CS 6460: Educational Technology Project: Milestone 2
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Introduction

This is the second milestone of my the eight-week research and development project to address the accessibility of digital media by the visually impaired. For reference, I've included my proposal, as submitted on 10/08/2017 as an appendix to this paper.

My focus for this assignment was to incorporate feedback as fixes into my web-application: https://rbobkoskie3.github.io/. I spent ~30hrs per week between the first and second milestone incorporating these fixes. The biggest challenge was to add an animation that traces the plot in synchronization with the sound 'sonification'. I also spend much time trying to scale the math plots with the 'tracer' animation so the web-application can work on multiple device resolutions, including smartphone.

Status: Second Milestone

The fixes I implemented for the second milestone are: tracer animation with scale, pause/play button, pause/play when image is clicked, high contrast setting includes all images and text on screen (including plot and G-Tech logo), volume buttons, reformatting of pages for a cleaner look (lines and parabola).

For reference, here were the pages that constituted the app for the first milestone, not that I use a default CSS, so, there may be a few updates in these legacy pages that did not exist at the time of the first submission:

https://rbobkoskie3.github.io/milestone1/m1Circle.html
https://rbobkoskie3.github.io/milestone1/m1Hyperbola.html
https://rbobkoskie3.github.io/milestone1/m1Line.html
https://rbobkoskie3.github.io/milestone1/m1Parabola.html

In the next week, I need to strengthen contact with my target audience: schools for the blind and visually impaired. I sent email requests to several schools, but have not received any responses or survey participation. I will focus on personal calls to introduce myself and hopefully get some participation. I will also add another demographic, senior citizens. Although this demographic was not included in my proposal, I need to consider other subject that I feel could benefit from enhanced contrast for digital media. I'm hoping this expanded target audience will also yield some results.

Please try out the website and provide feedback. The feedback for the first milestone was extremely useful. Also, if you have not taken the survey, please do so.

APPENDIX

I. Problem and Research Question: Improve Educational Opportunity for the Visually Impaired with Assistive Technology

Digital media is becoming much more than a supplement in the field of educational technology. Online books, journals, collaboration, and even graduate degrees can be obtained exclusively through digital resources. Indeed, pedagogy has kept pace with advances in digital technology, and for most, the educational experience has been enhanced. However, for those with a visual impairment, the ability to travel unabated in a digital world is rife with restrictions that limit access to information and educational enrichment. Although tools such as screen readers (text to speech), magnifiers, and high contrast settings allow the visually impaired to ride this information superhighway, these assistive technologies are difficult for the visually impaired to identify, locate, and configure. Even when configured, there are many differences in how assistive technologies are implemented. These inconsistencies further compound accessibility issues for the visually impaired. Introducing a standard(s) based approach for assistive technology would create uniformity across digital media, and would open the digital autobahn to the visually impaired. Another technology known as sonification [3] shows promise as an assistive technology to enhance learning in geometry, which is a completely visual form of mathematics [7]. Sonification uses sound: frequency, amplitude, and timbre to convey information. Sonification can increase accessibility by allowing observable objects such as curves in a Euclidian plane can be visualized. Sonification and Standardization of assistive technology are tractable, cost effective approaches to enhance pedagogy for the visually impaired.

II. Project Goals and Task Lists

My objective is to address the challenges that the visually impaired face in the world of digital technology. As the pedagogy of educational technology has shifted to a digital format, assistive technology to access digital content has not kept pace. My project will take a hybrid approach of research and development.

Research and Data Description

I plan to research the following areas to make a case that improvements in assistive technology for the visually impaired are necessary to increase accessibility for digital media. I will discuss how these improvements should be implemented and regulated through a standards body, not unlike the Americans with Disabilities Act (ADA).

1. The shift to digital media by educators. This will be obtained quantitatively, by referencing previous work: journals, conferences, books, and other articles.

2. The use of assistive technology by the visually impaired to access digital content. I will focus on the no-cost assistive technology known as High Contrast Settings (HCS) that are available on most operating systems and applications. I plan three methods of research for this topic:

   I. Quantitative research by referencing previous studies on assistive technology for the visually impaired. I will identify the current use, and dependency of assistive technologies for accessing digital media by the visually impaired. This will include deeper research into HCS and sonification.
   II. Qualitative research into the shortfalls of HCS solutions currently available on operating systems and applications. This will consist of my personal experience with various HCS solution from Microsoft, Adobe, Google, and Firefox.
   III. Opinion based quotative research through questionnaires. I plan to send out a questionnaire to (1-3) schools for the visually impaired to quantify the student use of HCS, and sonification.

