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Web Accessibility Digitally: Embracing Universal Design

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ABSTRACT
Web Accessibility can be attained by using latest versions of accessible hardware, software and text files/documents which support its universality and at the same time endorses the idea of developing such products and creating such environments whose features are usable and available to the widest variety of people, without any constraints or considering their age or ability and level of understanding and education. The same could be achieved by various Assistive Technologies such as NVDA, JAWS screen readers and alike. This paper will focus on how the Web Accessibility is created, achieved/implemented and how the effective adoption of Universal Design can ease the journey of differently abled people by lowering the gap between them and web to establish egalitarianism.
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I. INTRODUCTION

In today's modern commensurate world of technology every individual has an equal opportunity to access anything on internet. Despite the fact that an individual could be visually impaired or learning disabled he/she has an equal right to operate the internet, and it's all due to *Web Accessibility*. Web Accessibility works in removing the barriers which strongly hinders the interaction between differently abled people and the websites [1]. The web is one such thing that is unalloyed in its nature and designed to work for anyone. When the web meets all the goals, it becomes accessible to the people with diverse range of movement, cognitive, sight and movement ability. **Accessibility** buttresses social inclusion for people with disabilities as well as the old people. For instance if a person is blind or has an enfeeble eyesight then *Screen Reader* a software application recognizes the text displayed on the screen and translates those words. The translation is the then re-presented to the user with the help of Text-*to-Speech*, or a Braille output device. Screen reader is one such assistive technology (AT) that merges with other ATs such as screen magnifier etc. to help the differently able persons to use various applications and internet without a hinge [2]. In today's world of rapid innovation and technology turnover various software are being developed for smooth running of applications from mobile technology to aerospace engineering which need to be authenticated and tested before being released for the public. Al the software is being tested through a series of Test Applications so as to ensure they are safe, secure and less prone to hackers. Neuro-fuzzy based approach to event driven software testing: A new opportunity has been reported by Chaudhury *et al.* (2016) [3]. Recently, the importance and relevance of Penetration Testing as an effective and versatile tool for software security has been reported by Chaudhury *et al.* (2017) [4]. The present paper summarizes the key features of Web Accessibility for the effective adoption of Universal Design for making life easy for differently able people worldwide by lowering the gap between them and web for establishing social equality.

1.1.   The Screen Reader Technology (Assistive Technology)

One of the earlier assistive technologies was the screen readers. There are numerous kinds of screen readers like web/cloud based, command line text, self-voicing programs etc. A Screen reader closely works with the operating system to provide the information about any graphics, icon or text. Non-Visual Desktop Access also known as NVDA is a Microsoft Windows screen reader. It is an open source which was started by Michael Curran in 2006 [5]. NVDA is programmed in Python and C^{++}; it is based on accessibility

Application Program Interface (APIs) which is a derivative of Graphical screen reader. NVDA is currently available for Microsoft Windows operating system with the API Microsoft Active Accessibility and IAcceessible2. Furthermore NVDA also supports MS-Office that includes MS-Word/PowerPoint/Excel. Another well know AT is JAWS (Job Access with Speech) [6]. JAWS perform output in either two ways: (i) Text-to-Speech (ii) Refreshable Braille Display. Likewise NVDA, JAWS also supports windows (all windows released after Vista). Improving and providing greater details for better efficiency, developers of JAWS have released 18 versions of the software till the date. Both NVDA and JAWS are good at their own technology, but NVDA is free open source software while JAWS is a bit expensive and licensed software. Coming to the mobile phone industry there are also screen readers for both Android and IOS. **TalkBack** a screen reader is used in Android phones while **VoiceOver** is used in IOS phones. This allows the blind people to use their phone efficiently and equally as a sighted person.

1.2. Web Accessibility

Everyone should have an equal chance to use the web; web accessibility is one such way which grants everyone the equal right to do so. Web Accessibility refers to creating websites that are capable enough to be used by people with disabilities. This does not mean that we need to develop separate websites with different URL with the same content with some manipulations, but by making that particular website "accessible" for all people with and without disabilities.

