Standardizing Accessibility features on Websites for Vision

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ABSTRACT

Web users have different visual accessibility feature preferences, and unfortunately not all websites come with the same set of accessibility features. The goal of our study was to determine if users find it more convenient to use a standardized set of accessibility features implemented in one easy-to-use menu than to use whatever accessibility features they can find in their operating system, browser, or website. We measured this "convenience" in a few different ways: for one, we measured how long it took users to activate common accessibility features. We also measured user-reported ease with which they found such features, as well as user-reported comfort as they read through different websites. To achieve this, we designed a browser extension that combines several important accessibility features (as determined by our prior research) into a single, easy-to-access menu. Then, we conducted a study consisting of 16 participants divided into two groups. Both groups were asked to find and activate accessibility features using whatever means they saw fit, be it through the operating system, browser, website, or otherwise. Users in our control group did not have access to our extension whereas experimental group users did. After collecting and analyzing the results, we found that the average time to find and activate accessibility features in the control group was significantly higher than the average time for the experimental group. Experimental group users also reported that they were more comfortable browsing the websites. In this paper we will start by describing our background and motivations and discuss which HCI concepts are related to our study. Then we will show some related work before we present our design and implementation. Finally, we will describe the study we conducted and the results.

KEYWORDS

Websites; Vision; Accessibility; Assistive tools; Affordances; Web browsing.

INTRODUCTION

Almost everyone browses the internet, and every user has a different preferred look on a website. Users with poor eyesight, such as older users, may prefer larger text. Users with dyslexia may benefit greatly from having a sans-serif font as opposed to serif. Having a dark mode has been shown to reduce eye fatigue in users, making browsing the internet, especially for long periods of time and at night, significantly more comfortable. A reading mode greatly reduces clutter on a page and makes reading (as the name would imply) a much more streamlined process. Finally, users who are colorblind benefit greatly from having some form of colorblind mode, which adjusts the contrast of images on the page to allow users to better discern different colors. The vast majority of websites don't give users the option of choosing their preferred accessibility features, so users may waste time looking for features that don't even exist. If they exist, users often have to spend a fair amount of time on each website digging through menus to find these tools. These visual accessibility features are very important for visually impaired users but are often used even by those without impairment simply for increased comfort when browsing the web. Our proposed approach to solve these problems is standardizing accessibility features across all websites for visually impaired users. We believe that this approach is important because it standardizes the accessibility features that these users need across every website they browse. Users will be guaranteed that they can easily find and use these accessibility features across all websites, and they will waste no time to find each one. Our project fits into the realm of assistive technology, as it serves to help visually impaired users browse the web more comfortably. In the most extreme cases, our extension might even serve to allow our target users to browse websites that were essentially "off limits" to them previously. We consider our system to be an assistive technology to help people with low vision. According to Cook and Hussey, the focus of assistive technology is mainly of fitting non-standard users to use standard technology via inserting an assistive component between the users and the system. In our project, we target users with visual impairment as non-standard users to help them find their needed visibility accessibility features at any website they want to browse. [3]

Another area of human-computer interaction that we focused on in conducting this study was that of affordances. When we asked our participants to find some of these accessibility features, they were often surprised to find that some of these features are built in to their browsers, operating systems or even the website they were browsing. These tools are available, but the users have no idea how

to find and use them. One of the main issues we are addressing is the users' understanding about how to find and use these tools/features, which is precisely the purpose of affordances in HCI. According to Norman's definition, an affordance is the design aspect of an object which suggests how the object should be used [1]. He also states that "Affordances can make an action difficult or easy". As we will show later in this paper, it is quite clear to see that finding most of the accessibility features we have described is not easy on a standard-issue computer, but it becomes significantly easier when users have access to a tool such as ours. Perhaps the biggest issue that affects the affordance of existing websites' accessibility features is the lack of visual cues. Users sometimes know that there should be some way to access these features, but they usually do not know where to find them. In our design, we believe that we increased the affordance of the website's accessibility features by making it available in a single menu that is visible in the browser's toolbar. In this case, we will have an explicit affordance instead of hidden affordance.

