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Data Sonification and Sound Visualisation

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ABSTRACT

For all its potential in supporting data analysis, particularly in exploratory situations, visualization also creates barriers: accessibility for blind and visually impaired individuals. Regardless of how effective a visualization is, providing equal access for blind users requires a paradigm shift for the visualization research community. To enact such a shift, it is not sufficient to treat visualization accessibility as merely another technical problem to overcome. Instead, supporting the millions of blind and visually impaired users around the world who have equally valid needs for data analysis as sighted individuals requires a respectful, equitable, and holistic approach that includes all users from the onset. In this paper, we draw on accessibility research methodologies to make inroads towards such an approach. We first identify the people who have specific insight into how blind people perceive the world: orientation and mobility (O&M) experts, who are instructors that teach blind individuals how to navigate the physical world using non-visual senses.

Keywords-- Accessibility, blind users, sonification, visualization, spatial layouts, sound perception .

Introduction

It largely inaccessible to individuals who are blind or have visual impairments. Screen readers, the method blind people most commonly use to transform on-screen text to speech, generally cannot parse pixel visualizations, and few web-based visualizations provide sufficient textual descriptions or the underlying datasets. People with visual impairments are a large population of potential data visualization users. In 2015, globally there were 253 million people with visual impairments, out of whom 26 million were blind, and this number is estimated to reach around 703 million by the year 2050. This is also not just a sociotechnical problem, but a potentially legal one; for example, in the United States, Section 508 of the Rehabilitation Act requires that all federal government websites be accessible for people with disabilities, and the Americans with Disabilities Act similarly requires accessibility for most websites of public accommodations. Blind people1 navigate a 3D world of space and objects, and are therefore equally capable of understanding spatial layouts as sighted individuals. However, despite continuous advances in visualization research, little effort is devoted to accessibility. While our focus in this paper is on blind individuals, inaccessible visualization practices not only affect blind people, but also those with other impairments such as motor or cognitive impairments.

Methodology

Orientation and Mobility (O&M) Training Blind individuals enroll in Orientation & Mobility (O&M) training to learn to become independent travellers. As part of their O&M training, individuals are taught to use environmental cues to construct mental maps of the space around them. Orientation and Mobility instructors teach blind individual clients or students to travel both indoors and outdoors, and to increasingly rely less on the visual sense. It is often assumed that blind individuals are a homogeneous user group, but research has shown that the attitudes, needs, and behavior of persons who are blind vary greatly. In addition to O&M or Cane Travel, blind individuals are also able to enroll in programs such as Braille learning, Technology, Job Readiness, and Wood Shop Training. Orientation and mobility experts receive National Orientation and Mobility Certification (NOMC), a certification that is offered by the National Blindness Professional Certification Board (NBPCB). Certified trainers teach under the Structured Discovery Cane Travel (SDCT) model; one that focuses on individuals acquiring .

While there are potentially many user groups to interview in order to understand sensory substitution mechanism, we chose blind O&M instructors because they have significant lived experience of using non-visual senses in perceiving space, as well as are competent at teaching these skills to others, and have thus spent a significant amount of time retrospectively thinking about the skills. O&M training is particularly relevant because these skills have been shown to transfer to other contexts and settings in prior work. More specifically, visualizations such as maps, scatterplots, bar charts, and graphs rely on visual semantics such as shapes, size, color, position, labels, and axes to convey data to sighted individuals. Speaking to O&M instructors is a reliable way to explore how to translate a visualization's visual semantics into non-visual modalities based on how blind individuals perceive visual semantics of space. Compared to blind sonification or tactile graphic designers who may use their own experiences, blind instructors have a broader view from their training and certification to teach other blind individuals. Prior work also shows that the intuition of sonification designers may not lead to the best data-to-sound mappings

Block Diagram

This system uses Max/MSP which is a programming environment developed by a company called Cycling 74'. It is a commercial software but the user can download application runtime from company website. So everyone can use this application for free.
This system is a useful tool either for a person who has or who does not have enough composition skills and the knowledge of composition methods. The system uses time series data for composition, so that composer can create the music without the methods as they normally use when they compose music. The objective of this system is to find the ways of composition using time-series data. By limiting the way of composition method, composer can concentrate the way of expression using the data.

