

ShopaSonic - Voice-Enabled E-Commerce Platform for Visually Impaired Users

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Abstract - This research paper explores the development of ShopaSonic, an inclusive e-commerce mobile application designed to make online shopping fully accessible for visually impaired users. While online shopping offers convenience to many, most platforms rely heavily on visual navigation and text-based interactions, making them challenging for individuals with limited or no vision. To address this gap, ShopaSonic introduces a voice-driven shopping experience with a dedicated accessibility mode, enabling hands-free navigation, secure authentication, and seamless checkout. The app also incorporates gesture-based navigation enhancing usability. By prioritizing digital accessibility, this study aims to highlight how assistive technology can empower visually impaired individuals with a simpler, more inclusive shopping experience.

Key Words: Accessibility, Inclusive Technology, E-commerce, Voice Assistant, Voice Shopping.

1. INTRODUCTION

Accessibility plays a crucial role in ensuring equal access to information and services for all individuals. The Web Content Accessibility Guidelines (WCAG) were introduced to promote equal access and opportunity for individuals with disabilities. By ensuring web accessibility, people with disabilities can communicate, interact, and engage with content more effectively, making digital platforms significantly more inclusive [1].

1.1 Background

According to the World Health Organization (WHO), at least 2.2 billion people globally have a vision impairment or blindness, with 1 billion cases that could have been prevented or have yet to be addressed [2]. Additional reports suggests that 285 million people worldwide have some form of disability that limits their ability to read content on a website, with 39 million being completely blind [3].

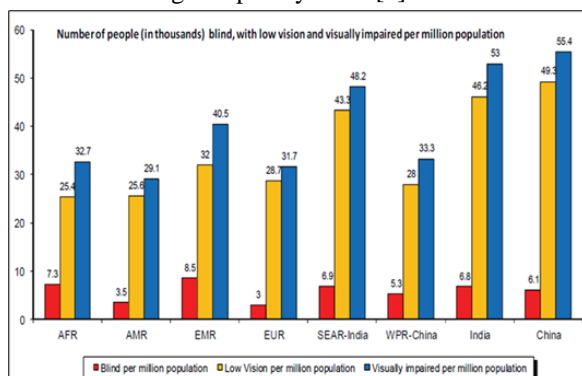


Fig -1: Worldwide Statistical Estimate of Visually Impaired People [4].

1.2 Problem Statement

In today's digital era, online shopping has become an essential part of everyday life, offering convenience, variety, and flexibility. From purchasing groceries to booking services, e-commerce platforms have transformed how people shop. However, this convenience is not equally accessible to everyone.

Most e-commerce platforms remain largely inaccessible to individuals with visual impairments. These platforms rely heavily on visual interactions, making independent shopping difficult. Tasks like navigating categories, comparing products, or completing payments become frustrating due to:

- Cluttered and inconsistent interfaces: Screen readers often fail to interpret improperly labelled buttons, inconsistent alt text, and complex page layouts, creating a disjointed experience.
- Limited voice support: While some platforms offer basic voice search, they often lack full voice control for cart management, reviews, and checkout.
- Language barriers: Most platforms use standard English for voice commands, making them less intuitive for non-native speakers, who often mix languages naturally.

1.3 Research Objectives

Despite growing inclusivity efforts, accessible e-commerce solutions remain scarce, forcing many visually impaired users to rely on sighted assistance for online shopping. To bridge this accessibility gap, we developed ShopaSonic—an inclusive e-commerce mobile application designed to make online shopping fully accessible.

By combining voice-driven navigation, gesture-based controls, and Hindi and English language support, the app enables users to browse, add to cart, review, and checkout using only their voice. The dedicated accessibility mode offers a unique voice authentication + spoken password feature, providing an added layer of security and convenience. By prioritizing digital inclusivity, ShopaSonic aims to empower visually impaired individuals with a simpler, more accessible, and independent shopping experience.

