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Thesis presented

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Development of a web-based working environment for visually impaired individuals

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Abstract

In today's digital era, the internet serves as an extensive repository of information, enabling swift dissemination of content across the globe. However, for individuals with low vision, navigating through this vast digital landscape poses significant challenges, as they encounter barriers while searching for specific content amidst the overwhelming information. Unfortunately, online content often neglects their unique needs, resulting in limited accessibility to valuable information. Therefore, there is a pressing demand for innovative solutions that prioritize web accessibility for individuals with low vision. In response to this need, our thesis focuses on developing a user-centric web platform specifically tailored to accommodate the preferences and requirements of this particular user group. Emphasizing inclusivity and empowerment, our envisioned platform aims to enrich the online experience for individuals with low vision, fostering equal opportunities in the digital realm.

Keywords :

Visually Impaired, Accessibility, Web Accessibility, Transcoding, Adaptive web pages , low vision pages.

Résumé

À l'ère numérique actuelle, Internet est une source inestimable d'informations, facilitant la diffusion rapide de contenu à travers le monde. Cependant, pour les personnes atteintes de basse vision, naviguer au sein de cet univers numérique vaste représente un défi de taille, car elles font face à des obstacles lors de la recherche de contenus spécifiques parmi la multitude d'informations disponibles. Malheureusement, la plupart des contenus en ligne négligent leurs besoins spécifiques, ce qui restreint leur accès aux informations précieuses. Par conséquent, il est urgent de trouver des solutions innovantes visant à améliorer l'accessibilité web pour les personnes atteintes de basse vision. En réponse à ce besoin, notre thèse se concentre sur le développement d'une plateforme web centrée sur l'utilisateur, spécialement conçue pour répondre aux préférences et aux exigences de ce groupe d'utilisateurs. En mettant l'accent sur l'inclusion et l'autonomie, notre plateforme envisagée vise à enrichir l'expérience en ligne des personnes atteintes de basse vision, favorisant ainsi l'égalité des chances dans le monde numérique.

Mots clés:

Les malvoyants, l'accessibilité, Accessibilité web, Transcodage, Page web adaptative

الملخص

في العصر الرقمي الحالي، يعد الإنترنت مصدرًا واسع النطاق للمعلومات، مما يسهل نشر المحتوى بسرعة في جميع أنحاء العالم. ومع ذلك، يواجه الأفراد ذوو الرؤية المحدودة تحديات كبيرة عند التنقل في هذا السياق الرقمي الضخم، حيث يصادفون الصعوبات أثناء البحث عن محتوى محدد بين غزارة المعلومات. وما يسيء الحظ، هو أن المحتوى الرقمي غالبًا ما يتجاهل احتياجاتهم الفريدة، مما يؤدي إلى تقييد إمكانية الوصول إلى المعلومات القيمة. لذلك، هناك حاجة ملحة للحلول الابتكارية التي تركز على إمكانية الوصول للويب بالنسبة للأفراد ذوي الرؤية المحدودة. في رد فعل على هذه الحاجة، يركز أطروحتنا على تطوير بيئة ويب مستندة إلى المستخدم ومصممة بشكل خاص لاستيعاب تفضيلات ومتطلبات هذه الفئة الخاصة من المستخدمين. بالتأكيد على التضمينية وتمكين المستخدمين، تهدف بيئتنا المصورة إلى إثراء تجربة الأفراد ذوي الرؤية المحدودة على الإنترنت وتعزيز فرصهم المتساوية في العالم الرقمي.

كلمات مفتاحية: ضعاف البصر، إمكانية الوصول، إمكانية الوصول إلى الويب، تحويل الترميز، تكييف.

Dedication

M. kaouthar

In the Name of Allah, the Most Gracious, the Most Merciful.

Thank you Allah for your guidance and boundless mercy, whose blessings have illuminated my path and granted me strength throughout this journey.

To my loving family, whose unwavering support and encouragement have been my pillars of strength, I am forever grateful. Your unconditional love, understanding, and sacrifices have made this achievement possible. I dedicate this work to you, my dear parents Zoubir and Leila, my brother Khalil, my grandmother my uncles and aunts for instilling in me the values of determination and perseverance.

I dedicate this work also for my beloved late grandfather, who patiently awaited my success since 2017. He waited for a long time, but death took him away from me in 2019, depriving him of sharing the joy with me on this special day. may Allah have mercy on you grandapa.

To my thesis partner, my dear Amal Kerrouche, I am deeply grateful for our shared journey, overcoming challenges together and reaching the finish line as a united team. Your unwavering support and friendship made our success possible, and I will always cherish our partnership.

To my dear friends, who have been my companions through thick and thin, thank you for your unwavering belief in me and your words of encouragement. Your presence in my life has added joy, laughter, and countless memories, making this academic journey all the more fulfilling.

I am deeply indebted to the faculty members, mentors, and advisors who have guided me with their expertise, wisdom, and valuable insights. Your dedication and commitment to excellence have shaped my academic growth and fostered my intellectual development.

Finally, I extend my heartfelt gratitude to all those who have contributed to this endeavor in ways seen and unseen. May this work serve as a testament to the love, support, and faith that have propelled me forward.

K. Amal

I dedicate this humble work to the reason for my existence, who sacrificed themselves for my happiness and success, to my mother...

To my father, my treasure, who has been there throughout my life to encourage and protect me.

May Allah keep and protect them..

To all my adorable brothers .

To my dear nephews and nieces Sara , Mohamed , Alaa ,Mahdi , Yasmine ,Idriss , Adam , Djana , Tamim .

To my family and my friends.

To all those dear to me.

To all those who love me.

To all those whom I love.

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We are immensely thankful to everyone who helped us in this endeavor. Each person's contribution was invaluable and played a vital role in our success

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List of Acronyms

IT: Information Technology .

ADA: Americans with Disabilities Act.

VI: Visually Impaired.

W3C: World Wide Web Consortium.

WAI: Web Accessibility Initiative.

W3C: Web Content Accessibility Guidelines.

WHO: World Health Organization.

BVI: Blind and Technology .

HTML: Hypertext Markup Language.

CSS: Cascading Style Sheets.

WWW: World Wide Web.

CERN: European Organization for Nuclear Research.

MIT/LCS: Massachusetts Institute of Technology / Laboratory for Computer Science.

ATAG: Authoring Tool Accessibility Guidelines.

UAAG: User Agent Accessibility Guidelines.

WAI-ARIA: Web Accessibility Initiative - Accessible Rich Internet Applications.

POUR: Perceivable Operable Understandable Robust.

UX: User Experience.

UI: User Interface.

AI: Artificial Intellegence.

WILI: Web Interface for People with Low Vision Issues.

CVD: Color Vision Deficiency.

General Introduction

Context

The eye serves as the gateway to visual information, as it enables us to perceive, interpret, and engage with visual information with just a single glance, making it an indispensable asset in the realm of IT.

In this digital world, where technology dominates, the internet presents itself as a vast wonderland, teeming with infinite possibilities, offering a broad assortment of knowledge, relationships, and experiences that are immediately accessible at our fingertips. The usage of the internet has expanded dramatically in the post-COVID-19 era. The pandemic has worked as a powerful catalyst, propelling the rapid adoption of digital technologies, this is what has made the soaring reliance on the internet an inseparable and essential part of remote work, online education, telemedicine, e-commerce, access information, and so on.

While the internet offers a multitude of benefits and experiences, it is important to acknowledge that not everyone perceives these advantages in the same way, especially people with disabilities, such as those with vision impairments. For them accessing and interacting with online content can present significant challenges, they are unable to swiftly deal with the content of webpages, as well as engaging with various multimedia content, from reading articles and engaging with social media to watching videos and exploring new information. This is the reason why many developers strive to create websites that are accessible to all users, regardless of their disabilities. The concept of Accessibility becomes the silver bullet solution. seeking to guarantee that the web is accessible to everyone.

In order to address this issue, countries such as the United States (ADA) and Canada have made the accessibility means mandatory. Similarly, France and European countries have established a legal framework promoting web accessibility.

Problem

The trial-and-error approach involves testing different solutions until the right one is found. However, some may have a different opinion, as for a visually impaired person, this approach can be challenging when navigating inaccessible web pages. As it requires them to repeatedly close and open new pages until they find the desired content or functionality. Due to the lack of awareness among web designers, visually impaired users face challenges in web interaction. Their visual impairment affects cognitive efficiency, hindering perception of shapes, colors, sizes, and distances. To overcome limitations, they rely on hearing and touch to interact with the user interface and accomplish tasks effectively. Currently, the majority of websites present significant accessibility obstacles. With this in mind, we strived to create a web environment tailored to visually impaired individuals need, by providing an inclusive browsing experience through adaptive features. Making web accessible and user- friendly for them.

Thesis Organization

The thesis is structured into 3 chapters as follows:

- In the first chapter, we define the concept of visual impairments and present various tools, techniques, we illustrate the various challenges related to visualizing web interfaces for individuals with visual impairments. and existing

  research around web accessibility to assist and facilitate information access for individuals with visual disabilities.

- In the second chapter, we describe the aspects of design and modeling of our proposed approach.

- In the third chapter, we highlight the work environment, and present the implementation of our web application, as well as the different interfaces used for adapting web pages according to the preferences of visually impaired users.

- Lastly, a general conclusion summarizes the problem addressed in this thesis. It also presents several perspectives considered for future studies.

CHAPTER 1

A Comprehensive Survey of Web Accessibility and Visually Impaired Users

1.1 Introduction

Vision is a remarkable gift bestowed upon us by Allah, enabling to delve into the vast realm of knowledge on the internet. However, for individuals with visual impairments, this fundamental sense presents unique challenges, particularly in the context of accessing and engaging with online content. In this chapter, we'll learn more about VI individuals and their challenges when using internet. We'll define key terms related to web accessibility and delve into its positive impact, as well as the main recommendations from W3C/WAI standards. We will provide answers on How to enhance the understanding of the content available on Websites for VI users? What has technology provided for them? And what is accessibility role in addressing their issues ?

1.2 Shedding light on visual impairment:

1.2.1 Visual impairment meaning:

The term Visual Impairment describe a condition of reduced visual performance [27] that cannot be corrected and fixed it by usual means (spectacles or contact lenses) to a normal level [34]. According to the latest statics of World Health Organization (WHO) there are 253 million people are visually impaired of whom around 36 million are blind [9]. The International Classification of Diseases 11 (2018) categories vision impairment into two groups. [43]

- Distance vision impairment is classified according to the following scale:

  - **Mild:** visual acuity worse than 6/12 to 6/18
  - **Moderate:** visual acuity worse than 618 to 6/60
  - **severe:** visual acuity worse than 6/60 to 3/60
  - **blindness:** visual acuity worse than 3/60

- Near vision impairment is classified as near visual acuity worse than N6 or N8 at 40 cm with the existing correction (benzouak, 2019)

1.2.2 Forms of visual impairment:

we mainly discuss three types of visual impairments:

- **Total blindness-people:** that refers to those people who have entirely lost their sight. This kind of user sis able to observe only an audio output
- **Low vision:** that refers to user who have weak visual acuity to light perception or deficient visual field. The most common types of low vision deficiencies are [35]:
  - **Central vision loss:** Central vision impairment affects the cells responsible for visual acuity in the retina, making it challenging for individuals to perceive shapes, colors, and intricate details. Reading, writing, and precision work become difficult, as does recognizing faces. However, they still retain the ability to perceive space and movement, enabling them to navigate independently.

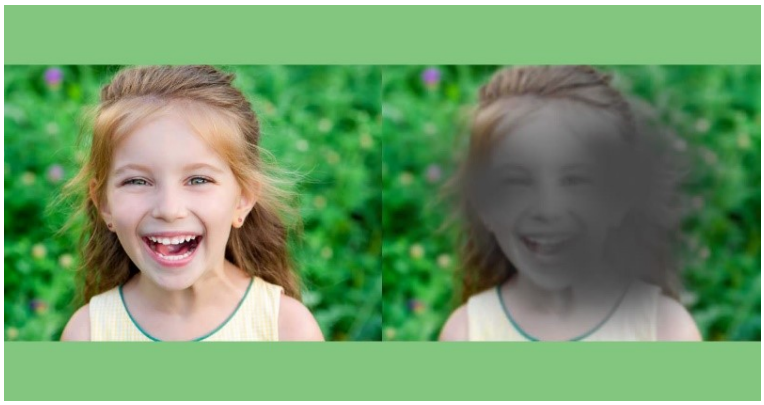


Figure 1.1: Example of central vision loss and normal vision

  - **Peripheral vision loss:** Impaired peripheral vision, or 'tunnel vision,' reducesthe visual field. While individuals may read small text without difficulty, they struggle to navigate surroundings and may collide with objects regardless of visibility. This compromises global perception, making tracking moving objects and independent navigation challenging.
  - **Blurry vision:** This visual impairment is like looking through frosted glass. causing luminosity diffusion and imprecise object contours. It hampers the perception of contrast, depth, and distances, especially in bright light. Tasks such as reading, writing, precision work, and navigation become difficult.

Figure 1.2: Example of peripheral vision loss and normal vision

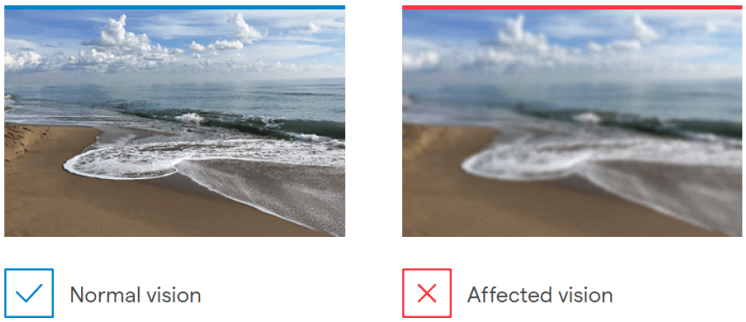


Figure 1.3: Example of peripheral vision loss and normal vision

  - **Visual disorders following brain injuries:** Visual disturbances resulting from trauma or brain damage often accompany attention, memory, or behavioral problems. These disturbances primarily affect the brain's ability to analyze visual information rather than directly impairing visual function itself.

