Challenges, Behaviour and Design Recommendations for Visually Impaired Participants (VIPs) in Accessible Shopping Experiences - A Literature Review Finding

16.12.2024

Introduction

- This presentation provides an overview of our literature study conducted to learn about challenges, and behavioural characteristics of the Visually Impaired Persons (VIPs) in everyday life, and shopping - both in-person and online
- This study also includes identifying and recording the recommendations from various researches to design an accessible shopping experiences

Defining Visual Impairment

Defining Visual Impairment

Category	From	To
Mid vision impairment	6/12	6/18
Moderate vision impairment	6/18	6/60
Severe vision impairment	6/60	3/60
Blindness	3/60	
Near vision impairment	N6 or M 0.8 at 40cm	

Table: Classification of severity of vision impairment, by WHO, based on visual acuity in the better eye

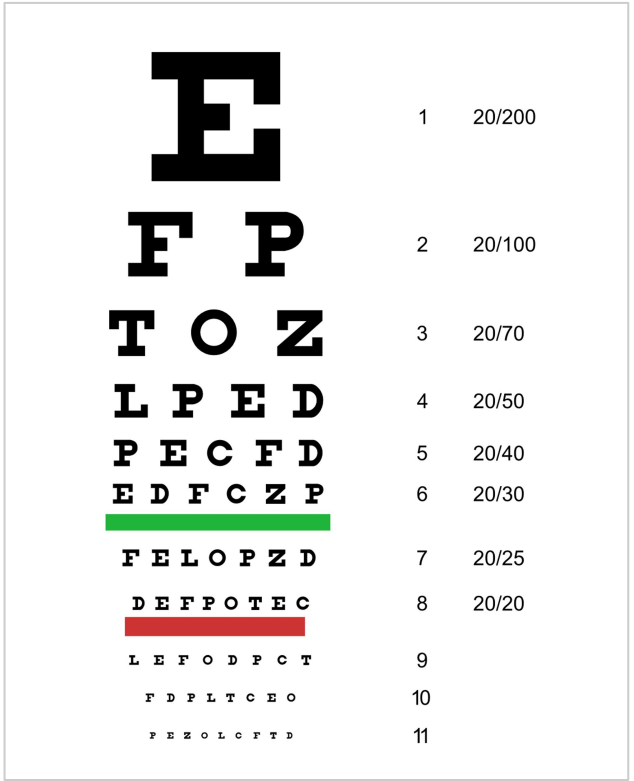

Fig: Snellen chart (a type of vision chart)

Defining Visual Impairment - Visual Acuity Testing

Start

Begin by standing or sitting about 20 feet (6 meters) away from the vision chart

Positioning

Stand or sit about 20 feet (6 meters) away from the vision chart

Read the Chart

Read aloud the **smallest** line of letters you can see clearly

Record Results

The results are recorded as a fraction

Visual Impairment Severity

As the fraction value decreases, the visual impairment becomes more severe

End

The test is complete when all steps are finished

Defining Visual Impairment - Near Vision Acuity Testing

Room Setup

Patient is seated in a well-illuminated room

Distance Setup

Handheld near vision chart is held 25–35 cm away from the eye

Variable Distance

Distance may vary depending on occupation or basic needs of the patient

Reading the Chart

Patient is asked to read the smallest text they can clearly see

Measure Near Acuity

The smallest text they can read is the measure of their near acuity

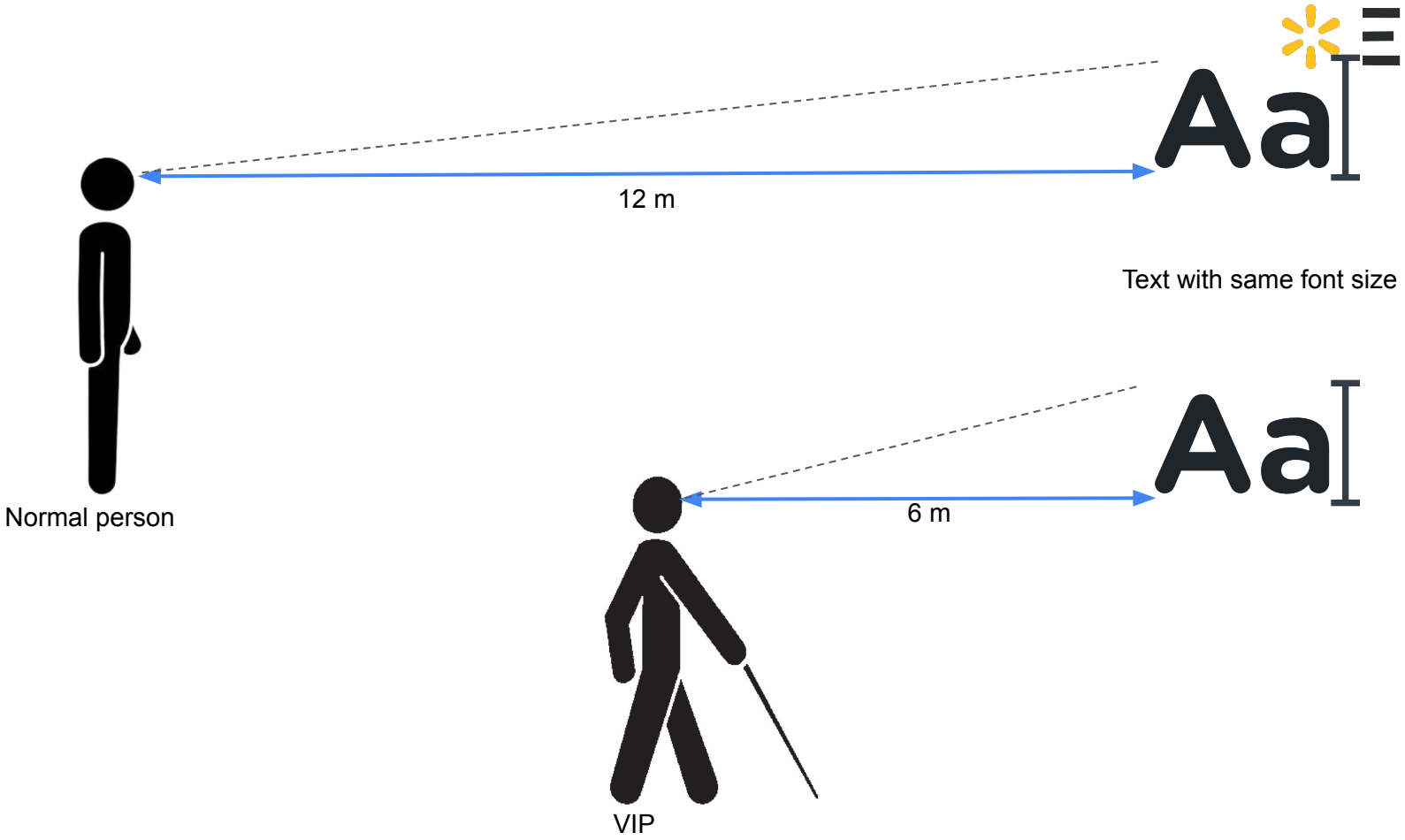

Fig: Visual illustration of 6/12 distance acuity

Better eye Best Corrected	Worse eye Best Corrected	Percent Impairment	Disability category
6/6 to 6/18	6/6 to 6/18	0%	0
	6/24 to 6/60	10%	0
	Less than 6/60 to 3/60	20%	I
	Less than 3/60 No Light Perception	30%	II (One eyed person)
6/24 to 6/60	6/24 to 6/60	40%	III a (low vision)
Or Visual field less than 40 up to 20 degree around centre of fixation or hemianopia involving macula	Less than 6/60 to 3/60	50%	III b (low vision)
	Less than 3/60 to No Light Perception	60%	III c (low vision)
Less than 6/60 to 3/60 Or Visual field less than 20 up to 10 degree around centre of fixation	Less than 6/60 to 3/60	70%	III d (low vision)
	Less than 3/60 to No Light Perception	80%	III e (low vision)
Less than 3/60 to 1/60 Or Visual field less than 10 degree around centre of fixation	Less than 3/60 to No Light Perception	90%	IV a (Blindness)
Only HMCF Only Light Perception, No Light Perception	Only HMCF Only Light Perception, No Light Perception	100%	IV b (Blindness)

Table: Guidelines for assessment of disabilities under rpwd act 2016 notified (2018). Available at https://divyangjan.depwd.gov.in/upload/uploadfiles/assessment_guidelines.pdf

Literature Study Objectives & Method

Study Objectives and Focus Areas

- The challenges faced by VIPs in everyday life
- The challenges encountered by VIPs during offline shopping
- The challenges faced by VIPs during online shopping
- The challenges faced by VIPs while shopping in virtual reality (VR)

Study Methodology

- We conducted a search in the Google Scholar using the following search strings:
  - ("challenges" OR "difficulties") AND ("blind" OR "visually impaired" OR "visual impairment")
  - ("shopping" OR "e-shopping" OR "online shopping") AND ("disability" OR "visual impairment" OR "visually impaired" OR "blind" OR "accessibility" OR "low vision")
  - ("shopping" OR "e-shopping" OR "online shopping") AND ("disability" OR "visual impairment" OR "visually impaired" OR "blind" OR "accessibility" OR "low vision") AND (“virtual reality” OR “VR”)

Methodology

- We included papers related to the topics mentioned before and reviewed a total of 15 studies, which were categorized as follows:
  - 2 papers and 1 blog post showcasing everyday challenges faced by VIPs
  - 3 studies focused on offline shopping
  - 11 studies focused on online shopping
  - 1 study focused on VR-based shopping