Table -1: Comparison - ShopaSonic vs. Traditional E-commerce

Features	Traditional E-commerce Apps	ShopaSonic
Navigation	Menu-driven, requires visual interaction	Voice commands, gesture-based navigation
Authentication	Text-based passwords	Dual-layer: voice + spoken password authentication
Checkout	Manual form-filling	Voice-enabled
Reviews	Text-based only	Voice-enabled review submission

Language Support	Text-based, limited language coverage	Hindi and English voice commands for better inclusivity
Accessibility Mode	Absent or limited	Dedicated mode with accessibility-first design

2. LITERATURE SURVEY

The literature survey explores existing research and developments in the domain of accessible e-commerce platforms, with a focus on technological advancements, assistive technologies, and digital inclusion for visually impaired users. Despite the growth of online shopping, many platforms remain inaccessible due to their reliance on visual navigation and text-heavy interfaces, limiting independent usage by individuals with visual impairments. This survey highlights significant findings from previous studies, including voice-assisted navigation, gesture-based interaction, and multimodal authentication, while identifying the gaps in current accessibility standards.

2.1 Accessibility in E-commerce

Smith et al. [5] explored the usability challenges faced by visually impaired users on e-commerce platforms. The study found that 80% of screen reader users struggled with poorly labelled buttons, missing alt text, and inconsistent navigation, making product search and checkout difficult. While the study suggested voice assistance as a potential solution, it lacked practical implementations. Similarly, Chand et al. [6] proposed a visually impaired-friendly e-commerce website that uses screen readers and keyboard navigation to improve accessibility. However, the solution was web-based and did not offer full voice-driven navigation, highlighting a gap that ShopaSonic addresses with its mobile-first, voice-controlled interface.

2.2 Voice Authentication & Security

A study by Lee and Kim [7] analyzed the security of voice authentication systems. It revealed that while voice-based login improves convenience, it is prone to spoofing attacks. To address this, the researchers suggested multi-layered authentication by combining voice and spoken passwords, similar to the approach used in ShopaSonic.

2.3 Bilingual and Multilingual Accessibility

Kangeswaran et al. [8] introduced a bilingual audio-based online shopping app for visually impaired and elderly people. The app featured voice search and basic shopping functions in two languages, making it more accessible. However, it lacked gesture-based navigation and voice authentication. Additionally, Rao and Iyer [9] investigated the language accessibility gap in digital platforms. Their findings showed that over 60% of users in India prefer apps with regional language support. The study emphasized the need for multi-language voice interactions.

2.4 Digital Inclusion

Kulyukin and Kutiyawala [10] reviewed accessible shopping systems for blind users. Their research highlighted

the state of the art in assistive technology but found that most solutions were hardware-dependent (using physical devices for navigation) rather than app-based, making them less practical for real-world e-commerce. Several academic efforts have investigated the use of voice assistants and gesture controls to support visually impaired users in everyday digital tasks. For instance, Karthik et al. [11] proposed a mobile voice assistant tailored for navigation. However, these solutions often focus on limited functionality, lack support for natural language variations.

2.5 Existing Gaps

While these studies highlight the need for accessible e-commerce, they reveal gaps in current implementations:

- Most platforms lack full voice control and still rely on visual navigation.
- Multi-language accessibility is rarely implemented in voice-driven systems.
- Few applications combine voice authentication with spoken passwords for added security.

ShopaSonic addresses these limitations by offering end-to-end voice navigation, gesture-based controls, Hindi and English support, and voice authentication, making it a comprehensive and innovative solution for visually impaired users.

3. RELATED WORK

Recent efforts in digital accessibility have explored various ways to improve the online shopping experience for users with visual impairments. However, many commercial solutions are either not accessibility-focused or offer only limited voice interaction capabilities. This section highlights relevant commercial technologies, academic research, and accessibility tools related to voice-enabled shopping.

