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Designing Accessible AI Systems for SMEs: Compliance with ADA and Section 508 through Conversational Interfaces

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Abstract: With lawsuits related to the Americans with Disabilities Act (ADA) resulting in approximately $4 billion in annual economic losses for businesses, small and medium-sized enterprises (SMEs) face significant cost pressures when developing accessible applications. This paper proposes an accessibility-focused conversational system based on an open-source natural language processing (NLP) framework, aiming to reduce legal risks for SMEs while enhancing digital accessibility for users with disabilities. The system integrates text-to-speech (TTS) and speech-to-text (STT) modules with a simple user interface, leveraging technologies such as Azure Cognitive Services, Play Framework, and MongoDB. Through example applications in online retail and restaurant ordering systems, the paper demonstrates the system's usability, ADA and Section 508 compliance, and seamless integration with existing content management systems. Experimental results indicate that the proposed approach significantly reduces development costs and improves the user experience for individuals with disabilities, providing a viable path for SMEs to implement digital accessibility and laying the foundation for future integration with large language models (LLMs) to enable more natural human-computer interactions.

Keywords: accessibility technology; natural language processing (NLP); small and medium-sized enterprises (SMEs); text-to-speech (TTS); speech-to-text (STT); ADA compliance; digital inclusion

1. Introduction

In recent years, with the widespread adoption of digital services across industries, businesses have increasingly encountered legal and regulatory challenges related to digital accessibility. According to recent statistics, lawsuits in the United States arising from violations of the Americans with Disabilities Act (ADA) result in approximately $4 billion in annual economic losses, and small and medium-sized enterprises (SMEs) are disproportionately affected due to their limited resources. Unlike large corporations, these SMEs often lack dedicated development teams and sufficient funding to implement comprehensive accessibility features, making it difficult to integrate accessibility design into existing websites, e-commerce platforms, and mobile applications. This not only exposes them to potential legal risks and financial penalties but also increases the likelihood of losing customers who require accessible services.

At the same time, access barriers for users with disabilities remain widespread and persistent in digital environments. Individuals with visual impairments, hearing loss, mobility limitations, or cognitive difficulties frequently encounter obstacles when performing everyday online activities, such as browsing e-commerce sites, placing restaurant or-

ders, or interacting with web-based services. These barriers not only reduce the independence and convenience of users with disabilities but also contribute to a widening digital divide, limiting their ability to fully participate in modern digital society.

To address these pressing challenges, this paper proposes an accessibility-oriented conversational system built upon an open-source natural language processing (NLP) framework. The system integrates text-to-speech (TTS) and speech-to-text (STT) modules with a simplified and intuitive user interface, allowing users with various disabilities to interact with digital services through natural language in both voice and text formats. Importantly, the system leverages mature and widely adopted technologies, including Azure Cognitive Services for speech processing, Play Framework for scalable backend development, and MongoDB for flexible and high-performance data storage. This combination enables SMEs to deploy accessibility features rapidly and cost-effectively, reducing both development overhead and ongoing maintenance costs, while simultaneously mitigating potential legal liabilities.

By deploying the proposed system, SMEs can enhance the accessibility of their digital platforms, ensuring that users with disabilities can access information and services independently and efficiently. Furthermore, the system promotes a more inclusive digital ecosystem by enabling equitable access, bridging the digital divide, and fostering social responsibility. Ultimately, this solution demonstrates that accessibility and business viability are not mutually exclusive, and that even resource-constrained enterprises can achieve both regulatory compliance and an improved user experience through thoughtful and technology-driven design.

2. Related Work

Accessibility technologies have undergone long-term development in the fields of human-computer interaction (HCI) and web applications, with the overarching goal of providing equal digital access for users with visual, auditory, mobility, and cognitive impairments. Early research primarily concentrated on improving web and mobile application accessibility through design strategies such as enhanced screen reader support, optimized keyboard navigation, semantic HTML tagging, and high-contrast color schemes to accommodate users with diverse needs. For instance, Lazar et al.proposed a task-based accessibility evaluation method to systematically quantify the operational challenges encountered by users with disabilities when performing common online tasks, providing measurable insights into usability shortcomings [1]. While widely recognized standards such as the Web Content Accessibility Guidelines (WCAG), Section 508, and the Americans with Disabilities Act (ADA) provide comprehensive design principles, practical implementation remains a challenge for small and medium-sized enterprises (SMEs). These organizations often face limited technical expertise, constrained development budgets, and ongoing maintenance pressures, which frequently result in digital products and services that are less friendly or accessible to users with disabilities [2].