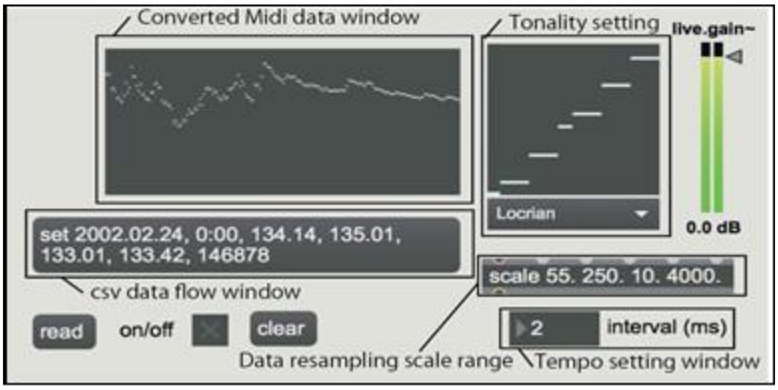

Figure 1. Screen-Capture from the Prototype

We aim to realize user-friendly software design by simplify. Not to decline composer's idea during switching or changing parameters of each functions. In this implementation, we used foreign exchange (FX) data for composition because the data have time information and clear to understand what they are. And, we have used cross JPY data. It means that the work shows the FX movement view from Japan. There are so many kinds of research about pitch of sound in the field of music composition and analysis. For example, a research of musical pitches in a tonal context associations of sound and light or basic research about human ability of pitch recognition. We have utilized these research results as the knowledge of composition methods in this system and implement as software.

This system creates MIDI data from time series .csv format data. The flow of data conversion of the time series data to MIDI data using foreign exchange data is described as bellows.

Prepare.csv data and import to this software. The data don't have to be separated to individual data series. (Time, Date, Price etc.Separate csv data cells into single information data cell that defines by composer.Rewrite these data into new single row csv file.Convert the file (step.3) into MIDI file. Users can edit the tempo, tonality and length.

Advantages

- Auditory displays exploit the superior ability of the human auditory system to recognize temporal changes and patterns.
- The auditory displays are most useful when displaying complex patterns, changes in time, warnings for immediate action, etc.
- In real-time environments, it would make the most sense to utilize sound instead of keeping a check on the visual systems.These systems make perfect sense for the visually impaired.
- Auditory systems are more suited for high-stress environments and when working with multiple data sets.
- Data visualization is still a challenge for smaller devices, hence auditory systems might play a bigger role (though I feel with improvements in UI/UX data visualization has become better on mobile phones.

Applications

1. Astronomy studies of star creation, interpreting cluster analysis ,and geoscience.
2. Various projects describe the production of sonifications as a collaboration between scientists and musician.
3. A target demographic for using data sonifications is the blind community because of the inaccessibility of data visualisation.

Conclusion

Our findings are based on a limited sample of 10 blind O&M instructors. We make an assumption that the expertise in training multiple blind individuals validates and adds weight to the opinions of the participants. Additionally, the feedback from the visualization brainstorming portion may not capture the opinions of students as participants mainly conveyed their own perspectives. Finally, blind individuals who do not have O&M learning experience, or those who do not experience the SDCT model of teaching, may have different opinions and perceptive abilities when considering sound and touch. We have reviewed prior work on sonification, HCI, and accessible visualizations, and found insights that can guide researchers interested in building accessible visualization solutions. To avoid a technologycentred approach, we engaged the blind community in our work by interviewing and discussing chart accessibility with 10 blind O&M experts. We found that touch modalities are more comparable to vision, and blind individuals are more familiar with tactile charts. We also found that complementing visualizations using a combination of touch and sound can lead to more holistic solutions. Finally, we identify key insights and discuss accessible visualization design considerations to guide technologists and designers interested in developing solutions for blind users. We hope our work will lead to more research on accessibility for blind individuals in the visualization community

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