3.1 Commercial Voice Commerce Solutions

Amazon's Alexa voice shopping is among the most recognizable commercial voice commerce tools. Users can add items to their cart, reorder past purchases, and track deliveries through voice. However, the platform is not designed with accessibility-first principles, and lacks multimodal features such as voice-based authentication or gesture control [12]. Similarly, Google Assistant enables users to interact with shopping apps through voice for basic tasks, but does not offer a complete, inclusive shopping journey [13].

3.2 Accessibility Tools and Screen Readers

Device-level accessibility solutions such as VoiceOver (iOS) and TalkBack (Android) assist users with visual impairments by reading screen content aloud. While useful, these tools rely heavily on developer-side optimization, such as proper labeling and semantic design. As a result, they cannot fully bridge the accessibility gap on their own [14].

3.3 Academic Research on Voice Commerce

Academic studies have also explored the application of voice assistants in commerce. A recent study by Mittal and Manocha [15] investigates how consumers engage with voice interfaces for online shopping. The study highlights that while users value convenience and hands-free interaction, there are

still issues related to trust, security, and limited functionality, especially when completing complex tasks like payments or product comparison. These findings reinforce the need for specialized voice platforms that integrate natural language understanding, multi-modal input, and personalized security features.

In summary, while various commercial and academic projects have advanced voice commerce, there remains a gap in the development of a comprehensive, secure, and locally adapted voice shopping experience tailored to the needs of visually impaired users.

4. METHODOLOGY

The proposed project ‘ShopaSonic’ follows a structured, multi-phase approach, focusing on modular design and accessibility-first principles. The methodology outlines the conceptual architecture, technical stack, and functional flow of the application. The technical stack of the project is:

- **Frontend:** React Native for cross-platform compatibility.
- **Backend:** Node.js with Firebase for real-time database operations.
- **Database:** MongoDB for scalable and flexible data storage.
- **APIs:** Google Speech-to-Text API for voice command processing.

4.1 Development Phases

The project is divided into four phases, covering the core e-commerce platform, accessibility features, and testing.

1. In the initial phase, the foundation of the application is designed with React Native to ensure cross-platform compatibility. The front-end interface includes product listings, categories, and basic user navigation, while MongoDB is chosen for managing the product database and user information. The back-end, built using Node.js with Express.js, handles authentication, data storage, and API interactions.
2. In the second phase, standard e-commerce features are introduced. This includes product search, filtering, cart management, and checkout flow. The checkout is designed with a dummy payment mechanism, ensuring a seamless shopping experience while prioritizing accessibility.
3. The third phase focuses on accessibility and voice-driven interactions. The app offers two modes:
 - The Normal mode functions as a standard shopping app, using visual navigation.
 - The Accessibility mode activates voice controls, enabling visually impaired users to navigate the app using spoken commands.
4. In the final phase, the system is tested to validate the flow, accessibility, and functionality. The testing process focuses on voice command accuracy, navigation consistency, and authentication reliability. The goal is to create an application that ensures a seamless, accessible shopping experience for visually impaired users.

4.2 Technical Architecture

The ShopaSonic architecture consists of three key modules: E-commerce Core, Voice & Accessibility,

and Authentication Module.