In recent years, rapid advancements in natural language processing (NLP) have introduced new opportunities for addressing accessibility challenges. Techniques such as automatic speech recognition (ASR), text-to-speech (TTS), natural language understanding (NLU), and natural language generation (NLG) have enabled the development of intelligent voice assistants, conversational interfaces, and question-answering systems that allow users to interact with digital platforms naturally through voice or text [3]. Notable examples include Microsoft's Seeing AI project, which combines NLP and computer vision to help visually impaired users obtain real-time information about their surroundings, and Google Duplex, which demonstrates the potential of automated voice-based dialogues for performing everyday tasks such as booking appointments. The availability of open-source NLP frameworks, such as Hugging Face Transformers, spacy, and Rasa, has

further lowered development barriers, empowering SMEs to experiment with AI-powered accessibility applications without requiring extensive machine learning expertise or infrastructure investments [4].

At the same time, research has examined the specific challenges faced by SMEs in implementing digital accessibility. Studies indicate that SMEs, due to limited funding and manpower, often struggle to simultaneously achieve legal compliance, optimize user experience, and maintain system scalability. This creates a pressing demand for accessibility solutions that are low-cost, modular, and quickly integrable into existing platforms. The accessibility-focused conversational system proposed in this paper is designed within this context, seeking to balance economic feasibility for SMEs, usability for users with disabilities, and adherence to legal and regulatory requirements. By bridging the gap between emerging NLP technologies and practical accessibility implementation, this work provides a foundation for future enhancements, including the integration of large language models (LLMs) to support more natural, intelligent, and context-aware human-computer interactions, ultimately contributing to the broader adoption of inclusive digital services [5].

3. System Design

The proposed accessibility-oriented conversational system adopts a modular design to facilitate rapid deployment, scalability, and maintainability for small and medium-sized enterprises (SMEs). The system is composed of three core modules—text-to-speech (TTS), speech-to-text (STT), and a simplified user interface (UI)—each designed to address specific accessibility challenges. The TTS module converts system-generated textual content into natural-sounding speech, allowing visually impaired users to access information auditorily and navigate digital platforms without visual dependency. The STT module captures and processes user voice input, converting it into text for further comprehension and system response. This bidirectional natural language interaction enables users to perform a wide range of tasks, such as browsing products, placing orders, and accessing information, through spoken commands. The simplified UI module offers an intuitive interface that supports multiple interaction modalities, including touch, keyboard shortcuts, and assistive devices, ensuring that users with varying physical or cognitive abilities can operate the system efficiently [3].

From a technical perspective, the system integrates mature and widely adopted technologies to guarantee reliability, performance, and flexibility. Azure Cognitive Services powers both speech recognition and synthesis, providing high accuracy, low latency, and multilingual support suitable for diverse user populations. The Play Framework is utilized for backend development, offering a robust and scalable architecture that can handle concurrent user requests and support complex business logic. MongoDB serves as the primary data storage solution, allowing flexible data modeling and efficient storage of user interactions, system states, and logs, thereby supporting future analysis and personalization features.

The modular design further facilitates seamless integration with existing content management systems (CMS) such as Shopify and WordPress. Through standardized APIs and plugins, SMEs can embed accessibility-oriented conversational features directly into their current websites or applications without major platform modifications, significantly reducing development time and cost. Additionally, the system's flexibility enables enterprises to configure voice languages, interface layouts, and interaction workflows to match their industry-specific requirements and target audience preferences. By balancing the accessibility needs of users with disabilities, the technical feasibility of deployment, and cost-effectiveness for SMEs, this design provides a practical, scalable, and maintainable foundation for implementing inclusive digital services across various business contexts.

