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An Assessment on Accessibility on Web-based Virtual Reality Applications using Web-Accessibility Tools and Visualize the Gaps Existing in the Applications

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ABSTRACT: Web Accessibility refers to the inclusive practice of designing and developing websites and web applications that can be used and accessed by people of all abilities and disabilities. The goal is to ensure that everyone, including those with disabilities, can perceive, understand, navigate, and interact with the web. To achieve web accessibility, web developers and designers can follow guidelines provided by the Web Content Accessibility Guidelines (WCAG) developed by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C). These guidelines provide a framework for creating accessible web content and cover a wide range of topics, including text alternatives, keyboard accessibility, time-based media, and more. By embracing web accessibility principles, businesses and organizations can create a more inclusive online environment, reaching a broader audience and ensuring that people with disabilities can participate fully in the digital world. Some of the key challenges include lack of awareness, inconsistent implementation, rapid technological changes, resource constraint, localization, content complexity, cultural nuances and legal and regulation compliances. Web-based Virtual Reality (VR) poses several accessibility challenges that can hinder users with disabilities from fully experiencing or interacting with content. Some of the key challenges include Visual Accessibility, Motor and Mobility Challenges, Auditory Accessibility, Cognitive Accessibility, Technical Requirements, Content Design and User Experience, Lack of Standards and Guidelines. Addressing these challenges requires a concerted effort from developers, designers, and VR platform providers to prioritize accessibility in their design and development processes. This includes implementing accessibility features, testing with users who have disabilities, and promoting awareness of accessibility issues within the VR community. In this project we shall be using Open-Source tools viz., Superset to visually understand the gaps in Accessibility in Web based VR applications using the Open Datasets available on the Internet.

KEYWORDS: Accessibility, WCAG, Web-based Virtual Reality, disabilities, Standards and Guidelines

I. INTRODUCTION

The Web is fundamentally designed to work for all people, whatever their hardware, software, language, location, or ability. When the Web meets this goal, it is accessible to people with a diverse range of hearing, movement, sight, and cognitive ability.

Thus, the impact of disability is radically changed on the Web because the Web removes barriers to communication and interaction that many people face in the physical world. However, when websites, applications, technologies, or tools are badly designed, they can create barriers that exclude people from using the Web.

Accessibility is essential for developers and organizations that want to create high-quality websites and web tools, and not exclude people from using their products and services. Web accessibility means that websites, tools, and technologies are designed and developed so that people with disabilities can use them. More specifically, people can:

- perceive, understand, navigate, and interact with the Web
- contribute to the Web

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Web accessibility encompasses all disabilities that affect access to the Web, including:

- auditory
- cognitive
- neurological
- physical
- speech
- visual

Web accessibility also benefits people without disabilities, for example:

- people using mobile phones, smart watches, smart TVs, and other devices with small screens, different input modes, etc.
- older people with changing abilities due to ageing
- people with “temporary disabilities” such as a broken arm or lost glasses
- people with “situational limitations” such as in bright sunlight or in an environment where they cannot listen to audio
- people using a slow Internet connection, or who have limited or expensive bandwidth

The Web is an increasingly important resource in many aspects of life: education, employment, government, commerce, health care, recreation, and more. It is essential that the Web be accessible in order to provide equal access and equal opportunity to people with diverse abilities. Access to information and communications technologies, including the Web, is defined as a basic human right in the United Nations Convention on the Rights of Persons with Disabilities (UN CRPD). The Web offers the possibility of unprecedented access to information and interaction for many people with disabilities. That is, the accessibility barriers to print, audio, and visual media can be much more easily overcome through web technologies.

Accessibility supports social inclusion for people with disabilities as well as others, such as:

- older people
- people in rural areas
- people in developing countries

There is also a strong business case for accessibility. As shown in the previous section, accessible design improves overall user experience and satisfaction, especially in a variety of situations, across different devices, and for older users. Accessibility can enhance your brand, drive innovation, and extend your market reach.

Web accessibility depends on several components working together, including web technologies, web browsers and other "user agents", authoring tools, and websites. The W3C Web Accessibility Initiative (WAI) develops technical specifications, guidelines, techniques, and supporting resources that describe accessibility solutions. These are considered international standards for web accessibility; for example, WCAG 2.0 is also an ISO standard: ISO/IEC 40500. Making website Accessible: Many aspects of accessibility are fairly easy to understand and implement. Some accessibility solutions are more complex and take more knowledge to implement. It is most efficient and effective to incorporate accessibility from the very beginning of projects, so you don’t need go back and to re-do work.