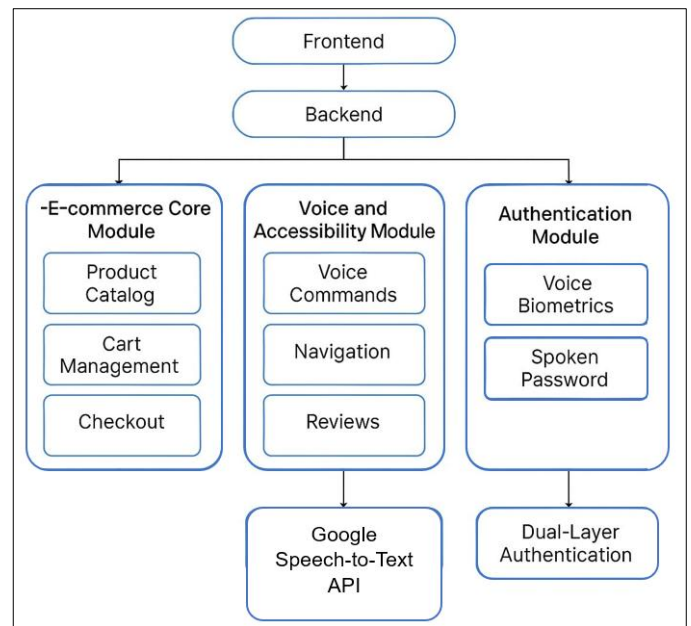


Fig -2: System Architecture

1. **E-commerce Core Module:** This module handles the product catalogue, cart management, checkout, and user profiles. It uses MongoDB for data storage and Express.js for back-end operations.
2. **Voice and Accessibility Module:** This component manages voice commands, navigation, and reviews. To support voice navigation, Google Speech-to-Text API is integrated. This allows users to search for products, add items to the cart, and manage the wish list entirely through voice instructions. Additionally, gesture-based navigation enhances accessibility by enabling swipe or tap gestures for common actions, catering to users with mobility challenges.
3. **Authentication Module:** The authentication system incorporates dual-layer security, combining voice biometrics and spoken passwords. When users activate Accessibility mode, they can log in by speaking their password, which is verified against both text-based validation and voice biometrics for enhanced security.

To further improve accessibility, the app supports voice-enabled reviews, allowing users to provide product feedback through spoken reviews, which are converted to text. Additionally, multi-language support in Hindi and English is incorporated, catering to a wider user base and ensuring natural, region-specific voice interactions.

4.3 Use Case Scenario

To better understand the intended functionality of ShopaSonic, consider the following use case involving a visually impaired user, who wishes to buy an using the app.

Upon launching the application, the user is greeted with a default Normal Mode interface. However, the user activates voice support by saying “Accessibility Mode On.” This triggers a shift from the standard interface to an accessibility-focused mode, enabling voice-driven navigation and gesture-based controls.

The app then prompts the user for authentication. The user speaks predefined password aloud, and the app verifies

both the spoken password content and her voiceprint using dual-layer voice authentication. Once authenticated, the user can navigate the app entirely through voice.

For instance, the user says “Search (item name),” and the app reads aloud the top results. Commands like “Add item to cart” and “Go to cart” allow seamless cart management. To proceed to checkout, the user says “Checkout”, and the app presents payment options via voice. The user chooses an option by voice and is redirected to a mock payment interface and completes a simulated payment. Finally, the app prompts the user to leave a voice review, which is transcribed and saved.

Throughout the interaction, the app uses natural phrases, making the experience intuitive and conversational. This entire process, from login to checkout and review, occurs without requiring visual input, allowing the user to shop independently and efficiently without visual interaction.

5. RESULTS AND DISCUSSION

The ShopaSonic project is designed to deliver a fully accessible and voice-enabled shopping experience, catering specifically to visually impaired users. The anticipated outcomes focus on enhanced accessibility, improved usability, and a streamlined shopping process.

5.1 Expected Outcomes

The proposed app aims to offer a seamless, hands-free shopping experience by leveraging voice commands for navigation, product management, and checkout. Users will be able to:

1. Navigate the app entirely through voice: Using commands to search, filter, and add products to the cart.
2. Log in with voice authentication: Combining voice biometrics with a spoken password enhances security while simplifying access for visually impaired users.
3. Perform checkout operations through voice: Enabling users to checkout and confirm their order using spoken commands.
4. Leave voice-enabled reviews: Enabling users to speak their feedback, which is converted to text, encourages greater participation and product evaluation.
5. Experience multi-language support: The Hindi and English voice interaction ensures that the app is accessible and intuitive, especially for Indian users, providing a more natural shopping experience.