   Task 2.3 has dependencies beyond my control. I will need to obtain permission and cooperation from the schools to participate in this study. School supervisors may deem the risk that un-vetted information reaching their student body too great to proceed with the study. In the event of limited or no participation from my study groups, the contingency plan is to rely more heavily on qualitative and quantitative research on previous work.

Development and Problem Definition

As described in the research and data section, I plan to consider the gaps in assistive technology for the visually impaired. My focus will be on HCS and sonification[1]. Research for this project has uncovered work on HCS, but not much about sonification. There seems to be room to improve accessibility for the visually impaired by using sonification to visualize digital media. For my project, I plan to implement sonification to visualize 2-dimensional cartesian graphs: line, parabolas, and circles.

To evaluate my research hypothesis, I plan to develop an application to consider human factors for the visually impaired. My objective is to host this application on a public domain, and use both visually impaired and fully sighted subjects for the assessment of the application. The non-visually impaired population is included to provide a placebo control group to the experiment. The non-visually impaired population will consist of (1-3) middle school math classes from the same public school. The visually impaired subjects will be the same (1-3) schools that receive the research questionnaire. The study will evaluate the physical ergonomics of HCS and sonification by tracking the number of clicks

[1] Sonification [1] uses sound: frequency, amplitude, and timbre to convey information. Sonification can increase accessibility by allowing observable objects such as curves in a Euclidian plane can be visualized. Upson [7] discusses using sonification to visualize geometry, which is a completely visual form of mathematics. Upson's proposes sonification as another vector for assimilating information, and targets middle school pupils. Essentially, using both sight and sound will increase the absorption of the material. Although Upson is not targeting the visually impaired, others [8, 9] have used sonification for this audience.

for sonified images, as well as for HCS and non-HCS images. I may also put survey question(s) on pages in the application.

The application will be hosted by a service such as Amazon S3 (AWS) or Google Cloud, and include:

3. Create static images of 2-dimensional graphs: parabolas, lines (pos, neg, and no slope) and circles with matplotlib.
    I. Generate images in HCS
    II. Generate images in standard contrast (non-HCS)
4. Create web-ui and host application.
    I. Create basic web-ui to display in HCS. If not HCS, use standard contrast.
    II. Host static images and create buttons to allow users to view images in both HCS and standard contrast.
    III. Include sonification for each plot. This will consist of a tone that corresponds uniquely to each plot. This will be accessed through user input (sonification button).
    IV. Evaluate the physical ergonomics of HCS and sonification by counting the number of clicks per button.

Like the research portion of this project, similar risks apply toward the use of unapproved resources by schools under consideration for this study. Unlike research, if I cannot obtain permission from the visually impaired subjects, I don't have as solid a contingency plan for replacement. For the non-visually impaired population, I can substitute other study groups such as work and school colleagues.

Other concerns are my lack of experience in the hosting environment and web-ui development. This will be a learning experience for me, and my schedule will need to accommodate it.

Intermediate Milestones and Final Deliverables

1. ***Milestone 1***: Complete research and development tasks: 1, 2.1, 2.2, 3.1 and 3.2. Finalize questionnaire, identify 1-3 schools for the visually impaired, and solicit response(s).
2. ***Milestone 2***: Build paper by integrating research from 2.1 and 2.2. If there is good participation from 2.3, incorporate data into paper. If not, fill in gaps with additional research from 2.1 and 2.2. Complete development: 4(1-4).
3. ***Final Deliverables***:
    I. Final paper: Add data from the physical ergonomic study to paper. Complete final reviews and submission.
    II. Final presentation

III. Calendar of Deliverables

Date	Deliverable
10/08/2017	Proposal
10/15/2017	Tasks: 1, 3.1, 3.2, identify 1-3 schools for the visually impaired.
10/22/2017	Tasks: 2.1, 2.2, finalize questionnaire, and solicit response(s).
10/29/2017	**Milestone 1**
11/05/2017	Build paper, 4.1, 4.2
11/12/2017	4.3, 4.4
11/19/2017	**Milestone 2**
11/26/2017	Add data from the physical ergonomic study to paper.
12/03/2017	Create presentation. Complete final reviews of paper, and incorporate changes into paper.
12/10/2017	**Final deliverables: Submit paper and presentation.**

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