Evaluating Web Accessibility: When developing or redesigning a website, evaluate accessibility early and throughout the development process to identify accessibility problems early, when it is easier to address them. Simple steps, such as changing settings in a browser, can help you evaluate some aspects of accessibility. Comprehensive evaluation to determine if a website meets all accessibility guidelines takes more effort.

- Initial checks
- Tools
- Conformance Evaluation and Reports
- User Behavioral tests

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There are evaluation tools that help with evaluation. However, no tool alone can determine if a site meets accessibility guidelines. Knowledgeable human evaluation is required to determine if a site is accessible.

II. RELATED WORK

Web accessibility means that people with some type of disability can make use of the Web in the same conditions as the rest of the people. When we talk about web accessibility, we refer to a web design and development that allows these people to perceive, understand, navigate and interact with the Web according to Milton et al. [1]. Accessible web design, 'design for all', or 'universal access' can remove these barriers and help to ensure as many users as possible can read and interact with websites, as well as ensure information can be interpreted by the technology used. In [2] a variety of methods are available to check web pages for accessibility and advice and guidelines on the subject of accessible web design are plentiful. It is important that evaluation tools are accessible so that people with disabilities can use them. Some tools provide information on how well they support accessibility [3]. According to the study [5], the accessibility analysis is carried out with three major tools: AChecker, WAVE, and aXe. With respect to the AChecker tool, the average of known problems was observed almost doubled in Universities than Polytechnic Institution websites of Portugal under all levels of conformance. With respect to WAVE tool, we found that the average of alerts, structural elements, and HTML5 & ARIA in terms of web accessibility status of websites of Polytechnic Institutes are less than the Universities, but contrast errors are found with more frequency in Polytechnic Institutes than in universities, and the average of errors and features are almost the same in both of the cases. This research[6] provides a pioneering concept for accessibility-aware framework approach. This approach could be utilized for developing accessible web applications and electronic services for people with disabilities. The proposed framework can be used as a road map to overcome accessibility challenges during any web application development life cycle. The rapid growth in online higher education, in terms of course offerings and student enrollment, has often been celebrated on the grounds that moving education online is an innovative way to increase the accessibility of university education. This article problematizes a range of assumptions that underpin those claims. To do so, two concepts are deployed: "authentic accessibility" and "programmatic definition" [7].

III. METHODOLOGY

The Web Accessibility evaluation methods follow WCAG-EM guidelines. The conformance evaluation procedure is detailed under 5 main steps:

1. Define the scope of the evaluation - defining what is included in the evaluation; the goal of the evaluation; and the WCAG conformance level (A, AA, AAA).
2. Explore the website - identifying key web pages; key functionality; types of web content, designs, functionality, etc.; required web technologies.
3. Select a representative sample - guidance on structured and randomly selected web pages when it is not feasible to evaluate every web page on a website.
4. Evaluate the selected sample - determining successes and failures in meeting WCAG; accessibility support for website features; and recording evaluation steps.
5. Report the evaluation findings - aggregating and reporting evaluation findings; making evaluation statements; and calculating overall scores.

Technical document format:
WCAG-EM follows the W3C format for technical specifications which includes several sections at the beginning: links to different versions, editors, copyright, abstract, and status with the link to errata and the email address for comments.
Web based VR essentials:

Testing for accessibility and usability is an essential step to ensure that your web application's VR features are successful. These aspects of your web application can have a great impact on how easy and enjoyable it is for users to access and interact with your VR content. You should test for factors such as navigation, interaction, content, and comfort. Navigation should be intuitive and consistent, while interactions should be clear and responsive. Content should be engaging and informative, while the experience should be comfortable and safe. To test for accessibility and usability, you can use user testing, heuristic evaluation, analytics, or VR quality checklists.

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IV. EXPERIMENTAL RESULTS

Accessibility testing using BrowserStack: BrowserStack is a cloud web and mobile testing platform that provides developers with the ability to test their websites and mobile applications across on-demand browsers, operating systems and real mobile devices. Choosing BrowserStack for my project for the following reasons:

- Website Scanner - Scan & Monitor- Understand baseline with a comprehensive website scan & setup recurring scans to monitor your WCAG compliance goals.
- Automated Workflow Analyzer- Find issues across multiple webpages in a single scan. Just start the scanner and navigate through your user workflow.
- Instant access to Screen Readers- Instantly access VoiceOver on Mac, NVDA on Windows, and TalkBack on Android devices hosted on the real device cloud.
- Assisted Tests for advanced issues- Identify issues in keyboard tab stops, as well as accessible name, role & states of your web elements like a pro.
- Automated Tests- Integrate accessibility testing into your regression suites with BrowserStack SDK to keep your workflows accessible.
- Central reporting dashboard- Access all reports from the past and present on one dashboard. Take only seconds to combine multiple reports into one.

