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WordWhiz: An AI-Powered Assistive Tool for Dyslexia Support

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Abstract: ***Dyslexia is a neurodevelopmental learning disorder that affects reading fluency, spelling accuracy, and written expression, often resulting in academic difficulties and reduced self-confidence. Conventional assistive tools provide limited support by addressing isolated learning challenges. This paper presents WordWhiz, an AI-powered assistive system designed to enhance reading comprehension and writing accuracy for individuals with dyslexia. The proposed system integrates text-to-speech with word highlighting, speech-to- text with grammar correction, phonetic spelling assistance, and transformer-based sentence simplification within a unified framework. The system is implemented as a device-based application to ensure low latency, data privacy, and offline usability. Experimental evaluation demonstrates improved text readability, reduced grammatical errors, and enhanced user engagement, validating the effectiveness of AI-driven assistive technologies in inclusive education.***

Keywords: Dyslexia, Assistive Technology, Natural Language Processing, Sentence Simplification, Text-to- Speech, Speech-to-Text.

I. INTRODUCTION

Dyslexia presents persistent challenges in language processing, often making tasks such as reading, spelling, and writing significantly harder for affected individuals. Traditional learning methods do not always address these difficulties, leading many learners to experience frustration, reduced confidence, and slow academic progress. With advancements in artificial intelligence, there is now an opportunity to create tools that adapt to individual learning needs rather than expecting learners to adapt to the tools. WordWhiz is designed with this philosophy using AI to support dyslexic users through personalized, interactive, and accessible language assistance The system integrates multiple technologies, including speech recognition, text-to-speech, phonetic guidance, and sentence simplification, to reduce cognitive strain and provide real-time support during reading and writing activities.

By combining intelligent automation with an intuitive user interface, WordWhiz aims to transform literacy development into a more empowering and engaging experience. The project ultimately seeks to demonstrate how AI-driven solutions can enhance inclusivity in education and offer meaningful support to learners with diverse linguistic needs.

II. RELATED WORK

Several studies have investigated the use of artificial intelligence and assistive technologies to support individuals with dyslexia and learning difficulties. Early research primarily focused on text-to-speech (TTS) based systems that convert written text into spoken audio to enhance reading accessibility. Smith et al. [1] proposed a TTS-based assistive system specifically designed for dyslexic learners, demonstrating improved reading comprehension. However, this approach mainly focuses on audio support and does not address sentence complexity, grammatical accuracy, or spelling difficulties. To improve text readability, Natural Language Processing (NLP)-based sentence simplification techniques have been explored. Kumar et al. [2] introduced rule-based and statistical methods to simplify complex sentences for learners with reading disabilities. Although these techniques reduce syntactic complexity, they are often limited to predefined sentence structures and may fail to preserve the original semantic meaning of the text. With the advancement of deep learning, transformer-based models have been applied to language correction tasks. Brown et al. [3] utilized BERT based transformer models for grammar correction and sentence refinement, achieving higher accuracy compared to traditional approaches. Despite their effectiveness, such models are commonly deployed in cloud-based environments, leading to concerns related to data privacy, internet dependency, and processing latency. Speech-based assistive technologies have also been proposed to support dyslexic learners through speech-to-text (STT) functionality. Wang et al. [4] developed an STT-based educational assistive system that allows users to convert spoken input into text, thereby reducing typing effort. However, this system operates as a standalone solution and lacks integration with text simplification, grammar correction, and spelling assistance features. In addition, phonetic spelling correction techniques have been studied to address common spelling errors made by dyslexic

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individuals. Lee et al. [5] proposed a phoneme-based spelling correction approach that suggests alternative spellings using dictionary matching. While effective for correcting isolated spelling errors, the system requires user intervention and does not adapt well to contextual word usage within sentences. Overall, existing assistive technologies mainly provide isolated functionalities rather than a comprehensive solution. The lack of an integrated, device-based system that combines sentence simplification, grammar correction, phonetic spelling assistance, and speech support highlights a significant research gap. This limitation motivates the development of the proposed WordWhiz system, which aims to provide a unified, lowlatency, and privacy-preserving assistive tool for dyslexic learners.

III. PROPOSED SYSTEM

The proposed system, WordWhiz, is an AI-powered assistive tool designed to support individuals with dyslexia in reading, writing, and text comprehension. The system integrates multiple Natural Language Processing (NLP) and speech-based components, including sentence simplification, text-to-speech, speech-to-text, grammar correction, and phonetic spelling assistance, into a unified application.

