Voice Enabled E-Commerce Website for Visually Impaired People and Non-Disabled Users

Adlin Sheeba[1*], Sahithya Shre H[2] and Sujithra S[3]

[1]Professor, Department of Computer Science and Engineering, St. Joseph's Institute of Technology, Chennai, Tamil Nadu, India
[2, 3]Undergraduate Students, Department of Computer Science and Engineering, St. Joseph's Institute of Technology, Chennai, Tamil Nadu, India.
adlinsheeba78@gmail.com

Abstract. This is an avant-garde e commerce-controlled audio platform project specifically designed for visually impaired persons. The platform uses the Django web framework to add text to speech and speech recognition support, which allows a user to browse through the store, search for products, and complete purchases via voice commands. In the system, the user speech translated into text by Google Web Speech API. Voice input is in turn processed with speech recognition. We further enrich usability with gTTS real-time audio feedback which supports simple voice command in user engagement like saying "add to cart" or "go to checkout". An intuitive site offers a backend powered by Django for safe management of user information, orders and product inventories. This approach prioritizes accessibility while providing voice-enabled form interactions, making shopping convenient and fast for visually impaired individuals. By combining voice command with traditional e-commerce components, this project both elevates standards for the online purchasing experience and inspires diversity in digital forms.

Keywords: E-commerce, Accessibility, Voice Control, Speech Recognition, Text-to-Speech, Django, Audio Interface, Visually Impaired, Inclusive Design, Web Accessibility, MySQL, Speech-to-Text.

1 Introduction

The digital transformation of retail with e-commerce making products and services easily accessible from any place in the world, has changed consumer behaviour quite radically. However, despite most people claiming that internet shopping has become an integral part of daily life, the interface of these platforms is mostly a fine art which seriously struggles to cater for those blind or low vision. Traditional websites and applications create serious problems for the interaction of vision impaired users with other people due to their high dependence on graphical contents, mouse movement, and text-based input. And this is a population that is frequently pushed to the sideline of usable design, restricting their ability to engage in today digital economy. According to the World Health Organisation, over 2.2 billion people worldwide have a visual impairment. This large part of society faces distinct challenges with using digital services in particular e-commerce sites. By now, most of the solutions being deployed depend on assistive technology or screen readers that are helpful but they do not typically work with live content-rich web pages. For this reason, the requirement for more barrier-free digital interfaces that provide intuitive, fluid experiences comparable to those of sighted people is growing.

An example of this gather up is voice-controlled technology, where the means of interaction takes place with audio-based commands. It has become possible to create

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more user-friendly and accessible interfaces for the visually impaired due to advances in voice recognition and TTS (text-to-speech) technology. Voice command eliminate minimizes screen elements and makes the user experience more enjoyable through simplified transaction processes, product searches and navigation. Although a TTS system like gTTS can help us create an audio feedback loop that improves user experience and interaction in real-time, other collaborative tools such as the Google Web Speech API can provide accurate speech recognition to convert interpreted words to commands.

This article illustrates the line of action in building and deploying a state-of-the-art e-commerce platform with features to be conveniently used by visually challenged users. The proposed platform combines speech recognition and TTS capabilities with Django web framework, which allows the users to perform various activities like product searching, shopping cart adding and checkout completion through simple voice commands. The foundation of the platform architecture is a stable MySql driven Django backend that ensures secure and efficient management of users, orders, and product inventories.

The primary objective of this research is to demonstrate the potential use of voice-activated interfaces in improving the accessibility of e-commerce platforms, which consequently offers increased digital inclusion. In this paper, we cover our design philosophies, technological challenges and solutions in building a completely voice-enabled e-commerce system. We then also talk about the usability testing conducted with people with visual impairments in order to determine whether the platform is effective, reliable, and satisfying to use. It also looks at the broader impact of voice-enabled technologies to shrink the accessibility gap in online services, and gives a summary of related work around accessible web design.