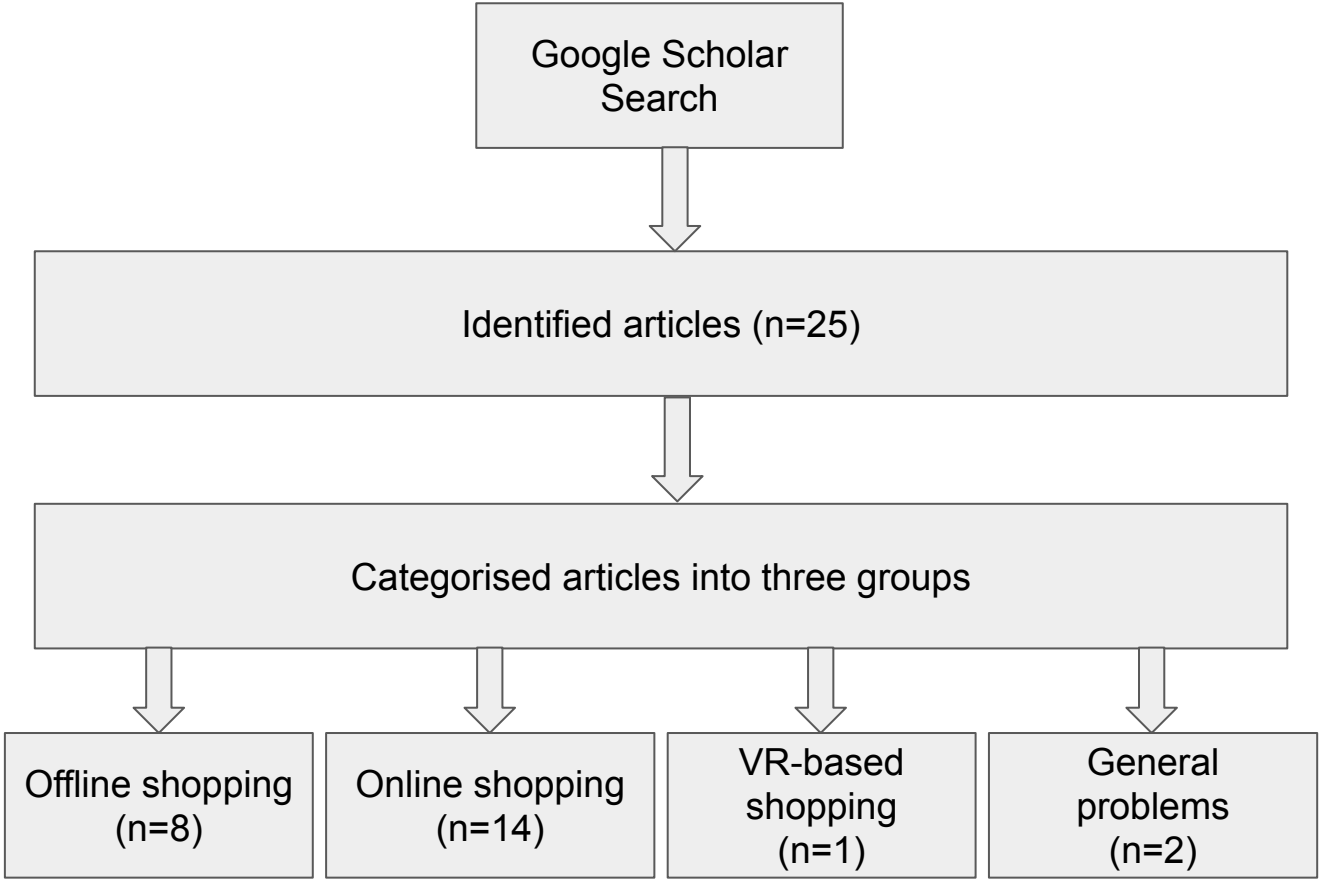

Fig: Flow chart of methodology used for literature review

Literature Study Findings
A Summary View

Offline Shopping Behaviors - A Summary

- Preparation:
  - VIP often prepare for shopping in advance by creating shopping lists
  - These lists are typically generated using Braille, audio recorders, or digital devices
- Navigation:
  - VIP use assistive tools like RFID tags, finger-worn camera, barcode reader, or smartphones for product identification
  - They prefer smartphones as assistive devices due to their familiarity and ease of use
- Post-shopping tasks:
  - VIP consider post-shopping tasks, such as organizing groceries, labeling items, and managing inventory, to be essential

Offline Shopping Challenges - A Summary

- VIP face challenges such as
  - Difficulty locating and picking items due to their similar appearances and crowded shelves
  - Difficulty in navigating stores efficiently
  - Lack of a assistive tool having comprehensive solution
  - Barcode readers that require scanning each item individually
  - Wearable devices that can be complex to use and costly
  - Limited integration of technologies for tasks like identifying low-stock items at home and organizing groceries post-shopping

Offline Shopping Recommendations - A Summary

- Assistive Technologies
  - Leverage smartphone-based systems with speech targeting, walking guidance, and picking-up guidance
  - Include hybrid systems (e.g., combining Computer Vision and RFID) for better accuracy
- Holistic Design
  - Develop solutions that cover all shopping stages, from pre-shopping tasks to post-purchase organization
  - Shift from deficit-based to strength-based designs, enhancing haptic and auditory senses
  - Use participatory design approaches involving VIP as co-designers

Online Shopping Behaviors - A Summary

- Congenitally blind people often need more assistance understanding visual aspects of the product than the acquired blind users
- VIPs often look for simple but detailed description about the product
- VIPs find audio and haptic feedback (e.g Force Feedback, Tactile Feedback, Collision Detection and Frictional Effects) to be helpful while navigating a shopping website

Online Shopping Challenges - A Summary

- Inaccessible visual content
  - Many websites and online shopping platforms fail to comply with accessibility guidelines
  - Websites often lack detailed alt-text for images
  - Descriptions of visual attributes, such as color and size, are frequently inadequate or unclear
- Navigation issues
  - Complex layouts and cluttered pages
  - Sequential screen reader navigation often limits efficiency

Online Shopping Challenges - A Summary

- Checkout barriers
  - Poorly designed payment forms create barriers to completing transactions independently
  - There is often a reliance on sighted assistance to finalize purchases

Online Shopping Recommendations - A Summary

- Enhanced Accessibility
  - Use AI to generate detailed alt-text and product descriptions
  - Simplify navigation with intuitive layouts and modular systems
  - Provide adjustable settings (e.g., text size, voice intensity) for personalized user experiences
- Assistive Systems
  - Develop voice and audio-guided shopping assistants
  - Incorporate haptic feedback for physical attributes like dimensions and textures
- User-Centric Approaches:
  - Enable user-defined settings (e.g., customizable contrast, voice preferences)
  - Provide clear instructions for tasks like checkout processes

VR Shopping Behaviors - A Summary

- Users in VR shopping environments exhibit behavior similar to that in physical stores
- VIPs may face difficulties in navigating and understanding visual-heavy interfaces
- VIPs depend heavily on auditory feedback, voice guidance, and other non-visual cues for a seamless shopping experience

VR Shopping Challenges - A Summary

- Difficulty in locating and accessing product information without visual aids can hinder VIP shopping experience
- Lack of universal design tailored for visual impairments, such as haptic feedback or voice-activated commands, creates barriers
- Most VR shopping platforms lack essential features like screen readers, voice guidance, and high-contrast settings

VR Shopping Recommendations - A Summary

- Implement auditory feedback for navigation and actions, such as reading product details or confirming selections
- Enable zooming, text enlargement, and high-contrast modes to improve usability for users with low vision
- Use vibration or tactile cues to guide users and provide interaction confirmation
- Design voice-based tutorials to familiarize users with VR controls and interfaces
- Offer intuitive navigation aids like voice commands and clear auditory signals for movement and product exploration

Literature Study - Detailed Findings

General Challenges Faced By The VIPs

Visual Challenges in the Everyday Lives of Blind People

- Contributions
  - The study examines the types of visual questions visually impaired individuals frequently encounter
  - By categorizing these needs, the authors aim to guide the development of more targeted and effective assistive technologies, including crowd-sourced solutions and automated tools

Brady E, Morris MR, Zhong Y, White S, Bigham JP. Visual challenges in the everyday lives of blind people. InProceedings of the SIGCHI conference on human factors in computing systems 2013 Apr 27 (pp. 2117-2126).

Visual Challenges in the Everyday Lives of Blind People

- Contributions
  - The authors reported on the findings of a study of visual questions that blind people would like to have answered
  - They developed a taxonomy categorizing the types of visual questions asked by VIPs (1,000 questions randomly selected from over 40,000 questions submitted by 5,329 visually impaired users)
  - Insights into how users interact with the VizWiz Social application, including their initial usage patterns, changes over time, and retention trends, are presented
  - They identified common accessibility issues of blind users
  - Based on findings, the authors provide guidelines for developing better assistive technologies that cater to the visual information needs of visually impaired individuals

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - The visual questions asked by visually impaired users were divided into four main categories : Identification, Description, Reading and Other
  - Identification:
    - No Context: Questions asking what an object is, without additional information (e.g., "What is this?").
    - Contextual: Questions seeking specific details about a known object (e.g., "Is this a diet Pepsi or regular Pepsi?").
    - Medicine: Identifying medical products (e.g., "What are these pills?").
    - Currency: Determining the denomination of money (e.g., "How much is this?").
    - Media: Identifying books, CDs, DVDs, or similar media.

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - Description:
    - Appearance: Describing physical attributes, such as someone’s looks (e.g., "How old does this man look?").
    - Color: Identifying the color of objects (e.g., "What color are the flowers?").
    - Clothing Design/Color: Describing or identifying patterns or colors in clothing (e.g., "What color is this tie?").
    - State (On/Off): Determining the state of an object (e.g., "Is this light on?").
    - Computer/TV Screen: Describing what is shown on a screen (e.g., "What is on this TV screen?").

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - Reading:
    - General Information: Reading text from documents or objects (e.g., "What does this say?").
    - Numbers: Extracting specific numerical data (e.g., "What's the thermostat set to?").
    - Digital Displays: Reading text/numbers on digital screens (e.g., "What is shown on this microwave display?").
    - Mail: Reading text from letters or envelopes (e.g., "What's written on this envelope?").
    - Cooking Instructions: Reading instructions on food packaging (e.g., "How do I cook this?").
    - Bathroom Products: Reading information from hygiene products (e.g., "Does this shampoo contain any special ingredients?").

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - Other:
    - Unanswerable: Questions that cannot be answered due to poor image quality, lack of audio, or irrelevant context.
    - Out-of-Range: Questions unrelated to the photograph or beyond the system’s capability (e.g., "Where can I buy this?").
    - About the Service: Questions regarding the VizWiz Social service itself (e.g., "Are you getting paid for this?").

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - The study identified the following common accessibility issues faced by visually impaired individuals
    - Object Identification
      - Difficulty identifying everyday objects without additional context (e.g., distinguishing between products or recognizing unfamiliar items).
    - Text and Display Reading
      - Challenges in reading text from physical objects, digital displays, or documents (e.g., instructions on food packaging, thermostat settings, or letters).
    - Color and Appearance Descriptions
      - Difficulty determining the color of objects, clothing, or surroundings.
      - Challenges in assessing personal or others' physical appearance.

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - The study identified the following common accessibility issues faced by visually impaired individuals
    - State of Objects
      - Inability to verify the operational state of devices (e.g., whether a light is on, or the settings on a control panel).
    - Cooking and Meal Preparation
      - Struggles with reading cooking instructions, identifying food items, or understanding packaging details.
    - Digital Accessibility
      - Issues with non-accessible interfaces on devices like computers, televisions, or kitchen appliances.

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - The study identified the following common accessibility issues faced by visually impaired individuals
    - Photography Quality
      - Problems with taking usable photographs, including issues like poor lighting, framing, or blurriness, which affect the ability to receive accurate assistance.
    - Urgency of Information
      - Many tasks require immediate assistance, making delays in receiving answers particularly problematic.
    - Limitations of Assistive Technology
      - Existing tools often fail to provide adequate support for subjective inquiries or complex, context-specific questions (e.g., “Does this outfit look good?”)

Visual Challenges in the Everyday Lives of Blind People

- Findings
  - Analysis of User Behavior
    - First-Time Use: Users with poor first experiences (e.g., unanswerable questions or low-quality responses) were more likely to abandon the service.
    - Power Users: Experienced users shifted from identification to reading-focused questions and improved photo quality over time.
  - Evaluation of Assistive Technology
    - Usability Issues: Common problems included poor photo quality, unclear questions, and difficulty understanding the system's functionality.
    - Answer Accuracy: Errors from crowd workers or system limitations affected user satisfaction and retention.

Visual Challenges in the Everyday Lives of Blind People

- Recommendations
  - Include tutorials and clearer instructions for using the app to reduce errors in photo-taking and question formulation
  - Develop solutions to handle common photographic issues like blur, poor lighting, and improper framing
    - Automated photo-quality checks before submission
    - The use of video or live-streaming for dynamic and interactive assistance
  - Implement better mechanisms to ensure the accuracy of answers from human workers, such as quality control or filtering out unhelpful responses.

Visual Challenges in the Everyday Lives of Blind People

- Recommendations
  - Prioritize the development of automated systems for repetitive, objective tasks like identifying objects or reading text to reduce reliance on human workers
  - Design systems to prioritize time-sensitive queries, ensuring users receive rapid assistance when urgency is critical
  - Track and analyze user interactions to understand evolving needs and tailor the system accordingly

Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review

- Contributions
  - The authors conducted a systematic review to address the challenges faced by VIP
  - The paper highlights the adaptive and maladaptive coping strategies employed by VIP

Tshuma, C., Ntombela, N. and van Wijk, H.C., 2022. Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review. Prizren Social Science Journal, 6(2), pp.71-80.

Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review

- Findings
  - The challenges faced by the VIPs are categorized into four domains:
    - Psychological Challenges
    - Social Challenges
    - Physical Challenges
    - Environmental Challenges

Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review

- Findings
  - Psychological Challenges:
    - High prevalence of depression, low self-esteem, and emotional trauma.
    - Feelings of dependency, loss of freedom, and impaired self-worth.
    - Increased psychological distress as vision loss severity increases.
  - Social Challenges
    - Social exclusion due to stigmatization and discrimination.
    - Difficulty in forming relationships because of the loss of non-verbal communication cues.
    - Experiences of loneliness and isolation, often exacerbated by societal ignorance and lack of awareness.

Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review

- Findings
  - Physical Challenges:
    - Frequent falls, injuries, and reduced mobility due to inaccessible environments.
    - Difficulty performing daily activities like cooking (navigating spaces and identifying items safely), cleaning, and commuting.
    - Barriers in public spaces, such as unreadable signs, inaudible announcements, and poorly designed infrastructure.
  - Environmental Challenges
    - High unemployment rates and workplace discrimination.
    - Lack of assistive technology adoption and workplace accommodations.
    - Financial struggles and insufficient access to healthcare and education.

Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review

- Findings
  - Coping strategies of adult VIPs
    - Reflective Coping: Engaging in thoughtful and optimistic approaches to manage challenges. Strategic planning and meaning-making.
    - Avoidance Coping: Temporarily distancing oneself from the problem when it feels overwhelming.
    - Family and Community Support: Utilizing help from family, friends, faith-based organizations, and social clubs.
    - Spirituality and Religion: Relying on faith, spiritual values, and meaning-making to cope with loss.
    - Strategic Planning: Breaking problems into manageable components.
    - Optimism: Maintaining a positive outlook to adapt to challenges.
    - Substance abuse: Alcohol and other substances used as a coping mechanism in some cases.

Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review

- Findings
  - Coping strategies of adult VIPs
    - Acceptance: Self-acceptance and adjustment through family and social support.
    - Rehabilitation Services: Using available training and services for better coping.
    - Support Groups: Participating in groups for shared experiences and guidance.
    - Counseling: Seeking professional help to address emotional challenges.
  - Interconnected Nature of Challenges and Coping
    - Challenges across domains (psychological, social, physical, and environmental) are interlinked, often amplifying one another. For example, reduced mobility leads to social isolation and impacts mental health.
    - Effective coping strategies depend on access to resources, family support, financial stability, and societal inclusion.

Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review

- Findings
  - Role of Support Systems:
    - Family acceptance and societal support significantly impact the coping ability of VIP.
    - Inclusive policies, improved infrastructure, and access to assistive technology can alleviate challenges and improve quality of life.

Common Problems Faced by Visually Impaired Individuals and How to Address Them

- The challenges faced by visually impaired individuals can significantly impact their independence and participation in society.
- Challenges faced by VIPs and the solutions are as follows:
  - Navigating Physical Environments
    - Challenge: Difficulty moving through crowded, unfamiliar places and identifying obstacles.
    - Solution: Incorporate tactile paving, audible signals, braille signage, and tactile maps to improve navigation.

Puneblindschool, 2024. Challenges and Coping Strategies of the visually impaired adults: a brief exploratory systematic literature review. Blog URL: https://www.puneblindschool.org/blogs/common-problems-faced-by-visually-impaired-individuals.

Common Problems Faced by Visually Impaired Individuals and How to Address Them

- Challenges faced by VIPs and the solutions are as follows:
  - Accessing Printed Information
    - Challenge: Inability to access traditional printed materials.
    - Solution: Provide content in braille, large print, audio, and digital formats compatible with screen readers
  - Using Public Transportation
    - Challenge: Identifying schedules, stops, and navigating platforms safely.
    - Solution: Use audio announcements, braille signage, tactile maps, and accessible apps for real-time updates.

Common Problems Faced by Visually Impaired Individuals and How to Address Them

- Challenges faced by VIPs and the solutions are as follows:
  - Accessing Digital Information
    - Challenge: Lack of accessibility features in digital devices and interfaces.
    - Solution: Ensure WCAG compliance, screen reader compatibility, and offer customizable display settings.
  - Participating in Education
    - Challenge: Limited access to educational materials and visual teaching aids.
    - Solution: Use accessible formats (braille, audio, digital), assistive technologies, and inclusive teaching methods.

Common Problems Faced by Visually Impaired Individuals and How to Address Them

- Challenges faced by VIPs and the solutions are as follows:
    - Social Inclusion and Communication
        - Challenge: Barriers due to non-verbal cues and inaccessible social settings.
        - Solution: Promote disability awareness, offer communication aids, and create inclusive social events.
    - Broader Solutions:
        - Awareness and Training: Educate the public and train professionals to assist visually impaired individuals effectively.
        - Accessible Infrastructure: Design spaces and systems that cater to diverse needs, ensuring independence and safety.
        - Technological Advancements: Leverage innovations in assistive devices and accessibility tools to bridge gaps in daily activities.

Offline Shopping For VIPs

MobiEye: An Efficient Shopping-Assistance System for the Visually Impaired With Mobile Phone Sensing

- Challenges Addressed
  - VIP struggle to locate and pick items from crowded shelves or the similar-looking products
  - Existing assistance systems are time-consuming (e.g. taking photos from finger-worn camera or barcode reader requires individuals to scan each item individually) for identifying multiple items
  - VIP require systems that offer timely and responsive guidance during shopping
  - VIP struggle with using complex wearable devices

Wang, Z., Guo, B., Wang, Q., Zhang, D. and Yu, Z., 2023. MobiEye: An Efficient Shopping-Assistance System for the Visually Impaired With Mobile Phone Sensing. *IEEE Transactions on Human-Machine Systems*.

MobiEye: An Efficient Shopping-Assistance System for the Visually Impaired With Mobile Phone Sensing

- Contributions
  - Interviewed VIP shoppers, identified their core needs at different shopping stages (8 users partial to total blindness)
  - They found the main issue to be efficiently locating the target commodity at the front of the shelf
  - They also found that the smartphones are more preferred due to their familiarity, cost effectiveness and compatibility with the screen readers
  - Developed “*MobiEye*”, a shopping-assistance system with three key modules: speech targeting, walking guidance, and picking-up guidance
  - They proposed an adaptive mobile-edge computing model to balance real-time video analysis with resource constraints

MobiEye: An Efficient Shopping-Assistance System for the Visually Impaired With Mobile Phone Sensing

- Contributions
  - Speech Targeting: Identifies items from spoken commands
    - Used iFLYTEK to capture speech information and convert it to text
    - Built a corpus with commodity's official names, colloquialisms, and abbreviations
  - Walking Guidance: Directs users to the item using real-time recognition and distance calculation
    - Used YoloV5 as the recognition model
    - Used the similar triangle method for distance calculation
    - System directs VIP shoppers to continue walking until the target commodity is found, then prompts them to stop at the right distance to pick it up

MobiEye: An Efficient Shopping-Assistance System for the Visually Impaired With Mobile Phone Sensing

- Contributions
  - Picking-Up Guidance: Tracks hand movements and provides feedback to help users grab the product in real time
    - Used Yolov5 network and the MediaPipe framework for commodity recognition and hand tracking
    - Proposed two methods for pick up: straight line and folding line

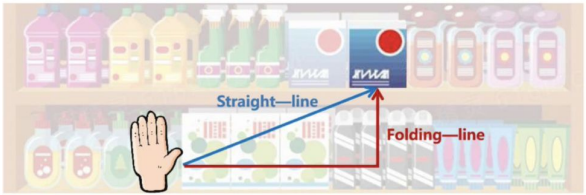

Fig: Proposed pickup methods

MobiEye: An Efficient Shopping-Assistance System for the Visually Impaired With Mobile Phone Sensing

- Contributions
  - Dense commodities placement
    - MobiEye identifies the optimal target commodity in crowded settings based on its placement
    - The system selects the commodity placed at the top of the stack to guide the user, preventing accidental knocks or falling items
    - The middle item in the group is chosen to avoid mistakenly picking adjacent non-target items
    - When the user’s hand overlaps 80% with the target item, the system alerts them that they have reached the correct item, minimizing errors in dense and crowded shelves
    - The system incorporates an occlusion inference algorithm that assesses whether the user’s hand obscures multiple items

MobiEye: An Efficient Shopping-Assistance System for the Visually Impaired With Mobile Phone Sensing

- Findings
  - *MobiEye* helps VIP shoppers pick items faster and more accurately as compared to VIP without assistant and VIP with Photo Recognition systems, especially in crowded shelves
  - Fewer errors and higher success rate in retrieving items compared to existing systems
  - VIP participants preferred using smartphones over wearable devices for shopping assistance
  - They found the folding-line method to be faster and required fewer voice prompts than the straight-line method
    - The folding-line method breaks the path into smaller, manageable segments, guiding the user step-by-step in a zigzag or segmented manner.
    - This reduces the need for precise angle judgment, making it easier for users to follow

Innovative ecosystem for informing visual impaired person in smart shopping environment: InnIoTShop

- Challenges
  - VIPs face significant challenges in grocery shopping due to limited spatial perception and orientation in a store without personal assistance.
  - Current solutions often only provide product identification through reading labels or tags, without facilitating navigation, obstacle detection (compromising user safety and independence), or contextual information.
  - The existing technologies and services are fragmented, focusing on individual aspects like product identification or navigation but not providing a comprehensive system that supports the entire shopping process.

Periša, M., Peraković, D., Cvitić, I. and Krstić, M., 2022. Innovative ecosystem for informing visual impaired person in smart shopping environment: InnIoTShop. *Wireless networks*, *28*(1), pp.469-479.

Innovative ecosystem for informing visual impaired person in smart shopping environment: InnIoTShop

- Contributions
  - Proposed a conceptual system architecture based on IoT to deliver real-time information and navigation assistance to VIPs in a smart shopping environment.
  - Defined a taxonomy for the service, encompassing perception, communication, data processing, and application layers to structure the smart store ecosystem.
  - Conducted surveys and interviews with visually impaired users (17 blind, 17 low vision) to identify specific needs, shopping behavior, and preferences for information presentation (e.g., audio, vibration, or visual cues).
  - Developed and tested a prototype of a smart cart equipped with sensors for obstacle detection, product identification, haptic feedback, and indoor navigation.

Innovative ecosystem for informing visual impaired person in smart shopping environment: InnIoTShop

- Findings
  - Survey results showed that 46% of respondents preferred sound feedback, 33% preferred enlarged text, and 21% preferred vibration-based feedback during shopping.
  - Existing solutions, such as smart canes and mobile applications like TapTapSee and BeMyEyes, do not provide comprehensive navigation or real-time product information, limiting their effectiveness in shopping environments.
  - The system enabled real-time user guidance, obstacle avoidance, and provision of hazard notifications, ensuring safety and ease of navigation in a smart store environment.
  - The IoT-based architecture, utilizing Fog and Cloud computing, successfully processed and fused data in real time, enabling seamless interaction between the smart store ecosystem and users.

Research on the Visually Impaired Individuals Shopping with Artificial Intelligence Image Recognition Assistance

- Challenge
  - VIPs face significant challenges when shopping independently due to their inability to acquire product information visually.
    - This forces them to rely on companions or store guides, which may not always be available.
  - The VIPs cannot easily access details such as product composition, price, and expiration dates.
    - This often leads to purchasing incorrect items or missing important information like nutritional details

Feng, C.H., Hsieh, J.Y., Hung, Y.H., Chen, C.J. and Chen, C.H., 2020. Research on the visually impaired individuals shopping with artificial intelligence image recognition assistance. In *Universal Access in Human-Computer Interaction. Applications and Practice: 14th International Conference, UAHCI 2020, Held as Part of the 22nd HCI International Conference, HCII 2020, Copenhagen, Denmark, July 19–24, 2020, Proceedings, Part II 22* (pp. 518-531). Springer International Publishing.

Research on the Visually Impaired Individuals Shopping with Artificial Intelligence Image Recognition Assistance

- Challenge
  - Reliance on others for assistance creates psychological stress and imposes social burdens, such as feelings of dependency and discomfort in asking for repeated help.
  - Existing assistive devices and solutions often have limitations in accuracy, usability, and adaptability, failing to fully meet the needs of visually impaired shoppers.

Research on the Visually Impaired Individuals Shopping with Artificial Intelligence Image Recognition Assistance

- Contributions
  - The researchers designed and implemented an assistive shopping device that combines AI and IoT technologies.
  - This device uses Convolutional Neural Networks (CNNs) for accurate image recognition and provides audio feedback on product details like name, composition, price, and expiration date.
  - The study curated a dataset of 1,329 product images, specifically designed to train the AI model for recognizing products commonly used by VIPs. This dataset was optimized through iterative training to improve accuracy.