- **Color blindness:** is determined by the discrimination of three qualities of coolor: hue, saturation and brightness. Those with color blindness have a deficiency or absence in one or more of these pigments.

1.3 VI and computer science

1.3.1 Breaking barriers:

Visual impaired community are the one of the hindrance group of accessing web content access in the world. By embracing computer science, they can unlock new horizons and achieve better experience in terms of access to information. This field offers accessible tools and techniques that empower the BVI to navigate the digital landscape with ease. This enables them to break down barriers, allowing visually impaired individuals to read what they want to read and write emails, browse the internet, engage in social media, access educational resources, and even pursue coding and programming [53].

1.3.2 Assistive technology:

In order to be able to use the global network, the VI individuals use assistive technologies [16]. Diverse disabilities require specific assistive technologies (AT) to overcome functional limitations [2]. So for VI users, the severity of their impairment determines the need for specialized AT [20]. To further enhance accessibilty, AT is employed, bridging the gap between users and technology, by seamlessly integrating assistive technologies into human-machine interaction. This helps navigating and interacting with web interfaces as easily as sighted individuals, fostering equal access to information and enhancing their browsing experience [40]. The main assistive technologies for blind and/or visually impaired individuals are as follows:

Software solutions:

- **Screen readers:** is an assistive technology, primarily used by people with vision impairments. It converts text, buttons, imagesand other screen elements into speech or braille. By accessing the underlying structure of the HTML, screen readers creates a sequential audio rendering of the web content [8]. It is an important accessibility tool designed to empower people with no or limited vision to access digital content on devices (computer, smartphone...), when they might otherwise be unable to. [25] The following are the primary technical aids available for blind or visually impaired users:
  - **JAWS:** Job Access With Speech by Freedom Scientific is one of the oldest and most popular screen reader applications for Windows [25] that converts text to audio or braille. It designed to enable VI and blind user to navigate systems, use applications, and browse the internet. [55] with all its features, but it's not free.

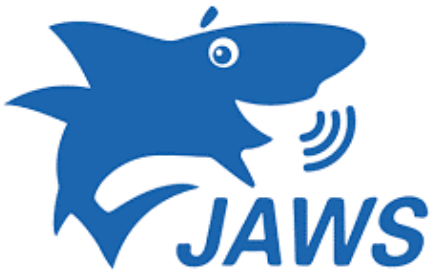


Figure 1.4: JAWS screen reader

  - **NVDA:** Non-Visual Desktop Access NVDA is the second most widely used screen reader for Windows, following JAWS, and it offers the additional advantage of being available for free.

Figure 1.5: nvda screen reader

There are also different screen reader options for Android devices like TalkBack, Apple devices come with the VoiceOver software, as for linux devices, it actually depends on some applications includes BRLTTY and Speakup ...etc. [25]

- **Screen magnifiers:** are software applications that enlarge text and graphics on computer and mobile screens, acting as virtual magnifying glasses. Users can selectively zoom in on specific areas for enhanced visibility and readability. [12]

Figure 1.6: Screen magnifiers

Hardware solutions:

- **Braille displays:** are electronic devices featuring tiny pins that raise and lower within six holes, allowing them to reflect the text displayed on a computer screen or any other device in braille. [1]
- **Braille notetakers:** are devices equipped with integrated refreshable braille displays, enabling users to access the Internet and utilize word processors and various software applications for school, office, or personal tasks while being away from home. [1]

1.4 Advancing Online Access for the Visually Impaired:

The advancement of the web and internet has allowed blind and visually impaired individuals to access previously inaccessible information and services. However, challenges arise with assistive technologies such as screen readers and reliance on a single sense for interaction, leading to frustrations in their browsing experience. Recognizing the importance of web accessibility, organizations like the World Wide Web Consortium (W3C) and the Web Accessibility Initiative (WAI) have been instrumental in promoting web accessibility. They have worked towards creating accessibility guidelines, which serve as a framework for designing websites that are accessible to individuals with disabilities.

1.4.1 A review of some essential terms definitions: or background:

What is the World Wide Web ?

The World Wide Web, or web for short, introduced by Tim Berners- Lee in late 1989, consists of publicly accessible websites and pages accessed via the internet on their local devices [11]. Users can browse web pages using a web browser, The content on the web can be in various formats, including text, images and video, and other multimedia content, they can easily navigate between them through hyperlinks. [3]. The Web has gone through different phases of development, these phases include the Web of documents (Web 1.0), the Web of people (Web 2.0), and Web of data (Web 3.0). [11]. It's essential to understand that the World Wide Web is a part of the broader internet infrastructure, but it is not the same thing as the entire internet. [3]

Figure 1.7: World Wide Web

Web accessibility meaning:

"The power of the web is in its universality. Access by everyone regardless of disability is an essential aspect", this is a famous quote by Tim Berners-Lee, inventor of the World Wide Web and director of the World Wide Web Consortium (W3C). [10] [15] the concepts of universal design and accessible design has become increasingly significant In rapidly evolving world, due to the role they play in fostering equal access and inclusivity.

"Universal design" focuses on creating products, environments, and services that are usable by as many people as possible, irrespective of their abilities or disabilities [19]. "Accessible design", on the other hand goes beyond that, it is specifically centered around the concept of designing products, services, environments, or systems in a way that make it accessible for individuals with disabilities [52].

Selovuo (2019) defines accessibility in his book as a moral obligation and a way to ensure fairness and equality in digital services, this brings us to the realm of web accessibility [21]. Web accessibility can be understood in various ways. First, it involves ensuring that individuals with physical limitations can comfortably navigate and access web content. Second, it pertains to the visibility of websites on search engines. Third, it relates to the visibility of websites on social media platforms. Lastly, it pertains to the availability of websites on the web [30].

In the light of this, it becomes evident that prioritizing web accessibility is crucial. By creating an open and inclusive web experience for all individuals [51] [49], we aim to enhance their understanding, navigation, and interaction on websites. This approach empowers people with diverse needs to fully participate in the digital world, fostering a more inclusive and equitable online environment. [41].

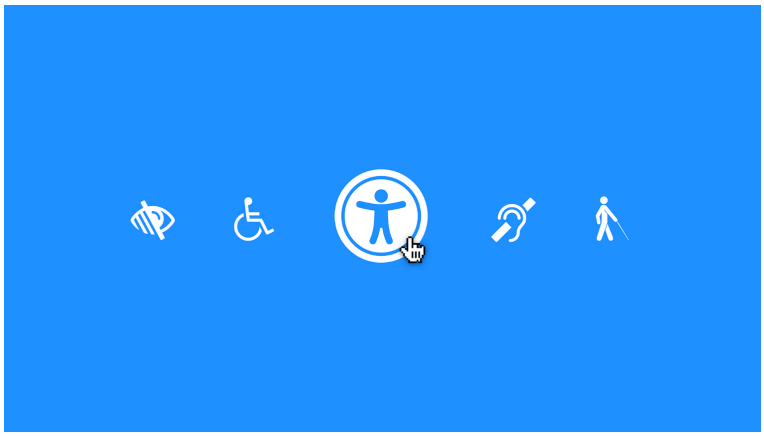


Figure 1.8: Accessibility for all

In the context of daily work on web accessibility, these endeavors are frequently interconnected with adherence to specific standards [32].

Web accessibility and standards:

In October 1994, Tim Berners-Lee partnered with CERN and MIT/LCS to form the international organization World Wide Web Consortium (W3C). [51]. The W3C stands as an international community committed to the development of open standards, ensuring the enduring growth of the web [33].

The Web Accessibility Initiative (WAI) associated with the World Wide Web Consortium (W3C) that standardized HTML and CSS languages, is among the organizations that have defined their own accessibility criteria [52] [24]. formed in April 1997, with the backing of the White House. Its primary objective is leading the efforts in supporting individuals with disabilities, facilitating their seamless access and utilization of the internet so that they can access and utilize the internet easily. [33] [55].

The Web Accessibility Initiative (WAI) promotes a tripartite model of accessibility that encompasses three key components [29]. One of the key achievements of WAI is the publication of the Web Content Accessibility Guidelines (WCAG) in 1999 [33], WCAG is a set of guidelines and norms that are considered as the gold standard for evaluating and making web more accessible for Those who encounter accessibility challenges [4], in many cases these guidelines is striving to help mitigate problems that visually impaired users face when accessing web content. [14].

The remaining two components of the WAI's tripartite model, the Authoring Tool Accessibility Guidelines (ATAG) and the User Agent Accessibility Guidelines (UAAG) complement WCAG by ensuring that authoring tools and user agents also adhere to accessibility principles. Together, these components form a comprehensive approach to promote an inclusive digital experience for all users. [29].

In addition to these components, WAI has developed the WAI-ARIA specification, a technological standard which incorporates methods to make markup-based components and elements like menus, forms, and widgets, more accessible to various assistive technologies. It aims to enhance web accessibility for individuals with physical limitations such as visually impaired users [21]

In order to achieve this goal, the developers make the web content more inclusive and usable for VI people. By adhering WCAG guidelines and incorporate WAI-ARIA attributes. [51] [28]

Overview of WCAG:

When it comes to making web content accessible for everyone, there is an important framework to keep in mind: The Web Content Accessibility Guidelines (WCAG). Over the years, there have been five versions of WCAG.

WCAG 1.0 were published In May 1999. The standard promotes accessibility by outlining 14 guidelines. It primarily focused on HTML and introduced the conformance levels of A, AA, and AAA as illustrated in table.

I the conformance levels			
Conformance Level	A	AA	AAA
Explanation	All SCs of level A are satisfied. This is the "minimum standard" which a website must meet to be considered accessible for any significant disability groups.	All SCs of Level A and AA are satisfied. This is a "professional practice standard", which a website should meet to be accessible to a broad range of disability groups.	All SCs (at all conformance levels) are satisfied. This is a "gold standard" of maximum accessibility which some websites may choose.

Table 1.1: the conformance levels of A, AA, and AAA

It was followed in 11 December 2008 by WCAG 2.0, unlike WCAG 1.0, this second ver-

sion took a wide variety of technologies into account and guided developers to make all digital content accessible, and integrated four principles known as POUR: Perceivable, Operable, Understandable, and Robust. [49] [22].

- **Perceivable:** Web content and components that make up the user interface should be clearly presented by all users, so that they can perceive it.
- **Operable:** website navigation should be seamlessly usable and functinal for all users.
- **Understandable:** To foster a user experience, website content and operation should be easily understandable by all users.
- **Robust:** the web page's content needs to be stable and strong enough to ensure adaptability across diverse range of assistive technologies. [4] [54]

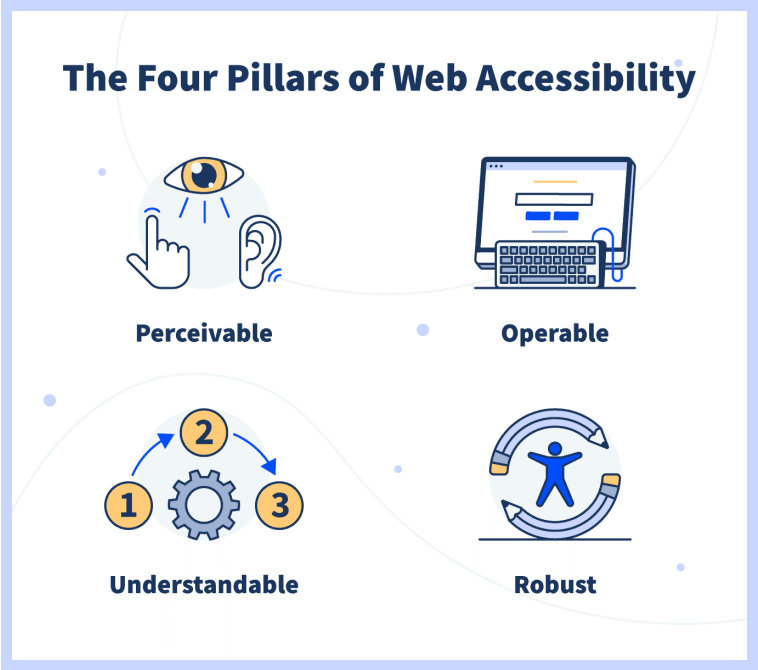


Figure 1.9: The four principal POUR

On 5 June 2018 an updated version of WCAG 2.0 released, WCAG2.1, includes new accessibility standards for mobile devices and individuals with low vision and cognitive disabilities. it was added many criteria and was approved as an ISO standard [24].

WCAG 2.1, an updated version of WCAG 2.0 released in 2018, includes new accessibility standards for mobile devices and individuals with low vision and cognitive disabilities. It is backward-compatible with WCAG 2.0, ensuring compliance with both versions simultaneously. [][22][24]. The objective of initiating WCAG 2.2 was to sustain and advance the advancements accomplished in WCAG 2.1. WCAG 2.2 aims to improve accessibility guidance for users with cognitive or learning disabilities, low vision, and disabilities on mobile devices. [https://www.w3.org/TR/WCAG22/].

WCAG 3.0 is the latest version, and its First Public Working Draft was published on January 21, 2021, with the latest draft released on December 7, 2021. An updated draft is expected

in May 2023. [50] WCAG 3.0 is a separate standard from WCAG 2.X, introducing additional tests and scoring mechanisms.it is not backwards compatible but provides an alternative set of guidelines alongside WCAG 2.2 and previous versions without superseding them. [24].

These guidelines serve as categories for the success criteria which constitute WCAG, each success criterion addresses a barrier or barriers to making content inclusive for all users.