RELATED WORK

There are many website accessibility features available today. These accessibility features help the user to easily read through different websites. The primary goal of accessibility on the web is to make the browsing experience for users with disabilities easier and more comfortable. The need to improve the web browsing experience by adapting and personalizing the software to user preferences and device characteristics has become evident [4]. A change in the overview of website design and a stronger inclusion of accessibility is needed given that visually impaired users still cannot fully benefit from the advantages of contemporary web technologies.[5]

One of the focus areas of accessibility features is dark mode, as dark mode generally makes content easier on the eyes and thus helps those users who have vision impairments. It has been suggested that this relates back to subjective impressions of higher visual comfort with dark mode, an overall sense of making it easier to read, and the impression that dark mode increased users' performance in the experiment. This result is associated with the findings of prior research that showed the positive effects of dark mode on visual fatigue levels.[6]

There has also been theoretical work that discusses that the font style used on a website also makes an impact on readability and the user's comfort level. The choice of typefaces and the characteristics of fonts can affect legibility and the reading performance of individuals with visual impairments such as dyslexia. Sans-serif typefaces, such as Arial, Helvetica, Verdana, or Adsans, are more readable than Times New Roman. Current guidelines on good design for printed materials for users that are visually impaired are extremely beneficial, and there is growing enlightenment among the sighted community and public and private organizations of the need to keep pace with these developments. It is perhaps only a matter of time before standardized concepts on the legibility of text for people with low vision are instituted on both the local and global scale. [7]

Work has also been done that demonstrates that users with vision impairment often tend to have issues when interacting with busy web interfaces. Those users who suffer from severe impairment benefit from having interfaces with little clutter, on which they might be able to memorize the location of the settings they need most so that they can easily activate such features in the future.[8] We had this research in mind when designing our interface, which led us to create an interface that is always in the same place, featuring large buttons and large text, that should allow extremely low-vision users to find and activate certain features based on memory.

SYSTEM DESIGN AND IMPLEMENTATION

Our system focuses on providing users with a web-user interface that can help them reach the website accessibility features that they need faster and more easily. Our goal in designing this system was to create a simple, easy-to-use and easy-to-find user interface that would allow users to activate and use a standardized set of accessibility features. To achieve this, we created an extension for the Google Chrome browser that users can install to have access to our interface on any website. Our extension, called "Accessibility Everywhere," serves to give users access to the accessibility features that our research told us are most valuable to low-vision web users.

In designing our interface, we aimed to follow the user-centered design process as much as possible. We came up with an initial prototype (seen in figure 3 below) that we then used to build off of for future iterations. As can be seen in the initial prototype, many of the features were activated by clicking small checkboxes located next to small text labels. Font color (later removed entirely) and style were changed by using a drop-down menu, again with small text everywhere. In addition, we had two separate colorblind modes and a font size slider. For most with unimpaired vision, this menu would do just fine. However, as we put ourselves in the shoes of our users, we discovered a number of flaws in our design. For one, our users are low-vision users, so small text and tough-to-click buttons were not going to cut it. These were replaced with large buttons and large text. In addition, the font size slider would have been difficult to work with and would require imposing font size limits that might not benefit some users, so that was replaced with large buttons as well. The font style drop-down was replaced with radio buttons allowing users to pick only serif, sans-serif, and default fonts, and our two colorblind mode plans were replaced with a single colorblind mode that should effectively benefit all of our colorblind users.

Our project is a research-oriented design (RoD) based project. It works as an assistive technology to help non-standard users (people with visual impairments) to easily access features they need to browse comfortably. The UI consists of features including a font

size adjuster, font style changer, dark mode feature, reading mode feature and a colorblind mode. Our system focuses on helping low-vision users read more comfortably on websites. The user interface is a menu that appears when the user clicks on the icon to activate our extension in the browser toolbar. The font size adjuster, consisting of two large buttons, one with a "plus" symbol and one with a "minus" symbol, allows users to increase and decrease the font size on the page they are on in 2-pt increments. The font style feature allows the user to select between serif, sans-serif, and default fonts, where the serif font selects a Times New Roman-based font family, sans-serif uses a Verdana-based font family, and default leaves the fonts that are active by default on the page. While our primary goal was to make our extension dyslexia-friendly by adding a sans-serif font option, we chose to also add a serif font option to make the feature feel more whole. Our extension also provides users the option to select a dark mode "theme" on the website they are browsing, which simply serves to set the page's background color to black and the text color to white. Reading mode, another feature of our extension, finds and removes all the images on the page, making the website text-only. This helps users to declutter the page they are on so that they can focus on just the text, allowing them a better reading experience. Colorblind mode, the last feature of our extension, increases the contrast of every image on the page by about 50%. The increased contrast, though a seemingly small difference to those users with normal vision, serves to greatly improve the viewing experience for colorblind users, who are much more easily able to distinguish between different colors. Another feature of our extension is that the selections made by the user are persistent throughout the browsing session. Once a user has selected the features they desire from our extension, they remain on as the user moves from site to site, allowing the browsing experience to remain uniform across the web.