Research on the Visually Impaired Individuals Shopping with Artificial Intelligence Image Recognition Assistance

- Contributions
  - The research evaluated the device's performance across three shopping scenarios—self-shopping, accompanied shopping, and device-assisted shopping—using metrics like shopping time, product identification accuracy, and user satisfaction.
  - The authors integrated hardware components, including a camera, Bluetooth headset, to create a practical and accessible device for real-world use by VIPs.
  - The study conducted experiments to compare the device-assisted shopping model against traditional methods (self-shopping, accompanied shopping), demonstrating its ability to significantly enhance shopping accuracy and autonomy for VIPs.

Research on the Visually Impaired Individuals Shopping with Artificial Intelligence Image Recognition Assistance

- Findings
  - The device-assisted shopping model achieved a high accuracy rate of 90.25%.
  - Accompanied shopping had the highest accuracy at 97.25%, while self-shopping had the lowest accuracy at 39%.
  - Women performed better than men across all models, with higher accuracy rates in both self-shopping and device-assisted shopping scenarios.
  - Device-assisted shopping required the longest average time (377.86 seconds) due to the time spent on product recognition and audio feedback.
  - Accompanied shopping took an average of 208.95 seconds.
  - Self-shopping was the quickest (204.71 seconds) but at the cost of lower accuracy.

Research on the Visually Impaired Individuals Shopping with Artificial Intelligence Image Recognition Assistance

- Findings
  - The device's product information audio extensiveness received the highest satisfaction score (4.5/5).
  - The device was considered effective for assisting shopping. However, issues such as lighting conditions, camera angles, and recognition errors in similar-looking products (e.g., black tea vs. milk tea) were noted.
  - Gender differences were significant in accuracy. Women outperformed men, likely due to familiarity with specific product categories such as personal care items.
  - The device-assisted shopping model was highly effective in enhancing the autonomy of VIPs, offering a substantial improvement in accuracy compared to self-shopping, though accompanied shopping remained marginally more effective in certain metrics.

Making Shopping Easy for People with Visual Impairment Using Mobile Assistive Technologies

- Challenges Addressed
  - Limited research has been conducted on the use of MAT to assist people with visual impairment in shopping
- Contributions
  - Reviewed 44 research papers to address the following questions:
    - What are the main categories of MAT shopping solutions for VIP?
    - What are the strengths and weaknesses of the latest MAT shopping help systems for VIP?
    - What capabilities do the best and most effective solution for VIP give?

Elgendy, M., Sik-Lanyi, C. and Kelemen, A., 2019. Making shopping easy for people with visual impairment using mobile assistive technologies. *Applied Sciences*, *9*(6), p.1061.

Making Shopping Easy for People with Visual Impairment Using Mobile Assistive Technologies

- Contributions
  - Identifies and categorizes various MAT shopping solutions, including their strengths and weaknesses
  - Shopping Preparation:
    - Most VIP prefer to follow a predetermined list
    - It is essential to help VIP prepare and store shopping lists in a database.
    - Technologies such as Optical Character Recognition (OCR), Speech-to-Text (STT), or Braille transcription are used to achieve it

Making Shopping Easy for People with Visual Impairment Using Mobile Assistive Technologies

- Contributions
  - Navigation and Product Identification
    - It is challenging for VIP to navigate inside shops and to reach and identify products
    - Tag-based Systems (e.g., RFID, NFC): Use wireless communication for navigation and product identification
    - Computer Vision (CV)-based Systems: Includes tag-based (QR codes, barcodes) and non-tag-based (object recognition via cameras) systems
    - Hybrid Systems: Combine different technologies (e.g., CV and RFID) to improve performance and accuracy

Category	Strengths	Weaknesses
Tag-Based Systems	VIP can read multiple tags simultaneously.	Requires infrastructure (e.g., tags and sensors). Limited to stores that have implemented the system
	Quick and accurate identification of items	RFID tags need regular maintenance
	Can provide additional information about products	VIP must have an NFC-equipped mobile
Computer Vision (CV) Based Systems	Cost-effective as they rely on existing smartphone cameras	Performance may suffer due to variable environmental conditions (lighting, motion blur)
	Can provide real-time visual information	May require extensive computational power
	No need for special hardware, making it more accessible	Feedback latency can be a barrier in practical use
	Versatile, as they can recognize a wide range of visual items	VIP may struggle with taking high-quality photos
Hybrid Systems	Combines strengths of multiple technologies for improved accuracy and usability	Complex implementation due to reliance on multiple technologies
	Improved accuracy, robustness, usability and performance	Increased infrastructure and operational cost
		User training may be needed for optimal use
Shopping List Preparation Tools	It makes easy for users to buy from a list	Assumes that VIP already knows what they wish to buy on their trip
		Shopping is not composed of simply purchasing a set of items on a list
		It is hard for VIP to make image good quality pictures

Table: Strengths and weaknesses of different MAT solutions used for accessible shopping

Constructing a holistic view of shopping with people with visual impairment: a participatory design approach

- Challenges
  - Difficulties faced by the VIPs in managing pre and post grocery shopping tasks,
    - Identifying low-stock items at home
      - Confusion in distinguishing products of similar size, shape or packaging
      - Keeping track of current stock levels is difficult due to the lack of effective tools for visually impaired users
      - Braille label, audio recorder, barcode scanners: cumbersome and time-consuming
      - Some items do not come with a barcode
      - Information like expiration date or ingredients that are not included in the database

Yuan, C.W., Hanrahan, B.V., Lee, S., Rosson, M.B. and Carroll, J.M., 2019. Constructing a holistic view of shopping with people with visual impairment: a participatory design approach. *Universal Access in the Information Society*, *18*, pp.127-140.

Constructing a holistic view of shopping with people with visual impairment: a participatory design approach

- Challenges
  - Difficulties faced by the VIPs in managing pre and post grocery shopping tasks,
    - Itemization and documentation
      - Documenting a clear list requires switching back and forth between braille and writing systems
      - A predefined shopping list restricts the shopper to only purchasing items on the list, preventing exploration of new products or brands
      - A mix of tools like braille, pen and paper, personal computer, mobile phone, voice recorders is used to complete the task: cumbersome and time-consuming

Constructing a holistic view of shopping with people with visual impairment: a participatory design approach

- Challenges
  - Difficulties faced by the VIPs in managing pre and post grocery shopping tasks,
    - Organizing groceries
      - A lot of efforts and strategies need to be put in re-labeling products so as to prepare for next shopping, which often requires significant cognitive effort
      - Failure to label properly can lead to dangerous mistakes, such as confusing dish detergent for cooking oil
        - Strategies include sensory identification (e.g., smell for spices), making tactile markings on packaging, and using braille labels or audio tags
      - Maintaining consistency in storage is essential but can be disrupted by others in shared living spaces
      - Organizing items so they are easy to locate and retrieve during daily use

Constructing a holistic view of shopping with people with visual impairment: a participatory design approach

- Challenges
  - Traditional research overlooks shopping activities beyond in-store tasks (e.g., meal planning, pantry organization)
  - The need to shift the perspective from treating VIP as "users with deficits" to empowering them as active contributors with unique strengths

Constructing a holistic view of shopping with people with visual impairment: a participatory design approach

- Contributions
  - Engaged VIP (n=5) in a year-long participatory design process to better understand their lived experiences and integrate their insights into assistive technology design
  - Investigates the broad challenges VIP face in grocery shopping
  - Investigated how current technologies have been appropriated
  - Authors suggested design directions for future work

Constructing a holistic view of shopping with people with visual impairment: a participatory design approach

- Findings
  - Pre and post shopping tasks are just as important as in-store navigation and require more attention in assistive technology
  - Current tools are fragmented and lack integration
  - VIP adopt assistive technologies like barcode readers and braille labels but face challenges with tasks like identifying produce’s freshness or expiration dates
  - Existing tools often rely on incomplete databases, limiting access to new product information

Constructing a holistic view of shopping with people with visual impairment: a participatory design approach

- Findings
  - Most tools focus on vision-related challenges while neglecting other senses like touch and smell.
  - Authors recommend to integrate technologies to support all shopping stages, from planning to organizing groceries.
  - Authors recommend a shift from deficit-based design (fixing what VIP lack) to strength-based design (enhancing existing skills)
    - Leverage VIP strengths like acute haptic and auditory senses for navigation and product identification
  - Authors encourage participatory design approach as they empowers VIP to contribute as co-designers, leading to meaningful and effective solutions

Food shopping, sensory determinants of food choice and meal preparation by visually impaired people. Obstacles and expectations in daily food experiences

- Challenges
  - Research regarding the impact of visual impairment on the ability of a person to choose food and to prepare meals is scarce

Kostyra, E., Żakowska-Biemans, S., Śniegocka, K. and Piotrowska, A., 2017. Food shopping, sensory determinants of food choice and meal preparation by visually impaired people. Obstacles and expectations in daily food experiences. *Appetite*, *113*, pp.14-22.

Food shopping, sensory determinants of food choice and meal preparation by visually impaired people. Obstacles and expectations in daily food experiences

- Contributions
  - They identified specific obstacles faced by visually impaired individuals during food shopping, meal preparation, and dining out, such as limited accessibility in stores, difficulty with sensory evaluation, and lack of adaptive kitchen tools.
  - They analyzed how sensory attributes (e.g., freshness, texture, and taste) influence the food choices of visually impaired people and highlighted differences compared to sighted individuals.
  - The study outlined practical solutions to improve accessibility, including the use of Braille labels, electronic label readers, consistent product placement in stores, and adaptive kitchen equipment like voice-enabled devices and electric peelers.

Food shopping, sensory determinants of food choice and meal preparation by visually impaired people. Obstacles and expectations in daily food experiences

- Contributions
  - The authors provided insights into the importance of Braille menus, supportive staff behavior, and guide-dog-friendly environments to enhance dining experiences.
  - They proposed actionable recommendations for retailers, food producers, and policymakers to make food-related environments more inclusive and supportive for visually impaired individuals.
  - Using a sample of 250 VIPs (41.6% blind, 22.8% sense of light, 15.2% could see a very little), the study provided empirical data to inform both public and private sector efforts to address the needs of this community.

Food shopping, sensory determinants of food choice and meal preparation by visually impaired people. Obstacles and expectations in daily food experiences

- Findings
  - Most VIPs shop at supermarkets, followed by local grocery stores. A significant number also prefer online shopping for its convenience and accessibility.
  - Challenges include difficulty in finding products on shelves, reading labels, and evaluating sensory attributes.
  - Assistance from family members, friends, or store staff is often necessary, but delays in receiving help from sales staff can make shopping time-consuming and frustrating.
  - Price is the most significant factor influencing food choice (92.7%), followed by brand loyalty (64.8%), sensory properties like taste and flavor (58.7%), and nutritional value (36.4%).
  - Most VIPs prefer buying the same brand repeatedly due to limited access to product information.

Food shopping, sensory determinants of food choice and meal preparation by visually impaired people. Obstacles and expectations in daily food experiences

- Findings
  - Freshness and texture are important for fruits, vegetables, and bread.
  - Taste and odor are critical factors for fruit juices, dairy products, and meat. Fat content is particularly important for meat.
  - Tasks like peeling vegetables (82.1%), frying (72%), and slicing (42.3%) are the most difficult for visually impaired individuals.
  - Despite challenges, 49.6% prepare meals independently, though many rely on ready-to-eat or pre-packaged items.
  - Dining out is a common activity, with the most frequent venues being family/friends' homes, snack bars, and restaurants.

Food shopping, sensory determinants of food choice and meal preparation by visually impaired people. Obstacles and expectations in daily food experiences

- Findings
  - Helpful staff and Braille menus significantly enhance the dining experience.
  - Key recommendations include Braille labeling, label readers, larger fonts on products, consistent product placement in stores, and adaptive kitchen tools like electric peelers and voice-assisted devices.
  - Access to online shopping is also recognized as an important enabler of independence.

