of exergames.

Then, I will use these scenarios to iteratively design (2) an exergame to support motor coordination and the generalization of the motor skills identified as particularly important in our fieldwork. I will use multiple design methods for the design of a set of low-fidelity prototypes that will be evaluated with potential users. Based on the results of these evaluations, I will then develop (3) a more robust exergame suitable for a field trial.

Finally, I will evaluate (4) the usability, usefulness, and effectiveness of the developed exergame through both in-lab and a deployment study. First, I will conduct a usability study with our developed exergame inviting parents and therapists of children with DCD to use the exergame deployed in the usability lab. Next, I will conduct a deployment study for six months at home with several children with DCD, to demonstrate how the exergame supports motor coordination and promotes skills generalization of children with DCD.

Completed work

To date I have conducted a contextual study and the design of a low-fidelity prototype of the exergame.

Contextual study

For a period of 4 months, I conducted a contextual study at a public rehabilitation center located in Ensenada, Mexico where 10 trained specialists (i.e., psychologists, physical therapist, rehabilitation doctor, occupational therapist) serve approximately to 100 patients with different motor impairments. I interviewed 5 specialists and observed how they conduct motor skills therapies at this clinic. Interviews lasted around one hour and the time of observation was about a half of hour per therapy session, for a total of eight observed therapies. I used affinity diagramming to group quotes obtained from interviews and observation-notes, and uncover potential emerging themes related to the treatment of children with DCD, the problems during the therapy sessions, and the strategies used by the specialist to address these problems.

The results of the contextual study indicate that motor therapies involve short-term goals and include the repetition of exercises matching a potential motor skill children could use it later in real life situations. For example, children practice move their arms up, down, left, right and lateral following verbal instructions for self-caring (e.g., crossing arms when dressing) or practicing sports (e.g., kicking the ball to play football).

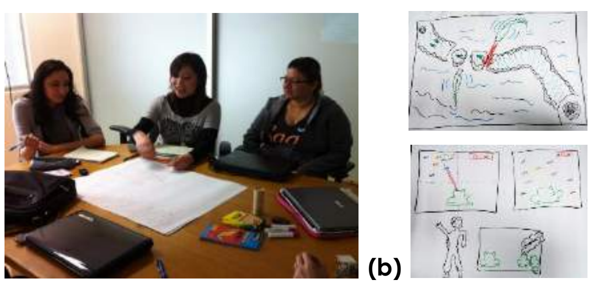

(a) (b)

Figure 2: Design process: (a) the design team during one participatory design session; (b) mock-ups of the proposed low-fidelity prototypes.

I used the results of the study to iteratively design several low-fidelity prototypes (see Figure 2) that exploit the short-term skills generalization goals, and motor exercises children with DCD practice during physical therapy. The low-fidelity prototypes were discussed during several participatory design sessions that help me to select the more appropriate prototype to develop.

Exergame design: first design of Froggy Bobby

I envisioned Froggy Bobby, an interactive exergame to help children improve motor coordination and to promote motor skills generalization. When using Froggy Bobby, children move their arms in a coordinated manner to catch multiple-colored flies by controlling the tongue of the avatar: the frog Bobby. Children must catch as many flies as they can to help Froggy Bobby feed friends and relatives.

Froggy Bobby has different levels varying the amount of prompting children gain from the game, the difficulty for catching flies, and the coordination exercises children use to catch flies. These coordination exercises mimic typical motor exercises children practice during therapies and were identified appropriated by therapists in the design team. For example, during levels 1-3, Froggy Bobby draws flies' trajectories demanding children to move their arms from side to side catching multiple-colored flies; on levels 4-5, Froggy Bobby demands children to move arms down, up, right, left to avoid "mad" mosquitoes that make the frog feel sick; and on level 6, Froggy Bobby asks children to match movements with a color to catch matching flies.

On each level and for every fly caught, children earn points and coins they could later exchange for items to personalize their avatar (e.g., hats, eyeglasses, shoes) or powerful flies they could use to their benefit (e.g., disappear all the "mad" mosquitoes). Froggy Bobby proportionally controls flies' speed according to children's activity intensity. Each level has a goal a child has to complete to move onto the next level (i.e., catch a pre-determined number of flies) –e.g., in level 1, children have to catch 20 flies. The number of flies increases on each level.

(a) (b) (c)

Figure 3: Froggy Bobby´s Screenshots: (a) Map to show the levels of the game; (c) Bobby catching flies and taking powerful flies; (d) Store where children can buy different accessories to personalize Bobby.

At the side of skills generalization, after a set of completed levels, children have to play a mini-game that demands from the child to use the previously practiced coordination movements to achieve a specific motor skill useful for self-caring and practicing sports (e.g., dressing/undressing, throw a ball in a specific point).

To show how children can use Froggy Bobby here I present a scenario:

Max, an 8-year old child with DCD, uses Froggy Bobby to practice coordination movements and motor skills. Froggy Bobby asks Max to move his arms up, down, right, and left to discover the distance between Max's arms and each quadrant on the screen. Froggy Bobby uses this information to decide the maximum and minimum level where flies and mosquitoes could be placed on the screen. Max navigates between levels displayed on a map (see Figure 3a) and enters level 1 where multiple-colored flies fly around the frog Bobby. Max moves his arms from side to side moving Bobby's tongue to catch flies (see Figure 3b). Max moves rapidly and when catching the 20 flies required to complete this level, he earns 20 coins. Then, Froggy Bobby asks Max to remove his shirt by coordinately moving their hands. Max executes the movements correctly and earns 50 more coins. Finally, Max uses his coins to buy Bobby a hat (see Figure 3c).

Preliminary formative evaluation

I gathered feedback from 24 typical children to uncover new design insights to improve *Froggy Bobby*'s design, and get a sense of potential users' engagement, and usefulness, ease of use and perceived intention to use *Froggy Bobby*. I presented a video showing different scenarios of children using *Froggy Bobby,* and asked participants to answer a survey including topics related to perceived acceptance, engagement, and potential new design features.

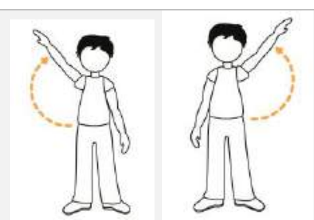
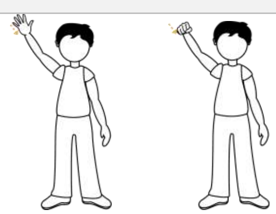
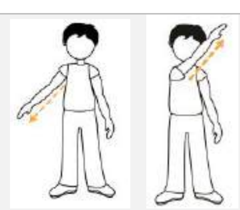
Results show that 96% of participants would use *Froggy Bobby*, and believe it would enhance motor coordination. 83% perceived *Froggy Bobby* is easy to use, and all children expressed *Froggy Bobby* and the motor-exercises are fun. 96% perceived the avatar is interesting and fun, and some children provided additional insights for improving the design —*e.g.*, include other avatars like monkeys or bears for catching bananas or bees, and to use legs to step on bugs.

Current work

Taking into account the results from the formative evaluation, I am re-designing the game. Particularly, I am closely working with a physical therapist in redesigning the motor exercises used to control Bobby's tongue. We are using the proprioceptive neuromuscular facilitation stretching techniques commonly used in athletic and clinical environments to enhance both active and passive range of motion, and to optimize motor performance and rehabilitation (Sharman, Cresswell, & Riek, 2006). We defined three set of exercises serving as a basis to execute different motor skills (see Table 1):

- Strength and motion control exercises improve "arms strength and arc of movement" and facilitates hair washing, bathing, and drying with a towel.
- Coordination and visual spatiality exercises improve "arms coordination and spatial orientation" and facilitates dressing, buttoning, and the manipulation of zippers and objects.
- Cross-lateral exercises improve "brain and body coordination" and improve teeth brushing, toothpaste manipulation and dressing balance.

Table 1: Set of exercises proposed for redesign the levels of the game.

Exercises	**Example**
Strength and motion control exercises	
Coordination and visual spatiality exercises	
Cross-lateral exercises	

With these group of exercises, I am planning redesign different levels of the game and select the parameters to be measured by the game.

Future work and conclusions

As future work, I plan to conduct several participatory design sessions and focus groups with specialized clinicians (i.e., rehabilitation doctors, physical therapists, occupational therapists, psychologists) and with children with DCD, to obtain different design insights, and improve and validate the game design. In addition, it is important to evaluate different models for promote motor skills generalization through an exergame (i.e., video modelling and avatar animations) and to select the motor skills that can have a major impact in the quality of life of children with DCD.

Now, I am starting with the development of some features of the exergame, including movement tracking. After de development, I will deploy the game in home of several children with DCD (approximately 8 children) to investigate the exergame's impact in motor coordination and skills generalization. I expect that the results extend my understanding of the design space of exergames for achieving motor skills generalization in real life situations.

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References

American Psychiatric Association. (2000). Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) (Four Editi., p. 943). Washington, D.C.

Asonitou, K., Koutsouki, D., Kourtessis, T., & Charitou, S. (2012). Motor and cognitive performance differences between children with and without developmental coordination disorder (DCD). Research in Developmental Disabilities, 33(4), 996–1005.

Behrenshausen, B. G. (2007). Toward a (Kin) Aesthetic of Video Gaming. The Case of Dance Dance Revolution. Games and Culture, 2(4), 335–354.

Burke, J. W., McNeill, M. D. J., Charles, D. K., Morrow, P. J., Crosbie, J. H., & McDonough, S. M. (2009). Optimising engagement for stroke rehabilitation using serious games. The Visual Computer, 25(12), 1085–1099.

Finkelstein, S. L., Nickel, A., & Suma, E. A. (2010). Astrojumper: Designing a Virtual Reality Exergame to Motivate Children with Autism to Exercise. In Virtual Reality Conference (pp. 267–268). IEEE.

Goh, D. H., Ang, R. P., & Tan, H. C. (2008). Strategies for designing effective psychotherapeutic gaming interventions for children and adolescents. Computers in Human Behavior, 24(5), 2217–2235.