4. Implementation

To validate the practical usability of the proposed accessibility-oriented conversational system, it was deployed in two common application scenarios: an online retail platform and a restaurant ordering system. In the online retail scenario, the system guides users' step by step through voice interactions, enabling them to browse product categories, check detailed product information, compare items, add products to the shopping cart, and complete checkout. During testing with actual users, visually impaired participants reported that voice instructions made it easier to navigate product lists without assistance, while mobility-impaired users appreciated the ability to complete tasks without relying on mouse or keyboard input. In the restaurant ordering system, users can select dishes, place orders, and make payments using voice commands or text input. The system provides real-time feedback on order status, confirms selections, and suggests popular or recommended items, ensuring that users with disabilities can complete orders efficiently and accurately. These real-world deployments demonstrate that the system can effectively support operational workflows across different business contexts while improving accessibility for users with various disabilities.

To ensure rapid and low-effort deployment for small and medium-sized enterprises (SMEs), the system includes seamless integration with widely used content management systems (CMS) such as Shopify and WordPress. Through standardized APIs and pre-built plugins, SMEs can incorporate the conversational accessibility features into existing websites or applications without significant modifications or specialized development expertise. The system also allows businesses to customize voice language, user interface layout, and interaction flow to meet the needs of different industries and user groups. In pilot deployments, SMEs were able to integrate the system within 2–3 weeks, with minimal technical support required. This practical approach reduces barriers for SMEs, enabling them to enhance the accessibility of digital services quickly, lower potential legal risks, and improve satisfaction among users with disabilities.

5. Evaluation

To validate the practical usability and effectiveness of the system, experiments were conducted in two typical application scenarios. First, in usability testing, 15 users with disabilities—including 8 visually impaired and 7 mobility-impaired individuals—were invited to complete routine tasks on the online retail and restaurant ordering systems. Participants were asked to perform common operations such as browsing products, checking detailed information, comparing options, adding items to the shopping cart, selecting dishes, customizing orders, and completing payments. Results indicated that users were able to successfully use voice commands to accomplish these tasks with minimal external assistance. Among them, visually impaired users achieved a 92% task completion rate using TTS voice feedback, while mobility-impaired users achieved an 88% success rate using the simplified UI. During the sessions, users provided qualitative feedback, noting that voice prompts were clear, the system responded promptly to commands, and the interface layout was highly intuitive. Several participants mentioned that the system reduced their reliance on assistance from family or staff, allowing them to perform online shopping or restaurant ordering independently. Overall, the interaction experience was significantly more seamless and less frustrating compared to traditional web interfaces, demonstrating the system's potential to improve daily digital accessibility for individuals with disabilities.

Second, to assess compliance, the system underwent thorough evaluation against ADA and Section 508 standards, including key metrics such as screen reader compatibility, keyboard navigation accessibility, color contrast, interactive element labeling, and voice output quality. Evaluation results demonstrated that the system met all compliance requirements, with particular strengths in voice interaction and interface navigation. These

findings indicate that the system not only provides legal compliance but also ensures strong assistive usability for users with varying types of disabilities.

Finally, in cost analysis, the system was deployed in a typical SME environment and compared with commercial ADA solutions currently available in the market. Experiments showed that the overall development cost of the proposed system was approximately one-third to one-half that of commercial alternatives, while the deployment cycle was reduced to only 2–3 weeks. Maintenance requirements were minimal due to the use of open-source components and cloud-based services, allowing flexible scalability and future upgrades. The ability to integrate with existing content management systems further reduced technical overhead and lowered the learning curve for SME development teams. These results indicate that the system can not only enhance the user experience for individuals with disabilities but also significantly reduce development, deployment, and compliance costs for SMEs. By providing a cost-effective and rapidly deployable solution, the system supports sustainable digital accessibility implementation and demonstrates a practical approach for smaller enterprises to meet legal requirements while improving service inclusivity.

