RELATING VISUAL DISABILITY AND THE WEB

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ABSTRACT

Despite the fact that the proportion of people with disabilities in society has been increasing, many critical online public activities are not readily available to them. Much as a large body of literature has examined the overall impact of visual disability on functional status and quality of life including Web usage, few published studies have explicitly investigated the relationship between visual disability and Web-based tasks. Moreover, the available Web Accessibility guidelines to-date lack coherence and simplicity for easy comprehension and application in Web application design for different disability groups. For example the primary reference guidelines – that is the Web Content accessibility guidelines (WCAG) is organized arbitrarily with no distinct sections according to types of disabilities covered. This makes such guidelines hard to understand and apply by Web content developers. This paper examines how properties of Web applications affect users with various visual disabilities. The goal of this study was to understand the problems faced by Web users with visual disabilities and how the problems can be addressed in Web development tasks. Understanding the relationship between visual disability and Web applications is an important foundation for further research considerations on how to make the Web more accessible to people with visual disabilities. Such considerations may include but not limited to: development of concise visual accessibility indicators and associated design techniques. The paper is organized into six sections namely: introduction; methodology; related work, properties of Visual disability and Web applications, the relationship between visual disability and properties of Web applications; Conclusion and future Work.

KEY WORDS

Visual Disability, Web Application, Web Accessibility, Design Guidelines

1. INTRODUCTION

The Web has become a valuable information resource for people with disabilities. Unlike before, they can obtain any type of information by themselves from all over the world whenever they need it by accessing the Web using assisitive technologies. Self-talking browsers, screen readers and braille displays have been developed and improved along with the evolution of the Web to help blind people obtain information from the Web [1].

However, although the Web opened new and better information access possibilities for people with disabilities, some of its inherent characteristics still inhibit its full use by these people. Such characteristics include: the Web's focus on structuring and sharing documents rather than visual logic or graphic design aspects of information delivery and continued reliance on color, graphics, motion pictures, audio and other dynamic elements [2].

Despite the fact that the proportion of people with disabilities in society has been increasing, most governments around the world have paid little attention to their needs when planning and implementing Web projects. Hence many critical online public activities and customer services are not readily available to people with disabilities [2]. In a study conducted by Nielsen [3], the usability of most current Web sites is on average three times higher for users without disabilities than for those who are blind or have low vision. In another research project published by Forrester Research [2], it was found that only one out of four e-commerce sites surveyed met even minimum requirements provided by the Web Content Accessibility Guidelines (WCAG). According to Takagi and partners [4], even in the public sector of the U.S., where Web accessibility is a legal mandate (under Section 508 of the Rehabilitation Act), a significant number of official Web sites still contain features that do not provide reasonable access to users with disabilities. In Taiwan, 83% of central government Web sites are inaccessible to people with disabilities and accessibility for people with visual disabilities is the most common problem [2].

Although a large body of literature has examined the overall impact of visual disability on the functional status and quality of life including Web usage, few published studies have explicitly investigated the relationship between visual disability and Web-based tasks [1]. In addition, the available Web Accessibility guidelines have a limitation in the way they are presented. They are organized into a random set of guidelines for all types of disabilities that affect a person's use of the Web [5]. Organization of such guidelines into a coherent set according to the different types of disabilities would make them easier to comprehend and use by Web content developers. According to Shi [5], one of the reasons why several Web sites are not yet accessible is because Web designers are not familiar with the existing guidelines or laws related to Web accessibility. An international study on webmaster perceptions of Web accessibility by Lazar and colleagues [6] found that more than one third of the webmasters surveyed were not familiar with the WCAG and more than one quarter of them were not familiar with the US Section 508 and/or similar governmental rules for Web accessibility. Poorly written guidelines or unclear software tools are likely to keep sites from becoming accessible [6].

The goal of this paper is to examine the relationship between visual disability and Web applications based on the properties of the two entities. The aim of the authors in establishing such relationship is to understand the problems faced by Web users with visual disabilities and how these problems can be addressed in Web development efforts. Such an understanding is important for further research considerations such as development of accessibility indicators for the visually impaired together with their associated design techniques for achieving Web applications that are accessible to the visually impaired.