Each version of WCAG builds upon the previous ones, incorporating new standards and recommendations to enhance web content accessibility, by addressing a barrier or barriers to making content inclusive for all users. Reasons for adapting WCAG:

- WCAG is universally acknowledged as the authoritative standards for designing accessible websites.
- The guidelines are regularly updated to reflect evolving accessibility requirements.
- The majority of user agents and assistive technologies adhere to the WCAG recommendations.
- The guidelines are designed to be generic and impartial to specific technologies.
- The guidelines are well-organized and appropriately categorized. [51]

1.5 Unraveling the benefits of Web Accessibility: or why does web accesibility matter?

Making websites accessible for people with disabilities specifically those who are visually impaired, unlocks opportunities beyond disabilities and assistive technologies.

In general, web accessibility offers:

- Web accessibility goes beyond disability inclusion, improving the overall user experience by organizing content logically and intuitively.
- Investing in web accessibility leads to cost savings through easier maintenance and reduced need for future modifications.
- Accessible websites are compatible with entry-level computers and slower internet connections, ensuring usability for users with limited resources.
- Web accessibility enhances portability by adapting to different screen sizes, making sites accessible on mobile devices and other platforms. (Benzouak, A. (2019)).

1.6 Accessibility, Usability, and User Experience:

According to the W3C, when talking about the basics of accessibility, it is essential to also talk about usability and UX, because they go very much hand in hand.

Usability and accessibility are slightly different lenses to assess user experience, accessibility pertains to the technical aspects of a website [47], Whereas, usability encompasses the overall user experience, as it focuses on designing user-friendly interfaces, theraby addressing that optimization of user satisfaction. This is why Accessibility and usability considered as key features in web design [13].

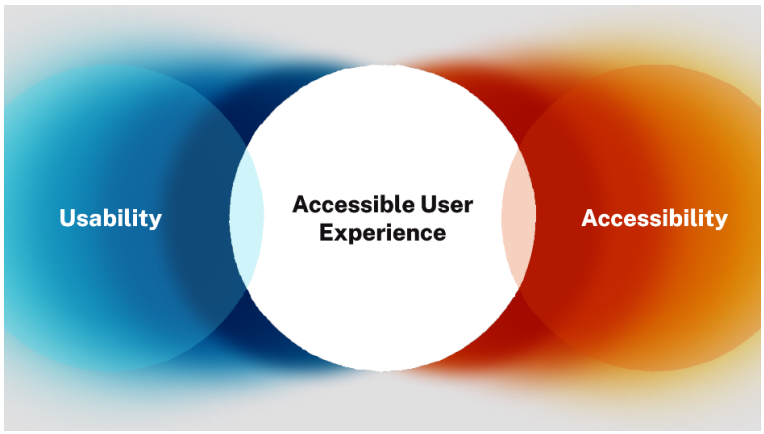


Figure 1.10: Accessibility, usability and UX

1.7 Evolution of web interfaces:

The User Interfaces that receive particular attention within the scope of this thesis are web interfaces. These interfaces, designed for web usage, present significant challenges for individuals with visual impairments, as they predominantly rely on visual elements [17].

Web technology advancements have transformed web interfaces from simple text-based layouts to dynamic, visually experiences that prioritize user engagement. These modern interfaces which are referred to as " interactive interfaces", provide a wide range of multimedia support, interactive features, and real-time information sharing. The shift towards rich interfaces transforms users from passive spectators to active participants, allowing them to interact dynamically with the interface and access a greater quantity and variety of information. [17]

1.8 Web accessibility for visually impaired user:

1.8.1 How to achieve web accessibility:

In order to achieve web accessibility for people with disabilities, particularly those with visual impairments, there are two methods available:

- **Active accessibility:** The first method, known as the active approach, is based on the use of specific accessibility features.
- **Passive accessibility:** The second method, referred to as the passive approach, relies building websites with inherent accessibility through proper coding and adherence to standards. [55]

1.8.2 Web accessibility issues:

Raufi (2015)'s study on web accessibility found that visually impaired users still struggle with route-finding issues, even when web pages adhere to WCAG. Ferati (2015)'s study on web accessibility emphasize that software solutions alone cannot guarantee accessibility for blind and visually impaired users; cultural aspects and other factors must be taken into account. [53], and mention that for designing interfaces for visually impaired users who are familiar with such techniques would entail comprehending their specific needs, rather than assuming they share identical characteristics. [51] .

Regarding visually impaired users, certain design aspects are identified as obstructive:

- **Content serialization:** In most cases the content blocks within hyperdocuments are presented in a sequential manner without considering design aspects and the relative positioning of the elements.
- **Navigation by special keyboard commands:** Visually impaired users prefer specialized keys for navigation, providing quick access to information. Ensuring keyboard functionalities is important, either through reading software or a special tag in hyperdocuments. Puzis et al. (2012) conducted a study using a predictive model to generate relevant actions for browsing, allowing users to select actions with specific keys.
- **Difference in information conveyance between visual layouts and those afforded by aural perception:** Secondary information is provided to sighted users to help them navigate (e.g., left or right menu bars, special headers). This information should also be made accessible for the visually impaired. The MultiVis Project (Kildal Brewster, 2007) addresses this by using haptics and non-speech sounds to create accessible visualizations of data, particularly for graphs and tables.

  Understanding these issues is essential step for devising effective strategies to facilitate adaptive interaction for individuals who are blind or visually impaired. Despite the constraints mentioned.

1.8.3 From web accessibility to web adaptability:

The challenge of web content adaptation for visually impaired users is addressed through two primary approaches: content and modality adaptation

- Content adaptation approach involves displaying and transforming the web content in a more accessible way suitable to user preferences in a specific context [19, 20, 43].
- Modality adaptation approach involves alternative content representation (often non-visual) that facilitate the content accessibility using voice narrators and other non-speech sounds. [51].

1.8.4 Enhancing Adaptive Interaction for Blind and Visually Impaired Individuals:

Despite the mentioned constraints, five adaptation techniques (four adaptive presentation techniques and one adaptive navigation support technique) have been identified to significantly benefit individuals with visual impairments. These techniques enhance accessibility, improve interaction experiences, and empower the blind and visually impaired community in digital interactions. [23]

- **Adaptive Multimedia Presentation:** It entails making multimedia content more accessible by adapting it to the user's preferences, such as recognizing specific content in context and presenting it accordingly. This may involve image transformation, resizing, or zooming/unzooming.
- **Canned Multimedia Presentation:** It relates to methods such as incorporating, omitting, concealing, deactivating, and filtering multimedia content based on the user's navigation patterns.
- **Canned Text Presentation:** It primarily includes techniques involving text manipulation and transformation, such as inserting or removing text fragments, altering text, filtering text, transforming text fragment contrast, and amplifying visual text.
- **Adaptation of Modality:** It primarily consists of non-visual alternative techniques that enhance content accessibility, such as voice narrators and auditory adaptations for navigating the content.
- **Adaptive auditory link serialization:** including serialized link manipulation, guidance, generation, and annotation, incorporates auralization techniques such as audemes (Ferati et al., 2012) and earcons (Brewster, 1998). This technique utilizes nonspeech sounds to draw the user's attention to content that requires additional focus.

1.8.5 How to build a user-friendly website for the VI:

web accessibility often gets put on the backburner when creating a website when it should be a priority. As a result, the internet's potential remains largely unavailable to people with disabilities. [23].

If the specific goal is to target individuals with visual disabilities and provide the best possible user experience, the following best practices can be employed to make websites accessible for blind and partially sighted individuals.

- **Provide Enough Color Contrast:** Text and background contrast on web pages is vital for readability, this is especially important for color-blind users. Low contrast can hinder reading for many users, even without visual impairments. At a minimum, you should meet WCAG 2.0 AA requirements, which require a contrast ratio of 4.5:1 for normal text and 3.1 for large text. It is important to maintain contrast standards to ensure comfortable reading experiences. [https://developer.mozilla.org/fr/docs/Web/Accessibility/Understan $\text{ding}_W CAG/F$

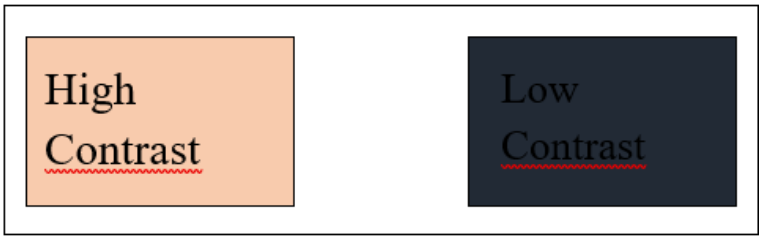


Figure 1.11: Example of high and low contrast

Avoid Text Over Background Images: If you choose to use text over background images, make sure that you use the right colors and ensure there is enough contrast so the text is easy to read.

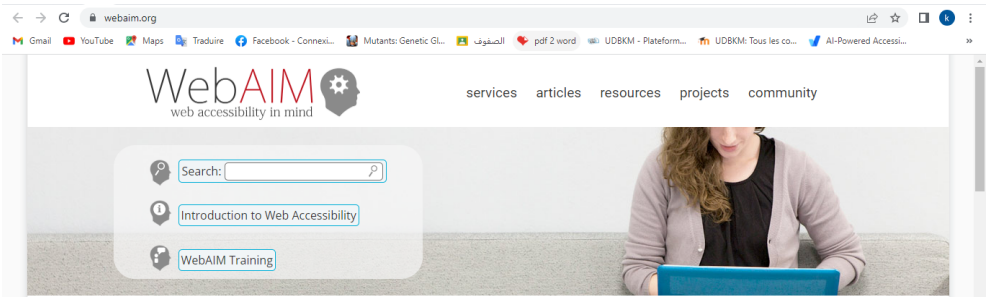


Figure 1.12: Example of text inserted over background image (https://webaim.org/)

- **Enable Manual Font Size Adjustment:** Font size is one of the most common issues that faced VI internet users. providing adaptive pages that allow users to manually adjust the font size addresses the issue.
- **Provide Alternative Content:** When individuals with visual impairments utilize technology to access content, it becomes crucial to offer alternative options for certain types of content. AI-based image recognition methods examine images and generate dynamically alternative text that can be read by screen. That improve the visibility of the web page.

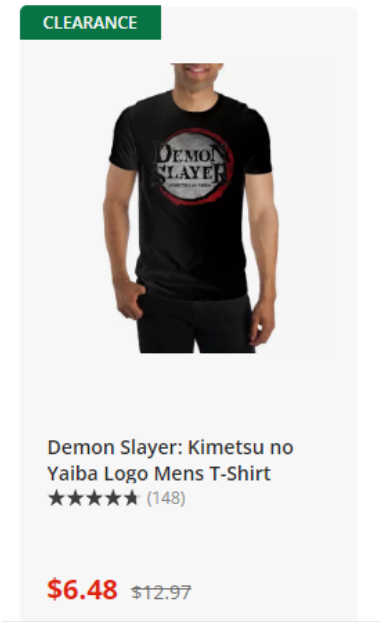


Figure 1.13: Example of alt text for image (from ThinkGeek)

the text underneath the image describes the image and is also rendered using HTML, which means screen readers will be able to find it.

- **Organize Content With a Descriptive Title and Headings:** Designing web pages with descriptive titles for screen reader accessibility, Using HTML elements like "h1," "h2," and "th" in tables to aid heading navigation enhance content comprehension by screen readers.

Figure 1.14: Example of descriptive title and headings

1.8.6 Web Content Adaptation:

Addressing the aspects of accessibility involves a tough problem of adapting interfaces based on the user's context, understanding, and preferences. Several studies [44] [6] have take into account addressing the question of "How to enhance the understanding of the content available on Websites ?". By exploring this question, researchers endeavor to uncover technologies, strategies and methodologies that can to deal with aspects of accessibility and comprehension for individuals with visual impairments.

"Transcoding for Web accessibility" is a category of technologies that transform inaccessible web content into accessible content on-the-fly. It allows people with disabilities to access web pages without asking the content authors to make modifications. This process occurs through an intermediary server that converts the content in real-time between the server and browser (Asakawa and al., 2019). The technology has advanced alongside voice browsing technology since approximately 1992 and saw significant utilization during the 2000s. [18].

1.9 Related work:

There is a plethora of works found in the literature which are dedicated to modifying web interfaces to cater to individuals with visual impairments. These works include personalization techniques and approaches used to meet visual needs. The literature contains numerous studies that center around users with low vision, suggesting fundamental modifications (such as larger text, increased spacing, font customization, specific text adjustments, and color control) required to accommodate their needs. [5] [45] Benzouak, A. (2019) [55] [38].

It is important to note that relying on a single approach to modify the display of text may not adequately address the diverse requirements of computer users with low vision. [39]

In [34], this article presents a exploratory study that explores how user's performance and overall satisfaction are improved when using an adapted version of a website. The study indicates that incorporating audio and visual assistance at the interface level, which provides users with supplementary information about links, has the potential to enhance performance. Moreover, enabling visually impaired users to adjust text size and view the site in reverse contrast facilitates easier and more confident interaction with the interface. [39].

A conceptual approach in [31], called WILI (Web Interface for People with Low Vision Issues), proposes making web pages accessible for individuals with low vision. It involves automatically replacing the display style of a web page with a new skin following guidelines from the Royal National Institute of Blind People.

Elements like menus, lists, sections and others play crucial roles in organizing and presenting information on websites, this is why some studies like [36] [37] [26], center around its specific functions and significance in creating effective and user-friendly interfaces. Other approaches address web accessibility for color-blind individuals.

Usually, scenarios in web design often incorporate the use of colors, which are defined by designers. This includes various colored interface elements like buttons, forms, menus, tables, and images. The article by [6] present the FAIBOUD Framework, which automatically adapts interfaces for individuals with Color Vision Deficiency (CVD) by considering their individual characteristics, preferences, and context. Using ontologies to express domain knowledge, FAIBOUD applies algorithms to modify interface elements like images, text, and backgrounds, achieving personalized recoloration.