Hernandez, H. A., Graham, T. C. N., Fehlings, D., Switzer, L., Ye, Z., Bellay, Q., … Stach, T. (2012). Design of an Exergaming Station for Children with Cerebral Palsy. In Human Factors in Computing Systems CHI'12 (pp. 2619–2628). Austin, Texas, USA: ACM.

Hillier, S. (2007). Intervention for Children with Developmental Coordination Disorder: A Systematic Review. Journal Of Allied Health, 5(3).

Sharman, M. J., Cresswell, A. G., & Riek, S. (2006). Proprioceptive Neuromuscular Facilitation Stretching. Sports Medicine, 36(11), 929–939.

Tsai, T., Chang, H., Huang, G., & Chang, C. (2012). WaterBall: The Exergaming Design for Rehabilitation of the Elderly. Computer-Aided Design & Applications, 9(4), 481–489.

Yim, J., & Graham, T. C. N. (2007). Using Games to Increase Exercise Motivation. In Proceedings of the 2007 conference on Future Play (pp. 166–173). Toronto, Canada: ACM.

About the Author:

Karina Caro is a Ph.D. Student in the Department of Computer Science at CICESE. With a background in Computer Systems Engineering, her research interests are in human-computer interaction, ubiquitous and pervasive computing, child-computer interaction and videogames for health. Her overall research goal is to apply technology to assist individuals with special needs, with special emphasis on children.

Motion-Based Game Interaction for Older Adults

Kathrin Maria Gerling
Interaction Lab, University of Saskatchewan
110 Science Place, Saskatoon SK S7N 5C9, Canada
kathrin.gerling@acm.org

Abstract

Decreased activity reduces life expectancy, yet many institutionalized older adults lead sedentary lifestyles: age-related changes and impairments limit the number accessible leisure activities, and nursing homes struggle to provide mental and physically stimulating activities for their residents. In this context, motion-based video games – games that integrate physical user input – are one opportunity of fostering physical activity, and research suggests that these games have a variety of positive effects on the well-being of older adults. However, currently available games are too demanding for this audience. My research will help foster the design of accessible and safe motion-based video games for older adults. In my PhD research, I explore motion-based game interaction design for older adults. By creating enjoyable video games for this audience, my research will help encourage cognitive and physical activity among nursing home residents, thereby increasing their quality of life.

Introduction and Background

Institutionalized older adults often lead sedentary lifestyles. Decreased activity adversely affects an individual's life expectancy, frequently leading to sedentary death syndrome (VanBeveren and Avers, 2012). Despite various efforts (Lee et al., 2011), few activities remain accessible to institutionalized older adults, and it is difficult to motivate them to remain cognitively and physically active as the impact of age-related changes grows: Common age-related changes include decrements in posture, balance and gait as well as fine motor skills (Czaja and Lee, 2006). Aging also negatively affects sensory processes such as vision and hearing (Czaja and Lee, 2006). Additionally, age-related changes negatively influence cognitive processes such as short-term memory, attention and vigilance (Czaja and Lee, 2006). Motion-based video games integrate physical user input to engage the player (Mueller et al., 2011). Much work has focused on creating sports-like experiences to fight sedentary lifestyles among younger audiences. Despite research results suggesting positive effects of such games on player cognition (Gao and Mandryk, 2012) and physical health (Whitehead et al., 2010), little research regarding the application of such systems for older adults is available. In this context, age-related changes and impairments have an impact on game accessibility; motion-based game controls extensively build on the player's physical abilities. Therefore, it is important to consider the needs of older adults when designing motion-based game interaction to provide safe and enjoyable gaming experiences.

Problem and Motivation

The overall goal of my research is to address the issue of decreasing levels of physical and cognitive activity among older adults through the design of motion-based video games. To be able to create video games that are accessible and engaging, it is important to understand the impact of age-related changes and impairments on player experience in general and game accessibility in particular. In this area, little research with a focus on motion-based games for older adults is available. The current generation of motion-based video games is largely designed for younger, able-bodied players. Therefore, many games are not suitable for older adults as they do not meet their needs in terms of game accessibility: input gestures may be too challenging for older adults, the pacing of games may not be appropriate, and game concepts targeting younger generations may not appeal to older adults. As a result, nursing homes struggle to offer video games as an enjoyable leisure activity, and many older adults require assistance when playing motion-based games, and cannot obtain the full benefits of engaging with these games despite their large potential to fight sedentary lifestyles.

Proposed Solution

In my research, I will address this issue by investigating how motion-based game interaction can be applied in a way that is accessible and enjoyable for older adults. In this context, it is important to examine motion-based game design for older adults from two perspectives. First, it is important to understand how older adults interact with motion-based game controls. Second, integrating suitable input methods into appealing game concepts is another crucial aspect of the deployment of motion-based video games for older adults. A number of steps have to be completed to reach this solution. My dissertation work includes five studies that investigate different aspects of motion-based game interaction for older adults.

1. Examining differences between sedentary and motion-based game controls to determine their overall feasibility for older adults. This part of my research has been completed, and results show that motion-based game controls are suitable for older adults (Gerling et al., 2013a).
2. Exploring whether motion-based game controls are suitable for institutionalized older adults, and how they would have to be implemented to be accessible and enjoyable for this audience. Results show that full-body motion-based game controls can be made accessible for older adults, but various challenges have to be addressed (Gerling et al., 2012).
3. Because many nursing home residents use walking assistance, the inclusion of wheelchair-based input is an important step towards the general accessibility of motion-based games for older adults. This part of my research investigates wheelchair input for motion-based games for older adults (Gerling et al., 2013b).

Based on the results of these studies, I plan to implement two motion-based games addressing different challenges in motion-based game design for institutionalized older adults.

4. The first game will implement principles of casual games to facilitate the long-term deployment in a nursing home environment to determine whether motion-based games appeal to institutionalized older adults over a longer period of time, and what

challenges need to be addressed to allow players to interact with games without external facilitation.

5. The second game will explore how we can apply motion-based video games to help build healthy relationships between older adults and caregivers by releasing stress through the engagement in play, contributing to the quality of life of both caregivers and patients.

Stage of Study and Research

I have completed all formal requirements of my PhD program (coursework, comprehensive exam, research proposal) other than giving an overview of my research to the department, and the preparation and defense of my thesis. I have completed the first two studies of my research (comparing sedentary and motion-based game controls for older adults (Gerling et al., 2013a), and full-body motion-based game interaction for institutionalized older adults (Gerling et al., 2012). My work on wheelchair-based game design has been presented at the ASSETS 2013 conference (Gerling et al., 2013b). I am currently working on the remaining games (long-term player motivation, games to connect older adults and caregivers; see list above). I hope to complete this part of my research by the end of 2014 and submit my work to CHI 2014 and the Entertainment Computing journal.

Expected Contributions

My research will make two main contributions in the fields of interaction design and game design for older adults. First, it will provide a systematic examination of motion-based game interaction for older adults, which is a crucial step towards designing motion-based video games that are accessible for this audience. Based on the results of the first two studies, I developed design guidelines for the creation of accessible motion-based game interaction. These considerations extend beyond the application to game design; results of my work generalize to interaction design for older adults and can help inform the work of designers in many fields, e.g., in ambient-assisted living. Second, the last two studies of my dissertation research aim to explore motion-based game design for older adults with a focus on game accessibility and player engagement. Based on the results, it will be possible to evaluate the overall feasibility of motion-based video games in a nursing home context.

On a general level, my work will provide answers to the question of whether motion-based video games can be designed in a way that is accessible and engaging for institutionalized older adults. On that basis, it will be possible to determine whether motion-based video games are a suitable means of fighting sedentary lifestyles among this audience, thereby using games to increase the quality of life of nursing home residents.

References

Czaja, S.J. and Lee, C.C. Information Technology and Older Adults. In: Sears, A. & Jacko, J.A. (Eds.): The Human-Computer Interaction Handbook. Lawrence Earlbaum Associates, New York and London (2006).

Gao, Y. and Mandryk, R.L. (2012). The Acute Cognitive Benefits of Casual Exergame Play. In Proc. of CHI 2012, ACM, New York, NY, USA.

Gerling, K.M., Dergousoff, K., and Mandryk, R.L. (2013a). Is Movement Better? Comparing Sedentary and Motion-Based Game Controls for Older Adults. In Proc. of GI 2013, ACM, New York, NY, USA.

Gerling, K.M., Livingston, I.J., Nacke, L.E., and Mandryk, R.L. (2012). Full-Body Motion-Based Game Interaction for Older Adults. In Proc. of CHI 2012, ACM New York, NY, USA, 1873-1882.

Gerling, K.M., Mandryk, R.L., and Kalyn, M.R. (2013b). Wheelchair-Based Game Design for Older Adults. In Proc. of ASSETS 2013, ACM, New York, NY, USA.

Lee, Y.S., Basapur, S., Chaysinh, S., and Metcalf, C. (2011). Senior Wellness: Pracitices of Community Senior Centers. In EA of CHI 2011, ACM, New York, NY, USA.

Mueller, F., Edge, D., Vetere, F., Gibbs, M.R., Agamanolis, S., Bongers, B., and Sheridan, J.G. (2011). Designing Sports: A Framework for Exertion Games. In Proc. of CHI 2011, ACM, New York, NY, USA, 2651-2660.

VanBeveren, P.J. and Avers, D. Exercise and Physical Activity for Older Adults. In: Guccione, A., Wong, R.A., & Avers, D. (Eds.). Geriatric Physical Therapy. St. Louis: Elsevier (2012), 64-85.

Whitehead, A., Johnston, H., Nixon, N., and Welch, J. (2010). Exergame Effectiveness: What the Numbers Can Tell Us. In Proc. of Sandbox 2010, ACM, New York, NY, USA.

About the Author:

Kathrin Gerling is a Ph.D. Candidate at the Interaction Lab at the University of Saskatchewan. Prior to moving to Canada, she obtained a Master's degree in Cognitive Science from the University of Duisburg-Essen, Germany. Her research interests evolve around video games with a purpose beyond entertainment. Before joining academia, she worked on different projects in the games industry.