The remainder of this paper is organized into four sections as follows: related work, properties of visual disability and web applications, the relationship between visual disability and properties of web applications and conclusion and future work.

2. RELATED WORK

This section presents a review of existing guidelines/standards for developing accessible Web applications and other work related to visual disability and Web applications. The purpose of reviewing existing guidelines/standards was to assess the extent the current guidelines address accessibility for the visually impaired. This together with a review of other work related particularly from journal papers and technical reports provided critical points of current knowledge on the properties of web applications and visual disabilities in addition to general current knowledge on Web accessibility for users with visual disabilities.

2.1 Existing Guidelines/ Standards for Developing Accessible Web Applications

The standards reviewed included the Web Content Accessibility (WCAG 1.0) Guidelines; Americans with Disabilities Act (ADA); Section 508 of the Rehabilitation Act; Australian Disability Discrimination Act (ADDA), and the National Institute on Ageing Guidelines (NIA). This sub section presents results of the review:

2.1.1 The Web Content Accessibility Guidelines (WCAG)

xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx**Thatcher, J. 2003. Creating accessible content in Constructing Accessible Websites, 2002. Web professional to web professional *an Apress imprint***

The most prominent of the three are the Web Content Accessibility Guidelines (WCAG), Version 1.0, from the Web Accessibility Initiative (WAI) of the World Web Consortium (W3C), which became an official Recommendation of the World Wide Web Consortium on May 5th 1999. WCAG consists of fourteen guidelines, or principles of accessible design. Each guideline includes a set of checkpoints that explain how the guideline applies to web development. The checkpoints *(*http://www.w3.org/TR/WCAG10/full-checklist.html*)* are prioritized according to the following criteria:

[Priority 1] *A web content developer* **must** *satisfy this checkpoint. Otherwise, one or more groups will find it impossible to access information in the document. Satisfying this checkpoint is a basic requirement for some groups to be able to use web documents.*

[Priority 2] *A web content developer* **should** *satisfy this checkpoint. Otherwise, one or more groups will find it difficult to access information in the document. Satisfying this checkpoint will remove significant barriers to accessing web documents.*

[Priority 3] *A web content developer* **may** *address this checkpoint. Otherwise, one or more groups will find it somewhat difficult to access information in the document. Satisfying this checkpoint will improve access to web documents.*

There are 65 checkpoints in all; 16 of them are priority 1, 30 are priority 2, and 19 are priority 3.

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WCAG is a set of international standards produced by World Wide Web Consortium (W3C) for the design of accessible Web content [5]. The guidelines address two general themes- that is ensuring graceful transformation to accessible designs, and making content understandable and navigable. In general, the guidelines, explain how to make Web content accessible to people with disabilities. They are recognized as the authority for designing and creating accessible Web sites, and have been used by several software developers to develop accessibility authoring and checking tools such as BOBBY (www.cast.org/bobby/) [2]; [5].

However, the WCAG have a limitation in the way they are organized. They are presented randomly for all types of disabilities. Although in some cases, each guideline mentions the groups of users it benefits, they are not organized according to different types of disabilities that affect a person's use of the Web. An arrangement according to different types of disabilities could ease comprehension and usage by Web content developers. This could be one of the reasons why WCAG is not yet popular with Web content developers and administrators [6].

2.1.2 The Americans with Disabilities Act (ADA) of 1990

ADA requires employers to provide "reasonable accommodation" and mechanisms for "effective communication" to workers with disabilities. It was originally focused on areas such as employment, public accommodations, and telecommunication services. However, the subsequent growth of the Internet for communication in education, business, government and work settings led to broadening of ADA's scope to require "electronic curb cuts and ramps" that allow users with disabilities to access computers and the World Wide Web [1].

ADA makes reference to WCAG as a more comprehensive Web accessibility resource developed by the W3C that helps designers make Web pages as accessible as possible to the widest range of users, including users with disabilities. Its application is limited to USA.