1.3. Facts and Figures

According to the US census of 2000, about 20% of Americans had a disability that hinders them to use and access the web and other internet resources [7]. Furthermore, in Canada about 3.6 million people experience some form of disability that limits their access to the internet: this is around 12 percent of their population [8]. Color blindness, deafness, blindness, physical disability, low vision are all physical or sensory difficulties that stops the interaction with digital information. As the world's population is growing exponentially there will be an increase in people with disability so web accessibility is certainly very important.

1.4.   Web Content Accessibility Guidelines 2.0 (WCAG)

There are several guidelines in web accessibility that defines the degree and kind of disability. Web Content Accessibility Guidelines (**WCAG**) 2.0 is the latest and current in a series of

guidelines published by the W3C. WCAG offers complete, precise standards for remediation, and is documented either officially or unofficially (reliant on country) as the universal standard for all-encompassing web design. WCAG 2.0 has made 3 levels; **A, AA, AAA** in order to certify a website accessible. As we go higher on level it is harder to make the website accessible adding more demands and pressure on developer [9]. Following example will clarify the three levels:

Under guideline 1.4, website should be easier for the operator to visualize and hear content that includes parting of foreground from background.

- Success Condition 1.4.1 is about the Use of Color. It states: Color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element [9]. (**Level A**)
- Success Condition 1.4.3 is about Contrast (Minimum). It states: The visual presentation of text and images of text has a contrast ratio of at least 4.5:1 [9], except for the following: (**Level AA**)
- Lastly, success condition 1.4.6 is about Contrast (Enhanced). It states: The visual presentation of text and images of text has a contrast ratio of at least 7:1, except for the following [9]: (**Level AAA**)

1.5.   WCAG Standard's

The WCAG Standard's emulates the following provisions:-

1.5.1.   Text Alternatives: Providing text substitutes for any non-text content (graphical) so that it can be transformed into several other forms according to the requirement of people, for instance large print, Braille, speech, symbols etc. In addition, a text transcript is also required for audio content [10].

1.5.2.   Adaptability: Creating content in such a way that can be illustrated in different ways without losing its originality, information or structure [10].

1.5.3.   Keyboard Accessibility: Making all functionality available from a keyboard [10].

1.5.4.   Time Limits: Providing operators adequate time to read and utilize the content [10].

1.5.5.   Seizure Prevention: By not designing websites that might cause seizures (for instance, avoiding anything that includes flashes more than three times per second) [10].

1.5.6.   Input Assistance: Helping users to evade making mistakes, and if so autocorrect that mistake [10].

2.1. Types of Disabilities:

The term disability could be interpreted differently and is applied in excessive range of problems.

People suffering with disability faces several obstacles and have many varying needs. Although there could be several disabilities from minor to a major one but the following disabilities are roughly divided into following categories [11]:

2.1.1. Cognitive or Learning Disabilities

In cognitive or learning disability a person has a hard time while doing mental tasks. A person with a score lower than 75 IQ test could be classified to have a cognitive disability. Generally cognitive disabilities have some root in biological of physiological development of an individual.
Some common examples are Autism, Dyslexia, Brain injury etc.

2.1.2. Auditory Disabilities

An auditory disability denotes to minor, average, critical, or profound hearing loss. The one who refers themselves as 'deaf' usually have either critical or profound hearing loss. According to a research by Johns Hopkins Medicine, more than 48 million people had an auditory disability in the U.S alone. Videos without captions and audio files without text transcripts will make it impossible to understand the given information that is why we have captions in almost every public video.

2.1.3. Visual Disabilities

Blindness or low vision distresses a huge number of people, counting those who use spectacles or contact lenses to correct vision. Blindness, or a complete absence of vision, is at the uttermost end of its level. Visual disability not only includes the intensity of eyesight but also colorblindness. People suffering from colorblindness have a hard time distinguishing few colors, for instance red and green. They cannot perceive certain colors appropriately.

People with visual disabilities face a hard time when web sites and electronic documents are not accessible by keyboard or images without descriptive alternative text or videos without audio explanations exemplifying key visuals.

2.1.4. Motor Disabilities

A motor disability can hinder a person's mobility, making it strenuous for the user to use hardware in the way that it was originally designed. Examples: Arthritis, muscular dystrophy, spinal cord injury etc. People with a motor disability have a hard time using the hardware which has small buttons or encountering of excessive usage of mouse.