Automatic Assessment of Problem Behaviour in Developmental Disabilities

Reuben Kirkham
Culture Lab, School of Computing Science, Newcastle University
Newcastle Upon Tyne, United Kingdom
r.kirkham@newcastle.ac.uk

Abstract

Many with developmental disabilities, especially severe Autism, exhibit what is clinically known as `problem behaviour', which includes persistent episodes of self-injury, aggression and disruption. Current treatments rely upon manually counting the individual episodes over a period of several weeks, which presents challenges in respect of accuracy, feasibility, and scalability. Situated in the domain of Human Activity Recognition, the goal of this PhD Project is to develop a system that automatically recognizes different types and degrees of problem behaviour on the basis of accelerometer sensor data. The proposed approach is detailed and justified, including how the field of Human Activity Recognition itself can be advanced, together with a clear plan of how the project is to be conducted.

1. Introduction

Problem Behaviour in Autism and related disabilities refers to the variety of severe behavior's exhibited by some children, including biting, hand-flapping, self-injury, and other forms of behaviour [1]. Against our current knowledge, Autism remains challenging to treat the implications and impacts of, with the only recognised approach towards analyzing problem behavior's is via the means of a Functional Behaviour Assessment (FBA) [2], which is necessary to inform future treatment. More specifically, an FBA is aimed at understanding the individual causes of an individual's particular behavior's and the patterns behind them. This currently involves trained observers spending a number of weeks counting and classifying each behavioural episode in a clinical setting; naturally this is expensive, unreliable, and takes place in locations very different to the children's usual environment.

The aim of this PhD project is to develop a system that automatically assesses problem behaviour in a quantitative fashion without the direct intervention of clinicians or observers, and thereby increase the quality and availability of these assessments, and in turn free up clinical time to perform the treatments necessary. This approach has been explored in a previous pilot study [3], which used accelerometers in order to classify with a reasonable degree of accuracy between the broad categories of Aggression, Disruption, and Self-Injury in a clinical setting. In order to have substantial utility in the clinical setting, this project needs to make a more fine-grained classification between a greater number of subclasses, provide an indication of the severity of the behaviour, whilst being validated against a more naturalistic setting. Other challenges are designing the system so that the individuals will tolerate it, given the sensory difficulties presented by most children with autism, as well as ensuring that the system is accepted within the parent and practitioner communities.

The approach of this project is situated in the discipline of Human Activity Recognition (HAR), and more specifically the emerging field of Computational Behaviour Analysis (CBA). To date, HAR has largely focused upon the recognition of basic actions, such as walking, running, and jogging, or simple gestures [4], [5] and this project aims to adapt and improve the necessary time-series methods well-honed in other domains and the wider HAR community, in order to accomplish the goals of the project. Similarly, despite the potential of Ubiquitous Computing systems to help in this domain, there have been very few efforts directed towards deploying ubiquitous computing systems in the autism domain to date. This proposed project therefore builds upon existing work, whilst nonetheless adopting a similar set of concerns to existing projects, namely the design of a system for effective data collection, the collection of data using the system (including the design of an annotation system acceptable in a non- mainstream school setting), and the processing of the resulting data into an effective recognition system.

This project is supported by Dr Plötz's collaborators in Atlanta (United States): Georgia Tech and the Marcus Autism Centre. As such, the project has access to both pilot data and results of on- going data collection efforts, as well as the opportunity to assert clinical relevance, by ensuring that the resulting system meshes well with the parent and practitioner communities. In what follows, the more detailed background is developed, before a clear statement of the problem at hand together with a timetable for effectively tackling it.

2. Progress to Date

Given that the pilot aspect of this project was completed prior to my arrival, much of the initial focus of this project has been upon data collection in order to scale the project from one participant onto the broader population of those with developmental disabilities, as well as providing the opportunity to engage in broader projects in relation to Ubiquitous Computing, including the BreakTime Barometer, which is a social awareness system recently published in ACM Ubicomp 2013 [6]. However, I have also been able to engage in several research projects that directly underpin the endeavors, specifically the following (expanded upon below):

- Data Collection and Automatic Annotation Correction
- Evaluation of a new Feature Methodology for Activity Recognition
- Investigating Appropriate Sampling Rates for Activity Recognition
- Legal Methods in relation to Assistive Technology and Ubiquitous Computing

2.1 Data Collection and Annotation Correction

Much of the initial work has focused upon data collection, which is fundamental to any work in the domain of activity recognition; any system must be developed (or in machine learning parlance, trained) and then tested using real human data captured using the sensing technology under study. Data from a relatively large number of participants (all of whom are being treated in the behavior clinic) is being collected through the Marcus Autism Centre involving around 15 children with autism and associated developmental disabilities, with four accelerometers (on each wrist and ankle)in relation to those who will tolerate it, and with two sensors in those who only tolerate their use on their wrists.

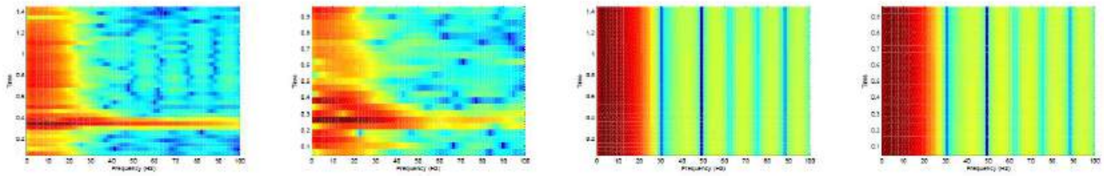
We will receive two forms of annotation from the Marcus Autism Centre and Georgia tech. The first will be real time, using the BDACS system that is currently used for problem behaviour assessments (i.e. annotations that are collected regardless); the second will be post facto, and thereby more accurate, annotations created by reviewing video footage. Given the resource involved in creating the additional annotations, this approach is not sustainable, and we wish to automate improving upon them as far as is practicable. This is particularly important in relation to problem behavior; because of the heterogeneous nature of its manifestation in different individuals, there is a need for a greater number of individuals to supply data for the system itself, otherwise the validation and system performance will be limited.

As such a substantive amount of my effort has been directed towards automatic correction of time series boundaries in activity data, which has the natural effect of greatly reducing annotation effort, and in turn will allow live annotations to be used in place of post-facto ones. Some of this initial work has been published [7], and an improved algorithm validated upon a wider range of applications is currently under review for future publication. The overall goal of this research is to expand the amount of data collected, and therefore make a wider range of applications, including specific datasets related to particular groups of disabled people feasible, thereby in turn widening access to Ubicomp systems for those with disabilities (amongst others).

Another problem within the domain of activity recognition is the lack of a large amount of general data from people without disabilities, which makes validation challenging where a system should not be confounded by so-called ‘normal’ behaviour. We plan to resolve this issue, by collecting from a broad community a large set of non- annotated ‘null data’, which is highly unlikely to have instances where the user is engaging in the specific activities to hand.

2.2 Feature Selection in Activity Recognition

With colleagues, I have engaged in evaluating a new feature representation for activity recognition in relation to accelerometer (and other sensor) data. This is known as the Empirical Cumulative Distribution Function, and takes a frame (or window) of accelerometer data and computes its cumulative distribution. The resulting evaluation, published in ISWC 2013 [8], found that this feature representation was superior to the state of the art in most circumstances, only breaking down in relation to determining the distinction between symmetric activities.



(a) Hitting a wall (100Hz). (b) Hitting a person (100Hz). (c) Hitting a wall (20Hz). (d) Hitting another person (20Hz).

Figure 1: Illustrations of the frequencies in the activity data for aggression directed towards people and objects. It can be clearly seen that a large amount of the relevant frequency information is lost if it is down-sampled to 20Hertz from 100 Hertz.

2.3 Determining Appropriate Sampling Rates for Accelerometer Data

Accelerometers are comparatively efficient sensors, although the amount of power they draw is proportionate to the sampling frequency, and therefore it is desirable to minimize its usage for data collection. The problem is determining the most appropriate sampling rate to use whilst not significantly reducing recognition performance. Although there has been previous work which investigates appropriate sampling rates, and suggests 20Hertz as being appropriate, these do not necessarily apply to the more complex range of activities likely to be relevant to a ubiquitous assistive technology. In relation to severe behavior, this is clearly illustrated by the Spectrograms in Figure 1, which shows the impact of different frequencies on discrete activities in relation to this particular activity recognition problem.

2.4 Disability Discrimination Law as Applied to Ubiquitous Computing

I have recently begun to explore the implications of disability discrimination law for Ubiquitous Computing, which has been published in a recent short work at the (UK) Digital Economy Conference [9]. This turns out to be particular concern in the target problem domain, where treatments are often not made available to those with these disabilities, on the basis that they are inadequately evidenced because there is a lack of reliable quantitative evidence (e.g. in Auton vs British Columbia [2004]). In relation to the specific project at hand, a concern of interest is therefore using a ubiquitous system to provide evidence as to the efficacy of these treatments, and in turn, make them obligatory to fund under certain legal systems. Beyond this project, there is a wider concern towards making Ubiquitous Systems available to those with disabilities who might benefit them, and for this to be an entitlement in law, rather than something which might be optionally be provided. This largely underexplored space has had an initial investigation, which will be expanded upon in my future work.

3. Future Directions

Whilst substantive progress has been made on this project, there are two fundamental aspects which need to be completed in addition to expanding upon domains which have been explored so far. These are time series methods and the implementation of a system which is appropriate to the particular needs of the problem domain at hand.

3.1 Time-Series Data Approaches

A key improvement upon existing work would be to use appropriate methodologies, such as Hidden Markov Models or Conditional Random Fields, which take account of the ordinal aspects of the data, namely the fact that events and parts thereof are more or less likely to occur depending upon what might have followed previously. This would also allow any system to take account of clinical prior knowledge, as well as assisting with the limitations in the current formulation of the system. Part of this concern might involve exploring novel representations of events which would lend themselves towards crowdsourcing feature and model selection, and thereby enable the wider public to partake in this research.