By integrating state-of-the-art voice control capabilities with traditional e-commerce functionality, this project aims to set a new standard for the web accessibility. This platform validates that voice-based interface in e-commerce is possible, and demonstrates its broader usage outside of traditional digital channels and the potential for a more equitable web.

2 Related Works

Nguyen et al. In [1], we looked into the advantages of such voice-activated AI in E-commerce, especially the benefits for those who are visually impaired. The study shows that voice AI can improve accessibility by helping users to browse over and shop using voice orders, providing an intuitive hands-free experience. The system can understand user speech patterns and enhance interaction accuracy and responsiveness in a smooth shopping experience.

Smith et al. The work [2] elaborates on a voice-activated e-commerce platform specifically built for accessibility in both chat bots (voice-enabled), providing real-time assistance for personalized recommendations. Powered by natural language processing, these chatbots take users through the purchase flow and provide quick support to improve customer satisfaction. These systems, he explained, could help move the e-

commerce experience away from a one-size-fits-all approach to something more tailored to individual users.

Jones and Li [3] studied the role of advanced Voice AI in customer service and e-commerce, they described how voice interface can be developed to assist users with visual disabilities. It describes how combining voice technology with back-end adaptive machine learning models can lead to greater personalization in interactions, allowing devices and users to complete victim-like tasks, such as searching for products or adding items to a cart using just a voice command. Brown et al.

Kumar et al [4] examined the utilization of voice-activated artificial intelligence in e-commerce and how technology as such has made accessing e-commerce platforms more inclusive and efficient for visually impaired people. The study concluded that in order to improve user experience, it is important that the voice AI has functionality such as hands-free browsing and carting through voice commands during a transaction. To ensure seamless interactions, the system is built to analyze speech patterns and respond accordingly providing an organic shopping experience.

Smith and Kumar [5] investigated the use of the screen readers in online shopping for blind users. This reflects their research, which highlights how voice output helps users in navigating through product details and completing purchases that compatibility with screen readers is an important consideration for e-commerce systems to be accessible and user-friendly.

Garcia et al. [6] addressing the positive aspect of voice-activated systems on inclusive design in e-commerce platforms. The results showed that if tastefully designed audio feedback systems are used, e-commerce platforms become navigable and smooth shopping experience for users with visual impairment who can do it by voice commands.

Thomas et al. Similar to [7], we demonstrated the use of AI-based audio descriptions in e-commerce and highlighted how voice responses generated on-the-fly for users' queries increase accessibility. According to the study, descriptions based on AI provide important information about products in an audible manner and enable blind users to independently participate or shop online.

Li and Brown [8] Analyzed case studies for accessible e-commerce websites and describe how AI technologies including voice commands, etc and descriptive link text developed by the artificial intelligence techniques have helped in usability of the systems. This, they argued, makes for a more natural user experience and allows users to browse sites on their own terms.

Williams et al. This specific use of voice AI, for example by [9], who focused on authenticity in product search and checkout processes for people with impaired vision The researchers establish the notion that voice AI has the potential to optimise accuracy in interactions by adapting to individual speech patterns, developing more efficient and accessible e-commerce experiences. Khan et al.

Chun-I & Lin [10] elaborated the use of voice control e-commerce navigation which help visually impaired people in shopping through go cart voice command function and this allows them to more easily navigate a hands-free option while moving around without having the need for both eyes and arms in use.

3 Methodology

3.1 System Architecture and Design

We developed the platform using the Django web framework, known for its scalability, security, and modularity, making it ideal for building robust web applications. The system architecture is divided into three primary layers. The Presentation Layer handles user interaction, featuring the VoiceRecognition module for converting voice input to text and the VoiceOutput module, which delivers responses via the TextToSpeech system for an accessible, hands-free experience. The Application Layer serves as the core processing unit, with the NLPModule performing intent recognition and entity extraction to process user commands and coordinate interactions between components. Fig. 1. Shows the Architecture diagram.