Users can provide input either through typed text or voice-based interaction, making the system flexible and accessible for diverse learning preferences.

The sentence simplification module employs transformer-based models such as T5 to transform complex and lengthy sentences into simpler forms while preserving their original semantic meaning. Grammar correction and phonetic spelling assistance modules help minimize common writing errors encountered by dyslexic learners, thereby enhancing writing accuracy and user confidence.

The text-to-speech functionality generates clear audio output to support auditory learning, while the speech-to-text module enables hands-free text input.The system adopts a modular architecture that facilitates interaction between the frontend interface, backend processing layer, and NLP models.

IV. FEATURE DESCRIPTION

A. Text-to-Speech (TTS)

The Text-to-Speech feature enables the system to convert written text into spoken audio output. This functionality is designed to support dyslexic users who experience difficulty in reading long or complex text passages. By providing clear and slow-paced speech output, the system allows users to listen to the content instead of relying solely on visual reading. This reduces cognitive load and improves comprehension. The TTS module also supports repeated playback, enabling users to listen to the same sentence multiple times until it is fully understood.

B. Speech-to-Text (STT)

The Speech-to-Text feature allows users to provide input through voice instead of typing. This is particularly helpful for users who struggle with spelling and written expression. The system captures spoken input and converts it into textual form using speech recognition techniques. The generated text is then passed to the language processing modules for correction and simplification. This feature promotes hands-free interaction and improves accessibility for users with writing difficulties.

C. Grammar Correction

The grammar correction module is responsible for identifying and correcting grammatical errors in user-provided text. Dyslexic users often face challenges with sentence structure, verb agreement, and punctuation. This module analyzes the input text and applies language rules and machine learning-based correction techniques to improve sentence clarity and correctness. By providing grammatically refined output, the system helps users produce clearer and more readable written content, thereby enhancing confidence in written communication.

D. Phonetic Spelling Suggestion

The phonetic spelling suggestion feature addresses spelling errors that arise due to sound-based confusion, which is common among dyslexic learners. This module uses phonetic encoding techniques to compare misspelled words with words that have similar pronunciation. Based on this comparison, suitable correction suggestions are generated. This approach helps users recognize correct spellings of words that sound similar, improving both spelling accuracy and vocabulary development.

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E. Sentence Simplification

The sentence simplification feature is designed to transform complex and lengthy sentences into simpler and more readable forms while preserving the original meaning. Dyslexic learners often experience difficulty understanding long sentences with complex grammatical structures and advanced vocabulary. This module analyzes the syntactic and semantic structure of the input text and applies transformer-based language models to generate simplified versions of the sentences. The simplified output reduces sentence length and replaces difficult words with more commonly used alternatives without altering the core message. This process helps lower cognitive load and improves reading comprehension. By presenting information in a clearer and more accessible format, the sentence simplification feature supports dyslexic users in understanding educational content more effectively and with reduced effort.

V. SYSTEM ARCHITECTURE

The system architecture of WordWhiz follows a modular design to ensure scalability and ease of integration. It is organized into three primary layers: the frontend user interface, the backend processing layer, and the NLP model layer. The frontend layer enables users to provide input in the form of text or speech and presents the simplified text along with audio output.

The backend layer manages request handling, feature coordination, and communication between the user interface and the language processing components. The NLP model layer incorporates pre-trained transformer-based models for sentence simplification, grammar correction, and phonetic spelling assistance. Speech processing modules, including text-to-speech and speech-to-text, are integrated into the backend workflow.

The sentence simplification component processes input text prior to further refinement to enhance readability. Grammar correction and phonetic spelling assistance are then applied to improve linguistic accuracy. The text-to- speech module converts the final processed text into clear audio output, while speech-to-text enables voice-based interaction. All system components communicate through well-defined APIs, ensuring smooth data flow and efficient processing.

The architecture is designed as a device-based application to promote data privacy, reduce response latency, and provide reliable performance. This layered structure enables efficient integration of AI models with user interaction components, making the system suitable for practical dyslexia support applications.