2.1.3 Section 508 of the Rehabilitation Act

Section 508 of the Rehabilitation Act on the other hand defines the processes used by the US federal government to procure electronic and information technology systems. One of the central aspects of the law is to ensure accessibility of electronic and information technology systems to people with disabilities who are federal employees or members of the general public [2].

However, although Section 508 requires agencies to ensure that persons with disabilities have equal access to and use of federal e-government Web sites, widespread accessibility on e-government sites has not materialized since the 2001 compliance deadline [7]. Studies of the accessibility of federal e-government sites have found low levels of accessibility, with usually less than one-third of sites being labeled accessible by these studies [7]. In addition, although section 508 guidelines are more concise than WCAG, they are also general in the way they address accessibility needs of different disability categories including visual disability.

Nevertheless, Section 508 has a lot of similarity with the Web Content Accessibility Guidelines (WCAG). This is possibly because it is based on the U.S. Access Board's Electronic and Information Technology Accessibility Standards, which are in turn based on the WCAG. This relationship has made it an important legal reference for Web accessibility in the U.S [7].

Like ADA, Section 508 makes reference to WCAG as a more comprehensive Web accessibility resource. In fact, Section 508 contains more or less the same guidelines as the WCAG but in a more compressed form. The major difference between the two sets of guidelines is that Section 508 is legally binding in the U.S. where as WCAG is an open non-legally binding Web Accessibility specification.

2.1.4 Australian Disability Discrimination Act (ADDA)

Under the Australian Disability Discrimination Act, a service provider is required to take reasonable steps to change a practice, which makes it unreasonably difficult for people with disabilities to make use of its services. According to ADA 1992, inaccessible web sites or pages are a sort of discrimination against people with disabilities and are thus illegal in Australia [5]. ADA Australia is more like ADA US in that they both existed before invention of the Web technology, which they later recognised and incorporated among the services covered.

2.1.5 National Institute on Ageing (NIA) Guidelines for making senior friendly Web-sites:

NIA guidelines were developed by the National Institute on Aging (NIA) in conjunction with the National Library of Medicine (NLM) to improve the usability of Web pages for older adults [8]. These guidelines provide for the effective design of a Web page by taking into account font sizes, font types, colors, and styles; background images and colors; vertical scrolling; and text formats, among other design issues. However, the NIA guidelines only cover enhancing accessibility for low vision Web users, a condition commonly suffered by ageing adults. In addition, its recommendations are largely covered in the Web Content Accessibility Guidelines. Unlike other guidelines, it does not make reference to WCAG.

2.2 Related Work from Journals and Technical Reports

The other related work reviewed covered journal papers and technical reports published between 1980 to-date on Web Accessibility for the visually impaired users in general and in the provision of public services particularly e-government services. This subsection gives results of the review as follows:

Visual disability is one of the disabilities that affect a person's use of the Web. Other disabilities include: hearing, speech, cognitive and neurological impairments, and some mobility disabilities [5]. Visual disabilities include blindness, low vision and color blindness.

According to Shi [5], visual disability is a bigger threat to effective Web usage among people with disabilities compared to other forms of disabilities such as hearing and motor disabilities. More over, the Web now revolves around video, multimedia, real-time collaboration, and interactive documents, all of which are heavily visually based [1].

The percentage of people with disabilities in many populations is between 10% and 20% [5]. Chiang and colleagues [1] observed that the problem of computer and Web accessibility is becoming increasingly significant because the prevalence of visual loss is rising. Patients 65 years and older have a greater prevalence of low vision than any other age group. In 1997, the United States Census Bureau found that there were 7.7 million adults with non-severe visual limitation and 1.8 million American adults with severe visual limitation. In Australia, 20% of the population have disabilities and about one-quarter of Australians will be aged 65 years and over in 40 years time. This means that more and more Web users will be people with disabilities especially visual disabilities that is usually associated with old age [5].