Another article [46] present @dapt++, a semantic model that performs automatic adaptations in webpages, using an ontology to improve accessibility for people with visual impairments. The model consists of components that do the page processing to prioritize relevant information and provide additional information so that the page elements become more understandable, Subsequently, the adapted page is finally delivered to the user.

Ferati and his team (Ferati et al., 2016) developed a prototype middleware that adapts websites based on the user's level of visual impairment, making them usable. Through three workshops involving diverse participants, eight different adaptation techniques were utilized, including image transformation (resizing), text transformation, color transformation (text and background), image filtering (highlighting relevant images), content filtering (identifying main content), context switching (adapting modes based on user needs), magnifying lens, and voice narrator. [51]

1.10 Conclusion:

Web accessibility goes beyond catering to individuals with disabilities. It benefits the elderly, mobile users, non-native speakers, and those with slower internet connections. by providing a user-friendly experience for all visitors.

In our work, we have adopted an active accessibility method, which has proven effective in

improving web accessibility. By prioritizing accessibility principles, we can create an inclusive web environment that fosters participation and opportunities for all users. A accessible website maintains his audience. In the next chapter, we will delve into the modeling of our work that improve web accessibility for visually impaired users.

CHAPTER 2

Modeling and design

2.1 Introduction

After exploring the theoretical part, including the study of visually impaired individuals and the assistive technologies at their disposal, as well as web accessibility, now, we delve into the practical aspect of our work, This part focuses on the design and modeling aspects of our proposal, aiming to enhance better achieve web accessibility for visually impaired users. This involves addressing issues related to non-compliant web pages for these individuals, by allowing users to adjust web elements for improved accessibility and usability. They can modify contrast, text size, and font type to enhance readability.

2.2 System Architecture and Design:

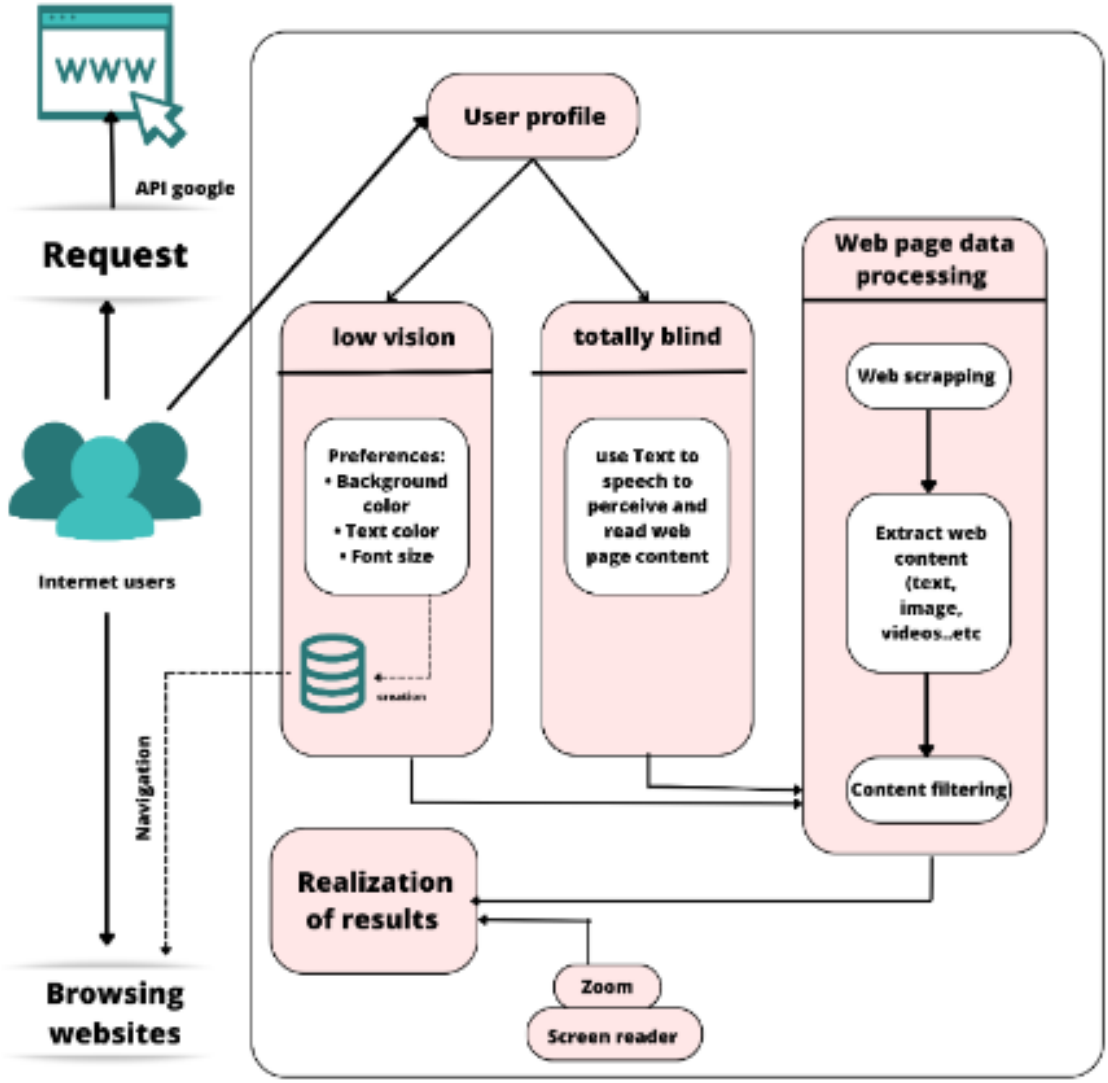


Figure 2.1: System architecture

2.2.1 Overview of the Proposed Solution:

As previously mentioned, our work aims to enhance web accessibility for individuals with visual impairments. This entails addressing the specific challenges arising from non-compliant web pages to better serve these users. Ferati propose a liste of all challenges identified in the workshops [26], these challenges serve as steps to be taken when we want to make web pages accessible for VI users, as depicted in the figure provided.

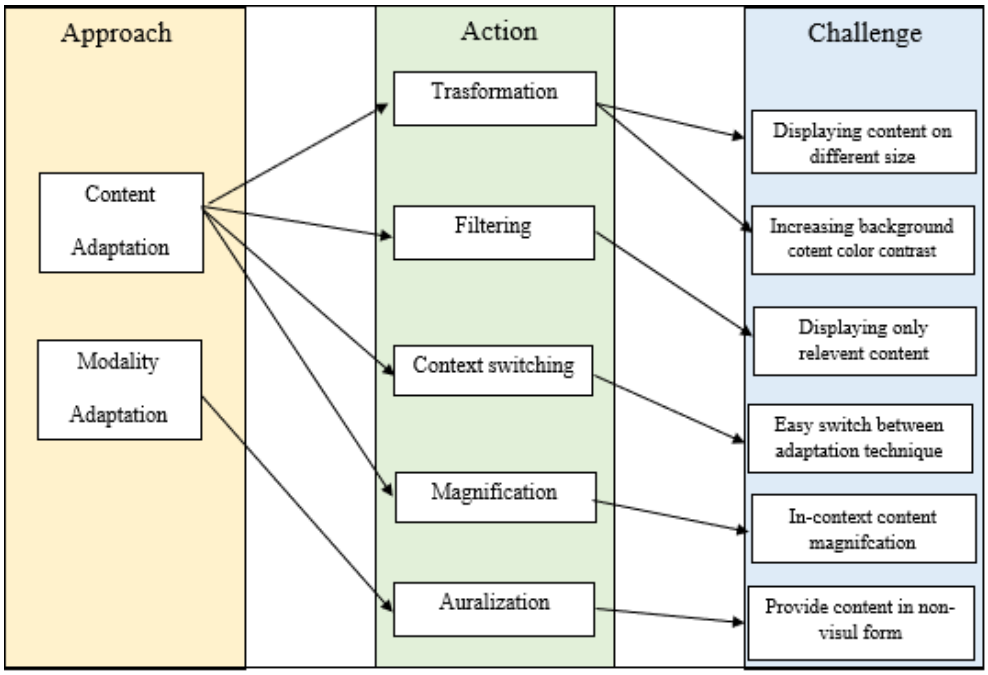


Figure 2.2: Approach, action and challenge

Considering that each user has their own habits and prefernces that are dependent on their comfort, and that can turn into challenges when they face difficulties in engaging with them like others. This holds true for visually impaired users when it comes to browsing web pages.

this figure illustrate the specific details of the mentioned steps.

2.3 Description of the entities in the proposed system:

The proposed model is represented by a UML class diagram and use case and sequence in these Figures.

- **Use case diagram:** The use case diagram of our system involves two participants: the user and the programmer. The roles played by these two participants are as follows:
  - **The user**
    - To consult the web application.
    - To choose an option (Tottaly blind/low vision)
    - Enter an url or image
    - see the result
  - **The programmer**
    - import the dataset
    - save user information in a database
    - check website url
    - construct results
    - display results

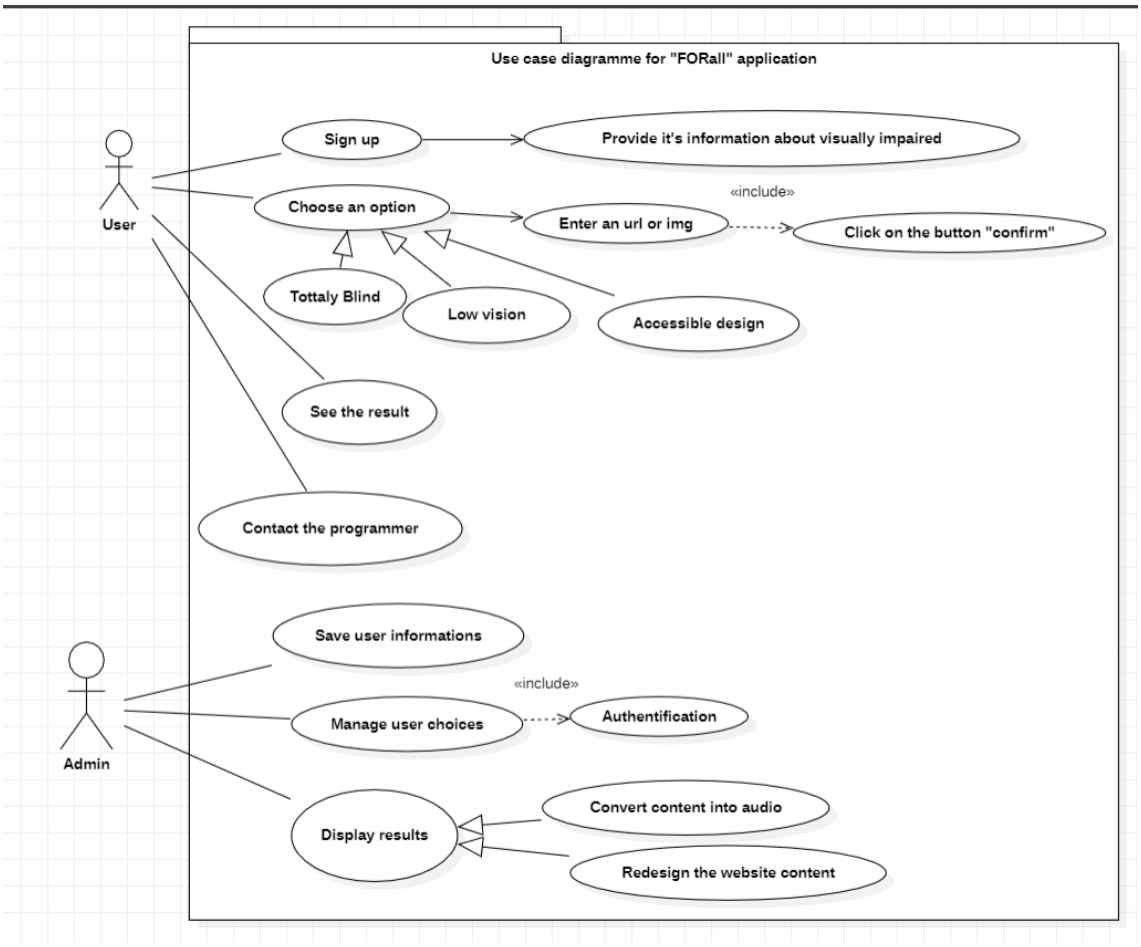


Figure 2.3: Use case diagram

- **Sequence diagram:** To predict our app results, the user must go through the following simplified sequence, represented by the following Scenario:
  - The user launches the web application.
  - The system loads the home page for the user.
  - The user selects the volu page.
  - The system loads the selected page.
  - The user choose an option.
  - The system load the chosen option.
  - The user enter an url/img.
  - When the "validate" button is clicked, the system display the result