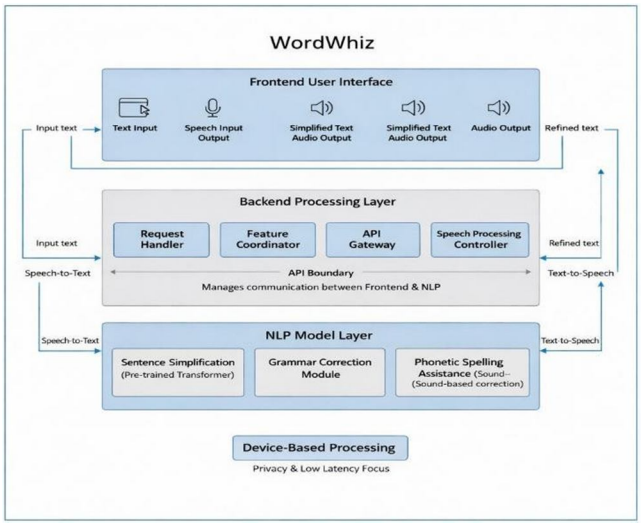


Figure 1. System Architecture

VI. IMPLEMENTATION

The implementation of the WordWhiz system is carried out using a modular and layered approach to ensure flexibility, maintainability, and ease of integration. The backend of the system is developed using Python, which handles all Natural Language Processing (NLP) tasks and core logic. Fast API or Flask is used to build restful APIs that act as an interface between the frontend and the NLP processing modules. These APIs receive user input, process it through the appropriate models, and return the output to the user interface. For sentence simplification, pre-trained transformer- based models such as T5 are utilized through the Hugging Face Transformers library. The input text is first preprocessed to remove noise and normalize formatting before being passed to the simplification model.

The model then generates a simplified version of the sentence while preserving the original meaning.Grammar correction and phonetic spelling assistance are implemented using NLP-based text processing techniques to identify and correct common errors faced by dyslexic learners. Speech-related features are integrated to enhance accessibility. The text-to-speech module converts the processed and simplified text into clear audio output, enabling users to listen to the content for better comprehension. The speech-to-text module allows users to input text using voice, which is then transcribed and passed through the same NLP pipeline for further processing. These features support users with different learning preferences and reading difficulties.

The frontend interface is designed to be simple and dyslexia-friendly, focusing on readability and ease of use. Users can enter text manually or through speech input and view the simplified text along with optional audio output. The frontend communicates with the backend APIs to fetch results in real time. All modules are integrated in a coordinated workflow to ensure smooth data flow and minimal latency. The entire system is designed as a device based application, meaning that data processing is performed locally without relying on cloud deployment. This design choice ensures user data privacy, reduced operational cost, and reliable performance even with limited internet connectivity. Overall, the implementation of WordWhiz successfully combines NLP models, speech technologies, and a user-friendly interface to provide an effective assistive tool for dyslexic learners secure cryptographic keys. The generated keys exhibited sufficient randomness and stability for encryption purposes. Key rotation and persistent key storage are planned for completion in the next phase.

VII. RESULT AND ANALYSIS

The WordWhiz system was evaluated using a variety of sample sentences and paragraphs that typically pose diffi- culties for dyslexic learners. The evaluation focused on the effectiveness of sentence simplification, accuracy of grammar correction, usefulness of phonetic spelling suggestions, performance of speech-based features, and overall system usability. The results indicate that the proposed system successfully improves text readability and writing accuracy. The sentence simplification module demonstrated strong performance in converting complex and lengthy sentences into simpler and more readable forms while maintaining the original meaning. This significantly reduced cognitive load and made the text easier to understand for dyslexic users. Simplified outputs showed shorter sentence length, clearer structure, and improved flow, which contributed to better comprehension. The grammar correction module effectively detected and corrected common grammatical errors such as subject–verb agreement issues, incorrect tense usage, and missing articles. Similarly, the phonetic spelling assistance feature provided accurate spelling suggestions based on pronunciation patterns, which helped users correct frequently misspelled words. These features together improved the overall quality of written text and increased user confidence during writing tasks. Speech-based features also performed reliably. The text- to-speech module generated clear and understandable audio output, allowing users to listen to simplified text and reinforce comprehension through auditory learning. The speech-to-text module accurately converted spoken input into text, enabling hands-free interaction and making the system more accessible for users who struggle with typing or reading. From a performance perspective, the system exhibited low latency and stable response times during testing. Since WordWhiz is designed as a device-based application, it does not depend on continuous internet connectivity, which ensures consistent performance and enhanced data privacy. The frontend interface was found to be user-friendly, with a dyslexia- oriented design that supported easy navigation and readability. Overall, the results demonstrate that WordWhiz effectively integrates multiple assistive features into a single platform, providing comprehensive support for dyslexic learners. Compared to traditional tools that offer isolated functionalities, the proposed system delivers a more holistic and accessible solution for improving reading comprehension, writing accuracy, and learning efficiency.