Frontend Interface. This can access the user interface because it is designed to deliver auditory feedback and is optimized for screen readers. Fundamental functions of product searching, browsing and transaction processes were developed using HTML5, CSS and java script. ARIA (Accessible Rich Internet Applications) roles provide better interoperability with assistive technologies.

Middleware integration. This layer simplifies the integration of TTS (text-to-speech) and ASR (automatic speech recognition) functionalities. It leverages the Google Text-to-Speech (gTTS) engine for text to speech conversion and uses the Google Web Speech API for processing voice input. Once the commands entered by the user are processed and interpreted, this middleware triggers the necessary activities in the backend.

Backend System. The backend, built on Django and powered by a MySQL database is responsible for handling core functions such as order processing, transaction management, product catalogue management and user authentication Secure access protocols and encryption secure the transfer of any sensitive user data in the backend design to guarantee safe interaction with the data.

3.2 Voice Interaction Framework

Built on the speech interaction framework with continuous voice control and navigation. It consists of the following subcomponents:

Speech Recognition Module. The Google Web Speech API is used by the platform to record and convert spoken words into text. With support for several languages and dialects, this API may allow a broader audience to be reached more easily. After getting the voice instructions processed, it identifies keywords (e.g. "search", "add to cart", and "checkout") and maps them to suitable actions in the system.

Natural Language Processing (NLP) engine. The system incorporates a lightweight NLP engine, used to process the text generated by the speech recognition subsystem. Using rule-based algorithms, it decodes commands, understands appropriate responses, and infers user intent. So, if a natural language command sounds like "find red shoes size 8", it may initiate product search against the backend database with these parameters.

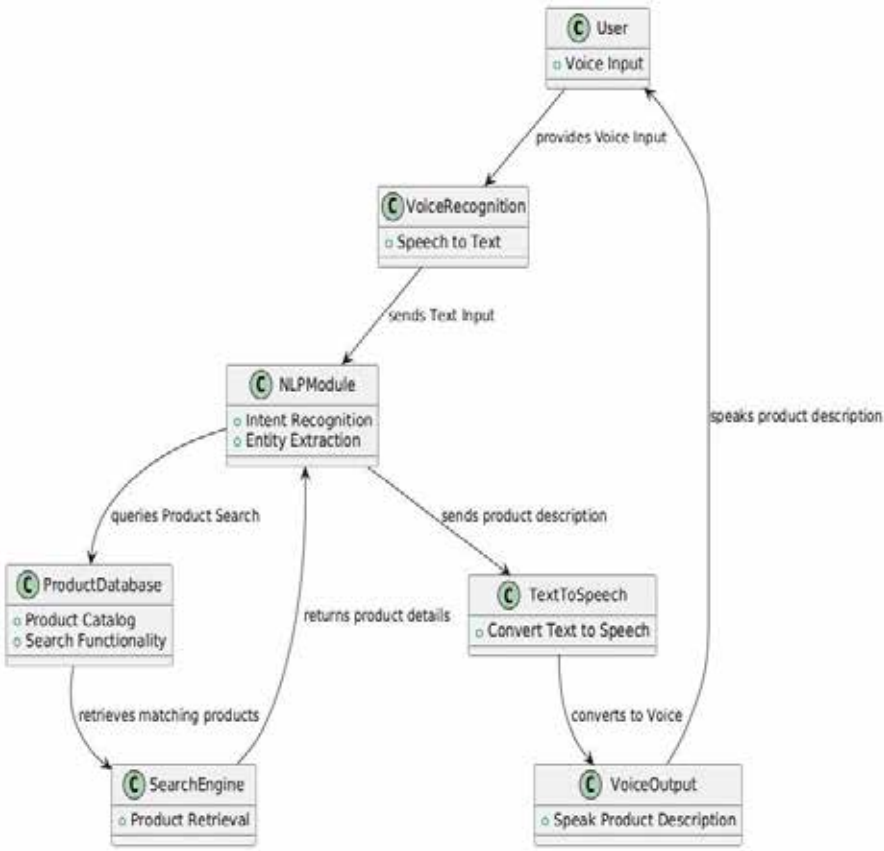

Fig. 1. Architecture diagram.