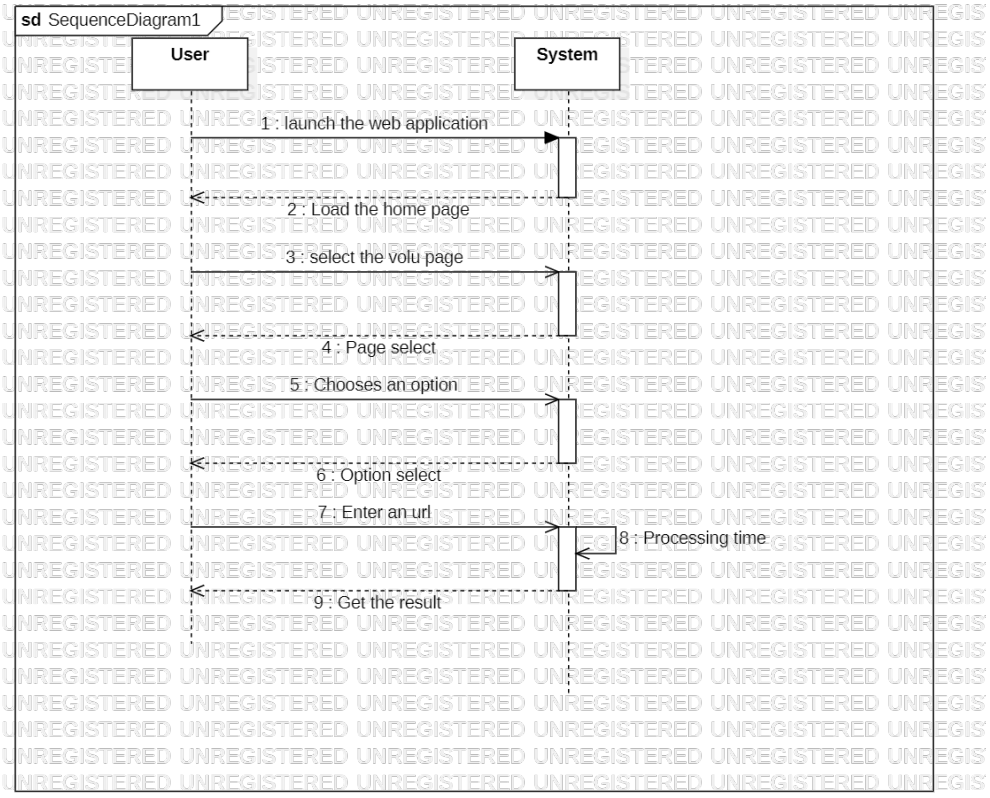


Figure 2.4: Sequence diagram

– Inscription:

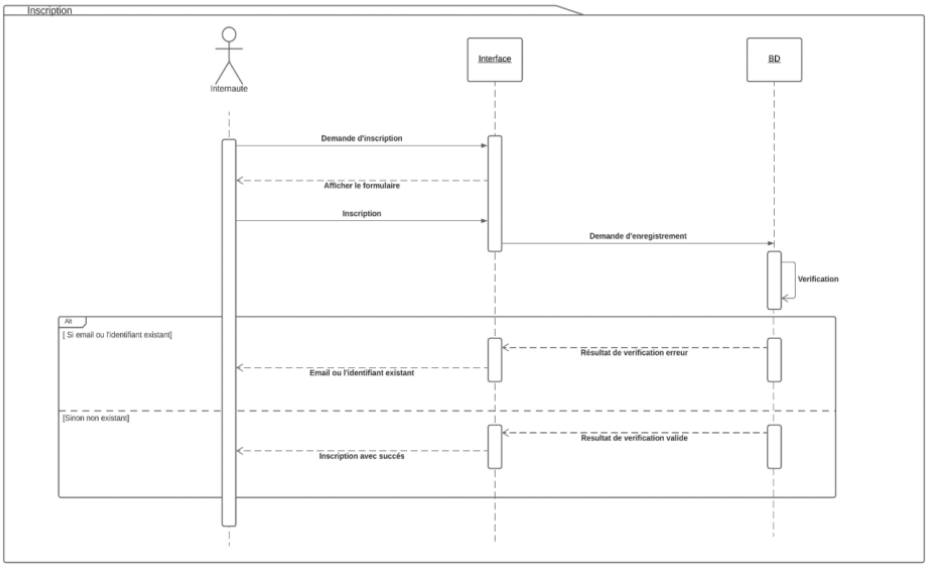


Figure 2.5: Inscription

– Authentification:

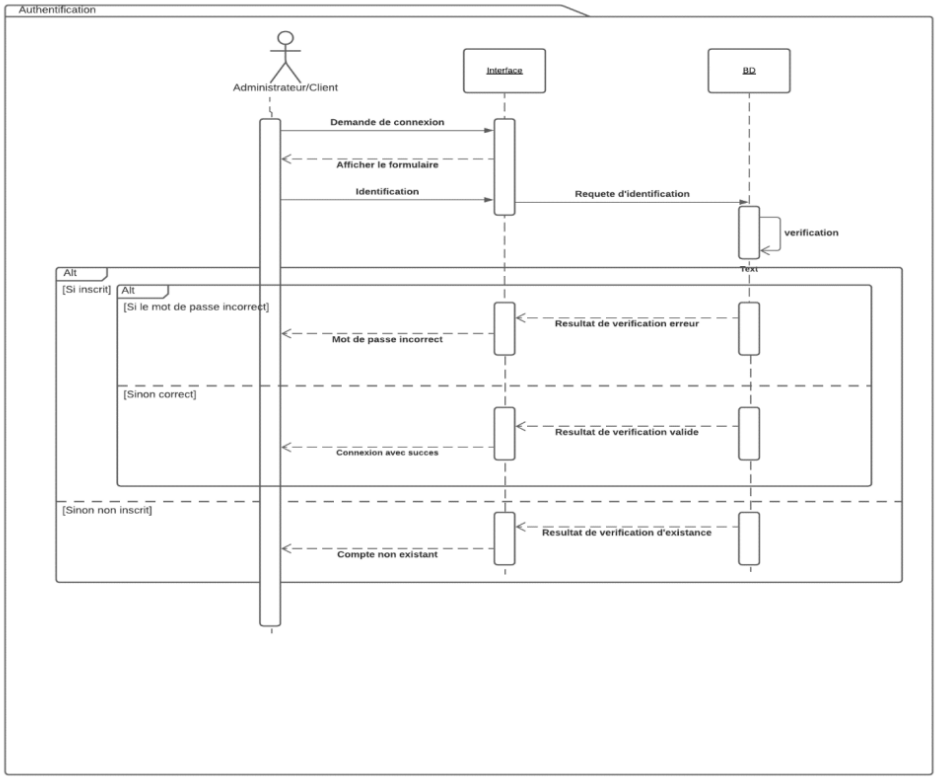


Figure 2.6: Authentification

- **Class diagram:** The proposed model is presented by a UML class diagram.

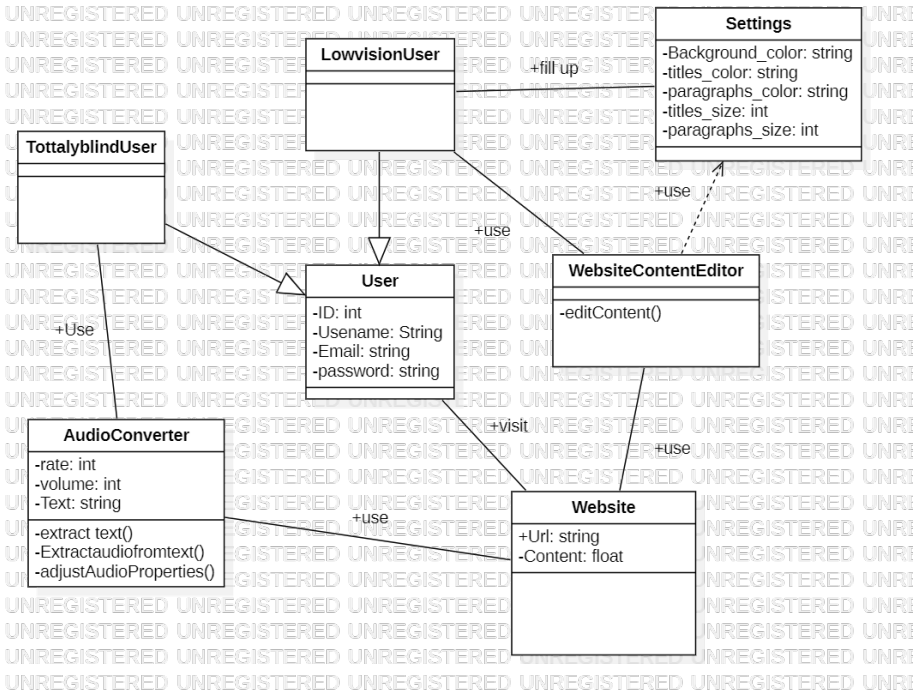


Figure 2.7: Class diagram

2.4 Working Mechanism:

Users have the ability to access web pages and customize them based on their preferences. The suggested approach for web page adaptation is divided into three phases, which are illustrated in the figure below.

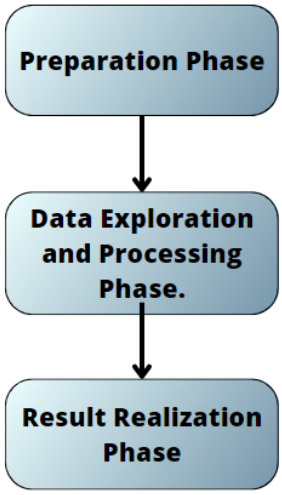


Figure 2.8: Preparation phase

2.4.1 Preparation phase:

This is a phase aimed at determining the type of visual impairment of the user using our application, adapting the display according to their situation, and specifying the link of the web page to be accessed.

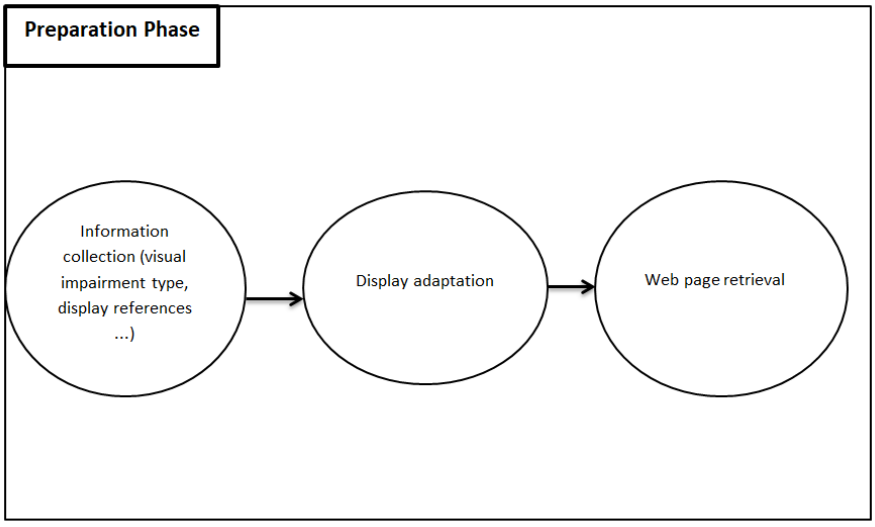


Figure 2.9: Preparation phase

Information collection:

This step allows determining the profile of the visually impaired individual as follows:

- Type of visual impairment: low vision or color blindness or totally blind.
- Individual's contact information (name, first name, email address).
- Display preferences for the system in the case of a low vision user.

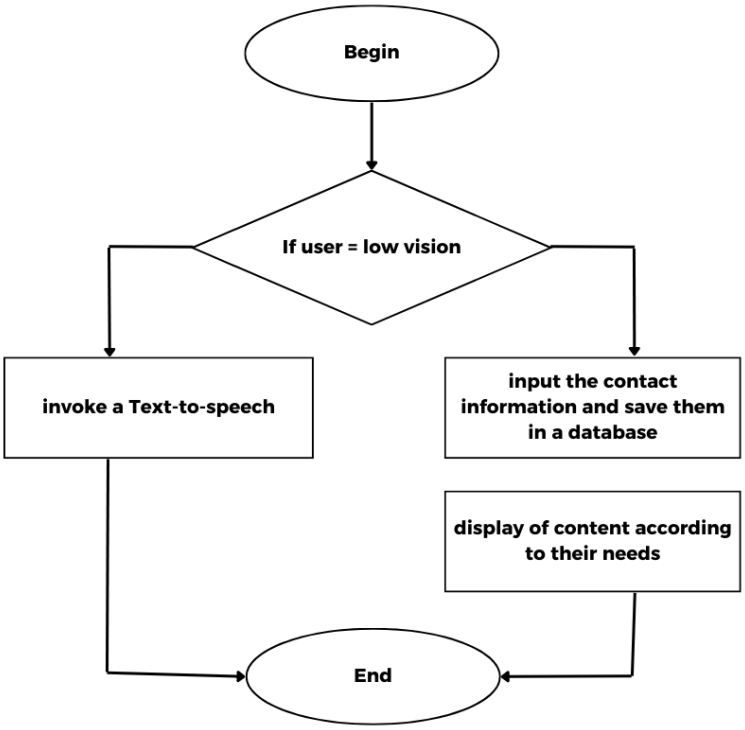


Figure 2.10: Flow chart for collecting information

Display adaptation:

The system will utilize the display settings entered in the previous step to apply them to both its own interface and the web pages being viewed, as depicted in the following Figure

Figure 2.11: Example illustrating display adaptation

The visually impaired users can access web pages of their choice with the display that suits their needs.

2.4.2 Data exploration and processing phase:

The core component of the web page adaptation mechanism lies in the data processing phase, as it is responsible for analyzing and transforming the content of web pages according to each user's preferences (previously chosen).

The data processing phase consists of three major processes:

- **Web page scraping:** This is the key process of the data processing phase. It is responsible for analyzing all visible elements (text, images, audio files, videos, hyperlinks, and executable or downloadable programs) as well as invisible elements (HTML code) of the HTML document. The DOM structure (Document Object Model) is the result of document analysis. This process is implemented using the Beautifulsoup library.
- **Extraction of web page content:** This process enables the identification and downloading of all resources within an HTML document (the viewed web page).
- **Content filtering:** This process aims to gather and organize the extracted visible data from the web page based on their different types, while removing unnecessary information (spam, advertisements, etc.).