3.2 Implementing an Appropriate System

One key concern is the aspects of recognition performance which are emphasized. For instance, it is possible to develop a system which offers higher recognition performance in relation to some activities over others. Similarly, any system would also have to be thoroughly validated to ensure that it was appropriate for the desired clinical setting. This would be a final step of the project, once a more mature framework for activity recognition has been developed, and a suitable amount of data annotated for training and testing of this framework.

3.3 Gameification of Feature Selection

A project that I have been recently engaged with is the gameification of feature selection, and thereby enabling an otherwise burdensome (and expensive) task be done without the use of a large amount of expertise in the activity recognition domain. In the context of machine learning, features translate the raw data by appropriately representing and summarizing it. This is currently in the prototype stage and undergoing evaluation.

3.4 Expanding upon Annotation Correction

The initial work in annotation correction has enjoyed some initial and substantive success. However, this could be improved upon and more strongly related to the real annotations generated in a treatment session, as opposed the simulated annotation errors in this work. The current method is also designed to be general in nature, whereas in the context of Severe Behaviour, in which there are likely to be in the order of 50,000 annotations in the initial dataset, it is consequently worthwhile tuning this method to the particular circumstances at hand. Future work will therefore be aimed towards addressing this.

Conclusion

The project relating to Automatic Assessment of Problem Behaviour has been presented, together with the current progress and future directions for research in this domain. If successful, this work has a great potential to provide more effective treatment for problem behavior in the context of developmental disabilities, as well as the opportunity to more effectively measure the efficacy of given intervention. Going forwards, this body of work should also have wider benefits in relation to the availability of activity recognition systems particular to the needs of different groups of disabled people.

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The author is grateful for comments on earlier drafts from Thomas Plötz, as well as to the support provided by the projects collaborators in Atlanta: Georgia Tech and the Marcus Autism Center.

Postscript

Since the Doctoral Consortium took place, the Digital Interaction Group has had further resource made available to pursue this work, particularly with respect to specialist technical expertise in relation to time-series data. The effect of this is that I have been afforded the opportunity to change focus in relation to my PhD Project, and in practice to broaden it. As a result, I have shifted towards examining the legal aspects of ubiquitous assistive technologies, including the broad concern of evidence gathering and support, and away from some of the more involved aspects of developing activity recognition methods and systems. The advantage is that my future work will be more closely aligned with the accessibility agenda as this relates to disabled people.

References

[1] E. G. Carr, "Emerging Themes in the Functional Analysis of Problem Behaviour," *Journal of Applied Behavioural Analysis*, vol. 27, no. 2, pp. 393–399, 1994.

[2] R. H. Horner, E. G. Carr, P. S. Strain, A. W. Todd, and H. K. Reed, "Problem behavior interventions for young children with autism: a research synthesis.," *Journal of autism and developmental disorders*, vol. 32, no. 5, pp. 423–46, Oct. 2002.

[3] T. Plötz, N. Hammerla, A. Rozga, A. Reavis, N. a. Call, and G. D. Abowd, "Automatic Assessment of Problem Behavior in Individuals with Developmental Disabilities," in *Ubiquitous Computing 2012*, 2012.

[4] L. Bao and S. S. Intille, "Activity Recognition from User-Annotated Acceleration Data," pp. 1–17, 2004.

[5] L. Chen, J. Hoey, C. D. Nugent, D. J. Cook, Z. Yu, and S. Member, "Sensor-Based Activity Recognition," *IEEE Trans on Systems, Man, and Cybernetics -- Part C: Applications and Reviews*, vol. 99, 2012.

[6] R. Kirkham, S. Mellor, D. Green, J. S. Lin, K. Ladha, C. Ladha, D. Jackson, P. Olivier, P. Wright, and T. Plötz, "The Breaktime Barometer – An Exploratory System for Workplace Break-time Social Awareness.," in *Ubicomp 2013: Ubiquitious Computing*, 2013.

[7] R. Kirkham, A. Khan, S. Bhattacharyra, N. Hammerla, S. Mellor, D. Roggen, and T. Plötz, "Automatic Correction of Annotation Boundaries in Activity Datasets by Class Separation Maximization.," in *Ubicomp 2013 Adjunct*, 2013.

[8] N. Hammerla, R. Kirkham, P. Andras, and T. Plötz, "On Preserving Statistical Characteristics of Accelerometry Data using their Empirical Cumulative Distribution," in *ISWC*, 2013.

[9] R. Kirkham, D. Roggen, T. Plötz, and P. Olivier, "Disability Law as a Driver for Innovation and Social Responsibility in Ubiquitous Computing," in *Digital Futures*, 2013.

About the Author:

Reuben Kirkham is a second year PhD Student at Culture Lab Newcastle University. His current research focusses upon the interface between ubiquitous assistive technology and disability discrimination law, with the aim of designing and validating new assistive systems in such a fashion that people with disabilities are entitled to access them. As part of this broader body of work, he also conducts research in the domain of applied activity recognition, with an emphasis upon systems directed towards helping to ameliorate some of disadvantages faced by people with a range of disabilities.

Facilitating Blind People To Independently Format Their Documents

Lourdes M. Morales Villaverde
University of California, Santa Cruz
1156 High Street, Santa Cruz, CA 95064, USA
lommoral@ucsc.edu

Abstract

There is evidence that blind people's documents are treated dismissively when they do not match "expected" standards of document presentation. Many blind persons feel it is important to format their document and rely on sighted people to help them format their documents. Still, research on word processors for blind people generally focuses on supporting tasks associated with writing documents rather than document formatting. My thesis research aims to help blind people be more independent in producing word-processed documents that meet the presentation standards expected by sighted readers. This will be carried out over the next four years, supervised by Prof. Sri Kurniawan and in collaboration with sighted and blind persons, as an iterative design and evaluation of a Microsoft Office add-in whose functionalities will be informed by what sighted people expect in well-formatted documents and the problems blind persons have with independent formatting using current tools.

Background and Motivation

There is considerable work that focuses on facilitating the interaction between blind people and computer-based applications [1,5,7], but there is not as much work on supporting blind people as creators of (electronic) documents. Research suggests that many blind people are uncomfortable with creating documents in which presentation is important or the documents are going to be read by "important" sighted readers, because they perceive that their documents are treated dismissively when their documents do not match "expected" standards of document presentation [2,4,8]. Sighted people credit these higher standards of presentation to the widespread usage of WYSIWYG (what you see is what you get) word processors [4]. Because blind people do not have access to the WYS part of WYSIWYG word processors, they are at a significant disadvantage when formatting documents. The study reported in [4] suggests that, since blind authors perceive that they have problems with document presentation, it is common for them to have their documents checked or produced by sighted peers. This means that blind persons cannot be as productive and independent as their sighted peers when creating documents. Likewise, sighted help is not always cheap or readily available, which also hampers blind peoples' productivity. Moreover, the study reported in [4] also notes that documents produced by blind people, while well written grammatically, often contain errors that fall into two broad classes: formatting and layout errors (a formatting error is the incorrect or inconsistent formatting of text and a layout error is the incorrect or unusual positioning of text on a page). Hence, there is a need for work that focuses on facilitating blind people to independently format their documents. Which is why the proposed research focuses on the design characteristics of tools that will help blind people to independently format their documents.

Related Work

There is extensive work into making the formatting and comprehension of mathematical equations accessible [3], but it does not generalize to creating well-formatted electronic documents. There is work on helping (sighted) authors "format" their documents for easier navigation and comprehension, but most of it deals with summarizing documents rather than actually formatting them [9]. Tools that employ a separation of content and style when creating documents like LaTeX can definitely mediate the issues, but this usually requires quite advanced technical knowledge, which would unavoidably exclude a percentage of blind persons.

Thesis Research

The overarching goal of this work is to facilitate independence for blind authors so that they may produce documents that match the presentation standards expected by sighted readers. The proposed research is for the development and evaluation of a Microsoft Office Word add-in (still the most commonly used electronic document creator) to address this issue. To develop an appropriate application, I will first gain an understanding of the interaction between blind authors, electronic documents and screen readers; and of how to optimize this interaction in a way that blind authors find useful and usable, through a combination of online surveys, interviews and focus group discussions. I will then use participatory design with screen reader users to develop the add-in iteratively.

Status of Research

We have collected around 500 documents created by blind persons, both informal (e.g., emails, blog posts, etc.) as well as formal ones (e.g., course assignments, letters). We also collected 500 documents from comparable sighted samples, and analyzed the formatting and layout errors. We interviewed 20 sighted persons on the strategies and expectations of sighted readers regarding document formatting and presentation of well-formatted documents, and 5 blind persons about their problems with document formatting using current tools. We also ran an online survey at SurveyMonkey.com for a month in October 2012 on document formatting and tools used to format documents among people who are blind (at most some light perception) and use word processors and screen readers. From the online survey, which was completed by 21 participants, we gathered more information on the challenges blind people face when independently producing and formatting word-processed documents with current tools and their ideas on possible solutions. As a result, several design guidelines for tools that can mediate formatting problems for blind persons emerged, and to test them we developed a proof-of-concept prototype tool. We have already tested the prototype with eight blind persons and, through early the feedback, started validating the guidelines and checking whether other guidelines emerge.

The next steps would be to run more user studies, improve the prototype based on the feedback, test the improved prototype and iterate until we determine the optimal design characteristics. We will keep collaborating with blind people and sighted people through user studies, surveys, and interviews to determine and validate what such a tool needs to do in order for it to work correctly and efficiently. Then, we will focus on improving these guidelines to cover educational tools for teaching blind people how to format word-processed documents and develop the educational version of this formatting and layout tool.

Current Results

Our results at this stage include a better understanding of blind peoples' views in regards to formatting documents and the formatting problems they experience with word processors used with screen readers, and an improved set of guidelines for tools that can help blind people mediate some of these problems. Our work and some of our results had been presented in more detail in a CHI 2013 Work-in-Progress [6].