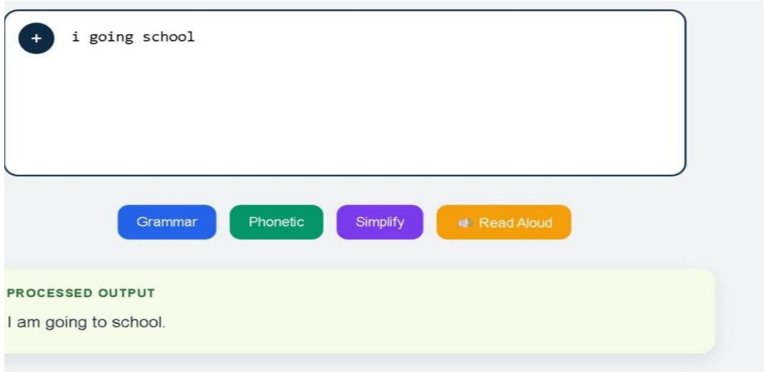


Figure2. Grammar Correction

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Figure3. Phonetic Suggestion

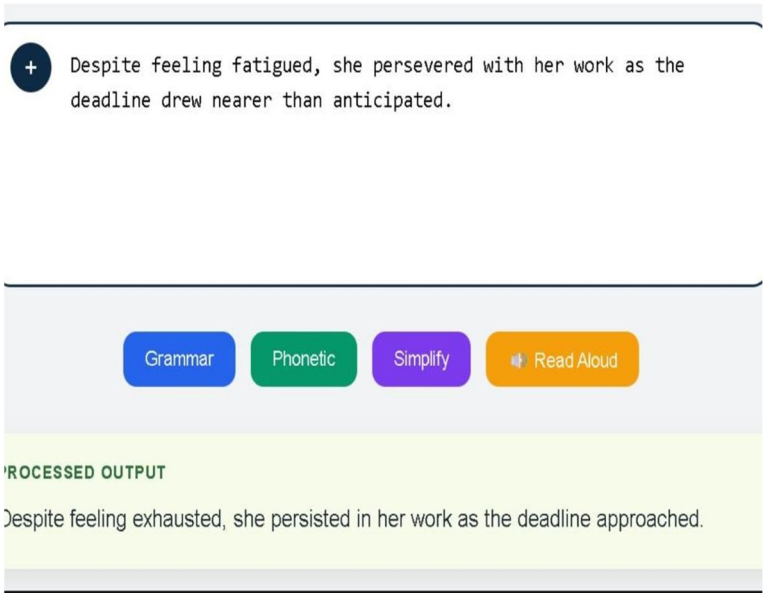


Figure4. Sentence Simplification

VIII. FUTURE SCOPE

The current implementation of WordWhiz demonstrates effective support for dyslexic users through text-to- speech, speech-to-text, grammar correction, sentence simplification, and phonetic spelling assistance. In future versions, user-level personalization can be incorporated to adapt system behavior based on individual learning patterns and reading abilities. By analyzing repeated errors and interaction history, the system can dynamically adjust the level of simplification and correction to suit each user's needs.

Another important direction for future enhancement is the inclusion of multilingual support. Extending the system to handle regional and international languages would enable broader adoption and provide assistance to dyslexic learners from diverse linguistic backgrounds. This can significantly improve accessibility and make the system suitable for use in multilingual educational environments.

Future work can also focus on improving evaluation and feedback mechanisms. Advanced readability assessment metrics and real-time user feedback modules can be integrated to track learning progress and measure improvement in comprehension and writing accuracy. Large-scale user studies can be conducted to quantitatively assess the long-term effectiveness of the system in educational settings.

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Additionally, the system can be extended to mobile platforms to enhance portability and ease of access. Incorporating adaptive learning techniques and lightweight on-device models can further improve responsiveness and personalization while maintaining data privacy. These future enhancements will strengthen WordWhiz as a comprehensive, intelligent, and inclusive assistive learning solution for individuals with dyslexia.

IX. CONCLUSION

This paper presented WordWhiz, an AI-powered assistive system developed to support individuals with dyslexia in reading, writing, and text comprehension. The system integrates multiple natural language processing and speech-based functionalities, including sentence simplification, grammar correction, phonetic spelling assistance, text-to-speech, and speech-to-text, into a unified application. By combining these features, WordWhiz addresses the limitations of traditional assistive tools that offer isolated support mechanisms.

Experimental results indicate that the proposed system improves text readability and enhances writing accuracy for dyslexic learners. The sentence simplification module effectively reduces linguistic complexity while preserving the original meaning, thereby lowering cognitive load and improving comprehension. Grammar correction and phonetic spelling assistance help minimize common writing errors, while speech-based features provide alternative interaction modes that improve accessibility and learning flexibility.