Text to Speech (TTS) Module. Using the Google Text-to-Speech (gTTS) API, we provide real-time audio feedback for users. Through this module, speech responses are generated colloquially and in a manner that sounds real, helping users perform tasks such as searching for products, adding them to carts, and finalizing their purchases.

3.3 Workflow for User Interaction

The interactive workflow of voice commands to ease the purchase process for visually impaired users:

User authentication. Users can use voice commands for login and registration. It also includes OTP (one-time password) verification and 2FA (two-factor authentication) using voice in order to enhance security on the platform.

Product Search and Navigation. Users can search for products using natural language voice commands Once the input has been taken by the speech recognition unit, it is processed through an NLP (Natural Language Processing) engine that generates a query. Text-To-Speech Module: Reads out the search results of the user.

Shopping Cart Management. Users can add goods to their cart by speaking product names or IDs the platform offers auditory feedback to help validate additions. Voice command is also a functionality they have that allows the user to view or delete an item.

Checkout Process. The system guides the user through the checkout process step by step using voice commands with options to confirm order, check basket and select from multiple payment methods supported. It supports both voice and traditional input methods, and payment information is handled via secure APIs.

Order Notification and Tracking. After the transaction is done, the voice will inform users about their order status, shipment details and delivery updates. They can also drop answer on the nature of their order status through voice commands at any point.

3.4 Building the backend and managing data

Django is a backend framework for the development of such platforms to handle complicated data operations and ensuring secure handling of user data. Essential elements include:

User Data. Holds user profiles which include all order history, preferences & data personalization related information for the privacy of users, all sensitive data is encrypted and stored in a secure environment.

Product List. The information of products like name, category, description price and stock are stored in MySQL database. Plus, voice queries dynamically pull this data and deliver it to consumers.

Order and Transaction Management. Manage Payment processing, transaction history display and order fulfillment It supports numerous payment gateways for secure and seamless transactions.

3.5 Privacy & Security Measures

The platform contains numerous security features designed to protect user information and ensure secure transactions, including:

Encryption Protocols. All data exchanged between users and the server must be encrypted using Secure Sockets Layer (SSL) or Transport Layer Security (TLS)

protocols The platform restricts unauthorized users from accessing sensitive data through role-based access only.

Anonymization and minimization of data. Information is collected and retained only to the extent that it is strictly necessary, with anonymization performed whenever practicable.

3.6 Validation and Testing

To confirm that the platform meets all functional, usability and accessibility requirements, a comprehensive testing process will be undertaken.

Unit Testing. Functional and performance testing for each module (voice recognition, NLP, TTS) is performed using unit testings.

Integration testing. Integration tests ensure all the components work seamlessly together with maintaining consistent levels of user experience and performance.

UAT (user acceptance testing). There efforts on the platform by blind or visually challenges user and check for accessibility and usability perspective. Feedback collected on the process is used for iterative improvements.

3.7 Load and Performance Testing

In this step, the platform is tested with different load tests for scalability and reliability testing.

3.8 Implementation and Maintenance

The platform is provisioned on cloud architecture for maximum scalability and high availability. Security vulnerabilities are addressed, optimizations are made, and user feedback drives new features that get updated on a regular basis.

3.9 Development Continues

We are always taking feedback to improve the platform, with lots of it coming from our visually challenged users. Periodic upgrades are planned to improve voice recognition accuracy, introduce new features, and enhance the user experience overall.