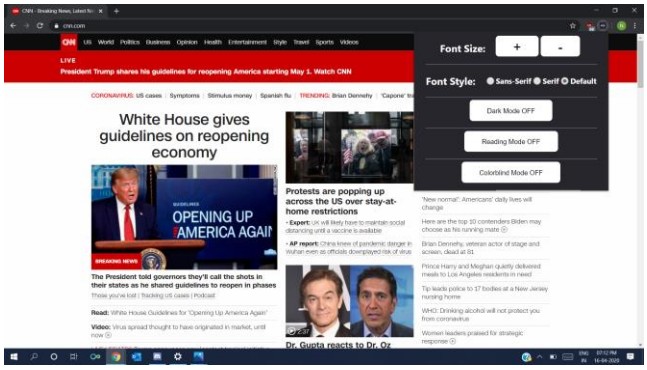

Figure 1: cnn.com with our extension's menu open and no features active

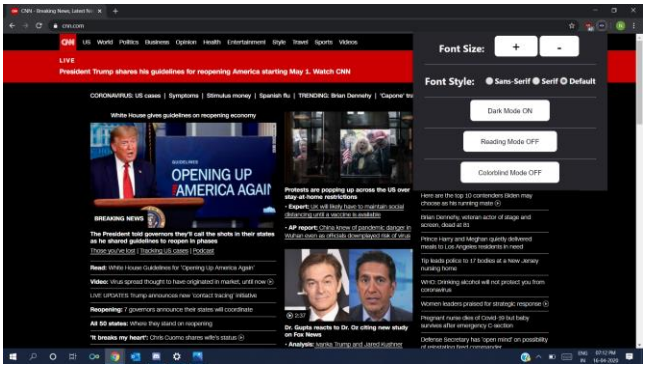

Figure 2: cnn.com, again with our extension's menu open, but this time with dark mode activated

Usability Testing

Our usability testing for this project followed the "quick and dirty" model. As we went through the process of going from the interface shown in figure 3 to that shown in figure 4, we received feedback from each other, our friends, and our classmates to adjust our interface to make it better for our users. We received feedback that led us to increasing the size of our user interface, as it was initially far too small relative to everything else on the screen. Some of the other feedback we received also led us to increasing the size of our buttons even further than we had initially. In addition, we ended up relabeling our font style buttons, which initially said "Times" and "Verdana" instead of "Serif" and "Sans-serif," and we also increased the size of the labels on our font size buttons.

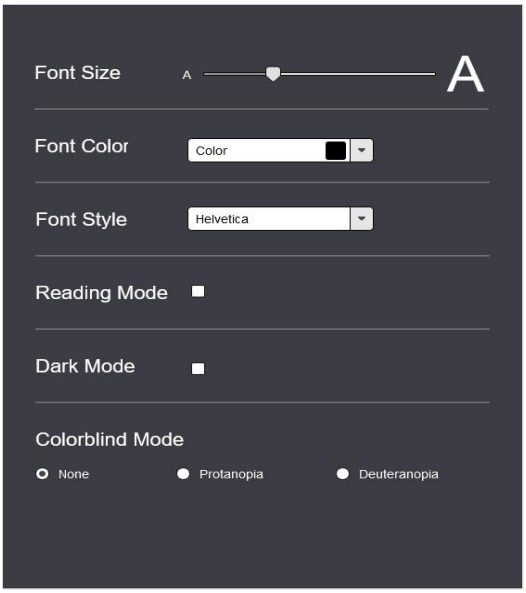

Figure 3: Our initial UI prototype

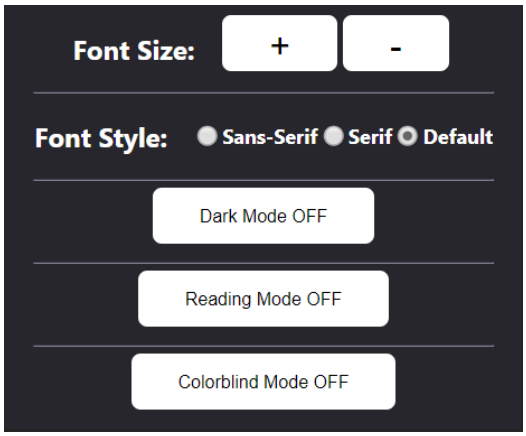

Figure 4: Our final UI

STUDY DESCRIPTION

For this project, we conducted a study to determine how easily users were able to find and use accessibility features when they had access to our extension, as well as how these features serve to improve the user's comfort when browsing. For our study, we took two groups, each consisting of 8 people. For both groups in this study, users were asked to use whatever settings they could find in their current computing environment. That included features built into the website they were browsing, features built into the browser itself, and features built into their operating system. Users were permitted to use search engines to find features if they wished. What made the difference between these two groups was that our control group did not have access to our extension, whereas the experimental group did.