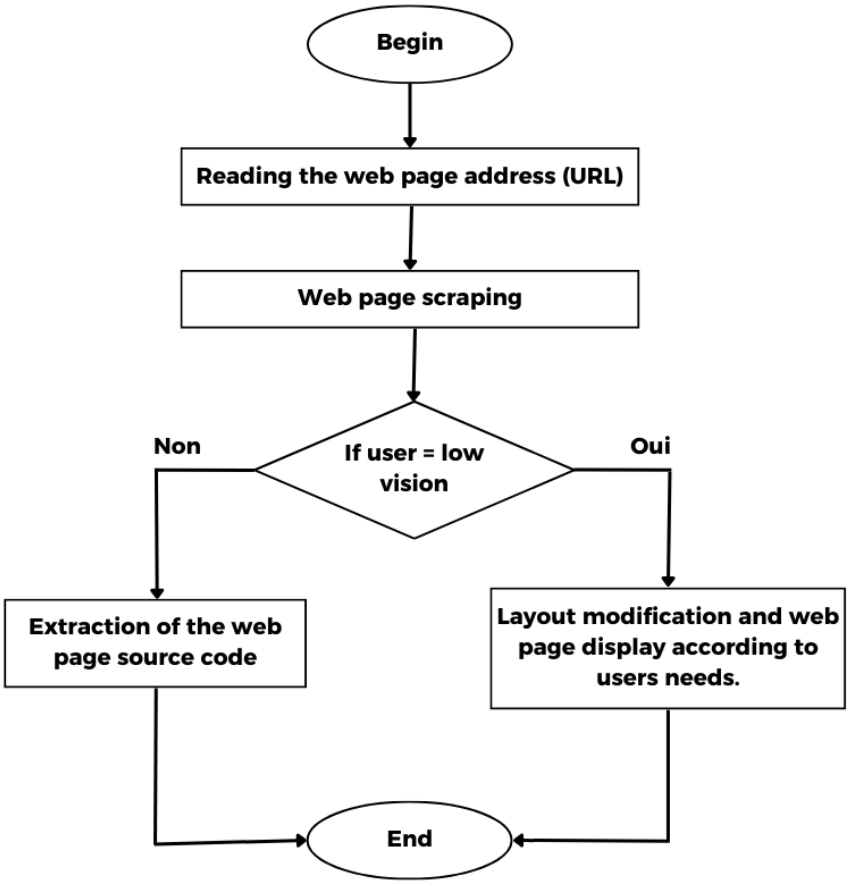


Figure 2.12: Flow chart of web page content scrapping

2.4.3 Result realization phase:

The final process is the browsing environment, which represents the user interface of the browser and is primarily used to access web pages, including viewing the personalized results based on user preferences. The tools used during the design phase to facilitate easy navigation for users with visual impairments are: the Zoom function (Windows magnifier), and pyttsx3 library for python.

2.5 Conclusion:

Design is a critical phase in the application development process, where the focus is on defining the various functionalities of the intended product. This chapter has provided a comprehensive overview of the proposed modeling, which outlines the behavior of the proposed system.

Moving forward to the next chapter, we will proceed with the actual implementation of the proposed model.

CHAPTER 3

Implementation And Results

3.1 Introduction:

This chapter addresses the final phase of our work, which involves the vital task of processing web pages to cater to the specific needs of visually impaired individuals. We provide an overview of the tools utilized for implementing our system and present the various interfaces of the system along with the obtained results.

3.2 Development Tools:

3.2.1 Development environment: (Hardware):

Hardware	
Device Name	Latitude 5420
Processor	11th gen Intel i5
Installed RAM memory	16Gb
Operating System	Windows 11 Professional

Table 3.1: Development environment

3.2.2 Tools:

Python:

Python is is an interpreted, object-oriented, and open-source programming language known for its versatility, ease of use, and high-performance capabilities. That offers many benefits, making it an ideal choice for front-end web development. Created by Guido Van Rossum in 1989 and its first released in 1991. Python provides language constructs and an object-oriented approach that helps developers write clear and logical code for projects of any scale. Python is excellent for developing web, API solutions, machine learning and more.

Figure 3.1: Python logo

Flask:

Flask is a lightweight and flexible web framework for Python that facilitates the development of web applications. It is categorized as a micro-framework due to its minimalistic design and the ability to choose and add components as needed. Flask provides the essential tools and features to build web applications, including routing URLs to view functions, handling HTTP requests and responses, managing templates, and interacting with databases. With its simplicity and extensibility, Flask is popular among developers for creating small to medium-sized web applications, APIs, and prototypes with ease and efficiency.

Figure 3.2: Flask

Supabase

Supabase stands out as an exceptional open-source Backend as a Service (BaaS) platform, empowering developers to swiftly create modern web and mobile applications without the hassle of managing backend complexities. Its remarkable features include a real-time database, ensuring instantaneous data synchronization; robust authentication and authorization mechanisms for secure user management; serverless functions for extensibility and automation; seamless storage and file management for media-rich content; real-time and offline capabilities for uninterrupted user experiences; an autogenerated RESTful API simplifying frontend-backend interactions; powerful websockets and Pub/Sub for event-driven applications; an active open-source community fostering collaboration and innovation; comprehensive developer-friendly documentation for quick starts and effective problem-solving; and a focus on security and scalability, making it a preferred choice for developers seeking a powerful and streamlined development experience.

Figure 3.3: Supabase

HTML (HyperText Markup Language)

HTML serves as the fundamental building block of web pages, defining their structure and content. It employs a series of tags to represent various elements, such as headings, paragraphs, images, links, forms, and more, organizing the information in a cohesive and accessible manner.

CSS (Cascading Style Sheets)

CSS takes web design to the next level by providing a style sheet language that controls the presentation and layout of HTML documents. It enables web developers to effortlessly apply styles like colors, fonts, spacing, positioning, and responsive designs, ensuring visually stunning and consistent webpage aesthetics.

JavaScript

As a dynamic programming language, JavaScript enhances user experiences by introducing interactivity and dynamic functionality to web pages. It enables developers to create responsive elements, handle user interactions, modify page content on-the-fly, and interact with servers, making it an essential tool for creating powerful and engaging web applications.

Together, HTML, CSS, and JavaScript form the bedrock of modern web development, working in harmony to produce captivating and functional web pages and applications. HTML establishes the structural foundation, CSS provides the artistic flair, and JavaScript brings life to the digital canvas, resulting in an immersive and user-friendly web experience.

3.2.3 General System Architecture:

The general architecture of our application consists of four main functions, as depicted in Figure 3.2.

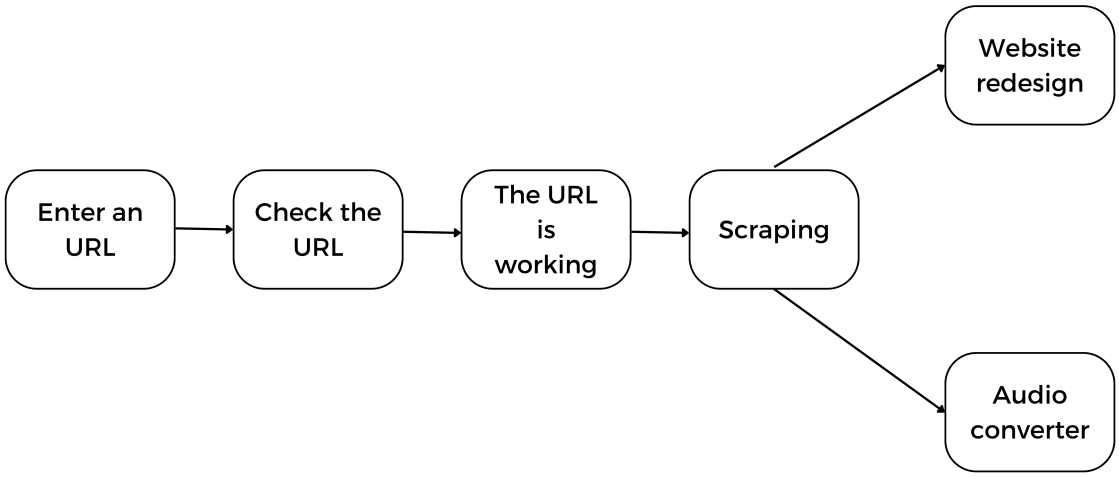


Figure 3.4: General System Architecture

- **The web scraper:** retrieves the source code of the web page.
- **The parser:**analyzes the source code, eliminating advertisements, spam, and any unnecessary elements, keeping only essential data for visually impaired individuals.
- **The filter:**organizes and separates data based on their types (text, hyperlinks, download links).
- **Result:** presents the optimized data.

3.3 Description of the operation of our application:

In this section, we present an overview of our application, along with the different user interfaces that have been developed.

3.3.1 Libraries, Open source, and API:

- **Beautiful Soup** is a Python library for parsing HTML or XML documents, enabling easy extraction of data from web pages. It is widely used for web scraping and data collection tasks, offering convenient methods to navigate and extract specific elements from the document structure.
- **Pyttsx3** is a Python library for text-to-speech synthesis, offering a user-friendly interface to convert text into spoken words. It supports various speech customization options and multiple TTS engines for versatile applications requiring speech output or voice interactions.
- **React** is a widely-used JavaScript library for building user interfaces with reusable components. It enables efficient UI updates based on data changes, making it popular for dynamic and interactive web applications. With a component-based architecture and a large community, React offers a fast and productive development experience.
- **Tailwind CSS** is a utility-first CSS framework that simplifies web interface styling with pre-defined utility classes. It offers flexibility, customization, and a rapid development workflow for creating modern and responsive user interfaces.
- **Googletrans**: library is a Python package that acts as a wrapper for the Google Translate API, enabling developers to translate text from one language to another programmatically. It simplifies the process of integrating translation functionality into Python applications and makes it accessible to developers who want to add multilingual support to their projects.
- **Langid**: is a powerful Python library designed for language identification or language guessing. It excels in accurately determining the language of a given text or document, even in cases where the language is unknown or unspecified. Utilizing sophisticated statistical models and algorithms, "langid" analyzes text using various linguistic features, such as patterns and character frequencies. This capability proves invaluable when handling multilingual data or automatically detecting the language of user-generated content, like social media posts, comments, or customer reviews. With its ease of use and versatility, "langid" finds applications in diverse fields, including natural language processing (NLP), content classification, and data preprocessing. Embracing "langid," developers can create language-aware applications that intelligently adapt and respond to different languages and user inputs with precision and efficiency.
- **Google Translate API**: is a service provided by Google that allows developers to utilize Google's powerful translation engine in their applications. It provides machine translation capabilities, supporting translation between various languages with high accuracy and performance. The "Googletrans" library serves as an intermediary between Python applications and the Google Translate API, enabling developers to interact with the API more conveniently.

3.3.2 Application Access:

Home Page :

Our homepage offers an inclusive and user-friendly experience engaging introductions, easy account access, and intuitive navigation for services make it seamless. With text-to-speech for accessibility, visually impaired users can effortlessly access content. Explore our vision in "About" and connect with us through "Contact."

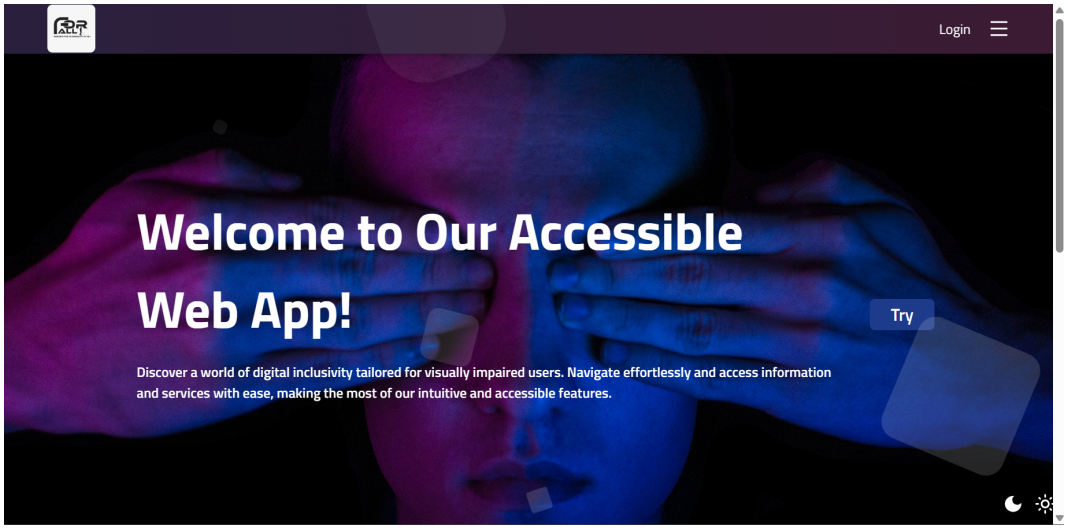


Figure 3.5: Home Page

Our Sign Up and Login pages are designed to offer a personalized and seamless onboarding experience for users.