BlindShopping: Enabling Accessible Shopping for Visually Impaired People through Mobile Technologies

- Challenges addressed
  - VIPs struggle to shop independently in supermarkets without assistance.
  - Ensuring minimal changes and costs for supermarkets by using off-the-shelf technologies like smartphones and RFID readers.
  - Maintaining the conventional shopping experience (close to sighted users) for visually impaired users, supporting both planned and opportunistic (exploration) shopping.
  - Designing a cost-effective and portable solution that integrates with familiar tools for visually impaired individuals, such as white canes and mobile devices

López-de-Ipiña, D., Lorido, T. and López, U., 2011. Blindshopping: enabling accessible shopping for visually impaired people through mobile technologies. In *Toward Useful Services for Elderly and People with Disabilities: 9th International Conference on Smart Homes and Health Telematics, ICOST 2011, Montreal, Canada, June 20-22, 2011. Proceedings 9* (pp. 266-270). Springer Berlin Heidelberg.

BlindShopping: Enabling Accessible Shopping for Visually Impaired People through Mobile Technologies

- Contributions:
  - A navigation component combining an RFID reader attached to a white cane with mobile technology to guide visually impaired users through supermarkets using verbal instructions.
  - Implemented a product recognition system using embossed QR codes on product shelves, which can be scanned using a smartphone camera to identify products and provide details audibly.
  - Web-based management platform to configure and maintain the system, including the generation and mapping of RFID tags on the supermarket floor and QR codes on shelves.

BlindShopping: Enabling Accessible Shopping for Visually Impaired People through Mobile Technologies

- Contributions
  - A focus on affordability and practicality by leveraging off-the-shelf technologies (eliminating the need for specialized, costly devices) without requiring major infrastructural changes in supermarkets
  - Support for mixed shopping behavior (both planned and opportunistic) to maintain an enjoyable and conventional shopping experience for visually impaired users
  - The authors conducted a basic usability evaluation of their BlindShopping system with a blind individual.
    - The user navigated through different sections of a simulated supermarket using the white cane with an attached RFID reader and the smartphone application. She tested both UPC code and QR code

BlindShopping: Enabling Accessible Shopping for Visually Impaired People through Mobile Technologies

- Findings
  - The navigation process was found to be intuitive. Locating RFID tag markings on the floor was easy. Verbal navigation commands were considered helpful and effective in reaching the desired targets.
  - The user found QR code recognition with the smartphone camera to be more plausible, faster, and reliable than using the barcode scanner. The QR code method was judged as more efficient for real-world use.

Online Shopping For VIPs

All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users

- Challenges
  - E-commerce websites typically spread product-related information (e.g., descriptions, specifications, reviews) across multiple sections and pages, making navigation cumbersome for blind users dependent on screen readers.
  - Blind users face difficulties due to the linear navigation model of screen readers, which requires sequential processing of extensive text to find specific information.
  - Current solutions mainly enable quick navigation to the beginning of specific segments but do not simplify accessing detailed content within those segments or across multiple pages.

Prakash, Y., Nayak, A.K., Sunkara, M., Jayarathna, S., Lee, H.N. and Ashok, V., 2024. All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users. *Proceedings of the ACM on Human-Computer Interaction*, *8*(EICS), pp.1-25.

All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users

- Challenges
  - Gathering and retaining information from different sections and pages to compare products is labor-intensive, leading to frustration and interaction fatigue.
  - Previous research primarily focuses on improving navigation within single web pages, with minimal support for content spread across multiple pages.

All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users

- Contributions
  - Authors designed and implemented InstaFetch, a browser extension that provides a unified, screen-reader-friendly interface to aggregate product-related information (descriptions, specifications, and reviews) scattered across e-commerce webpages.
  - InstaFetch includes a feature that allows blind users to input product-related natural language queries and receive precise responses, simplifying information retrieval.
  - They built a custom Mask R-CNN model trained on a manually annotated dataset of 3,000 images to accurately extract relevant information from the detailed pages of e-commerce websites.

All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users

- Contributions
  - They conducted an IRB-approved user study with 14 blind participants to evaluate InstaFetch against both standard screen readers and a state-of-the-art solution, demonstrating significant improvements in usability and efficiency.
  - InstaFetch employs a Retrieval-Augmented Generation (RAG) framework combined with Chain-of-Thought (CoT) and ReAct techniques for reasoning across multiple sections of webpages to generate accurate query responses.

All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users

- Findings
  - Users spent an average of 182 seconds per item with InstaFetch, compared to 310 seconds with state of the art system SaIL and 478 seconds with screen readers.
  - The number of keyboard shortcuts pressed per item was reduced to an average of 57 with InstaFetch, compared to 145 with SaIL and 397 with screen readers, indicating reduced navigation effort.
  - Participants explored more items during tasks using InstaFetch, averaging 6.8 items compared to 3.5 items with SaIL and 2.2 items with screen readers.
  - InstaFetch achieved a significantly higher System Usability Scale

All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users

- Findings
  - Participants reported a lower perceived workload with InstaFetch, as measured by the NASA-TLX score (average of 38.96), compared to SaIL (57.03) and screen readers (76.83).
  - Participants reported less frustration, reduced interaction fatigue, and greater satisfaction with InstaFetch due to its ability to consolidate information in one place and simplify navigation.
  - Some participants used the natural language query feature for curiosity-driven, exploratory queries unrelated to their immediate task
  - Participants used repeated queries across items to compare specific attributes, such as the number of positive reviews

All in One Place: Ensuring Usable Access to Online Shopping Items for Blind Users

- Findings
  - When InstaFetch returned incorrect query responses, most participants adapted by either rephrasing the query (64.7%) or manually exploring other interface sections (35.3%) instead of abandoning the tool
  - Some participants found lengthy item-related segments (e.g., reviews) challenging to navigate and expressed a desire for summaries instead of full text
  - As users became more comfortable with InstaFetch, they began issuing more complex and specific queries, indicating growing confidence in the tool's capabilities

Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India

- Challenges
  - VIP consumers face significant challenges while shopping online due to inaccessible images, lack of product descriptions, and non-compatible interfaces for assistive technologies like screen readers.
  - Limited or missing details, such as product size, ingredients, or expiry dates, hinder informed decision-making.
  - The process of claiming refunds or returning items is often inaccessible, requiring external assistance and deterring high-value purchases.
  - Current online shopping platforms inadequately cater to VIP, leading to feelings of exclusion and dissatisfaction.
  - Limited studies focus on the shopping experiences of VIP in regions like South Asia, despite having a high prevalence of visual impairments.

Thadikaran, G.B. and Singh, S.K., 2024. Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India. *Organizations and Markets in Emerging Economies*, *15*(1 (30)), pp.90-108.

Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India

- Contributions
  - It documents strategies employed by VIPs to overcome accessibility challenges, including reliance on assistive technology, consumer reviews, memory of previous purchases, and cash-on-delivery options.
  - Employed a qualitative approach to capture the lived experiences of VIP while shopping online in India.
  - Examines how online shopping fosters independence and personal growth among VIP while also highlighting its limitations, such as reduced socialization opportunities.
  - Data was collected from 15 participants(13 blind, 2 low vision) through semi-structured interviews, and the transcripts were analyzed using the Interpretative Phenomenological Approach (IPA)

Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India

- Contributions
  - The study presents novel strategies employed by VIPs to navigate online shopping obstacles.
  - The authors provided actionable insights for improving website and application accessibility, including aligning with WCAG guidelines and designing inclusive systems.

Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India

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Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India

- Findings
  - VIPs face significant accessibility barriers, including inaccessible images, lack of detailed product descriptions, and difficulties with customer care services, returns, and refunds.
  - Accessibility issues often demotivate VIPs from shopping online and create a "vicious cycle" of dissatisfaction.
  - VIPs use various strategies to overcome challenges, such as relying on assistive technology, consumer reviews, familiar brands, and cash-on-delivery options.
  - Assistance from others and memorizing product details are also common practices
  - Online shopping fosters independence and enhances VIP’s confidence and well-being.

Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India

- Findings
  - The independence achieved often comes at the cost of reduced socialization.
  - Male participants showed a stronger preference for online shopping, whereas women preferred in-store shopping more often.
  - A growing preference for online shopping was observed among VIPs due to convenience factors like time savings and home delivery.
  - Mixed opinions were noted, with preferences varying based on product type, time availability, and circumstances.

Fostering Inclusion in Digital Marketplace: Vistas into the Online Shopping Experiences of Consumers with Visual Impairment in India

- Findings
  - Participants preferred in-store shopping for certain products like fresh produce, as it allowed them to touch and inspect the quality.
  - When participants had sufficient time, they opted for in-store shopping to explore and experience products. Conversely, when busy, they preferred the convenience of online shopping.
  - Situational factors, such as the unavailability of specific products in physical stores or the convenience of home delivery for heavy items, influenced the choice of shopping mode.

Enhancing Accessibility in Online Shopping: A Dataset and Summarization Method for Visually Impaired Individuals

- Challenges
  - Individuals face difficulties in online shopping, especially in understanding product features from customer reviews and review videos
  - Challenges include navigating visual content, time-consuming video consumption, and lack of accessibility-focused tools for video-based content

Pal, R., Kar, S. and Sekh, A.A., 2024. Enhancing Accessibility in Online Shopping: A Dataset and Summarization Method for Visually Impaired Individuals. *SN Computer Science*, *5*(8), p.1010.

Enhancing Accessibility in Online Shopping: A Dataset and Summarization Method for Visually Impaired Individuals

- Contributions:
  - Developed PVS10, a dataset of 100 YouTube product review videos (Top 10 review videos per product for 10 products)
  - Introduced an audio-guided text-mining approach to summarize product review videos, making them easier and faster to understand
  - Proposed a new evaluation metric, the question-answer-based F-measure, to assess how effectively video summaries provide key product information like camera quality, battery life, and features

Enhancing Accessibility in Online Shopping: A Dataset and Summarization Method for Visually Impaired Individuals

- Findings:
  - The proposed summarization method helps people with VIP engage with product review videos by reducing time consumption and improving accessibility
  - The study highlights the need for involving VIP users in the design and evaluation process to better address their preferences
  - The study have some limitations including grammatical errors in the generated summaries and the narrow scope of the dataset, which could be expanded

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Challenges:
  - The need for tools that allow visually impaired users to shop independently, without relying on sighted help
  - VIP users face difficulties
    - Reading screen content due to inaccessible Links
    - Navigating websites
      - Navigating through product options, perform search and navigating through menus
    - Challenges in checkout processes
      - Finding and completing payment forms
    - Identifying images while shopping online

Villegas-Ch, W., Amores-Falconi, R. and Coronel-Silva, E., 2023. Design proposal for a virtual shopping assistant for people with vision problems applying artificial intelligence techniques. *Big Data and Cognitive Computing*, *7*(2), p.96.

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Challenges:
  - Inability to easily browse, search, or filter products due to non-intuitive website designs
  - Difficulty completing payment forms and understanding the steps in the checkout process
  - No tailored shopping experience or personalized product recommendations for visually impaired users

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Contributions:
  - The system follows an easy-to-understand conversational structure, avoiding complex or lengthy dialogues
    - Manual interaction using clicks
    - Voice commands, where users begin their requests by saying "Zuri" followed by the command
      - Commands are straightforward and intuitive to minimize user effort. Examples include:

        “Zuri go to the start”

        “Zuri sign out”

        “Zuri it interests me”

        “Zuri, I want to register”

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Contributions:
  - Designed Zuri, a voice assistant specifically for eCommerce
  - Users can interact with the eCommerce platform through voice commands rather than visual navigation
  - The system is designed to be compatible with screen readers and other assistive technologies
  - Provides detailed product descriptions, including prices, sizes, and availability, in a clear and concise voice format

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Contributions:
  - Allows users to know their location within the system and access desired sections quickly
  - Zuri guides users through the checkout process, including filling out forms and confirming transactions
  - Recommend products based on previous purchases and browsing behavior
  - Adheres to data privacy regulations, ensuring user control over what data is collected and how it is used

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Findings:
  - 48% of participants preferred using Zuri for online shopping over manual navigation.
  - 35% of all users reported faster and easier shopping experiences with Zuri.
  - Among visually impaired users:
    - 50% found Zuri significantly more advantageous compared to traditional methods
    - 55% experienced improved navigation and efficiency through voice commands
    - The voice assistant helps people with visual problems navigate the website more easily and quickly since they can ask questions and give orders instead of reading and searching for information visually
  - Zuri allowed visually impaired users to shop independently, which was not as critical for the general user group
  - General users showed increased spending when using voice assistants, while visually impaired users showed higher satisfaction and efficiency but no direct data on spending changes

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Findings:

Parameters	Description	Feeling Generated
Interaction	Ease of use and the ability to understand and respond to user needs.	The ability to recognize speech, understand natural language, and the ability to respond quickly.
User experience	The satisfaction and convenience of the shopping experience.	The ability to customize, the ease of searching and browsing, and the speed of loading.
Business impact	The effect on sales, customer loyalty, and compliance with accessibility regulations	Increased conversion rates, increased average order value, and compliance with web accessibility guidelines.
Technology	The technology's ability to integrate with other systems and scalability.	The ability to integrate with payment and inventory management systems, the ability to expand into new platforms and markets, the ability to handle high volumes of requests, and the ability to provide a consistent experience across devices and channels.
Security	Protection of customer information and compliance with privacy regulations.	The ability to protect customer data and payment information, comply with privacy and data protection regulations, and the ability to offer customer privacy and security options.