6. Discussion

The proposed accessibility-oriented conversational system demonstrates not only technical feasibility but also significant social impact. First, by providing voice interactions and a simplified user interface, the system substantially enhances digital accessibility for visually impaired and mobility-impaired users in online retail, restaurant ordering, and other everyday digital services. Users with disabilities often face numerous barriers when navigating conventional websites or applications, leading to reduced independence and increased reliance on others for routine tasks. By enabling natural voice-based communication and streamlined interface navigation, the system allows users to independently browse products, place orders, and access information with greater efficiency and confidence. This inclusive design not only improves the immediate user experience but also contributes to narrowing the digital divide, promoting equity in access to digital services, and supporting social inclusion for individuals with disabilities in the broader community. Additionally, the system's adaptability to different business contexts ensures that a wide range of digital platforms can provide consistent, accessible experiences for all users, further amplifying its positive social effects.

Second, for small and medium-sized enterprises (SMEs), deploying a low-cost, rapidly integrable accessibility system offers tangible business benefits alongside social impact. ADA-related lawsuits continue to cause billions of dollars in annual losses, and SMEs often struggle to meet accessibility standards due to limited technical expertise, financial constraints, and tight operational timelines. By adhering to ADA and Section 508 requirements, the proposed system provides an economically feasible compliance solution that enables SMEs to meet legal obligations without extensive resource investment. The system's modular architecture allows enterprises to selectively implement functionality based on priority areas and user needs, while its scalability ensures that future feature upgrades—such as additional voice languages, enhanced interaction flows, or integration with emerging technologies—can be deployed with minimal disruption. This flexibility not only reduces potential litigation risks but also allows SMEs to enhance overall customer satisfaction and engagement by offering more accessible and inclusive digital services.

Overall, the system successfully achieves a balance between social and business value. It addresses the accessibility needs of users with disabilities while providing SMEs with a practical, cost-effective compliance tool. By demonstrating that inclusive design and business sustainability can coexist, the system offers actionable insights for promoting digital inclusion, reducing legal exposure, and supporting long-term, socially responsible business development. Furthermore, as digital accessibility awareness continues to grow

and regulatory frameworks evolve, such systems may serve as a foundation for wider adoption of inclusive technologies, contributing to a more equitable and universally accessible digital ecosystem for all stakeholders [2].

7. Conclusion

This paper proposes an accessibility-oriented conversational system specifically designed for small and medium-sized enterprises (SMEs), leveraging an open-source natural language processing (NLP) framework. The system aims to enhance digital accessibility for users with disabilities while simultaneously reducing development costs, technical complexity, and potential legal risks for businesses. Through a modular architecture, the system integrates text-to-speech (TTS), speech-to-text (STT), and a simplified, intuitive user interface, enabling voice-based interactions that allow users to browse products, place orders, and access services with minimal assistance. The system has been demonstrated in typical application scenarios such as online retail and restaurant ordering, where experimental results indicate significant improvements in usability, compliance with ADA and Section 508 standards, and overall cost-effectiveness compared to commercial solutions. These results validate not only the technical feasibility of the system but also its practical value for SMEs seeking to implement digital accessibility features rapidly and efficiently.

Looking ahead, future work will focus on incorporating large language models (LLMs) to further enhance human-computer interaction capabilities, enabling more natural, intelligent, and context-aware conversations. By leveraging LLMs, the system will be able to interpret complex user intents, generate personalized responses, provide proactive recommendations, and engage in multi-turn dialogues that more closely resemble human interaction. This will substantially improve the experience for individuals with disabilities, allowing them to complete tasks more efficiently and receive a higher level of service. In addition, future research will explore cross-platform deployment, enabling the system to function seamlessly on mobile devices, web applications, and other digital platforms, broadening its applicability across various industries. Efforts will also be made to extend support to a wider range of disability types, including hearing impairments and cognitive limitations, ensuring that the system is inclusive for diverse user groups. By promoting accessible digital solutions for SMEs, this work contributes not only to business competitiveness and legal compliance but also to the broader goal of fostering a more equitable, inclusive, and socially responsible digital environment. Ultimately, the proposed system provides a scalable foundation for SMEs to implement sustainable accessibility solutions, bridging the gap between technology, business, and social equity.

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