Expected Contributions

The *scientific contributions* of this project are 1) an impact-weighted taxonomy of common document presentation errors of blind authors; 2) blind authors' mental models and learning and coping strategies and how these models and strategies contribute to the success of independent document formatting and layout-setting activities.

The *technological contribution* of this project is an integrated solution to document presentation for blind authors (a Microsoft Word compatible formatting and layout checker that is accessible through most screen readers).

The *methodological contributions* of this project concern 1) participatory design practice with blind users, and 2) controlled experiment method for investigating real-time non-visual presentation of grammar, spelling, formatting and layout statuses, errors, and corrections (including through the use of haptic feedback and spatial sound).

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References

[1] Asakawa, C. and Itoh, T. User Interface of a Home Page Reader. In Proc. ASSETS 1998, Sheridan Publishers (1998), 146-152.

[2] Diggle, T., Kurniawan, S.H., Evans, G., Blenkhorn, P. An Analysis of Layout Errors in Word Processed Documents Produced by Blind People. LNCS 2398. Springer Verlag (2002), 587-588.

[3] Edwards, A.D.N, McCartney, H. and Fogarolo, F. Lambda: A multimodal approach to making mathematics accessible to blind students. In Proc. ASSETS 2006 (2006), 48-54.

[4] Evans, D.G., Diggle, T., Kurniawan, S.H., Blenkhorn, P.L. An investigation into formatting and lay out errors produced by blind word-processor users and an evaluation of prototype error

prevention and correction techniques. IEEE Trans. on Neural Systems and Rehabilitation Engineering 11, 3 (2003), 257-268.

[5] Kerscher, G. The Essential Role of Libraries Serving Persons Who Are Blind and Print Disabled in the Information Age. LNCS 4061, 100-105.

[6] Morales, L., Arteaga, S. M., & Kurniawan, S. Design guidelines of a tool to help blind authors independently format their word documents. In CHI'13 Extended Abstracts on Human Factors in Computing Systems (pp. 31-36). ACM.

[7] Tatcher, J. Screen Reader/2: Access to OS/2 and the Graphical User Interface. In Proc. of ASSETS 1994. ACM Press (1994), Marina del Rey, CA, Oct 31-Nov 1, 1994, 39-46.

[8] Wang, K., Barron, L.G. and Hebl, M.R. Making Those Who Cannot See Look Best: Effects of Visual Resume Formatting on Ratings of Job Applications with Blindness. Rehab. Psychology 55, 1 (2010), 68-73.

[9] Zhou, Q. and Farkas, D.K. QuickScan: Formatting Documents for Better Comprehension and Navigation. Technical Communication 57, 2(2010), 197-209.

About the Author:

Lourdes Morales-Villaverde is a second year Ph.D. student in Computer Science at the University of California, Santa Cruz. Her research interests are in the areas of Assistive Technology, HCI and Universal Access. With her thesis research, she hopes to help blind people be more independent and improve their chances of having the same opportunities as sighted people to develop personally, academically and professionally.

Understanding and Addressing Real-World Accessibility Issues in Mainstream Video Games

John R Porter
Human Centered Design & Engineering, DUB Group
University of Washington
Seattle, WA 98115, USA
jrporter@uw.edu

Abstract

Video games have become an important part of various facets of society and culture. However, due to widespread and often critical accessibility issues, many gamers with disabilities are finding themselves cut off from full participation in the world of gaming. Although game accessibility has received a fair amount of interest from our community in recent years, this work lacks adequate consideration of the real-world context of the mainstream gaming. Here, I consider limitations in the existing body of game accessibility research, outline my proposed work as a solution and its contributions to our community, discuss the current status of my research, and state my interest in participation in the ASSETS '13 Doctoral Consortium.

1. Introduction to the Problem

Video games have, over the past few decades, begun to transcend their status as mere outlets of entertainment. As they grow increasingly complex and pervasive, we more and more frequently see them leveraged in areas like teaching [4], health [11], and even lifestyle persuasion [3]. And beyond specialized games being developed to facilitate specific outcomes such as these, we see that mainstream games are more broadly assuming roles as sociocultural mediating artifacts. For players and developers alike, this makes it an exciting time to be part of the gamer community.

In spite of this trend, we also see a widespread pattern of systematic inaccessibility in the world of mainstream gaming. For the most part, the commercial game development industry has developed parallel to and isolated from academic human-computer interaction (HCI) research [9]. Because of this divergence, game development has not benefited from the same 'bleedthrough' of accessible design principles that have so positively impacted other facets of the hardware/software development industry with stronger ties to academic HCI research [12]. As Miesenberger et al. argue, this fundamental mismatch is denying individuals with disabilities the ability to equally participate "in a societal phenomenon of growing importance" (p. 253) [5].

As will be further elaborated in the next section, contemporary research efforts seeking to address the problem of inaccessible games generally either seek to develop specialized games tailored for the needs of one or more specific types of impairments or offer design recommendations or similar assets for the development of future games. While such projects make great strides in the conceptual problem space of game accessibility, their impacts unfortunately rarely cascade out to the context of individuals trying to engage with mainstream games.

In my proposed work, I aim to build on the foundation of this body of work by bringing in a strong focus on the real-world context of mainstream gaming in order to (1) understand the gap between prior game accessibility research and industry development, (2) understand how accessibility barriers are manifesting in mainstream games, and (3) develop novel and relevant game accessibility solutions.

2. Related Work

Existing academic game accessibility research tends to steer clear of commercial, mainstream gaming. The closest our community comes is taking the core gameplay concepts and mechanics behind successful mainstream games and translating them into an accessible form. Examples include Blind Hero [13], which borrows from the popular Guitar Hero rhythm game franchise, and VI-Bowling [6], which takes inspiration from Nintendo's motion-controlled Wii Bowling game. These efforts typically produce solutions that are highly specialized for a discrete impairment class. Other development projects, including Westin's first-person shooter game Terraformers [10] and Trewin et al.'s educational virtual world PowerUp [8], are more ambitious in the scope of their products and in the number of populations for whom they aim to simultaneously address the accessibility needs. They also embrace participatory design strategies which allow for emergent barriers to be addressed in the development process which might not as easily be identified through ability-model-based barrier prediction methods.

However, in spite of their strengths, these efforts stop short of directly addressing what I contend is a major issue of game accessibility: the mainstream context of real-world play. By the very act of translating gameplay concepts out of their original presentation into a new and accessible form, context and situation is lost. We may be making accessible games, but that does not mean that our efforts make *gaming* as a shared conceptual activity accessible. Academic efforts have produced comprehensive lists of universal design strategies for particular types of games (e.g. [5, 8]) as well as models [12] and tools [2] to allow practitioners to heuristically predict likely barriers and better understand the needs of gamers with impairments. While these in particular seem as though they should have a positive impact on mainstream gaming's accessibility, this has largely not been the case.

To understand why this is, and to ensure that future game accessibility research is as relevant and accepted as possible, I believe the focus of game accessibility research has to escape the lab and situate itself firmly in the commercial and mainstream gaming arena.

3. Solution & Contributions

To that end, I plan to carry out with my dissertation work a set of complementary projects focusing on accessibility issues in the context of commercial game development and play. These can be characterized in terms of three major thrusts, each of which contributes to the body of game accessibility research knowledge in its own way.

I. I intend to provide our community with an articulation of why mainstream game development Scott has not adopted nor implemented the guidelines and solutions we offer through direct engagement with members of the industry. I posit that, by understanding the nature of this existing schism, I will be positioned to develop and suggest strategies for bridging the gap.

II. I will use empirical methods to determine where and how accessibility barriers are actually manifesting in the naturalistic context of mainstream games being played outside the lab. This will let us better gauge the ecological validity of current and future proposed solutions, as well as appropriately focus efforts moving forward.

III. I will apply the findings of II to inform the design of novel solutions which emphasize overcoming prevalent barrier scenarios on the gamer-end without dependence on proactive intervention on the part of game developers themselves. This will empower gamers with disabilities to more fully engage with the mainstream gaming ecosystem sooner rather than later while other efforts (e.g. I) continue to strive for elimination of barriers altogether.

4. Status of the Research

I have already completed a pair of initial studies, discussed in a paper which has been accepted to ASSETS '13 [7], in which I began to investigate mainstream game accessibility from the perspective of both industry developers and gamers. In terms of the former, I conducted a series of interviews and focus groups to understand accessibility's role in industry development processes. Regarding the latter, I used a web-based survey to reach out to disabled gamers to uncover specifics regarding their real-world experience with accessibility barriers and their strategies for overcoming them.

Moving forward, I will work to keep engaging with individuals from the game development industry to continue to build a richer understanding of the current state of accessibility, going beyond studio game developers to consider other relevant parties such as hardware and middleware developers. I also intend to further probe the experiences of gamers with disabilities through direct or remote observation of them as they play to better understand their current practices in the context of various impairment classes, game types, and assistive technologies.

Currently, I am also beginning the design of a prototype system for leveraging Bigham et al.'s 'human-powered access technology' approach [1] to facilitate gamers' remote social assistance to overcome discrete, short-duration barriers. My previous study of gamers found that, when possible, they often seek help from a collocated friend or family member to overcome temporary barriers in an otherwise accessible game. I plan to use a crowdsourcing approach to allow gamers to remotely receive this same manner of assistance from other gamers using one of several incentivization models focusing on social capital.

References

[1] Bigham, J.P. et al. 2011. The design of human-powered access technology. *Proc. ASSETS '11* (New York, New York, USA, 2011), 3–10.

[2] Grammenos, D. 2008. Game over: learning by dying. *Proc. CHI '08* (New York, New York, USA, Apr. 2008), 1443–1452.

[3] Jianqiang, D.S.D. et al. 2011. Farmer's tale. *CHI '11* (New York, New York, USA, May. 2011), 581–584.

[4] Kebritchi, M. and Hirumi, a 2008. Examining the pedagogical foundations of modern educational computer games. *Computers & Education*. 51, 4 (Dec. 2008), 1729–1743.