Accessibility Analysis graph charts
An Accessibility test tool called “accessiBe” was scanned, analyzed, and remediated 10,000,000 of websites.

- 85% of websites were hosted in the U.S. & Canada and 15% in Europe and Asia
- 65% of websites were top-level domains (com, net, org, etc.) the others were 2nd and 3rd-level (io, co, app, XYZ, etc.)
- 80% of websites had lesser than 1,000 pages
- 19% of websites had 1,000 – 100,000 pages
- 1% of websites had about 100,000 pages (We stopped counting a website's pages after it reached 100,000)

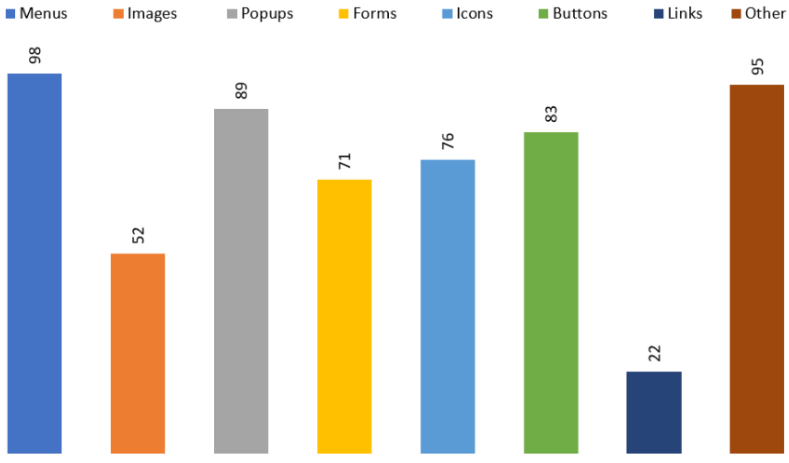

Fig 1: The bar graph below shows the percentage of all pages scanned that failed to comply with the requirements for menus, images, pop-ups, and other accessibility essentials

The major Accessibility factors that most of the websites fail at is:

- Missing alternative text
- Missing form labels

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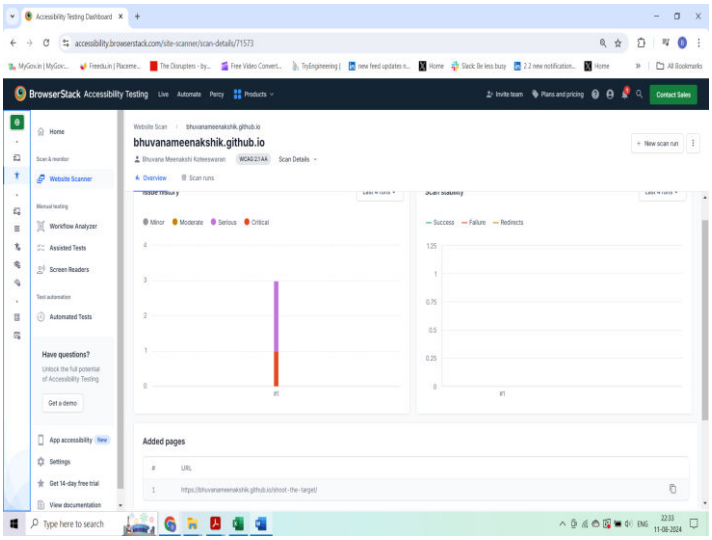
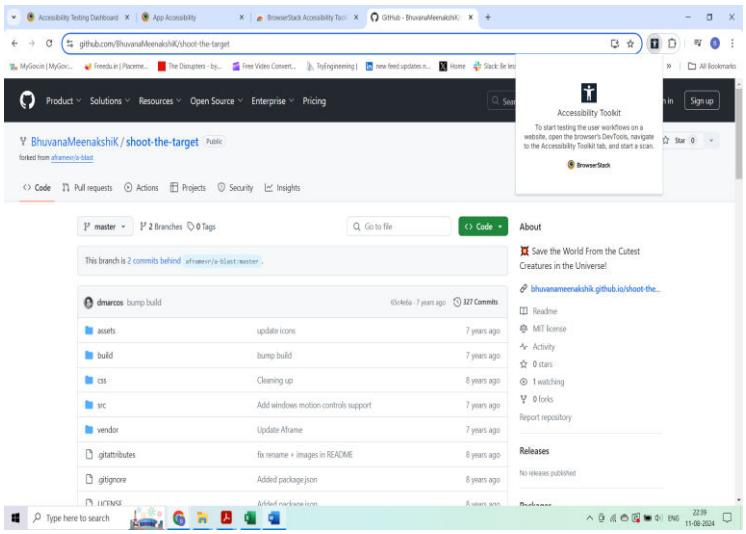
- Empty buttons
- Empty Links
- Contrast errors