Table: Evaluation of parameters in the use of a voice assistant in eCommerce, in relation to the feeling generated by users

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Findings:

Parameters	Description	Value
Error rate	Percentage of times the attendee provided an incorrect answer.	3%
Response time	The average time it takes for the wizard to respond to the user.	2.5 s
Task success rate	Percentage of times the assistant completed a task successfully.	85%
User satisfaction rate	Percentage of users who were satisfied with the wizard experience.	90%
Speech-to-text transcription accuracy	Percentage of accuracy in converting the user's voice to text.	95%
Learning capacity	Percentage improvement in assistant accuracy after a test interaction.	100%

Table: Evaluation of the usability of the assistant in eCommerce, with the use of voice assistants

Design Proposal for a Virtual Shopping Assistant for People with Vision Problems Applying Artificial Intelligence Techniques

- Findings:
  - Limitations:
    - Limited availability and quality of AI technologies (for voice recognition and natural language processing) may require significant investment
    - Users might face challenges like lack of internet access or compatible devices, which could limit the assistant's reach
    - Virtual shopping assistant could have difficulties adapting to the individual needs of each user, which could limit its effectiveness
    - Because the proposal involves using artificial intelligence technology, there could be concerns regarding the privacy and security of users' data
    - There could be resistance from some users to rely on a virtual shopping assistant instead of making purchases themselves

Investigating Accessibility Challenges and Opportunities for Users with Low Vision Disabilities in Customer-to-Customer (C2C) Marketplaces

- Challenges:
  - Limited work has focused on the accessibility of C2C marketplaces
  - Lack of knowledge about the accessibility for sellers in C2C platforms, accessibility issues created by customer-generated contents, and challenges in offline activities that C2C activities entail

Ryskeldiev, B., Hara, K., Kobayashi, M. and Kusano, K., 2022, October. Investigating Accessibility Challenges and Opportunities for Users with Low Vision Disabilities in Customer-to-Customer (C2C) Marketplaces. In *Proceedings of the 24th International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 1-4).

Investigating Accessibility Challenges and Opportunities for Users with Low Vision Disabilities in Customer-to-Customer (C2C) Marketplaces

- Contributions:
  - Conducted a study (through remote interview) with 12 participants with low vision to understand accessibility barriers on C2C platforms, focusing on both buying and selling experiences
  - Explores the specific challenges faced by VIP when using C2C platforms and identifies common practices they use to mitigate or work around these accessibility issues

Investigating Accessibility Challenges and Opportunities for Users with Low Vision Disabilities in Customer-to-Customer (C2C) Marketplaces

- Findings for Buyers:
  - Participants faced difficulties in viewing product images due to low contrast, poor lighting, and the absence of adequate alternative descriptions
  - Insufficient or missing descriptions, especially regarding color and condition, making it challenging to assess items
  - The lack of high-quality product images and detailed descriptions made item comparison difficult
  - Difficulties arise when navigating grid views or expanded listings due to inaccessible design layouts

Investigating Accessibility Challenges and Opportunities for Users with Low Vision Disabilities in Customer-to-Customer (C2C) Marketplaces

- Findings for sellers:
  - Difficulty understanding the condition or positioning of items for accurate representation, while taking picture of the product
  - Positive feedback on tools that pre-fill item details using barcodes, though some users faced difficulties locating barcodes
  - Users encounter challenges in finding appropriately sized packaging, managing weight constraints, and ensuring secure packaging
  - Offline challenges like packaging and product inspection required external help, often from family or friends
  - Appreciation for features that generate shipping labels without revealing personal address details, aiding privacy and reducing manual entry burdens

Investigating Accessibility Challenges and Opportunities for Users with Low Vision Disabilities in Customer-to-Customer (C2C) Marketplaces

Recommendations for buyers

- Developing accessible user interfaces for searching and comparing items
- Incorporating conversational interfaces or accessible messaging to support decision-making

Investigating Accessibility Challenges and Opportunities for Users with Low Vision Disabilities in Customer-to-Customer (C2C) Marketplaces

- Recommendations for sellers
  - Introducing automated or AI-driven tools to help visually impaired sellers capture well-positioned and properly lit photos
  - Providing guidance or real-time feedback during the photo-taking process
  - Improving features like barcode-based description extraction
  - Creating solutions to assist with offline activities like item inspection and packaging
  - Encouraging sellers to provide higher-quality images and detailed descriptions
  - Designing incentive mechanisms to nudge sellers toward creating accessible listing

A Bilingual Audio Based Online Shopping Mobile Application for Visually Impaired and the Elderly People

- Challenges
  - Inaccessible and complex user interfaces in current online shopping platforms.
  - Dependency on others for shopping due to lack of independent access.
  - Lack of suitable assistive tools tailored for these user groups.
  - Existing assistive technologies primarily support English, excluding users who are not proficient in it.
  - Reliance on generic visual content, which is not useful for visually impaired individuals.

Kangeswaran, V., Vasandarai, D., Eliyas, C., Munsil, M.M.M., Kodagoda, N. and Suriyawansa, K., 2021, December. A bilingual audio based online shopping mobile application for visually impaired and the elderly people. In *TENCON 2021-2021 IEEE Region 10 Conference (TENCON)* (pp. 658-663). IEEE.

A Bilingual Audio Based Online Shopping Mobile Application for Visually Impaired and the Elderly People

- Contributions
  - Proposed a bilingual (English and Tamil) audio-based online shopping mobile application designed for visually impaired and elderly users
  - Incorporated accessibility technologies, including:
    - Speech Recognition for voice-based navigation and interaction.
    - Optical Character Recognition (OCR) to digitize handwritten and printed text for creating and searching product lists.
    - Image Recognition for identifying and classifying products through images, including distinguishing between grocery and pharmaceutical items.

A Bilingual Audio Based Online Shopping Mobile Application for Visually Impaired and the Elderly People

- Contributions
  - Designed features tailored to specific needs, such as:
    - Product recommendations through audio.
    - Checking prescriptions for pharmaceutical products.
    - Allowing users to search and modify shopping lists through voice commands.

NB: the paper does not explicitly mention any evaluation of the proposed system

Revamp: Enhancing Accessible Information Seeking Experience of Online Shopping for Blind or Low Vision Users

- Challenges
  - Inadequate descriptions of product images on e-commerce sites
  - Alt-texts are often empty or uninformative, lacking details like color, shape, and size
  - Descriptions provided by sellers are often vague or generic, making it difficult for Blind or Low Vision (BLV) users to understand product appearances
  - Screen readers make it challenging to navigate through large amounts of scattered or irrelevant information on product pages
  - Passive and sequential reading modes of screen readers hinder efficient information retrieval compared to the scanning abilities of sighted users

Wang, R., Chen, Z., Zhang, M.R., Li, Z., Liu, Z., Dang, Z., Yu, C. and Chen, X.A., 2021, May. Revamp: Enhancing accessible information seeking experience of online shopping for blind or low vision users. In *Proceedings of the 2021 CHI Conference on Human Factors in Computing Systems* (pp. 1-14).

Revamp: Enhancing Accessible Information Seeking Experience of Online Shopping for Blind or Low Vision Users

- Challenges
  - Over-reliance on human helpers (friends, family, or paid services) raises privacy concerns and limits independence
  - Automatic tools, such as Seeing AI, provide overly generic descriptions without nuanced visual details
  - Screen readers lack features for efficient interaction with densely populated web pages
  - While reviews are valuable resources, BLV users find it labor-intensive to sift through large volumes of unrelated or redundant reviews to extract useful insights

Revamp: Enhancing Accessible Information Seeking Experience of Online Shopping for Blind or Low Vision Users

- Contributions
  - Conducted interviews with 20 BLV participants to identify key challenges in online shopping:
    - Lack of visual information, such as detailed descriptions of color, shape, size, and logo.
    - Inefficiency in navigating cluttered product pages using screen readers.
  - Highlighted reliance on human helpers and shortcomings of existing tools like Seeing AI.
  - Developed syntactic rules to extract informative review snippets from customer reviews, focusing on:
    - Descriptive phrases (e.g., “shiny red finish”)
    - Comparative expressions (e.g., “the size of a soda can”)
    - Structured sentences using conjunctions or explanations (e.g., “I chose this color because it’s bright and easy to spot”).

Revamp: Enhancing Accessible Information Seeking Experience of Online Shopping for Blind or Low Vision Users

- Contributions
  - Filtered out uninformative reviews, such as overly vague comments (“nice color”) or redundant remarks (“looks like the picture”)
  - Implemented Revamp, a browser extension for Amazon.com that:
    - Simplifies product pages by removing irrelevant content and organizing reviews.
    - Provides BLV users with review-based image descriptions and answers to visual questions.
    - Divides reviews into positive and negative lists with a sentiment summary to help users interpret product feedback.
  - Conducted system evaluations with eight BLV participants:
    - Demonstrated improved understanding of product appearances through descriptive reviews
    - Observed significant reductions in navigation effort compared to standard Amazon pages

Revamp: Enhancing Accessible Information Seeking Experience of Online Shopping for Blind or Low Vision Users

- Contributions
  - Proposed specific guidelines for improving online shopping experiences
    - Simplify web page layouts to focus on task-relevant information
    - Leverage user-generated reviews for filling visual information gaps
    - Allow modular and explainable systems to accommodate future improvements

Revamp: Enhancing Accessible Information Seeking Experience of Online Shopping for Blind or Low Vision Users

- Findings
  - Customer reviews contain valuable, detailed, and descriptive information about visual attributes that can bridge the information gap for BLV users
  - Rules targeting specific visual attributes (e.g., color, shape, size, logo) and filtering out irrelevant reviews significantly improved review quality and relevance
  - Revamp improved BLV users' ability to understand product appearances by providing:
    - Simplified product pages focused on essential information
    - Review-based descriptions and responses to visual questions (like asking "What color is the product?")
  - Participants reported greater confidence and independence in shopping online without human assistance

Revamp: Enhancing Accessible Information Seeking Experience of Online Shopping for Blind or Low Vision Users

- Findings
  - The findings highlight the potential of using review data and rule-based systems to address these limitations
  - BLV participants found Revamp to be more effective and efficient than existing solutions, with higher ratings for:
    - Ease of locating information
    - Quality of answers to visual questions
    - Understanding product appearances

Understanding Smartphone-based Online Shopping Experiences and Behaviors of Blind Users

- Challenges
  - Online shopping websites have varied and inconsistent layouts, making navigation time-consuming and confusing for screen reader users.
  - Detailed product information is often provided as images without adequate alternative text (alt-text), which screen readers cannot interpret.
  - Blind users face difficulty and inefficiency in browsing and extracting useful information from lengthy customer reviews.
  - Blind users often struggle to shop independently due to these accessibility barriers, reducing their ability to make informed purchase decisions efficiently

Park, J., Han, Y. and Oh, U., 2020. Understanding smartphone-based online shopping experiences and behaviors of blind users. *International journal of advanced smart convergence*, *9*(3), pp.260-271.