[5] Miesenberger, K. et al. 2008. More Than Just a Game: Accessibility in Computer Games. *HCI and Usability for Education and Work*. A. Holzinger, ed. Springer Berlin / Heidelberg. 247–260.

[6] Morelli, T. et al. 2010. Vi-bowling: a tactile spatial exergame for individuals with visual impairments. *Proc. ASSETS '10*. (2010), 179–186.

[7] Porter, J.R. and Kientz, J.A. An Empirical Study of Issues and Barriers to Mainstream Video Game Accessibility. *Proc. ASSETS '13* (Conditionally accepted).

[8] Trewin, S. et al. 2009. Exploring Visual and Motor Accessibility in Navigating a Virtual World. *TACCESS*. 2, 2 (Jun. 2009), 1–35.

[9] We're Not Listening: An Open Letter to Academic Game Researchers: 2006. *http://www.gamasutra.com/view/feature/1783/were_not_listening_an_open_.php*. Accessed: 2013-05-01.

[10] Westin, T. 2004. Game accessibility case study: Terraformers–a real-time 3D graphic game. *Proc. ICDVRAT '04* (2004), 95–100.

[11] Whitehead, A. and Johnston, H. 2010. Exergame effectiveness: what the numbers can tell us. *Proc. Sandbox '10*. (2010), 55–62.

[12] Yuan, B. et al. 2010. Game accessibility: a survey. *Universal Access in the Information Society*. 10, 1 (Jun. 2010), 81–100.

[13] Yuan, B. and Folmer, E. 2008. Blind hero: enabling guitar hero for the visually impaired. *Proc. ASSETS '08*. (2008), 169–176.

About the Author:

John R Porter is a third year Ph.D. student in the Department of Human Centered Design & Engineering at the University of Washington advised by Dr. Julie A. Kientz. His research focus is on improving the accessibility of mainstream games, particularly through deriving more relevant and acceptable adaptive solutions from embedded, naturalistic understandings of user populations' current 'workaround' practices

The Development of Novel Eyes-Free Exercise Technologies Using Participatory Design

Kyle Rector
Computer Science and Engineering
DUB Group | University of Washington
Seattle, WA 98195
rectorky@cs.washington.edu

Abstract

People who are blind or low vision may have a harder time participating in exercise classes due to inaccessibility, travel difficulties, or lack of experience. My dissertation research will attempt to lower the barrier between people who are blind or low-vision and exercising independently. Three new fitness technologies will be developed: Eyes-Free Yoga, Eyes-Free Rock Climbing, and Eyes-Free Track Running. In addition, I plan on collaborating with the visually impaired and those who are involved in their fitness. This will materialize into a focus group and a list of priorities for Eyes-Free Exercise Technology. So far, I have completed Eyes-Free Yoga and completed formative work toward Eyes-Free Rock Climbing. With participatory design and collaboration, I hope to design and develop technologies that will be beneficial for blind and low-vision wellness.

Introduction

Research studies indicate that people who are blind or low vision are generally not as healthy as people without disabilities. They are more likely to be obese [1], [10] and to report poor, fair, or worsening health. Youth and adolescents with visual impairments do not complete enough physical activity to maintain an adequate fitness level [1]. As a child's visual impairment increases, the importance of exercise and their parents' expectations decrease [8]. As a result, the amount of physical activity decreases [6]. Furthermore, solutions such as exercise classes and gym access have their own barriers [5].

The goal of my dissertation research is the bridge the gap between visual impairments and exercise using novel exercise technologies, such as exergames and adaptations to exercise equipment. My research will involve participatory design and determine how technology may enhance eyes-free exercise. These findings will make exercise more accessible to people who are blind or low-vision and offer design strategies for eyes-free interactions to benefit the sighted population.

Related Work

The explicit design of health technologies for those who are blind or have low vision has not received nearly as much attention, despite the opportunities for significant impact. I conducted a comprehensive search with the ACM Digital Library under our listed keywords in addition to "barriers to health care" and "primary care". We conducted an additional search by reviewing 12 related proceedings from 2008-2012. We identified two strong efforts from Morelli et al. with their creation of accessible alternatives to Wii Sports games, VI-Bowling [3] and VI-Tennis [2]. Recently, Eyes-Free Yoga was developed with six design principles pertaining to coaching yoga with auditory-only feedback [4]. I am not aware of any efforts on eyes-free exercise “in the field” at venues like the gym or the running track.

Proposed Solution

My proposed solution to this problem involves a suite of eyes-free exercise technologies with a participatory design approach. My first project, Eyes-Free Yoga (**Figure 4**), involved collaborating with yoga instructors both with and without experience working with people who were blind or low-vision. In addition, the exergame was piloted on one blind researcher before the controlled study. Before developing two other solutions, I want to define a set of design principles for eyes-free exercise technology. The priorities of exercise technology change when vision is not involved in the interaction. In order to properly define this space, I plan to collaborate with people who are visually impaired and to those who are involved in teaching fitness strategies to the visually impaired. I plan on conducting interviews with both groups of people and organizing a focus group with the visually impaired about integrating technology into their fitness routine.

My next proposed project, Eyes-Free Rock Climbing will involve new challenges from Eyes-Free Yoga. While there has been rock climbing education for the blind [9], instrumenting the wall with infrared and vill provide technical

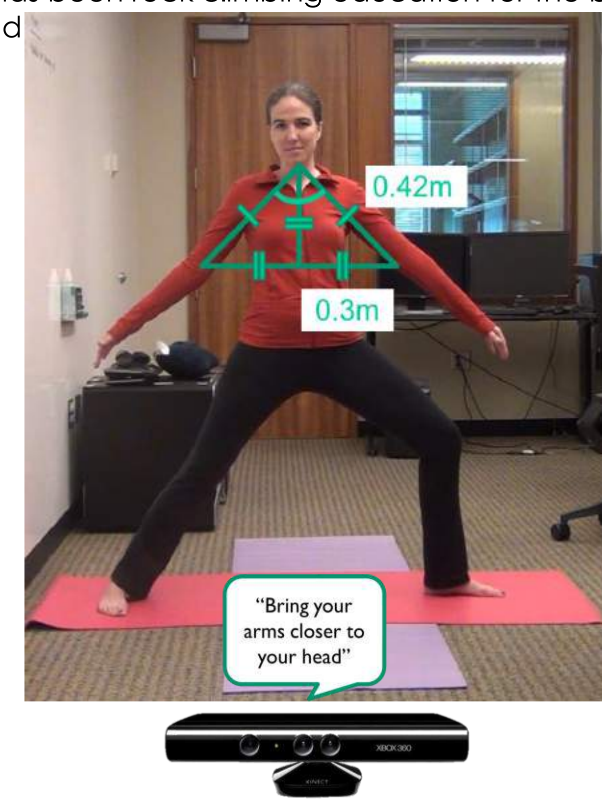

Figure 4: In Warrior II, her arms are at 45° and need to be raised to ≥ 80°. The Kinect responds with a verbal correction.

challenges. The climber would wear wrist and ankle bands containing infrared tape for tracking, small motor to communicate proximity to a rock climbing hold, and head phone to hear the difficulty of grabbing the hold. As a person scans with their hand or foot, the hold in which they are pointing would be described as easy, medium, or hard. In addition, the motor would vibrate at a frequency based on distance from the climbing hold. Higher frequency means they are closer, while lower frequency means they are further away. I would recruit participants to run a feasibility study of the system. The evaluation metrics include whether or not they were able to climb the prescribed route and their opinions of the system. The core contribution would be in the design and development of the overall system.

Eyes-Free Track Running has a smaller form factor: it would involve a small camera attached to a pair of glasses and a set of headphones. The camera would detect the track lanes and determine which lane the runner has chosen. Two proposed methods for the interaction are as follows: 1) push information to the runner by informing the numerical position on the track from left to right [7], 2) when the runner is no longer running in their lane, play a sound in the direction that they should be traveling instead. My goal is to allow a visually impaired person to run on a track independently. Participants would either run with option 1 or 2 for the audio feedback, and we would collect their trajectory on the running track. The evaluation metrics include their ability to stay in the same lane, their efficiency traveling around the track, and their opinions while using the system. The core contribution would inform the type of directional audio feedback that should be given when a visually impaired person is traveling at a faster pace.

Stage of Research

My previous work contributed a novel exergame, Eyes-Free Yoga [4] using the Microsoft Kinect. Eyes-Free Yoga acts as a yoga instructor, teaches six yoga poses, and has customized auditory-only feedback based on skeletal tracking. We ran a controlled study with 16 people who are blind or low vision to evaluate the feasibility and feedback. We found participants enjoyed the game, and the extra auditory feedback helped their understanding of each pose. The findings of this work have implications for improving auditory-only feedback and on the design of exergames using depth cameras.

Future work will involve field work and a focus group with people who are blind or low-vision to inform exercise solutions, and the participatory design and development of two eyes-free technology solutions. I will involve myself in current eyes-free fitness opportunities and interact closely with people to determine design principles for eyes-free exercise. This involvement will prepare me to develop two future technologies, Eyes-Free Rock Climbing, and Eyes-Free Track Running.

Contributions

My research contribution lies in making eyes-free exercise accessible to those who are blind or low-vision with the use of novel technology solutions and participatory design. The motivation and foundation to my work will be presented at the upcoming ASSETS 2013 conference [4].

References

[1] Capella-McDonnall, M. The need for health promotion for adults who are visually impaired. J VISUAL IMPAIR BLIN, 101(3), 133-145, 2007.

[2] Morelli, T., Foley, J., Columna, L., Lieberman, L., Folmer, E. VI-Tennis: a Vibrotactile/Audio Exergame for Players who are Visually Impaired. FDG 2010.

[3] Morelli, T., Foley, J., Folmer, E. Vi-bowling: A Tactile Spatial Exergame for Individuals with Visual Impairments. ASSETS 2010.

[4] Rector, K., Bennett, C.L., Kientz, J.A. Eyes-Free Yoga: An Exergame Using Depth Cameras for Blind & Low Vision Exercise. ASSETS 2013.