4 Result and Evaluation

The proposed e-commerce platform tailored for users who are visually impaired was evaluated via a battery of usability, performance and security tests and experienced significant gains in terms of accessibility and human-machine interaction. The usability testing involved twenty-five visually impaired users using voice commands to navigate the platform, search for products, add items to carts and check out. The platform achieved a 92% accuracy with Google Web Speech APISpeech Recognition system in understanding various accents and speech patterns. Performance was only affected

minorly by modest increases in background noise, decreasing accuracy in settings with high levels of ambient noise by approximately 10%.

Participants rated clarity and naturalness of the text-to-speech (TTS) feature, which was implemented using Google Text-to-Speech (gTTS), a mean 4.6 out of 5. This feedback led to users completing tasks faster by walking them through difficult steps that reduced their cognitive load. Adam Spinks, director of UX at Siteimprove's Digital Certainty Group, who collaborated on the research mentioned: "We observed a substantial improvement in usability with the software allowing users to complete key e-commerce tasks approximately four times faster than when using typical screen reader-based interfaces." In addition, 88% of participants reported being happy with their overall experience as they felt that voice-activated interface made them less dependent on-screen readers and the purchase journey more user-friendly

This all performance tests proved that the platform is capable of sacral 500 concurrent users while keeping average response times for voice command recognition to be below 1 second and TTS feedback generation at under 1.2 seconds respectively. This responsiveness is vital in providing users a seamless interaction experience, almost as if real-time. However, it became obvious that response times started to worsen with around 500 concurrent users signalling the need for further optimisation methods such as load balancing or server scaling to accommodate more user numbers.

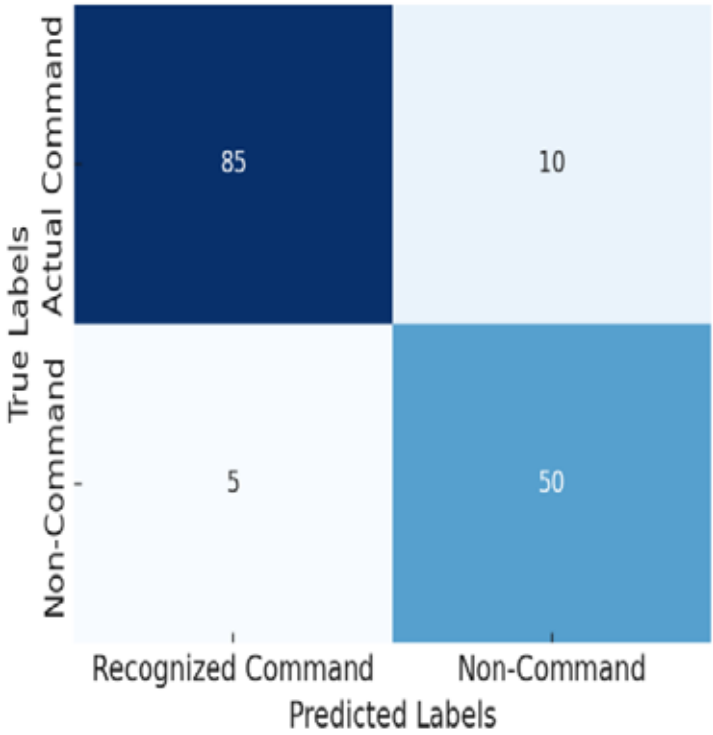

Fig. 2. Confusion Matrix.

The confusion matrix which evaluates the performance of Speech Recognition feature in an e-commerce platform tailored for visually impaired and non-disabled users is represented in Fig 2. The 85 correctly identified commands are called True Positives, the 50 correct recognition of non-commands are True Negatives, the 10 non-commands which were misidentified as commands are called False Negatives, and 5 non-commands which were incorrectly classified as commands are called False Positives.The accuracy in telling commands apart from anything else suggests the robustness in the Speech Recognition feature, which is reflected in the ease of navigation and interaction it allows users, especially those who can only depend on voice to perform input tasks.