5.2 Accessibility Impact

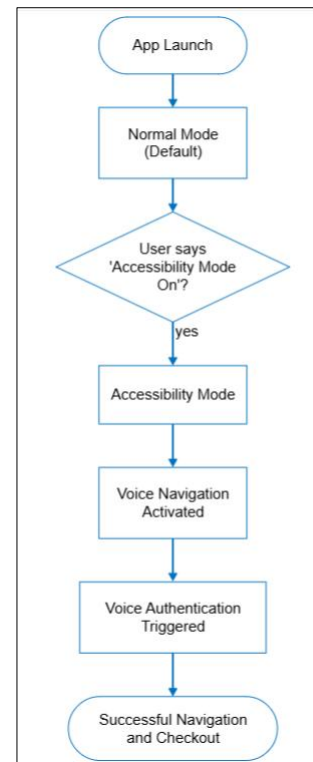


Fig -3: Accessibility Mode Switching Flowchart

The Accessibility Mode is designed to significantly enhance the usability of e-commerce platforms for individuals with visual impairments. By combining voice commands, gesture navigation, and voice-based authentication, the app offers an inclusive and efficient shopping experience. The voice authentication system provides a secure yet convenient login method, addressing accessibility challenges while maintaining security. Gesture-based navigation allows users with visual and mobility impairments to interact with the app easily.

5.3 Potential Challenges and Considerations

While the proposed project offers innovative solutions, certain challenges and considerations are anticipated:

1. Voice Accuracy and Recognition: The effectiveness of voice commands depends on the accuracy of speech recognition. Variations in accents, background noise, or unclear speech could affect performance.
2. Authentication Reliability: Although dual-layer voice authentication enhances security, there may be challenges with false positives or negatives in voiceprint matching.
3. Multi-language Support: While the app supports Hindi and English interactions, expanding to more regional languages could further enhance accessibility but may require additional NLP models and training datasets.
4. Privacy Concerns: Since the app uses voice biometrics, ensuring data security and privacy is critical to gain user trust and comply with regulations.

Table -2: Potential Benefits vs. Challenges

Category	Benefits	Challenges
Accessibility	Hands-free navigation with voice commands	Accuracy of speech recognition
Security	Voice + password authentication improves security	False positives/negatives in voice authentication
Ease of Use	Voice-enabled reviews simplify feedback	Handling noisy environments during voice input
Scalability	Potential to add real payment gateways	Requires API integration and security measures

5.4 Future Enhancements and Scope

The ShopaSonic project has the potential for further development and real-world deployment. Future iterations could include:

1. Real Payment Integration: Adding payment gateway APIs would enable the app to process secure, real transactions, making it fully functional for e-commerce.
2. Enhanced Voice Commands: Expanding the range of voice commands to cover more complex shopping actions, such as sorting, filtering, and advanced search.
3. Advanced Accessibility Features: Introducing screen readers, haptic feedback, and customizable gestures for broader accessibility support.
4. Personalized Recommendations: Using machine learning algorithms to offer personalized product suggestions based on past purchases and browsing history.

6. CONCLUSION

Traditional e-commerce platforms often present navigation and usability challenges for individuals with visual disabilities. ShopaSonic aims to eliminate these barriers by integrating voice navigation, gesture controls, and dual-layer voice authentication, making online shopping more inclusive and convenient. The Accessibility Mode empowers users to browse, search, and manage their cart entirely through voice commands. While the project demonstrates significant potential, certain challenges remain, such as speech recognition accuracy, authentication reliability, and multi-language expansion. The anticipated future enhancements include real payment gateway integration, advanced voice commands, and support for additional regional languages, making the app more comprehensive and user-friendly. By combining technological innovation with accessibility-first design, ShopaSonic aims to redefine e-commerce inclusivity. The project offers a promising foundation for future development, with the potential to impact the lives of visually impaired individuals by enabling greater independence and autonomy in online shopping.

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