[5] Rimmer, J.H. Building Inclusive Activity Communities for People with Vision Loss. J VISUAL IMPAIR BLIN, 100(suppl), 863-865, 2006.

[6] Robinson, B.L., Lieberman, L.J. Effects of visual impairment, gender, and age on self-determination. J VISUAL IM-PAIR BLIN, 98(6), 351-366, 2004.

[7] Rose, D. Paralympics: The perils of being a blind athlete. BBC News, 9/6/2012.

[8] Stuart, M.E., Lieberman, L., Hand, K.E. Beliefs about physical activity among children who are visually impaired and their parents. J VISUAL IMPAIR BLIN, 100(4), 223-234, 2006.

[9] Touchstone Climbing | Hatien Center for the Blind at Ironworks. Written 4/29/2013. http://www.touchstoneclimbing.com/news/5-ironworks/547-hatien-center-for-the-blind-students-at-ironworks#.UcdeB9Wnapg

[10] Weil, E., et al. Obesity among adults with disabling conditions. JAMA. 288, 1265-1268. 200.

About the Author:

Kyle Rector is a 4th year PhD student in the Department of Computer Science and Engineering (CSE) and is co-advised by Professor Julie Kientz (HCDE) and Professor Richard Ladner (CSE). She earned her MS (CSE) in 2012. Her research interests involve making exercise technologies accessible to the blind. She is a NSF Graduate Research Fellow, Google Anita Borg Scholar (2010), Computing Research Association Outstanding Undergraduate Research Award Finalist (2009), and Palantir Scholarship for Women in Technology Semi-Finalist (2013). Website: http://kyle-rector.com

Accessibility of Computer Therapy and Technology for People with Aphasia

Abi Roper
Division of Language and Communication Science &
Centre for Human Computer Interaction Design
City University London
Northampton Square, London, EC1V 0HB, UK
Abi.Roper.1@city.ac.uk

Abstract

Language difficulties present within aphasia can substantially affect a user's ability to access and interact with technology. Surprisingly however, there is comparatively little research into the impact of this condition upon accessibility. The described project aims to examine general technology access and confidence in users with aphasia. It additionally seeks to shed light on the specific cognitive and linguistic factors affecting rehabilitative therapy technology use. Using an interdisciplinary approach, outcomes are intended to provide new language and technology insights to both the accessibility and the speech and language therapy communities.

Overview

Aphasia affects an estimated 1 million people in America (NAA, 2013) and 250,000 in the United Kingdom (Connect, 2013). It impairs people's ability to use language without affecting their general intelligence. It can affect speaking, understanding reading and/or writing and is caused by brain injury – most commonly stroke - with approximately 1/3 of people who have had a stroke being affected (Connect, 2013). Speech and Language Therapists aim to improve communication in aphasia, e.g. through targeted language exercises. When problems are very severe, alternative non-verbal forms of communication, such as gesture, may be promoted within rehabilitation. [Within the context of aphasia therapy, the term gesture is used to refer to a pantomime action, which can be used to stand in for a specific object or person in the absence of a spoken label for that object or person. For example, to replace the spoken word "drink" you might mould your hand as if you were holding a cup and then lift the hand to your mouth as if drinking.]

Aphasia rehabilitation however – including gesture training - requires intensive repeated practice (Caute et al., 2013; Bhogal et al., 2002) and this level of input is often difficult to achieve within current therapy provision (Katz et al., 2000). Computer therapies propose a promising solution to this challenge, offering an opportunity for people with aphasia to self-administer therapy exercises in their own homes, at a time convenient to them and at a high level of intensity. However, impaired language abilities can greatly impact upon an individual's ability to access technology. Existing research into technology for users with aphasia has so far provided some examination of tools to assist or augment communication (Allen et al., 2007; Daeman et al., 2007; Koppenol, 2010) or to provide therapeutic benefit (McCall et al., 2009).

The aim of this inter-disciplinary research project is to combine and develop insights from the fields of human computer interaction design and of language and communication science to examine technology accessibility for people with aphasia both at a general level and also, more specifically, in relation to aphasia rehabilitation for gesture.

Exploration of Issues

Figure 1. GeST Computer Gesture Therapy

The above issues are being explored in relation to an existing computer gesture therapy tool, GeST (Figure 1).

GeST was created in consultation with representatives with aphasia and is intended to be accessible for self-administered therapy practice by those severely affected by aphasia (Galliers et al., 2011; Gallers et al., 2012). The tool is operated via an accessible, external keypad and uses vision-based gesture recognition to identify practiced gestures.

GeST software comprises three activity levels; the first providing simple video presentation of target gestures, the second introducing practice activities within a 3D virtual environment, and the third demonstrating video vignettes of the gestures being used in real-life situations. A pilot trial of GeST with 9 people indicated that regular use over a 6 week period enabled users to produce an increased number of gestures clear enough to be identified by strangers (Marshall et al., 2013).

Methods

Building on methods developed within the above pilot trial, the current study will provide GeST therapy to 30 further participants with severe aphasia and measure the effects of its more intensive use over a 5-week period. Measurements of participants' abilities to demonstrate communicative gestures – both during assessment and additionally within in a more real-life context - will be taken before and after this period to monitor improvement. To investigate the impact of difficulties with language processing, sequencing and visuospatial skills upon access to computer therapy, detailed measures of cognition and language will be taken (CAT - Swinburn et al., 2004, CLQT – Helm-Estabrooks, 2001). Results of these assessments will then be examined in relation to the number of hours of computer use and the scale of improvements in gesture made by each individual.

Video recordings of participants using GeST at both early and later stages in their practice phase will be analysed to record instances of successful and unsuccessful interaction with the tool. These will then be examined in relation to individual users' performance on cognitive and language measures to assess whether the chosen measures can effectively predict levels of successful interaction with GeST.

Finally, a newly developed measure of technology confidence will be used to examine the effect of exposure to GeST on participants' attitudes towards other everyday technologies. This aims to further unravel pilot participant reports of having reduced access to technologies such as microwaves, washing machines and computers as a consequence of their aphasia. The technology confidence measure will additionally be administered to an age-matched group of people without aphasia to allow for interpretation of results in specific relation to the presence of aphasia.

Progress to date

Following the development of research methodology detailed above, data collection for the described project is currently under way. 10 users have so far taken part in the described protocol. A further 20 will receive GeST during the following year. Results will be analysed following completion of data collection.

Intended Contribution and Conclusions

Findings are intended to contribute to the growing evidence base surrounding technology use in healthcare, specifically in relation to people with aphasia, a group largely under-represented in the existing literature. The analysis of detailed cognitive and language assessment data, as well as timing and usage information, in relation to participants' communicative gains following computer therapy aims to shed light on issues of efficacy and accessibility in computer aphasia rehabilitation. Furthermore, the collection of data specifically related to reports of confidence in technology-use for people with severe aphasia aims to contribute to a wider discussion regarding the role of language in the successful navigation of the technological systems becoming increasingly integral to many facets of modern everyday life.

References

Allen, M., McGrenere, J. and Purves, B. The Design and Field Evaluation of PhotoTalk: a digital image communication application for people with aphasia. in *9th international ACM SIGACCESS conference on computers and accessibility. ASSETS'07.* (New York, USA, 2007). ACM Press, 187-194.

Bhogal, S.K., Teasell, R., and Speechley, M. (2003) Intensity of aphasia therapy impact on recovery. Stroke, 34, 987 – 993.

Caute, A., Pring, T., Cocks, C., Cruice, M., Best, W. & Marshall, J. (2013) Enhancing communication in aphasia through gesture and naming therapy. Journal of Speech, Language and Hearing Research, 56, 337-351

Daeman, E., Dadlani, P., Du, J., Li, Y., Erik-Paker, P., Martens, J., and De Ruyter, B. (2007). Designing a free style, indirect, and interactive storytelling application for people with aphasia. Human Computer Interaction – INTERACT 2007, Lecture Notes in Computer Science, 4662/2007, 221- 234.

Galliers, J., Wilson, S., Muscroft S., Marshall, J., Roper, A., Cocks, N., Pring. T. (2011). Accessibility of 3D Game Environments for People with Aphasia: An Exploratory Study. in *The 13th international ACM SIGACCESS conference on computers and accessibility. ASSETS'11*. (Dundee, UK, 2011), ACM Press, 139-146.

Galliers, J., Wilson, S., Roper, A., Cocks, N., Marshall, J., Muscroft, S., and Pring, T. (2012). Words are not enough: empowering people with aphasia in the design process. in *Proceedings of the12th Participatory Design Conference: Research Papers – Volume 1*, (Roskilde, DK, 2012), ACM Press, 51-60.

Helm-Estabrooks, N. (2001) Cognitive Linguistic Quick Test, San Antonio, TX: The Psychological Corporation.

Katz, R. C., Hallowell, B., Code, C., Armstrong, E., Roberts, P., Pound, C. & Katz, L. (2000) A multinational comparison of aphasia management practices. *Int J Lang Comm Dis*, 35, 303 – 314.

Koppenol, T., Al Mahmud, A., and Martens J.B, (2010) When Words Fall Short: Helping People with Aphasia to Express. *Proc. ICCHP 2010, Part II,* 45–48.

Marshall, J., Roper, A., Galliers, J., Wilson, S., Cocks, N., Muscroft, S., and Pring, T. (2013) Computer delivery of gesture therapy for people with severe aphasia. *Aphasiology*, 27 (9), 1128-1146.

McCall, D., Virata, T., Linebarger, M., and Berndt, R.S. (2009) Integrating technology and targeted treatment to improve narrative production in aphasia: A case study. *Aphasiology,* 23 (4). 438-462.

National Aphasia Association Aphasia FAQ page: Retrieved 13th June 2013 from http://www.aphasia.org/Aphasia%20Facts/aphasia_faq.html.

Swinburn, K., Porter, G. and Howard, D. (2004) Comprehensive Aphasia Test. New York, Psychology Press.