For our study, we selected 3 different websites on which users were going to have to read passages. The first website we selected was a post to Reddit's "Announcements" subreddit. This post was made by Reddit administrators informing users of the website of new features that were recently added. The next website we chose was a relatively brief article on ABC News regarding a recent decision from President Donald Trump, and the final website was simply the home page of the news aggregation website Drudge Report.

On each website, users were asked to activate each accessibility feature found in our extension in order. Users were timed on how long it took them to activate each feature (up to 3 minutes, after which users were stopped). Once users had located each feature, they were asked to activate whichever accessibility features they thought would make their browsing experience most comfortable, then read through the passage on the website. After each website, each user answered a survey in which they reported the ease with which they found a feature on a scale of 1 to 5 (where 1 was "impossible" and 5 was "very easy"). Users also reported on their level of comfort when reading through the passage on a scale of 1 to 5. In addition to timing how long it took for users to activate each feature, we timed how long it took users to read each passage. For experimental group users, we also took note of how many features they used on our user interface vs. those found elsewhere, to see if use of our UI increased over time.

The goals we aimed to achieve with our system compared to the baseline, which is simply websites that do not have a standardized set of accessibility features, are:

1. Easier access to visibility features

2. Higher familiarity with finding those features

3. Better browsing performance and comfort

We took the following metrics to assess our study:

1. Interface use ratio—number of features used in our interface/number of available features. We tracked this only for experimental group users who had access to our interface.

2. How easily the user found the accessibility features.

3. Comfort during reading: Collected through questionnaire.

4. Performance: Collected through reading time for each section of a webpage.

5. Ease with which users could find and activate these features again in the future.

Metrics 1, 2 and 5 were used to evaluate ease of access and familiarity. Metrics 3 and 4 were used to evaluate browsing performance and comfort. We collected our subjective data by asking users to answer questions on a survey after each website they visited. Objective data was recorded by the subject's observer.

DATA ANALYSIS

We have organized all the data we collected on the above metrics in ways that can directly compare and evaluate our system's goals with the baseline.

The bar chart in figure 5 shows and compares the average time participants took to find and activate each feature in our study. This lets us get an objective understanding of how easily users can get to each feature.

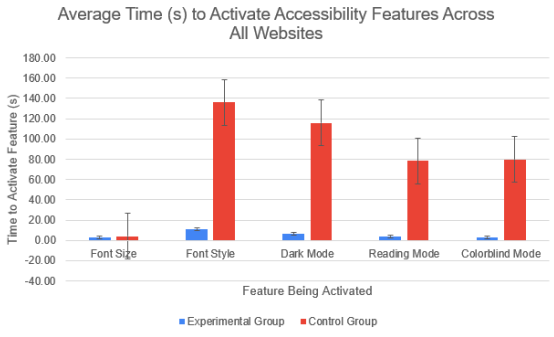

Figure 5: Average time taken to activate accessibility features

We also organized and compared participants' subjective feeling of ease in getting to each feature. The bar chart in figure 6 uses the data we collected on ease of access from our survey to show differences between the two groups on user-reported ease with which features were found.

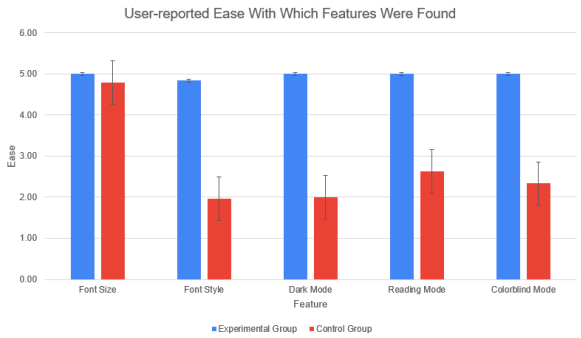

Figure 6: User-reported ease with which features were found

To evaluate our system's goal of having users achieve a higher degree of familiarity, we analyzed the subjective results from our survey question that asked users how easily they could find these accessibility features in the future. The results from that are shown in figure 7.