The modular architecture of WordWhiz enables efficient coordination between the user interface, processing layer, and language models, ensuring smooth operation and scalability. Its device-based implementation promotes data privacy, reduces dependency on continuous internet connectivity, and provides low-latency response, making it suitable for practical deployment in educational environments.

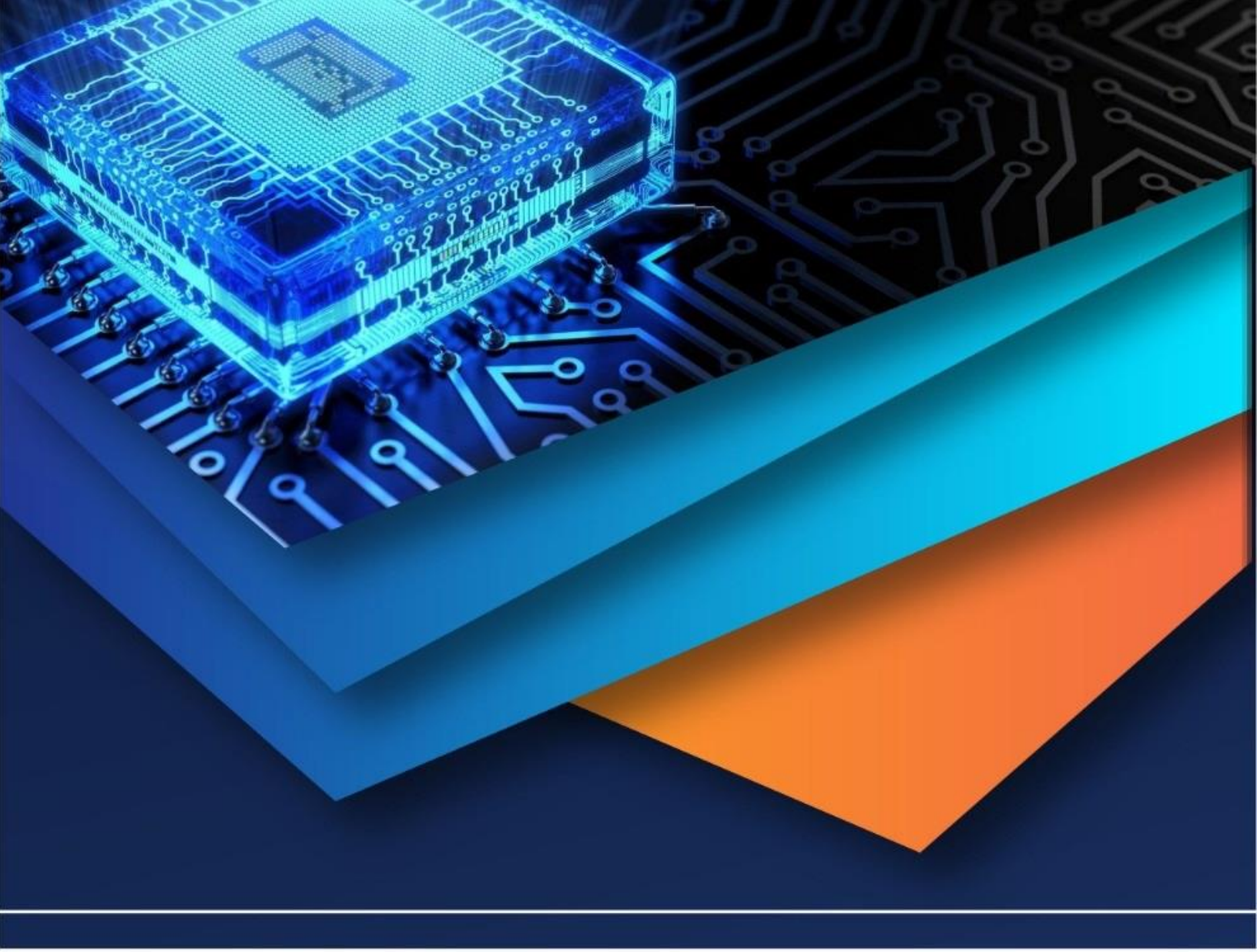
Overall, WordWhiz demonstrates the potential of AI-driven assistive technologies in supporting inclusive learning for individuals with dyslexia. The results validate the effectiveness of integrating text and speech processing techniques within a single system to improve usability and learning outcomes. The proposed approach provides a foundation for future advancements in personalized and adaptive dyslexia support systems.

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