In light Mode:

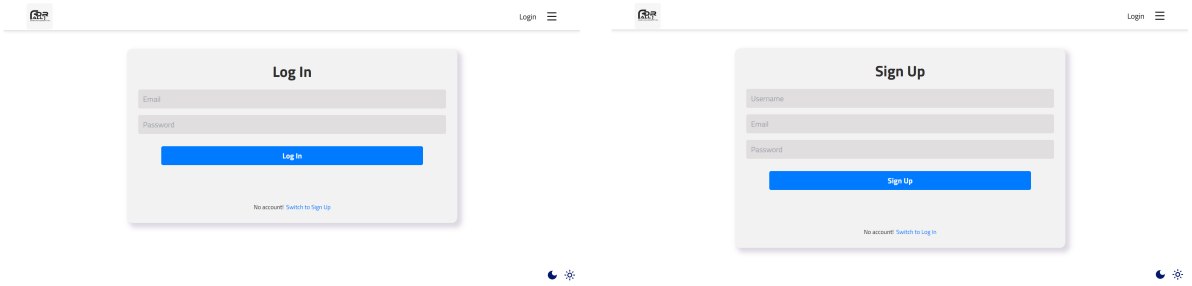


Figure 3.6: Light mode

In Dark Mode:

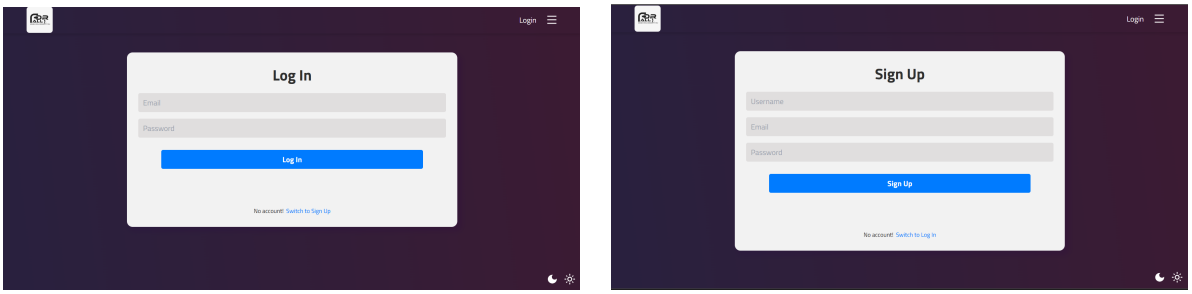


Figure 3.7: Dark mode

List of application users :

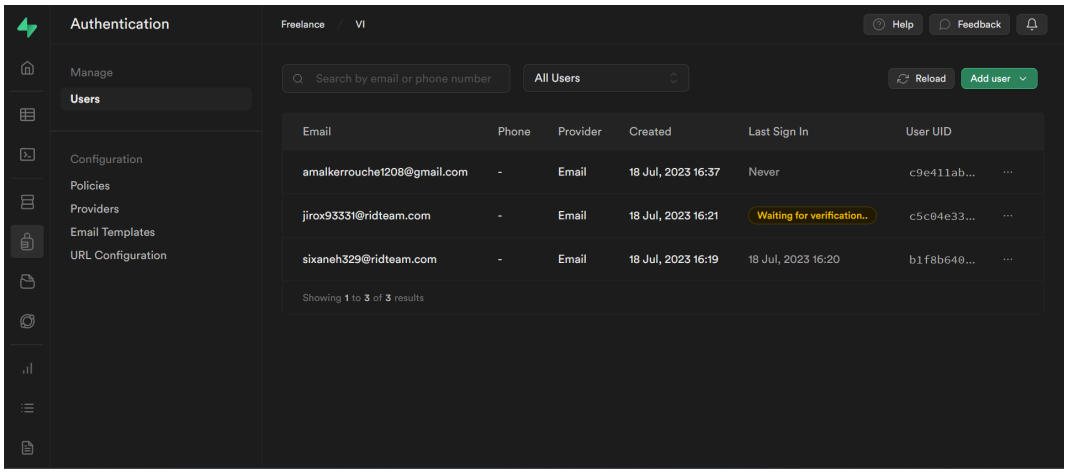


Figure 3.8: List of user profiles

Changing display parameters :

Users are invited to provide key preferences to tailor their interface appearance.

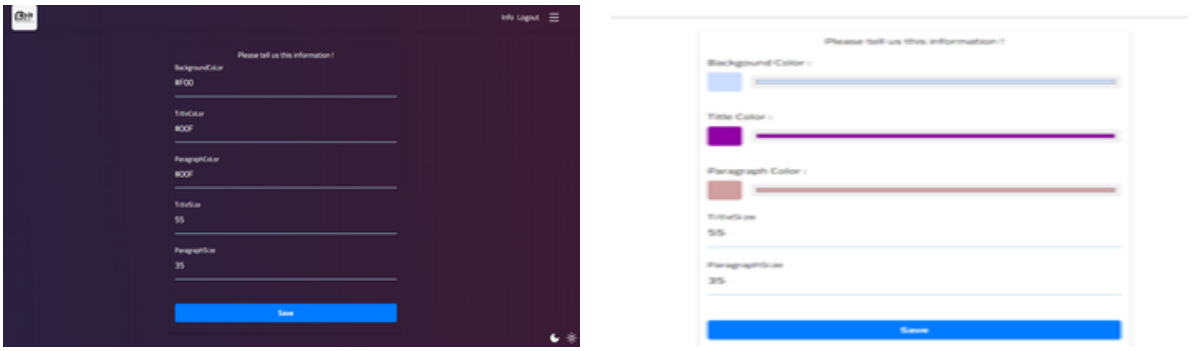


Figure 3.9: Display settings

The main page :

In this section, we explore our User Choice page, designed to empower users with three distinct options, each catering to their unique needs and preferences.

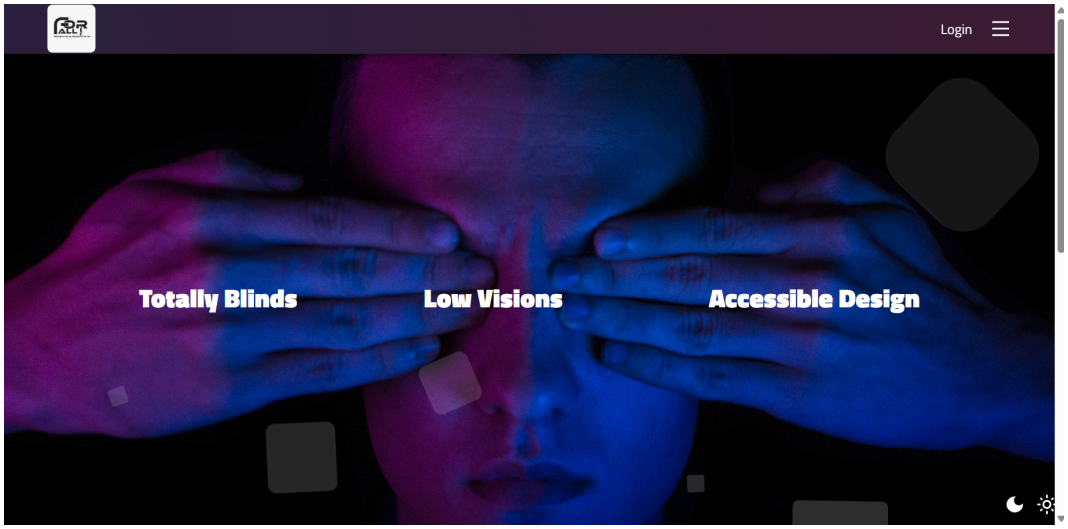
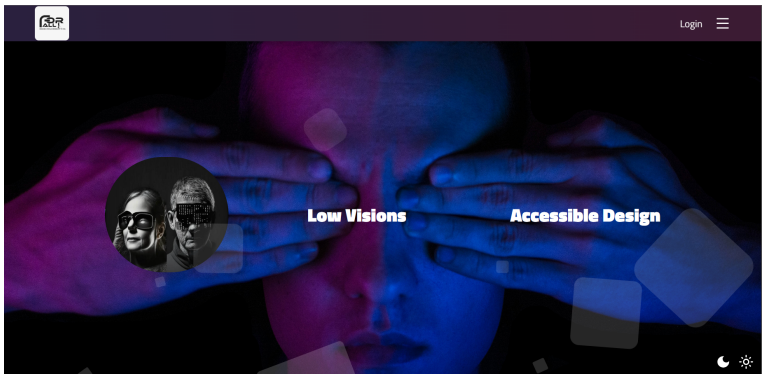
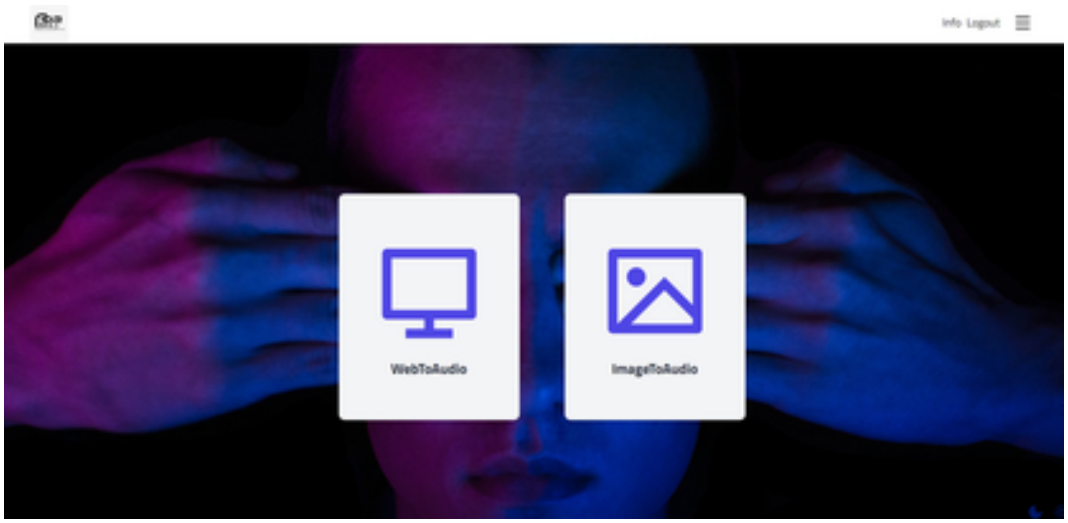


Figure 3.10: The main Page

- **Totally Blind :**



For users who are visually impaired, Option 1 offers two distinct pathways to explore:



Web to Audio :

Embrace the power of web content transformed into audio. Users can seamlessly navigate web pages through an auditory experience, enhancing accessibility and ease of use

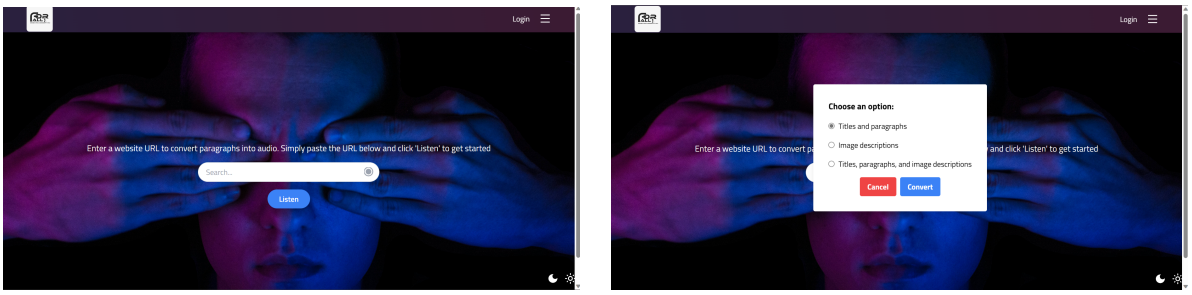
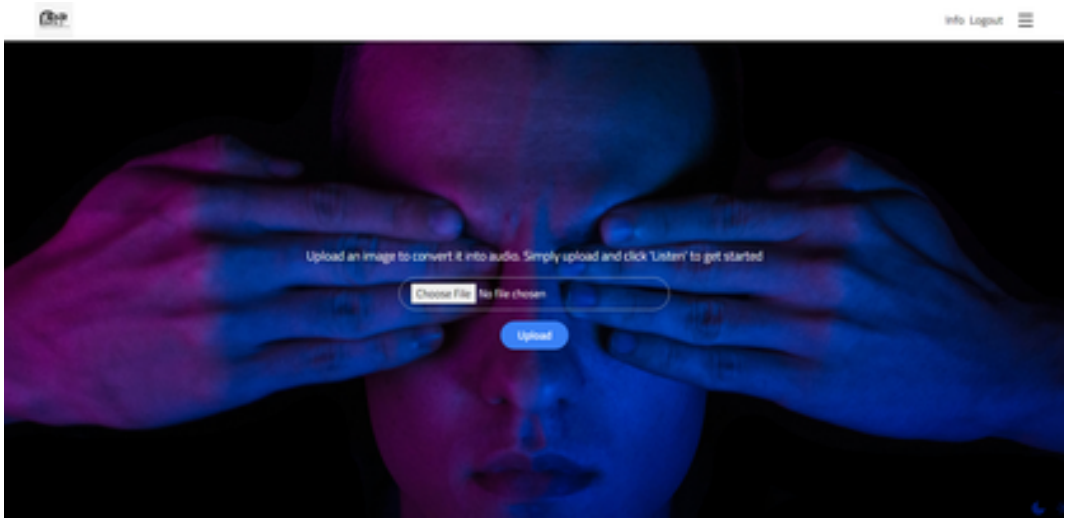


Figure 3.11: WebToAudio

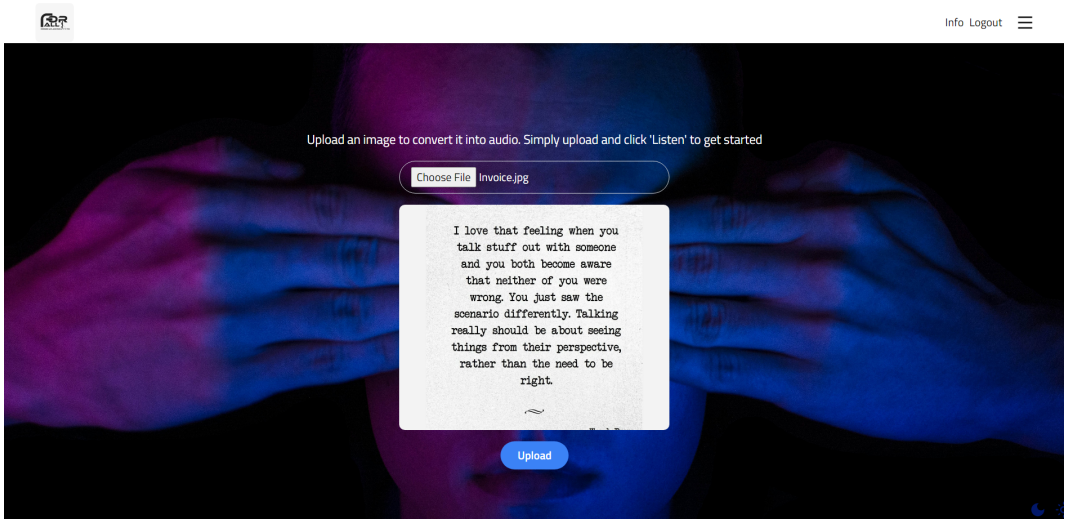
Image to Audio

Unlock the potential of images transformed into audio descriptions. With this feature, visually impaired users can gain a deeper understanding of visual content, enriching their digital interaction.