Understanding Smartphone-based Online Shopping Experiences and Behaviors of Blind Users

- Contributions
  - Designed and implemented a mobile shopping application, BarrierFreeShop, specifically for blind users to address accessibility challenges in online shopping.
    - They created a consistent layout template to organize product information systematically. Key details, such as price and purchase options, were prioritized and placed prominently, while less critical information, like refund policies, was positioned lower or hidden.
    - Extracts and organizes key keywords from customer reviews to help users efficiently gather relevant information.
    - Converts text within images into accessible alt-texts, enabling screen readers to relay detailed product information.

Understanding Smartphone-based Online Shopping Experiences and Behaviors of Blind Users

- Contributions
  - Conducted a month-long user study with 80 blind participants, analyzing app usage logs, and collecting feedback
  - Identified online shopping behaviors and challenges unique to blind users
  - Proposed improvements for future accessibility solutions, including personalized layouts and enhanced review filtering mechanisms.

Understanding Smartphone-based Online Shopping Experiences and Behaviors of Blind Users

- Findings
  - The BarrierFreeShop app reduced the time required for blind users to complete an online purchase by 80%, compared to traditional shopping methods using existing e-commerce platforms.
  - 93.3% of participants reported being able to shop independently using the app, including 81.8% of those who previously could not make online purchases on their own.
  - 48% of participants found layout automation improved navigation and identification of information.
  - 32% highlighted the OCR feature as the most helpful for accessing product details within images.
  - 20% appreciated the review summarization feature for saving time while comparing products.

Understanding Smartphone-based Online Shopping Experiences and Behaviors of Blind Users

- Findings
  - Blind users primarily purchased categories like daily supplies, processed food, and electronics, avoiding visually dependent products like fashion items.
  - Blind users were most active in online shopping during stationary conditions, such as after work or classes, with peak activity at 4 PM, unlike sighted users who shop throughout the day.
  - Users relied significantly on customer reviews to make purchasing decisions due to the lack of accessible detailed product descriptions.

Understanding Smartphone-based Online Shopping Experiences and Behaviors of Blind Users

- Recommendations
  - Authors emphasized the need to provide descriptions of non-textual attributes, such as color, texture, and style, to expand the range of products blind users can confidently purchase.
  - They proposed implementing a feature that allows users to search for specific words or phrases within customer reviews. This would make the review filtering process more personalized and efficient by targeting the exact information users want.
  - Instead of using a fixed template, they suggested designing layouts that can be personalized based on individual user preferences and shopping behaviors. This would ensure better usability and satisfaction for diverse users.

Visually Impaired Friendly E-commerce website

- Challenges
  - Websites often lack audio features, making it difficult for visually impaired users to complete tasks independently
  - Issues with layouts that disrupt screen reader functionality, such as excessive links and hyperlinks, create confusion and hinder usability
  - Popular e-commerce platforms like Amazon, Flipkart, and Alibaba focus on mobile applications for accessibility but fail to provide adequate support for desktop versions, including keyboard or Braille navigation
  - Overwhelming recommendations and cluttered interfaces make it hard for visually impaired users to make decisions

Chand, M., Mulchandani, S. and Mirkar, S., 2019, December. Visually Impaired Friendly E-commerce website. In *2019 4th International Conference on Electrical, Electronics, Communication, Computer Technologies and Optimization Techniques (ICEECCOT)* (pp. 191-196). IEEE.

Visually Impaired Friendly E-commerce website

- Contributions
  - Addresses challenges by implementing the following solutions
    - Voice Assistance: Provides system-generated voice instructions for navigation and input
    - Keyboard Input: Enables interaction using keyboard or Braille keyboards
    - High-Contrast Colors: Uses purple and yellow to assist color-blind users
    - Simplified Layout: Reduces clutter for intuitive use
    - Uses collaborative filtering approach for recommendation
    - Implemented linear navigation:
      - Users are guided through tasks (e.g., registration, login, product selection) in a predefined order without jumping between elements randomly
      - Each step provides clear, voice-assisted instructions, ensuring users complete one action before proceeding to the next
      - Actions like selecting categories, adding items to the cart, and checking out are performed using specific keyboard keys, simplifying interactions.

Visually Impaired Friendly E-commerce website

- Contributions
  - Conducted a usability study with 4 blind participants
  - Follows WCAG accessibility guidelines for broader inclusivity

Visually Impaired Friendly E-commerce website

- Findings
  - Existing e-commerce platforms lack sufficient accessibility for desktop users with visual impairments
  - The website achieved an average task completion rate of 70% among visually impaired users during usability testing
  - Tasks were completed with an average efficiency of 75%, indicating usability with minimal time and effort
  - Blind users found the voice-assisted, keyboard-based navigation and linear flow helpful for performing tasks independently
  - High Contrast Color Scheme are beneficial for color-blind users, improving section differentiation

“I Bought This for Me to Look More Ordinary”: A Study of Blind People Doing Online Shopping

- Challenges
  - Limited research on how visually impaired people shop online, focusing mainly on website usability
    - Most of the research has been on accessibility and usability issues on online shopping websites or in-store shopping technologies
- Contributions
  - Conducted semi-structured interviews with 20 blind individuals who use screen readers and shop online
  - Understanding Blind People's Online Shopping Practices
  - Explored the differences in shopping behaviors between congenitally blind and acquired blind individuals

Liu, G., Ding, X., Yu, C., Gao, L., Chi, X. and Shi, Y., 2019, May. " I Bought This for Me to Look More Ordinary" A Study of Blind People Doing Online Shopping. In *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems* (pp. 1-11).

“I Bought This for Me to Look More Ordinary”: A Study of Blind People Doing Online Shopping

- Findings
  - Desire for Ordinariness:
    - Blind people prioritize appearing "ordinary" to blend into society, avoiding products or tools that label them as blind
    - They focus on the visual appearance of items, even if they cannot see them, to align with societal norms
  - Challenges in online shopping:
    - Visual product information is often inaccessible due to reliance on images without adequate descriptions
    - Limited or unclear product descriptions lead to difficulties in evaluating the suitability of items (e.g., color, fit, or style).
    - Judging whether a product is appropriate for their personal style or social context is a major obstacle.

“I Bought This for Me to Look More Ordinary”: A Study of Blind People Doing Online Shopping

- Findings
  - Reliance on Social Assistance:
    - Blind users depend heavily on friends or trusted individuals to describe products and confirm their choices
    - This reliance can lead to delays and frustrations, especially when assistance is unavailable

“I Bought This for Me to Look More Ordinary”: A Study of Blind People Doing Online Shopping

- Findings
  - Learning About Visual Trends:
    - Blind users gather information about fashion and social norms through indirect means like conversations, customer reviews, and books.
    - They struggle to independently stay updated on current trends.
  - Congenitally blind participants often need more assistance understanding visual details like colors and aesthetics, while those with acquired blindness rely on past visual experiences.
  - Many blind shoppers avoid customer service to conceal their blindness and reduce stigma.
  - Most blind people prefer using mainstream shopping platforms to avoid appearing different.
  - They try to avoid disclosing their blindness to customer service to prevent stereotypes

BrowseWithMe: An Online Clothes Shopping Assistant for People with Visual Impairments

- Challenges faced by visually impaired individuals in both online and brick-and-mortar shopping contexts
  - In brick-and-mortar stores:
    - VIP struggle to find products in stores due to poor layouts and lack of accessible maps
    - Blind individuals often rely on sighted guides to navigate physical stores, limiting their independence
  - In Online Shopping:
    - Many shopping websites are not designed with accessibility in mind, making it difficult for screen readers to interpret the content
    - Screen readers often provide long, irrelevant lists of content, making it hard to locate specific product details like price, size, or material

Stangl, A.J., Kothari, E., Jain, S.D., Yeh, T., Grauman, K. and Gurari, D., 2018, October. Browsewithme: An online clothes shopping assistant for people with visual impairments. In *Proceedings of the 20th International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 107-118).

BrowseWithMe: An Online Clothes Shopping Assistant for People with Visual Impairments

- In Online Shopping:
  - Images (e.g., clothing details) often lack proper descriptions (Alt text), leaving VIP unable to understand visual content
  - Users can’t easily request specific details, like fabric type or magnified images
  - General-purpose voice assistants (like Siri or Alexa) aren’t tailored for VIP shoppers, especially when interacting with online shopping websites

BrowseWithMe: An Online Clothes Shopping Assistant for People with Visual Impairments

- Contributions
  - Conducted interviews with VIP in the broader context of brick-and-mortar and online shopping experiences to make online clothes shopping experiences more accessible

BrowseWithMe: An Online Clothes Shopping Assistant for People with Visual Impairments

- Contributions
  - Developed a prototype called BrowseWithMe, with the following features:
    - Standardized design for easy navigation and consistency across websites.
    - Automatically fills missing data, like Alt text for images
    - Allows users to access product details at varying levels (overview vs. detailed)
    - Identifies and describes clothing items in images, categorizing them (e.g., top, pants, shoes)
    - Enlarges selected items in an image, providing a focused, zoomed-in view

BrowseWithMe: An Online Clothes Shopping Assistant for People with Visual Impairments

- Contributions
  - Developed a prototype called BrowseWithMe, with the following features:
    - Provides key product info (price, material, description, and color)
    - Lists all clothing items and their colors in an image
    - Supports questions like “What’s the price?” or “Describe the outfit.”
    - Allows users to interact via typing or voice commands

BrowseWithMe: An Online Clothes Shopping Assistant for People with Visual Impairments

- Findings
  - BrowseWithMe simplifies online shopping by allowing users to query specific product details (price, material, color) with a consistent interface across websites.
  - AI-generated descriptions outperformed traditional Alt text, increasing median recognition accuracy by 20%
  - Users reported greater confidence, efficiency, and independence while shopping online.
  - Smart magnification helped users with low vision, but higher resolution and better zooming were requested.
  - Users wanted detailed product descriptions (e.g., patterns, textures), additional features like pocket detection, and social feedback tools

BrowseWithMe: An Online Clothes Shopping Assistant for People with Visual Impairments

- Findings
  - While effective, the computer vision module occasionally misclassified colors and confused skirts with dresses
  - Users expressed interest in expanding BrowseWithMe to other product categories (e.g., electronics, household items) and supporting the entire shopping process (e.g., search, checkout)
  - Some participants wanted further improvements to the magnification feature, such as higher-resolution images and better zooming capabilities for different screen sizes

I Didn’t Know that You Knew I Knew: Collaborative Shopping Practices between People with Visual Impairment and People with Vision

- Challenges
  - The authors are addressing the challenges that VIPs face in everyday social and collaborative interactions, particularly in contexts like grocery shopping.
  - Research has focused on enhancing accessibility for independent living but overlooked the social and collaborative interactions between VIP and sighted individuals.
  - Equal participation for VIPs requires active involvement in social contexts, not just independent living.
  - Collaborative interactions between VIPs and sighted people need to be studied to improve integration and participation.
  - The study aims to inform the design of technologies that support VIPs in collaborative tasks.

Yuan, C.W., Hanrahan, B.V., Lee, S., Rosson, M.B. and Carroll, J.M., 2017. I didn't know that you knew I knew: Collaborative shopping practices between people with visual impairment and people with vision. *Proceedings of the ACM on Human-Computer Interaction*, *1*(CSCW), pp.1-18.

I Didn’t Know that You Knew I Knew: Collaborative Shopping Practices between People with Visual Impairment and People with Vision

- Contribution
  - Conducted field observations and interviews (5 VIP and 6 sighted participants, over 5 months long) to study the dynamics of VIP-sighted collaboration during grocery shopping.
    - Observations focused on how shopping goals were communicated, decisions were made, and tasks were coordinated.
    - Semi-structured interviews covered specific incidents observed during the trips and general shopping practices, challenges, and strategies.
  - Identified three critical sources of common ground for effective collaboration
  - Provided guidelines for designing assistive technologies that enhance situational awareness, facilitate mutual understanding, and support equal participation for VIP in collaborative tasks.