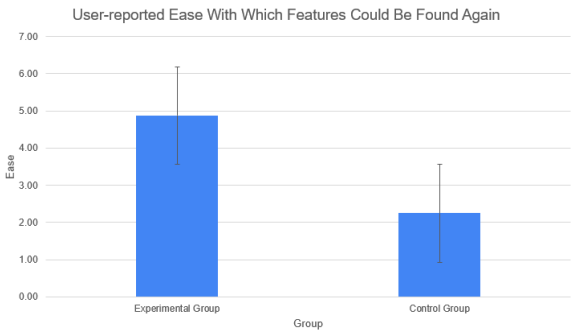

Figure 7: User-reported ease with which they could find features again

We then analyzed participants' subjective comfort reading through passages on the websites across both groups. Their performance in reading those passages was also tracked through time taken. Figures 8 and 9 show the differences between the control and experimental groups based on these values.

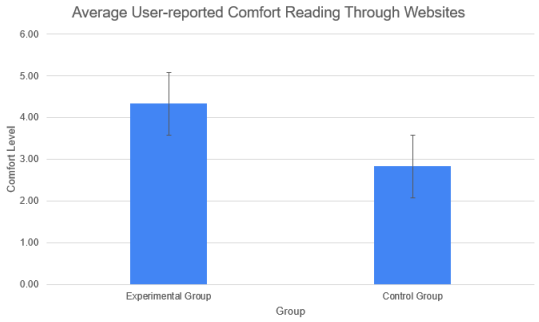

Figure 8: Average user-reported comfort in reading through websites

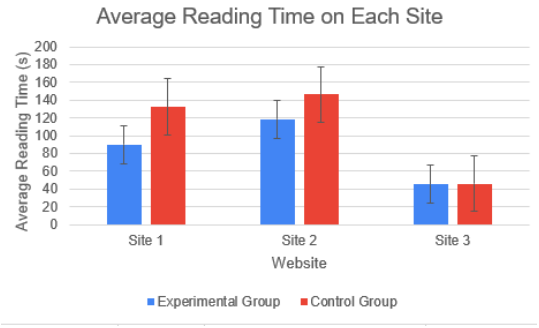

Figure 9: Average time taken to read through each site

Finally, as an additional metric, we also tracked the use of our UI across the three websites in our experimental group. Figure 10 shows how it changes over time.

Figure 10: UI use in the experimental group across all 3 websites

For each of the above relevant comparisons, we also performed t-tests to see if there are significant statistical differences in the data between our two groups.

RESULTS

The data we analyzed showed some key results:

The average time taken to find and activate each feature, except for font-size, was significantly (meaning that the corresponding t-test returned a p-value < .05) lower in the experimental group. User-reported ease of finding each feature, again except for font-size, was also significantly higher in the experimental group. We believe that the reason why the font size statistics stand out from the rest is because most of the participants in the control group knew shortcuts (like CTRL-+ or CTRL-scroll up) that increased the size of the all content on the website. We do not consider this to be a drawback since we still expect some users in our target population to be unaware of these shortcuts. User-reported ease with which they could find features again in the future was significantly higher in the experimental group as well, which suggests that users developed a good degree of familiarity with our system even during just our short study. User-reported comfort was significantly higher, while the time it took them to read each passage was significantly lower in the experimental group. UI use across websites by experimental group participants increased from website 1 to website 2 and stabilized by the time they were done with website 3. This suggests that once experimental group participants found our UI on their browser, they preferred using the features on it more as opposed to some of the other methods they employed on the first website.

DISCUSSION AND CONCLUSION

Accessibility features on the web are lacking, to say the least. Most websites fail to implement any of these features, let alone all of the ones that low-vision users need to browse the web comfortably. Knowing that so many websites fail to implement these features makes our results more interesting, for sure, but also more concerning. Our findings show that even our study population—consisting of college-age students with no major vision problems—still found that it was significantly more comfortable to read through sections of a website with these vision-assistance features active. With that knowledge, one can only begin to imagine how much these features might benefit users with visual impairments. Another interesting thing that we learned from this study was that many of these features aren't impossible to find. Often, control group users did find one way or another to actually access the features they were asked to find, but it did take them a significantly longer time to do so. The affordances exist but are generally buried beneath menus. Our project serves to bring those affordances to the forefront of the browsing experience and make them readily apparent to the user. This leads us into what is probably our biggest opportunity for future work—to conduct a study with our true target population. While we found that users without visual impairment find these features much faster with our extension than without, one has to wonder if that might be because they don't normally use such features. While we might think that these results for users without impairment can be easily adapted to those users with impairments, it is entirely possible that impaired users are already so used to dealing with the inadequacy of web accessibility and already know exactly what to turn on and where to find it. That being said, finding a feature is only half the battle, and our results show that our novel user interface has more than just a speed advantage over built-in features. With the foundation we've built, we believe there is a lot of potential for this project and similar ones in the future.

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