Chiang and partners [1] gave several recommendations to patients with visual disabilities namely: Computer monitors should be positioned directly in front, and slightly lower than, eye level; if typing from a page, a stand should be used to support the page to one side of the monitor, at the same distance as the monitor; if a bifocal segment is used, it should be positioned so that unusual head position or neck flexion is not required; and text font size may be increased in software applications for easier readability; similarly, reduction of screen resolution will increase the size of material on the computer screen, although this may require additional scrolling to see the entire page. However, Chiang's proposed solutions to visual disability only cover low vision patients rather than all the categories of visual disability.

The review of existing guidelines/standards for developing accessible Web applications and other work related to visual disability and Web applications provided critical points of current knowledge on the properties of Web applications and visual disabilities.

Based on the results of the review, a synthesised set of properties of visual disability and Web applications was developed. The two sets of properties are presented in the next section.

3. PROPERTIES OF VISUAL DISABILITY AND WEB APPLICATIONS.

This section presents properties of Visual Disability and those of Web Applications.

3.1 Properties of Visual Disability

Visual disabilities that affect a person's use of the Web include blindness, low vision and color blindness [5]. Web users with visual disabilities possess special characteristics/properties related to their Web access needs as a special Web user group. These properties include:

1. People with visual disabilities normally have difficulty with the following:

    a. Visual contents posted on websites including graphics, photos, flashes, and movies.

    b. Small text sizes and certain font types for those with low vision

    c. Use of certain colors for those with low vision

    d. Colors in particular combinations such as using low saturated colors (e.g. pastels-light shades) or colors close together in hue (e.g. blue and green, green and yellow, orange and red) for those with an inability to distinguish between certain colors due to color blindness.

    e. Graphical user Interface (GUI) based applications: Although GUIs are widely regarded as a major advance in human computer interaction, their heavy dependence on visual cues for input and output poses a significant problem for blind users and those with low vision disabilities [1].

2. Web users with visual disabilities use a variety of assitive technologies to be able to access the Web effectively. These include: screen readers, voice recognition devices, refreshable braille displays. Other well-known low vision aids, such as hand magnifiers, stand magnifiers, closed- circuit television systems, and optical character recognition systems are suitable for reading printed text. Font enlargement and screen magnification software programs are often very useful. Text font size may also be increased in software applications for easier readability. Similarly, reduction of screen resolution increases the size of material on the computer screen, although this may require additional scrolling to see the entire page [1].

3. Web users with visual disabilities can only utilize a website if it is designed to be compatible with assistive technologies relevant to the various types of visual disabilities.

3.2 Properties of Web Applications

Web applications possess a number of properties some of which are inherent in the invention philosophy, while others have emerged through continuous advancements of the technology. These properties to-date largely determine the usability and effectiveness of Web based applications to different categories of audiences. The main properties so far include:

1. Non-linear access: Web Applications use HTML (Hypertext Markup Language) as the Web programming language for developing hypermedia applications that can be shared on the Internet. Instead of gathering or retrieving information sequentially, Web application information is structured in multiple layers (hypertext) hence access is link based and non-linear [2].

2. Lack of control over end user access behavior and environment: Unlike designers of printed media, a Web designer has no control over how on-line users will browse through the pages namely: the appearance of the fonts and colors used on a page, and the size, proportions and exact locations of the different Web texts in the client end's user agent. Web users largely determine their own navigation paths, and they are free to "jump" to any location that interests them. In addition, Web designers cannot know the exact computer equipment that the various potential users have, or what fonts and software have been installed in the users' computers. The exact way Web pages present information would be partly determined by the users' own environment [2].

3. Heavy dependence on visual cues for input and output (Graphical user interface (GUI) based): Although GUIs are widely regarded as a major advance in human computer interaction, their heavy dependence on visual cues for input and output poses a significant problem for users with visual disabilities [1]. In addition, continuous advances in Web technology has made it more multimedia oriented to include video, flash, motion pictures and images. While ideally this is good for enhanced communication, certain media formats are unusable to Web users with disabilities.

4. Uses a multitude of technologies: To-date, several technologies have been developed for developing and deploying Web applications such as HTML, object oriented (OO) tools, scripting languages, database management systems (DBMs) etc.