UK Connect charity questions and answers page, (2013). Retrieved 13th June 2013, from Connect: http://www.ukconnect.org/aphasiaquestionsandanswers_302.aspx

About the Author:

Abi Roper is a Ph.D. student in the Division of Language and Communication Science and the Centre for Human Computer Interaction Design at City University London. She is a qualified Speech and Language Therapist with an undergraduate degree in Cognitive Science. Her PhD focuses on the testing and evaluation of a novel computer gesture therapy for adults with very severe aphasia (a communication difficulty following stroke). Abi has previously worked both in clinical practice and in speech and language computer therapy research in both Sheffield and London, UK.

Sighted Eye for the Blind Guy: Providing Personalized Responses to Visual Questions

Michele A. Williams
UMBC
1000 Hilltop Circle, Baltimore, MD 21250
mawilliams@umbc.edu

Abstract

Technology has fostered many opportunities for increased independence for people with vision impairments, often making visual information available (such as screen readers announcing on-screen text). However, not all entities are made accessible simply by translating visual information into another medium. Many situations present questions that are complex, context-filled, and require personalized responses often based on feedback from others. Our research has encountered such challenges in two specific domains: fashion and pedestrian navigation. Though inroads for providing personalized responses are being made via question-asking and social networking Internet systems and other collaborative technologies, there is no clear ideal solution for facilitating personalized question asking. Thus our work intends to contribute a typology of questions and propose the best technological solutions to help facilitate reliable, trusted responses.

Introduction

Our prior work has studied two universal and ubiquitous aspects of everyday life from the perspective of people with vision impairments: fashion and navigation. Participants in our previous studies have been able to function sufficiently with tasks such as dressing, shopping, and finding new locations, but shared continual challenges when conducting activities without sighted assistance. Fashion and navigation are very visual entities that often present many subjective questions for which a personalized response is necessary. For instance, fashion questions about what to wear require responses based on the context of the occasion, the person's personality, current trends, and many other factors. In navigation our prior work revealed there are personality and situational aspects that impact the type of information needed to travel independently [9]. For instance, a confident traveler in a familiar area may only need a few pieces of information to arrive at their destination, while a less confident traveler in a new and unfamiliar location may need turn-by-turn directions with significant details.

Our participants desired technology solutions that would address their current challenges. Technology's ability to facilitate information sharing presents ample opportunity for obtaining personalized responses. Current technologies for fashion opinions are not accessible for people with vision impairments and also give limited advice. For instance, you can upload a photo to Fashism.com[1] but you will not receive feedback on the photo (which may be needed for blind photographers), and generally responses are simply thumbs up/down with no further information. Current navigation solutions, while remarkably helpful, have limitations outdoors including lack of precise door-to-door directions, and no commercially available systems for indoor navigation. While navigation devices tend to be standalone and seemingly not involve collaboration with others, at the core navigation is a set of answered questions pertaining to one's path. Thus, our future work will contribute to mechanisms for gaining personalized responses by expanding upon current question-asking research.

RELATED WORK

Researchers have long studied technology's role in answering an individual's questions. However, this is generally focused on objective information gathering; that is, questions for which there are factual responses that do not change. Subjective questions, on the other hand, do not have "right" answers and are simply based on the opinions of people and context of the question. Consequently, using technology to gather responses becomes a social and interactive activity, more so than typical information search and retrieval. Researching the use of technology to facilitate answers to subjective questions then requires two facets of analysis: evaluating who answers the questions and exploring which technology systems to use to receive the "best" responses.

Subjective Q&A: Tools & People

Nichols, et al, used Amazon Mechanical Turk[2] ("MTurk") workers to rate the subjective qualities of product reviews written via Twitter, Amazon, and Yelp [8]. While they concluded the systems were similar, the traditional recommendation systems were better received over Twitter. Their suggested future design considerations included aspects particularly relevant to opinion-based responses such as ensuring domain suitability, being able to target answerers, and allowing for more feedback to frame the question and guide the response. Morris, et al, conducted preliminary work with Facebook to categorize what types of questions people pose, showing that subjective questions are sometimes asked in the social networking site not originally intended for question asking [7]. Researchers have also classified the interactions on Websites built specifically for question answering, such as work with Yahoo Answers [1].

Along with appropriate technology, the person answering one's personalized question is equally important and challenging given the vastness and anonymity of the Internet. Mahmud, et al, presented a tool called "qCrowd" to automatically detect which strangers to target on Twitter for questions regarding product reviews and airport wait times [6]. Bigham, et al, created an iPhone application called VizWiz that allows for crowdsourced answers to visual questions from people with vision impairments [2]. While Nichols, et al, used MTurk workers to *evaluate* responses, VizWiz uses these workers to *answer* questions when the user chooses this option. Brady, et al, categorized a year's worth of data from

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[1] http://www.fashism.com

[2] https://www.mturk.com/

VizWiz and in doing so presented the success of using workers for visual questions, though users mostly asked objective questions [3]. Our prior work used a special instance of VizWiz for answering both objective and subjective clothing related questions using a closed set of volunteers [4]. Responses from a pool of "trusted strangers" were found a viable option in our preliminary investigation. "Trusted strangers" stems from work by Hong, et al, which focused on a special social network for teens with Autism [5]. The site extends the person's network from family, friends, and close professionals to "people who are willing to commit their time to help the individual…and give the individual trustworthy feedback".

Overall, however, these investigations have only shown preliminary findings and are yet to be conclusive in identifying the best subjective question asking systems. As no single project has presented an ideal solution for personalized information, our work will continue to contribute analyses of current question asking systems and ratings of answerers, working towards revealing solutions for personalized responses in our domains of interest.

CURRENT AND FUTURE WORK

Our current work continues to engage people with vision impairments to ensure a firm understanding of the information needs, as well as the form and structure of their questions. The future work will have three major contributions: a comprehensive set of questions for which a technology solution should be able to address, concrete user interface considerations for such a system, and findings on trusted responses.

Within the fashion domain, we plan to conduct a study that observes a participant and sighted companion while shopping for clothes. The corpus of questions and photos from this study will then be presented to crowd workers, volunteers, the participant's social network contacts, dedicated question-and-answer sites (specific to fashion and generic), and subject matter experts. Participants will predict what source they feel will have the best response, and then rate the responses for accuracy, helpfulness, and comprehension. Participants will also be asked to evaluate how much they trust the sources and responses, with comparisons made between the systems at the outcome.

For the navigation focus, we plan to conduct observations of current navigation technology use to understand the questions left remaining despite the available systems. We will also compare the questions with the personas we propose in our current work ([9]) to reveal any trends in information needs. Finally we will work with robotics experts to create a prototype to address the findings and test them for feasibility and usability.

From this work we hope to answer what solution(s) best answer the complex, context-filled, personal questions identified: whether that is an information on-demand interface based on computer vision such as OrCam[3], crowdsourcing or a pool of volunteers dedicated to answering questions like the VizWiz system, a means of connecting with friends and family via social networking, and/or an improved answers interface akin to Yahoo Answers.

Whereas our work focuses on people with vision impairments and the visual questions encountered in their daily routines, we recognize the universal nature of subjective information seeking. Thus, we aim to contribute to the broader collaborative technology

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[3] http://www.orcam.com

community by making it easier for everyone to gain trusted advice from others on activities of daily living.

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REFERENCES

[1] Adamic, L.A., Zhang, J., Bakshy, E. and Ackerman, M.S. 2008. Knowledge sharing and yahoo answers. *Proceeding of the 17th international conference on World Wide Web - WWW '08* (New York, New York, USA, Apr. 2008), 665.

[2] Bigham, J.P., Jayant, C., Ji, H., Little, G., Miller, A., Miller, R.C., Miller, R., Tatarowicz, A., White, B., White, S. and Yeh, T. 2010. VizWiz : Nearly Real-time Answers to Visual Questions. *Proceedings of the 23nd annual ACM symposium on User interface software and technology (UIST '10)* (New York, New York, USA, 2010), 333–342.

[3] Brady, E., Morris, M.R., Zhong, Y., White, S. and Bigham, J.P. 2013. Visual challenges in the everyday lives of blind people. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13* (New York, New York, USA, Apr. 2013), 2117.

[4] Burton, M.A., Brady, E., Brewer, R., Neylan, C., Bigham, J.P. and Hurst, A. 2012. Crowdsourcing Subjective Fashion Advice Using VizWiz: Challenges and Opportunities. *Proceedings of the 14th international ACM SIGACCESS conference on Computers and accessibility (ASSETS '12)* (New York, New York, USA, 2012).

[5] Hong, H., Kim, J.G., Abowd, G.D. and Arriaga, R.I. 2012. Designing a social network to support the independence of young adults with autism. *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work (CSCW '12)* (New York, New York, USA, 2012), 627–636.

[6] Mahmud, J., Zhou, M.X., Megiddo, N., Nichols, J. and Drews, C. 2013. Recommending targeted strangers from whom to solicit information on social media. *Proceedings of the 2013 international conference on intelligent user interfaces - IUI '13* (New York, New York, USA, Mar. 2013), 37–48.

[7] Morris, M.R., Teevan, J. and Panovich, K. 2010. What do people ask their social networks, and why?: a survey study of status message q&a behavior. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI '10)* (New York, New York, USA, 2010), 1739–1748.

[8] Nichols, J., Zhou, M., Yang, H., Kang, J.-H. and Sun, X.H. 2013. Analyzing the quality of information solicited from targeted strangers on social media. *Proceedings of the 2013 conference on Computer supported cooperative work (CSCW '13)* (New York, New York, USA, Feb. 2013), 967.

[9] Williams, M.A., Hurst, A. and Kane, S.K. 2013. "Pray Before You Step Out": Describing Personal andSituational Blind Navigation Behaviors. *Proceedings of the 15th international*

ACM SIGACCESS conference on Computers and accessibility (ASSETS '13) (New York, New York, USA, 2013).

About the Author:

Michele A. Williams is a third year Human-Centered Computing PhD student at UMBC. Her primary research interests involve designing accessible technology solutions based on the information needs gathered from participants through qualitative studies.