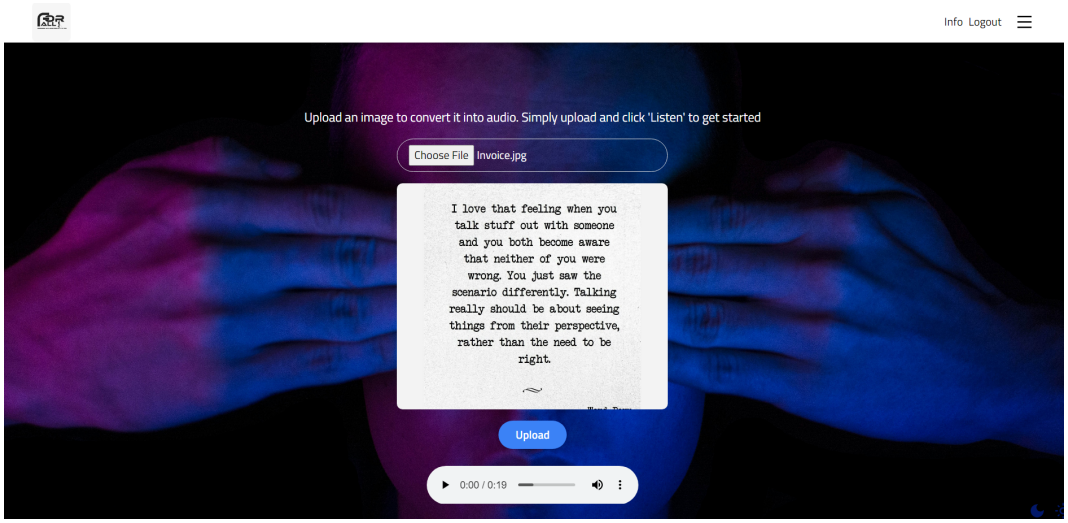
– Initially before we upload :



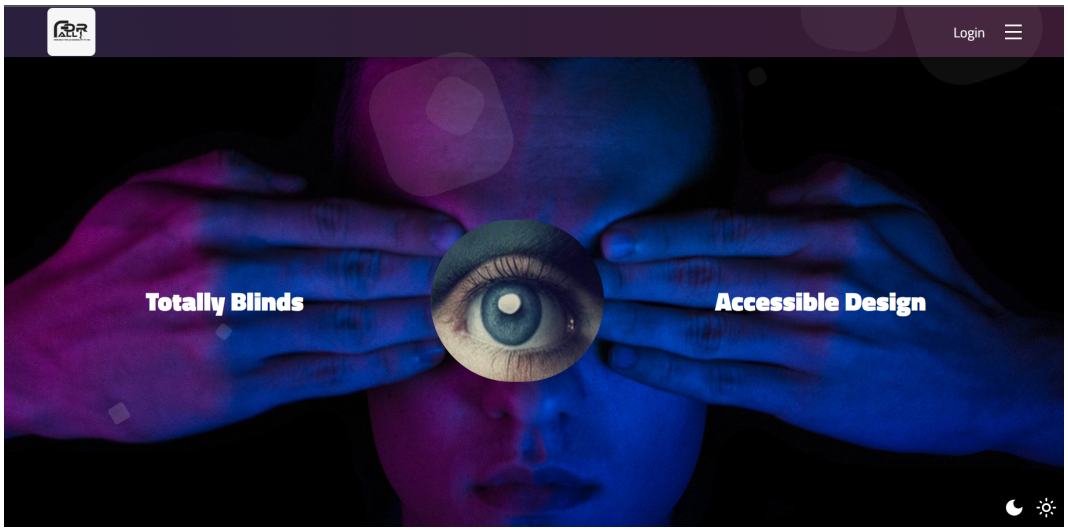
– After we selected an image :



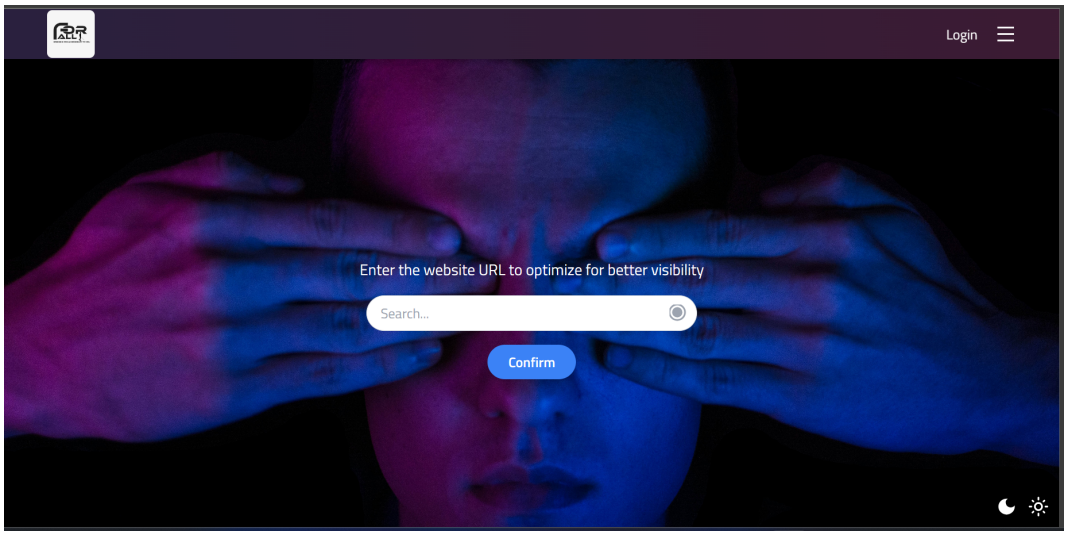
– When we click upload and the conversion is finished :



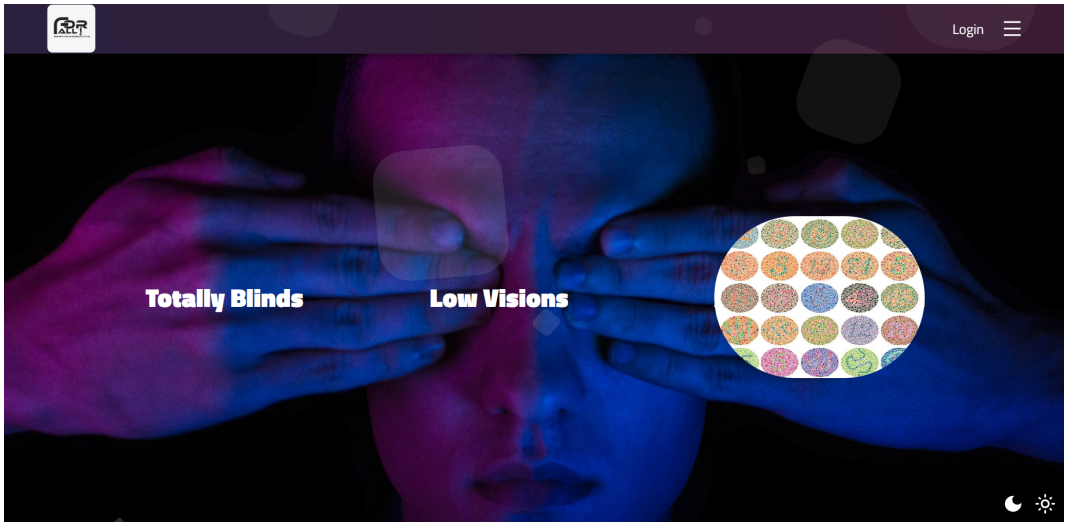
- **Low Vision :**



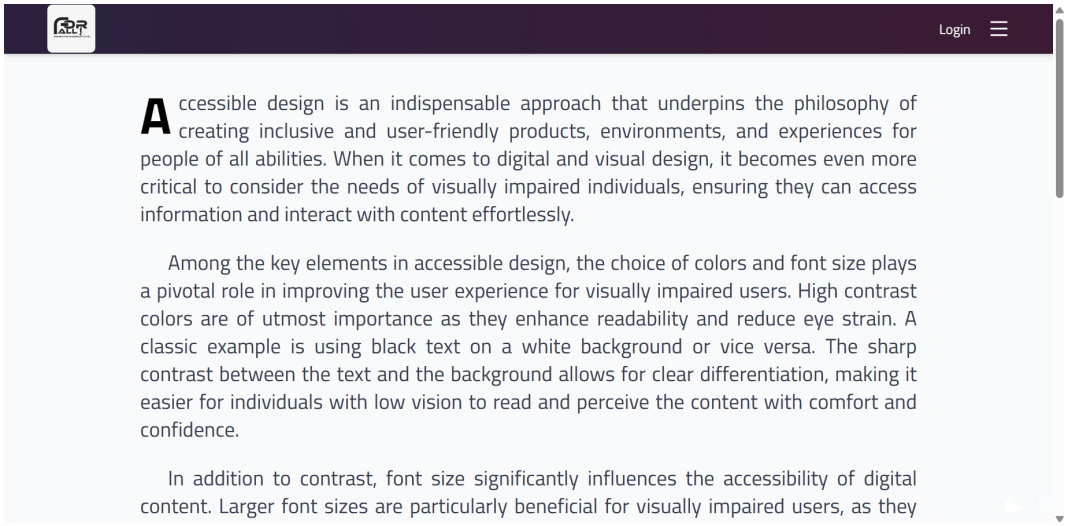
Option 2 caters to users with low vision. By inputting a URL, users can experience a personalized redesign of the web page. The redesign incorporates the user's preferred background color, title color, paragraph color, title size, and paragraph size—ensuring a visually comfortable and enjoyable browsing experience tailored to individual needs.



- **Accessible Design :**



Option 3 presents users with valuable insights into accessible design principles. Explore the importance of choosing the most useful colors and font sizes for visually impaired users. Discover how accessible design creates an inclusive and user-friendly environment, fostering a seamless digital experience for all.



3.4 Conclusion

In this chapter, we have meticulously elaborated on the development architecture and the interaction environment. Additionally, we present a series of display screens that offer an insightful preview of the web page presentation, leveraging the diverse libraries mentioned earlier.

These libraries serve as the backbone of our system, enabling us to effortlessly extract an HTML document with its associated scripts and CSS, precisely announce the distinct components of the web page, and seamlessly read the text using advanced text-to-speech synthesis techniques.

Through this comprehensive approach, we have achieved remarkable capabilities in enhancing the accessibility and user experience of our web application.

General conclusion and perspectives

The internet emerges as a tool connecting individuals to the world, provided that its accessibility is further taken into account, offering visually impaired individuals (those with low vision) access to information. Information and communication technologies (ICT) play a crucial role in the social and professional integration of people with visual impairments.

The ease of disseminating information on the web leads to a vast amount of data production. As a result, visually impaired internet users have to sift through a large volume of information to find the desired results and access the information they seek. However, their access to the desired information is often suboptimal due to various reasons, such as a lack of accessibility training, limited interest in catering to their user profiles, time constraints, and more. Hence, the role of web accessibility has emerged as a prominent and essential theme in the context of creating a website, ensuring inclusivity and equal access for all users, regardless of their abilities or disabilities.

In this work, we have addressed the issue of web accessibility for the visually impaired, as the majority of websites are neither accessible nor adapted for this segment of the population. The objective of this study is to improve the accessibility of web information for visually impaired individuals by facilitating navigation and reducing information search time. Initially, we differentiate between visually impaired individuals, including those with low vision and those who are blind, and provide specific methods for accessing web pages for each group.

To overcome the challenges of web page accessibility, we have proposed an approach to customize the content of web pages according to user preferences. Our work is the result of the study conducted in the first chapter. For individuals with low vision, who have some degree of visual clarity, we adapted the application to their preferences and provided a zoom feature to enhance their viewing experience. As for individuals who are blind, we scraped the web page's source code, analyzed and filtered it to generate an appropriate result. We utilized libraries such as beautifulsoup, as well as the pyttsx3 library, which enabled us to read the paragraphs within the web page in english, and we utulize ..... for generating the alt text for images. Visually impaired users also can extract the text within the images on web pages.

This work has successfully improved certain functionalities, such as speech synthesis, generating alt text, web page display, and navigation speed. These enhancements enable individuals

who are blind to explore web pages more efficiently without significant time loss.

This research domain has gained significant attention and has drawn the interest of the accessible web design community. However, there is still much work to be done to meet the web accessibility needs of the visually impaired population.

Due the time contraints we were unable to:

- Find a dataset specifically for the domain of web accessibility, so we choose dataset designed to be used as benchmarks for machine learning-based phishing detection systems. There is no low or rule banning web scraping, but that does not mean we can scrape everything. Some web pages detect web scraping tools, this the reasong why when we try to scrap some websites like Wikipédia, when the website detect the operation, and find it suspicious, our request get blocked.
- Generate alt text by using NLP techniques, we want to train a model on our dataset to generate accurate and descriptive alt text for a given image
- Translate the web pages content into other languages
- Do comparative study, by making comparative Study between our app and web browser for VI users such as webbIE, lynx and voxiweb ...etc. Based on the web page adaptation time, the time elapsed between the initiation of the URL search and the simplified display of the web page on the screen.

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