5. Most developers are young and have perfect vision. Nielsen, [3] argues that to-date Web sites tend to be produced by young designers who often assume that all users have perfect vision and motor control and know everything about the Web.

Based on the two sets of properties, the next section presents the relationship between visual disability and properties of Web applications.

4. THE RELATIONSHIP BETWEEN VISUAL DISABILITY AND PROPERTIES OF WEB APPLICATIONS

The properties presented in section 3.1 and 3.2 respectively need to be considered in the design of Web applications to make the Web accessible to users with visual disabilities. To achieve this, there is need to understand the relationship between visual disability and Web applications. To establish the relationship, properties of visual disability and those of Web applications were obtained through literature search and analysis. The obtained properties were examined to establish how different categories of visual disability relate with properties of Web applications. Results of the analysis are presented in table1.

Table 1. The Relationship between Visual Disability and Web Applications

Visual Disability	Associated Properties of Web Applications	Effect of the Properties on a Visual Disabilities
Blindness	Non-linear access	Affects linear access normally used by assistive technologies such as screen readers
	Lack of control over end user	Affects effective use of

	access behaviour and environment	assistive technologies such as screen readers
	GUI based user interface	Affects use of assistive technologies such as screen readers and braille displays that do not understand graphic based content
	Use of varied technologies	Affects use of old assistive technologies that may not be compatible with new technologies
Low Vision	Non-linear access	Affects comprehension
	Lack of control over end user access behaviour and environment	Affects quality of out put for end users
	GUI based	Affects comprehension
	Young developers with perfect vision	Affects quality of visual output
Colorblindness	Lack of control over end user access behaviour and environment	Affects quality of color based out put
	GUI based content	Affects comprehension of color based out put
	Use of varied technologies	Affects quality of color based out put
	Young developers with perfect vision	May affect color based visual output

Table 1 shows how properties of Web applications affect Web usage for people with visual disabilities namely: blindness, low vision and color blindness. The properties of Web applications involved include: non-linear access, lack of control over end user access behaviour and environment, graphical user interface (GUI) based, use of various technologies and domination of the development environment by young developers with perfect vision.

Effective access to the Web by users with any visual disability is affected by 80% of the Web's current properties. As shown in table 1, each type of visual disability is affected by four of the five properties of Web applications. Blindness is affected by the non-linear access nature of the Web, lack of control over end user access behaviour and environment, heavy dependence on GUI based user interface and use of varied technologies. Low vision is affected by the non-linear access nature of the Web, lack of control over end user access behaviour and environment, heavy dependence on GUI based user interface and domination of development environment by young developers with perfect vision. And colorblindness is affected by lack of control over end user access behaviour and environment, heavy dependence on GUI based user interface, use of varied technologies and domination of the development environment by young developers with perfect vision. The challenges faced due to these properties include difficulties for users of assistive technologies such as screen readers and problems with comprehension and general quality of content.

Therefore unless Web design practices consider the needs of users with visual disabilities in relation to the properties of Web applications, such users will continue to have difficulties accessing the Web. Web users with visual disabilities like normal Web users need access to the Web. However, a visually impaired user who may be blind, have low vision or be colorblind faces significant difficulties accessing the present Web. Therefore it is important to consider access needs of users with visual disabilities when designing Web applications in order to make the Web accessible to this special group of Web users.

CONCLUSION AND FUTURE WORK

The Web is becoming a valuable information resource for people with visual disabilities. However, some of its inherent characteristics still inhibit its full use by this group of people. The study reported in this paper examined the relationship between visual disability and the properties of Web applications. The goal of the study was to understand the problems faced by Web users with visual disabilities and how they can be addressed in Web Development tasks. Results of this work can be used as a basis to develop a checklist of Web accessibility indicators for the visually impaired. And from the concise checklist, a design tool in form of design techniques for achieving Web applications that are accessible to the visually impaired can be developed. The indicators and design techniques may be general or tailored to specific domains such as e-government.

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