Assistive Technology for the Visually Impaired

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ABSTRACT

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 approach to convey information is to utilize a second sensory input. A 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.

Keywords

Accessibility, assistive technology; digital media; educational technology; pedagogy; sonification; standards; special needs, visual impairment.

INTRODUCTION

The world of digital media is vast and seemingly unbounded. However, for the visually impaired, it can be narrow and challenging to explore. In the context of this paper, visually impaired will refer to individuals with low vision that require special needs. According to the National Eye Institute, "low vision means that even with regular glasses, contact lenses, and medicine or surgery, people find everyday tasks difficult to do.

Education has become increasingly digitized. Research [4] presented in **Table 1** shows that teachers (K-12) are heavy users of digital content in the classroom. If this content is not accessible to the visually impaired, then a significant portion of their education is inaccessible.

Table 1: Teachers' Use of Digital Content in the Classroom.

%	Videos Found Online	Real Time Data	Online Textbook	Anima-tion	Virtual Labs
All	48	18	27	22	9
Sci	63	32	32	52	42

A very effective assistive technology for the visually impaired is the High Contrast Setting (HCS) available on most operating systems (OS), and applications such as Adobe Reader and various web browsers. HCS is freely available, both in cost and distribution, and will be the focus of my research. Fok, et al. [2] show that Adaptive Computer Technologies (ADT) such as HCS are used by 57.7% of their sample group. Although this seems high, it is not the most used assistive technology from their study. The use of HCS can be expanded if the format and configuration are standardized across platforms and applications. Phillips and Zhao [6] identified the ease of device procurement, and poor device performance as reasons why users abandon assistive technology. Although the scope of assistive devices in [6] is much larger, and includes physical

aides such canes and wheelchairs, the reasons can be extrapolated to disregarding ADTs. Standardization of ADTs can reduce or eliminate procurement issues, and greatly improve the performance of HCS. Sonification can be used to provide another modality to further expand educational opportunities for the visually impaired.

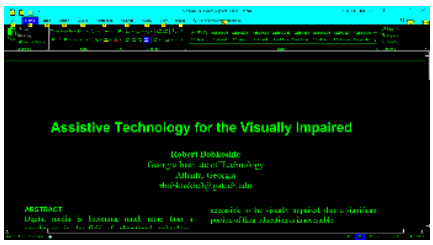
RESULTS AND DISCUSSION

Although ADT, and HCS allow the visually impaired to experience digital media, seemingly minor improvements can endow significant benefits. This discussion will highlight existing HCS, the positives and negatives, as well as methods to improve HCS. In addition, sonification will be explored as a potential ADT for enhancing the pedagogy of mathematics for the visually impaired.

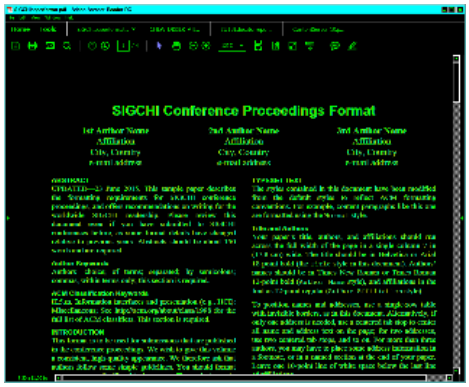
High contrast settings in good light

High contrast setting, in their current availability have features that enable the visually impaired to navigate digital media. High contrast is defined as a large difference in magnitude and gradient between colors in an image. In the context of this paper HCS will refer to the difference in color between the background and foreground (text, images) in digital media. The images in fig. 1 show the HCS available embedded with the OS (Windows) or application (Adobe Reader, Google Chrome, Mozilla Firefox).

(A) Windows OS



(B) Adobe Reader



(C) Windows OS with Mozilla Firefox on left, Google Chrome on right.

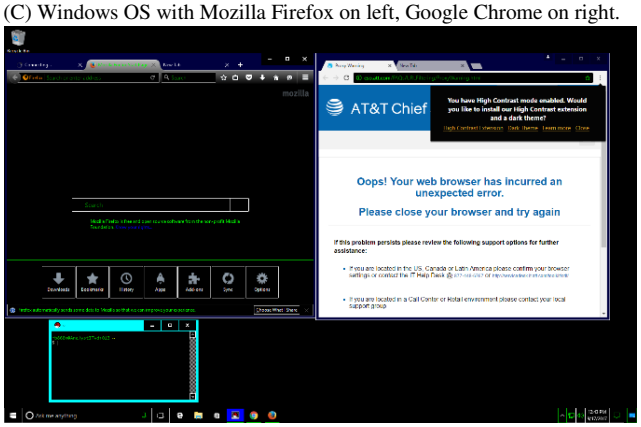


Figure 1: Images of ADT, Windows OS, Adobe Reader, Google Chrome, Mozilla Firefox, Internet Explorer.

Where is the high contrast?

The images in fig. 2 show the inconsistent styles of high contrast displays available as ADT embedded with the OS or application. Each ADT has (dis)advantages, and all present difficulties for a visually impaired user to initially set up. With Mozilla Firefox, the title in the Google search results is difficult to read.

Figure 2: Results from a search query string: 'Images for fred flintstone': Google Chrome, Mozilla Firefox, Internet Explorer. Note, increase size of images in next draft

(A) Windows IE (B) Mozilla Firefox (C)Google Chrome

Let's hear about sonification

Another ADT that has not been fully exploited is sonification. For this discussion, the term 'sonification' refers to the "use of non-speech audio to convey information or perceptualize data" [3]. Chew [1] assessed using auditory graphing systems for visually impaired middle school students in mathematics. Studies in the field of ophthalmology have stressed the importance of assistive technology resources, such as learning tools for visually impaired students [5].

FUTURE WORK

This section will be developed as the project undergoes further development. For now, it will serve as a reference and guide for additional work. As results, and additional research comes in, the section will expand to accommodate it.

Arrange images to increase size of image.

Add in examples of good HCS applications, Putty, and bad applications HCS: eclipse, Adobe HCS for old documents and images in some Adobe files.

Add in section in discussion describing non-standard approaches to initial set-up of HCS.

Human Factors Study

Find additional research on sonification, and game development, as I plan a small proof of concept tool that uses sonification for simple graphs on a 2-dimensional plat. The objective is to host this tool, and have students (both sighted and visually impaired) evaluate it. The toll will count the number of times students enable high contrast and sonification.

Identify additional research that highlights the acceptance and efficacy of ADT for the visually impaired, in particular, high contrast. I would also like to have a counterpoint that shows good usage, but if the high contrast were more standardize, it would have an even greater impact.

Identify resource that show the traditional white background is not usable for the visually impaired. High contrast, in particular, a dark background with light text works best. Some examples from users of Adobe high contrast: https://forums.adobe.com/thread/777688

Inaccessible Accessibility

The ADTs offered on operating systems and applications are difficult to initially configure for the visually impaired.

CONCLUSIONN

In summary, research has been presented that highlights the need for additional, and a more standardized approach toward assistive technologies for the visually impaired. Moreover, standardization and sonification can fill gaps in existing ADTs, and allow for a more effective and rich educational experience for the visually impaired.

ACKNOWLEDGEMENTS

My mentor, Zach Hooks. My cohort who provided invaluable peer feedback throughout this project.

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