I Didn’t Know that You Knew I Knew: Collaborative Shopping Practices between People with Visual Impairment and People with Vision

- Findings
  - VIPs face challenges in collaborating with sighted partners due to the absence of shared visual space, resulting in communication gaps and inefficiencies.
  - Sighted partners often fail to provide critical information, such as product options, prices, or locations, leading to a lack of situational awareness for VIP.
  - Sighted partners need to understand how to assist VIP effectively, including when and how to provide relevant information.

I Didn’t Know that You Knew I Knew: Collaborative Shopping Practices between People with Visual Impairment and People with Vision

- Findings
  - Three Sources of Common Ground for Effective Collaboration:
    - Assistance Knowledge: Sighted partners need to understand how to assist VIP effectively, including when and how to provide relevant information.
    - Interpersonal Knowledge: Collaboration benefits from long-term relationships or shared experiences, such as a spouse knowing the preferences of the VIP partner.
    - Domain Knowledge: Familiarity with shopping practices, store layouts, and product information allows sighted partners to guide VIP more effectively and enhance the shopping experience.

I Didn’t Know that You Knew I Knew: Collaborative Shopping Practices between People with Visual Impairment and People with Vision

- Findings
  - Variations in Collaboration Styles:
    - Stakeholding Collaboration: Seen with spouses, where responsibilities are shared, and decisions are jointly made, resulting in richer engagement and mutual trust.
    - Leading Collaboration: Seen with caseworkers or courtesy shoppers, where VIP take charge of the shopping process, often requiring detailed organization and clear instructions for efficient outcomes
  - VIPs need access to real-time information about store layouts, product availability, promotions, and product details (e.g., weight, price, freshness). This awareness supports decision-making and promotes a sense of independence.

I Didn’t Know that You Knew I Knew: Collaborative Shopping Practices between People with Visual Impairment and People with Vision

- Findings
  - Partners with prior experience in assisting VIP or those with training provide significantly better support.
    - For example, experienced caseworkers anticipate VIP’s needs and adjust their assistance dynamically, while untrained courtesy shoppers often provide inconsistent or inadequate help.
  - VIP often relied on touching items for confirmation, especially for new or variable products (e.g., fresh produce).
    - Courtesy shoppers were less likely to facilitate this interaction compared to spouses or caseworkers.

HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired

- Challenges
  - Many websites have accessibility barriers, including ambiguous links, unstructured layouts, lack of alternate text for images, and elements like animations that are inaccessible to screen readers
  - Due to inaccessible design, VIP often rely on sighted individuals to help them navigate and shop online, limiting their independence.
  - Existing online shopping platforms do not integrate haptic and audio feedback

Wong, E.J., Yap, K.M., Alexander, J. and Karnik, A., 2015, August. HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired. In *2015 ieee conference on open systems (icos)* (pp. 62-67). IEEE.

HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired

- Challenges
  - VIP find it hard to perceive product dimensions, textures, or other physical attributes due to it's visual dependence
  - Popular web browsers lack haptic feedback and do not integrate well with assistive tools like screen readers, Braille displays, or voice browsers.
  - Current web browsers lack haptic plugins, making it challenging to render haptic feedback for product evaluation

HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired

- Contributions
  - Developed a haptic-audio enabled online shopping prototype
  - Uses a simple three-section design (header, middle content area, footer) with static content.
  - Users receive audio feedback and directional cues to assist navigation and provide updates about their position on the page
  - Each page begins with an audio description of its layout to help users orient themselves

HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired

- Contributions
  - The system incorporates a Falcon haptic device to allow users to physically interact with 3D models of products, helping them evaluate dimensions, textures, and firmness
  - Products are broken down into individual components in 3D, and users can explore these parts with accompanying audio descriptions for better understanding
  - Users can issue voice commands to interact with the system, navigate pages, and perform actions such as adding products to a shopping cart

HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired

- Contributions
  - The system surrounds pages with active frames at the edges, giving cues when the user reaches the edge of the screen
  - The shopping cart provides audio feedback about the items, including descriptions, prices, and quantities.
  - The payment system simplifies the checkout process by automating form entry, reducing cognitive load for users
  - Different voices and sound cues are used to differentiate product descriptions, warnings, and navigation instructions, reducing cognitive overload
  - The system is evaluated by visually impaired participants who perform tasks like navigating the website, selecting products, and completing purchases

HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired

- Findings
  - The system enabled most participants to shop independently, demonstrating the effectiveness of haptic-audio integration
  - Participants sometimes needed to repeat commands due to variations in voice pitch, pronunciation, and intonation. Training and adaptation were suggested for improvement
  - Participants found the haptic device effective for evaluating dimensions, textures, and firmness of products.
  - Using multiple voice profiles for audio descriptions and cues improved participants' ability to distinguish different types of information
  - The three-section layout with static content was effective in helping users understand page structure and navigate independently

HABOS: Towards a platform of haptic-audio based online shopping for the visually impaired

- Findings
  - Providing haptic feedback combined with detailed audio descriptions significantly enhanced product evaluation and decision-making
  - Too much audio information during haptic exploration sometimes overwhelmed users. Short audio cues for individual product parts were recommended
  - Initial difficulty in using voice commands highlights the need for more training and optimization of the voice recognition system
  - Payment forms remained a challenge, but the automatic form-filling feature was helpful for simplifying the process

Online Shopping Involving Consumers with Visual Impairments – A Qualitative Study

- Challenges
  - Limited research on the online shopping experiences of visually impaired users

- Contributions
  - Conducted interviews with 10 visually impaired participants to identify barriers and needs in online shopping

Fuchs, E. and Strauss, C., 2012. Online shopping involving consumers with visual impairments–a qualitative study. In *Computers Helping People with Special Needs: 13th International Conference, ICCHP 2012, Linz, Austria, July 11-13, 2012, Proceedings, Part I 13* (pp. 378-385). Springer Berlin Heidelberg.

Online Shopping Involving Consumers with Visual Impairments – A Qualitative Study

- Findings:
  - Barriers Faced in Online Shopping
    - Websites often lack compatibility with assistive technologies like screen readers, Braille devices, and magnifiers.
    - Flash content, dropdown menus, and dynamic elements obstruct navigation
    - Companies prioritize visually appealing designs while neglecting accessibility requirements for visually impaired users
  - Emotional and Psychological Reactions
    - Feelings of frustration, helplessness, neglect, and exclusion caused by inaccessible shopping platforms
    - Satisfaction and independence when able to shop without assistance
    - Fear of data theft or misuse, especially regarding credit card details, and low trust in online shops and unclear information persisted

Online Shopping Involving Consumers with Visual Impairments – A Qualitative Study

- Findings
  - Consumer Preferences
    - While independence is valued, many consumers also appreciate assistance from acquaintances or professional support systems
    - Reliable and accessible customer services are key factors in selecting shopping platforms.
    - Situational factors like urgency (e.g., buying gifts) also affect behavior

Understanding Markets as Online Public Places: Insights from Consumers with Visual Impairments

- Challenges
  - Unlike physical spaces, websites are not universally considered "public places" under the Americans with Disabilities Act (ADA), leading to a gap in legal accessibility requirements for online platforms
  - Visually impaired consumers often experience frustration and powerlessness due to poor website design, which limits their ability to browse, evaluate, and make purchases independently

Kaufman-Scarborough, C. and Childers, T.L., 2009. Understanding markets as online public places: Insights from consumers with visual impairments. *Journal of Public Policy & Marketing*, *28*(1), pp.16-28.

Understanding Markets as Online Public Places: Insights from Consumers with Visual Impairments

- Contributions
  - Conducted telephonic interviews with 45 visually impaired participants to understand their experiences with online shopping
  - The analysis focused on themes such as usability, consumer vulnerability, and empowerment in the context of online retail environments
  - They highlighted the need for improved web accessibility to better serve visually impaired users

Understanding Markets as Online Public Places: Insights from Consumers with Visual Impairments

- Findings
  - Online shopping provides VIP with a level of independence not available in physical stores
  - Participants reported feeling empowered and more “normal” as consumers because they could access information and make decisions independently, similar to sighted shoppers
  - The ability to shop from home at any time, especially during adverse conditions like bad weather, enhances convenience
  - Websites often lack compatibility with screen readers, screen magnifiers, or keyboard navigation
  - Elements like unlabeled buttons, poorly described images, and inaccessible dropdown menus create significant barriers

Understanding Markets as Online Public Places: Insights from Consumers with Visual Impairments

- Findings
  - Visually impaired users face challenges navigating "busy" websites with visual distractions like pop-ups, flash graphics, or complex layouts
  - Participants frequently encountered vague or unhelpful product details, such as non-standard color names (“desert rose” instead of red) or minimal text alternatives for images
  - Problems with filling out forms (e.g., payment and shipping details) due to poor website design led to errors, frustration, and in some cases, abandonment of purchases
  - While online shopping provides independence, it is often seen as more *practical* than *enjoyable*
  - Some participants combined online research with phone orders or in-store visits to complete purchases

Understanding Markets as Online Public Places: Insights from Consumers with Visual Impairments

- Findings
  - Many participants adopted workarounds, such as using familiar websites with simpler layouts, calling customer service, or relying on friends and family for assistance
  - Participants preferred websites with layouts and interfaces that minimized unnecessary visual elements
  - The study found strong support for treating websites as public accommodations under the Americans with Disabilities Act (ADA)

VR Shopping for VIP papers

Design and verification of universal virtual shopping store application

- Challenges
  - Lack of appropriate research on universal design that considers various user groups
  - Making VR shopping environments accessible to a diverse group of users, including those with disabilities or other special needs.
  - Integration of product information and purchasing process in VR environment

Lee, D., Kim, H.K. and Park, J., 2024. Design and verification of universal virtual shopping store application. *Virtual Reality*, *28*(4), pp.1-19.

Design and verification of universal virtual shopping store application

- Contributions
  - Conducted a systematic literature review and video ethnography (watching how people shop in physical stores) to identify the essential features and user preferences within virtual shopping stores
  - A prototype of the virtual shopping store was developed following the identification of the key features
  - Features of the prototype includes tutorials, avatar-based virtual fitting, user location/orientation control, voice guidance, colour customization, high contrast, central interface placement and visual cues for differentiating product types
  - A usability test was conducted to further validate the effectiveness of the created experience

Design and verification of universal virtual shopping store application

- Findings from video ethnography study
  - Navigation took up a significant 28.8% of total shopping time. Most time was spent exploring clothing on hangers (57.4%), while less time was dedicated to items on desks (9.7%) and mannequins (4.1%)
  - Necessary features identified from the study
    - Teleportation and Mini-map warp for movement
    - Checking detailed product information
    - Virtual fitting using avatars
    - Confirming product design

Design and verification of universal virtual shopping store application

- Findings from usability study
  - Universal design features such as voice guidance, tutorials, and intuitive user interfaces (Central Interface Placement, High Contrast & Color Changes, Visual Cues for Product Types and Product Interaction UI) had high satisfactory rate for users, including beginners and those with vision issues
  - The voice guidance feature (e.g., when moving to the hanger, a voice uttering “Moved to the front of the hanger”) was appreciated by some for its clarity, but sighted people felt it was too intrusive and preferred it to be optional
  - Magnification and high-contrast text helped users with reduced vision, making it easier for them to interact with the VR environment

Design and verification of universal virtual shopping store application

- Findings from usability study
  - Customizable color settings worked well for users with red-green color blindness.
  - Participants found the "Colour changes and high contrast" design "attention-grabbing" and positively received due to its bold contrasts.
  - The centralized interface design helped reduce dizziness by limiting the need to move the head a lot, making the shopping experience more comfortable

Thank You

[Project Website]

Study Media Repository

- Google Drive (videos, images, study artifacts): https://drive.google.com/drive/folders/13xvJ1hm4cnXdJGTX1CIJZ7naHANFaEAf?usp=sharing

Submitted Research Article

- Submitted manuscript (Google Drive): https://drive.google.com/file/d/1yuv40Uof10vsNlgyxFw00QcdsJRb2rJd/view?usp=sharing

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Thank you