3.1. Accessibility: Embracing Universal Design

The term "**Universal Design**" can be defined as the creation of a given product and environment whose attributes can be employed to the widest variety of people as possible, regardless of their age, ability, or status. Given below are the seven principles of Universal Design which must be taken into account for evaluation of current online courses [12].

3.1.1. Equitable Use: The design provides an equal opportunity of application for anyone accessing resources or at least be otherwise equivalent.

3.1.2. Flexibility in Use: The design allows a wide range of individual preferences and abilities. (e.g., left or right handed access and application)

3.1.3. Simple & Intuitive Use: The design is easy to understand, regardless of the user's experience, knowledge, language skills, or existing expertise.

3.1.4. Perceptible Information: The design imparts necessary information potently to the user, regardless of ambient conditions or the user's sensory abilities.

3.1.5. Tolerance for Error: The design minimizes the chances of adverse effects of mishaps or unintended actions and wrong doings.

3.1.6. Low Physical Effort: The design can be implemented efficiently and comfortably. (e.g., without causing any physical or mental stress and strain for the user).

3.1.7. Size, Space for Approach & Application: The design provides an easy move toward, reach, manipulation, and application regardless of user's body size, posture, or mobility. (e.g., online learning platforms allow for the use/integration of assistive devices such as a JAWS reader.)

4.1. Digital Accessibility (Online Learning)

Web accessibility is comprised of three major apparatus such as: Accessible hardware, Accessible software, and the Accessible text documents with tools for graphical representation of audios and video options [13].

4.1.1. Accessible Hardware

Hardware, such as desktops, laptops, tablets, all in one systems, blue tooth devices and recording devices should support accessibility features that accommodate disabled students. Administrators have the power to create accessibility from the bottom up by requesting accessible devices and components in purchasing contracts. One approach is to offer companies an exclusive contract in exchange for accessibility features added to a current acquisition. It will be very effective if the purchase of hardware can be clubbed with nearby institutions for collective purchase at a much reduced rate/discounted pricing.

4.1.2. Accessible Software

The Accessible software should be capable to cater the needs of differently able requirement of the end users to ensure that flow of information is available to all the users. For example, a simple switch in Microsoft Word settings can enable Screen Readers for the blind for interpreting headings, tables, and supplementary images. Attempt should be made in developing compatible and upgradable software to educate teachers/instructors about software accessibility and make the simple adaptations obligatory.

4.1.3. Accessible Text Documents
Digital documents should be accessible to people who use Screen Readers in an efficient manner. The PDFs should be designed and formatted in such a manner that a Screen Reader can navigate and read all components of a given document. PDF/UA (PDF/Universal Accessibility), the international standard for PDF accessibility, offers comprehensive accessibility guidelines that can be applied to most digital documents. Accessible text documents can be created by inclusion some of the following aspects:-
● Add alt text to images and objects
● Specify column header information in tables
● Use consistent styles in long documents
● Use short titles in headings
● Ensure all heading styles are in the correct order and are unique
● Use hyperlink text that is meaningful
● Use simple table structure
● Ensure that the reading order of each slide is logical
● Increase visibility for colorblind viewers
● Avoid using blank cells for formatting
● Structure layout tables for easy navigation
● Avoid using repeated blank characters
● Avoid using floating objects
● Avoid image watermarks

5.1. Accessible Web Designing
For Accessible web designing one should follow Web Content Accessibility Guidelines (WCAG), a fantastic set of standards published by the Web Accessibility Initiative (WAI), which is part of the World Wide Web Consortium (W3C) https://www.w3.org/standards/webdesign/accessibility. Described below are salient recommendations for designing Accessible websites. At the same time one should avoid inclusion of frames, JavaScript, and Flash without alternate provisions. Scrolling text and redundant animatronics should also be avoided [14].

5.1.1. Format
The format should be using a standard page template. One should not presume that what

you are seeing is the same that what other users will also see; websites are rendered differently depending on the device, browser, monitor size, resolution, and font settings. Logos, menus, and navigation features should be consistent and predictable. The format should be such that the visitors should always know where they are on the site and be able to easily go back over their steps or return to the home page by a single click. They should be easily convertible to mobile phone display mode and routine desktop mode interchangeably.