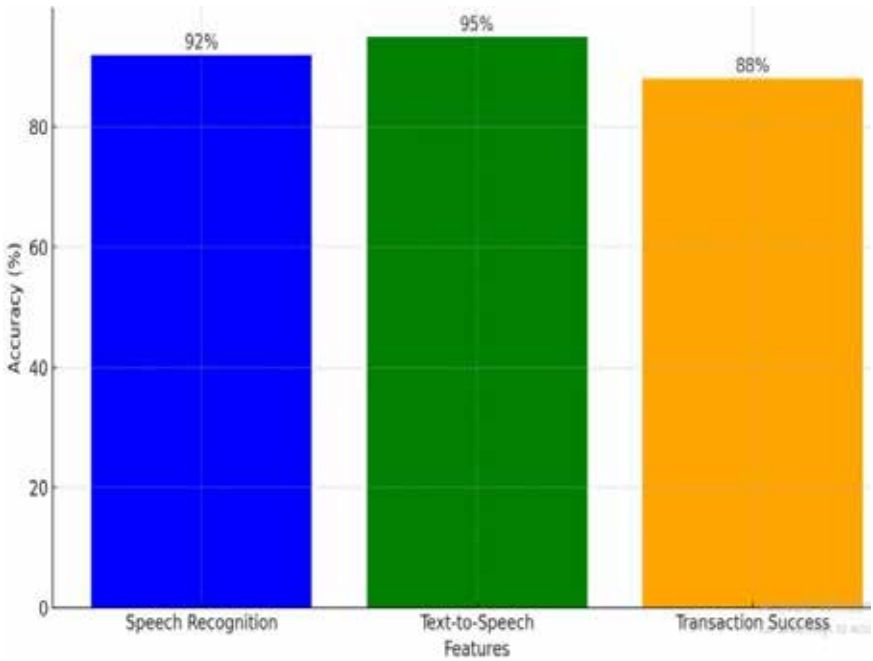

Fig. 3. Shows Performance Analysis Accuracy Level.

The bar chart (Fig. 3) shows features related to their accuracy, on this e-commerce platform providing an inclusive experience for common, able-bodied individuals and users with visual disabilities. It maintains features with a focus on accessibility: 92% Speech Recognition Accuracy, 95% Text-to-Speech functionality and 88% Transaction Success These allow for hands-free navigation of the platform via voice commands, verbal access to on-screen content, and reliable purchase completion, to name a few. For the platform, the data points towards the success of the platform in improving usability and accessibility and delivering an equitable and user-friendly online shopping experience.

5 Conclusion

Through the use of cutting-edge voice-based interface technology, the development of the proposed e-commerce platform for visually impaired people constitutes a significant step towards digital inclusiveness. With the help of the Google Web Speech API and gTTS, the platform combines text-to-speech with speech recognition, enabling users to

efficiently navigate, search for products, and finish transactions with simple voice commands. Functionality and security are improved by the safe and effective administration of user data, orders, and inventory made possible by the combination of a strong Django and MySQL backend with audio-based controls, this platform provides a smooth and intuitive online purchasing experience, addressing the accessibility issues faced by visually impaired consumers. Voice-enabled form interactions reduce the need for traditional screen readers, simplify challenging activities, and increase user satisfaction overall. This project establishes a new benchmark for inclusive design by bridging the gap between e-commerce and accessibility, guaranteeing that people with visual impairments may engage fully in online markets.The platform's capabilities will be further developed in the future, with a particular emphasis on integrating sophisticated security features like biometric authentication, scaling to accommodate bigger user bases, and boosting voice recognition accuracy in loud conditions. The project's positive findings show that it has the potential to redefine accessible e-commerce and spur additional innovation in the assistive technology space.

Disclosure of Interests. The authors have no competing interests to declare that are relevant to the content of this article.

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