Test results from BrowserStack -
WebVR game website: https://bhuvanameenakshik.github.io/shoot-the-target/



(a)



(b)

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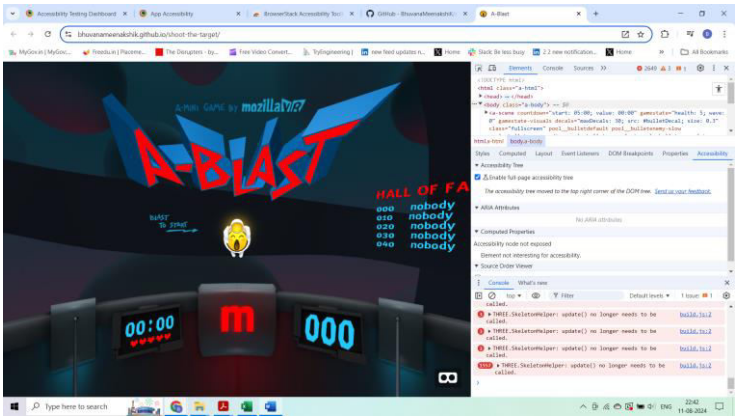
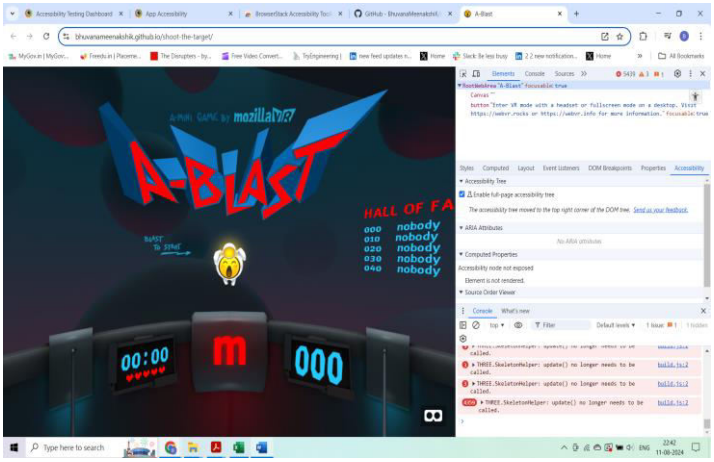


(c)



(d)

Fig 2: BrowserStack Accessibility test screenshots: (a) Screenshot of the website Analysis by BrowserStack, (b) Screenshot of Accessibility Toolkit WebExtension, (c) WebVR scanned and analyzed by the Accessibility extension, (d) WebVR Accessibility console showing the Accessibility Tab

V. CONCLUSION

This project results derived on Accessibility helps researchers and developers in choosing an appropriate testing mechanisms for developing accessible websites against various parameter. Although the WCAG has made improvements in the latest compliance release, developers must work more closely with the WCAG to improve the accessibility and usability of WebVR/3D websites. In addition, many public information such as government websites must adopt web accessibility standards and create regulations to monitor compliance. Bearing in mind that accessing websites in general is everyone's right, so it should be accessible to ensure equal access for people with disabilities. Much work needs to be done on awareness and dissemination of web accessibility to address its problems and effects on society. It is recommended that templates be developed for websites that comply with each country's standards, regulations and laws for web accessibility and educational inclusion and their implementation. A great deal of emphasis has been placed on the importance of web accessibility and the need to adhere to standards and guidelines. The W3C WCAG in particular have been adopted by many public and private institutions as an indication of what level of accessibility their websites should reach. How the new version of WCAG (WCAG 2.0) will translate onto the many

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guidelines and policies developed by institutions and companies remains to be seen. Recommendations to provide appropriate training not only for web designers, but for web commissioners, information managers, policy makers etc. are therefore vital if a culture of accessible design and universal access is to be shifted from the perception of an add-on, to be just another fundamental part process of commissioning, designing, and developing websites that will be accessible for everyone.

The Accessibility for WebVR/ multidimensional website pages could get more complicated with 360-degree spaces and 3d virtual objects. Therefore, the latest WCAG compliance must be followed in order to check the Accessibility factors in these webpages. Also, the medium of access to the WebVR such as mobile or desktop versions would have distinct usages which have to be seamless for the Users. The latest WCAG guidelines need further improvements and developments when it comes to complex systems and designs such Web-based VR or Extended Reality (XR).

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