5.1.2. Fonts
The fonts should be chosen in such a manner that defaults or common fonts which work well for web display, such as Arial, Georgia, or Verdana be included. Since the displayed font size is affected by monitor size and screen resolution, as well as the browser's settings. It is better to use relative instead of absolute font sizes. If using absolute, minimum font size should be 10 on a PC or 12 on a Mac. Use a different font for navigation than content, use of more than two font types per website should always be avoided.

5.1.3. Color
One should use high contrasting background and text color, preferably light background and dark and bright text so that it is clearly visible and soothing for the eyes. Avoid backgrounds that obscure the text. Use a 256-color palette, which is standardized across all browsers and platforms. Colors should be specified for all elements or none; if none are specified, the site will default to the visitor's settings. Specifying only some colors can result in inconsistent formatting throughout the site and will result in poor resolution and readability.

5.1.4. Images
Use alternative descriptive text (alt tags) to describe the content or function of every substantive image. This is critical for people who are visually impaired or have low vision, but it's also important for search engine optimization and cases when browser images are disabled. One should omit big images as text or links. Bulky or bloat sized images should always be avoided. The images should be concise and self explanatory.

5.1.5. Tables
One should invariably specify the table dimensions and cell width in percentages rather than absolute pixels. Rows should shrink or expand to fit a screen size. Fixed width rows and increased font sizes may result in horizontal scrolling on

small screens. This will affect the readability by user and he table may even go out of screen.

5.1.6. Links

One should invariably use descriptive anchor text rather than **"Click here"** Use the pipe character | to separate consecutive links. Do not use images as links because it is difficult to tell that they are clickable. The links should always be in a different color code.

6.1. Testing and Validation

The website should invariably be tested across different computer platforms, browsers, and devices. The website should be viewed in black and white settings to check for color blindness accessibility. Delete images to check it fully accessible for people with visually impaired users. The W3C HTML validation service provides free HTML validation for conformance to W3C web standards should be adopted.

7.1. Accessible Video and Audio

Online video is rapidly becoming the dominant medium for teaching and learning for Smart Class Room initiatives worldwide. Awareness of key concerns should be borne in mind for as long as proper Transcripts, Captions and Audio descriptions for providing considerable assistance to people with different level of disabilities [15].

7.1.1. Transcripts

Transcripts are an important part of video and audio accessibility because they provide a textual version of the content that can be accessed by anyone. Transcripts are valuable to both deaf and blind users. Deaf users can read the transcript, while blind users can digest a transcript with a refreshable Braille reader or screen reader. For web video, both captions and a text transcript should be provided. For content that is audio only, a transcript is sufficient.

7.1.2. Captions

The captions provide a good time-synchronized text which can be read while watching a video. Captions assume that the viewer is completely deaf and include all spoken content as well as non-speech elements, such as sound effects and speaker identification. Captions differ from subtitles, which presume a viewer can hear, but can't understand the language. For web video, closed captions are favored over open captions because they can be toggled on and off in a video player. Web video captions are typically displayed in two lines at the bottom of the screen, which is called a Caption Frame. Captioning can be done in

real time, often referred to as CART (Communication Access Real-Time Translation), or in post-production, sometimes referred to as Offline Captioning.

7.1.3. Audio Description

A good audio description is an audio track that describes what is happening visually in the video. While blind users are able to hear the spoken content, they aren't able to see demonstrations or diagrams. In education, omitted out on these references can come to a standstill the learning process. If a web video is developed with accessibility in mind, it may be possible to avoid the need for audio description by describing the visual actions as part of the main audio. This will definitely be very useful in an effective communication of a given theme.

II. CONCLUSIONS

Coordinating accessibility initiatives across a university, school or an organization can be time consuming and laborious task. The solution is to embrace universal design and organize efforts laterally as well as vertically. An endeavor of this size requires buy-in and contributions from many different parties. From developers to content experts till end users all of them need to contribute to achieve the web accessibility digitally focusing on accessible hardware, accessible software and accessible text documents. Screen Readers and assistive technology will play a huge role in overcoming the gaps between the web and the end users with disability.

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