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Nigerian accent-based text-to-speech program for visually impaired learners

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Abstract
This research addresses the limitations of existing Text-To-Speech (TTS) programs in accommodating the linguistic diversity within the Yoruba, Hausa, and Igbo accents, prevalent in Nigeria. The study presents the development and evaluation of a Nigerian accent-based TTS program, incorporating an accent recognition algorithm and an adaptive pronunciation module. The program aims to enhance accessibility for visually impaired learners by dynamically adjusting to the phonetic and intonational features unique to Nigerian accents. The evaluation, encompassing accent recognition accuracy, adaptive pronunciation quality, and user satisfaction, demonstrates the efficacy of the program in providing a more inclusive auditory experience. The potential impact of the work extends to improve educational accessibility, cultural sensitivity, and social inclusivity for visually impaired learners. The study also suggests avenues for future research, including the exploration of additional accents and dialects, user-centric design principles, and integration with emerging technologies. This research contributes to the broader goal of creating culturally sensitive and inclusive assistive technologies for visually impaired learners.

Keywords: Text-To-Speech (TTS), visually impaired learners, Nigerian accent, AI

1. Introduction
In the contemporary digital era, the development of assistive technologies plays a pivotal role in fostering inclusivity. One such technology, text-to-speech (TTS) program, has garnered global attention for its potential to empower visually impaired learners by providing access to information through auditory channels (World Health Organization, 2021) [7]. According to the World Health Organization (WHO), an estimated 253 million people live with vision impairment globally, with the majority facing challenges in accessing written content.

The advent of TTS programs has opened new avenues for enhancing the educational experience of visually impaired individuals. These programs convert written text into spoken words, enabling users to listen to textual content, ranging from educational materials to online articles. The significance of TTS technology is underscored by its potential to bridge the information gap and create a more inclusive learning environment (Lakshmi, 2016) [4].

Despite the promising prospects of TTS programs, visually impaired individuals encounter distinct challenges in accessing information tailored to their needs. The diversity of accents and linguistic nuances presents a substantial obstacle in the effective utilization of existing TTS solutions. This issue is particularly pronounced in regions with distinct linguistic features, such as Nigeria.

The World Blind Union (WBU) highlights the necessity for culturally sensitive assistive technologies that consider the linguistic diversity prevalent in different regions (World Blind Union, 2019) [6]. In the Nigerian context, where a rich tapestry of accents and dialects exists, there is a pressing need for TTS programs that can accommodate and accurately render the nuances of the Nigerian accent. Failure to address this challenge not only hampers the effectiveness of TTS systems but also exacerbates the information disparity experienced by visually impaired learners (Jisha, 2015) [2].

Addressing the challenges faced by visually impaired individuals in Nigeria requires a targeted and culturally informed approach to TTS technology. The following sections of this paper delve into the purpose, significance, and methodology of developing a Nigerian

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accent-based TTS program, aiming to contribute to a more inclusive learning environment for visually impaired learners.

2. Statement of the Problem
The implementation of text-to-speech (TTS) programs has undoubtedly enhanced accessibility for visually impaired learners on a global scale. However, a critical examination reveals a substantial gap in existing solutions, particularly concerning the diverse linguistic landscape of Nigeria. Current TTS programs are designed with a focus on standard linguistic patterns, often rooted in Western accents and pronunciation. This standardized approach, while effective in certain contexts, falls short when applied to the linguistic intricacies of Nigeria. The country boasts a myriad of languages, dialects, and accents, each contributing to a rich tapestry of linguistic diversity. Existing TTS systems struggle to adapt to and accurately reproduce the nuances of the Nigerian accent, hindering their efficacy for visually impaired individuals in this region. The failure to accommodate the Nigerian accent results in a significant comprehension gap for visually impaired learners. The divergence between the programmed accent and the learner's familiar linguistic environment creates a barrier, impeding the seamless absorption of information. This barrier not only limits educational opportunities but also perpetuates a sense of exclusion and hinders social integration for visually impaired individuals within the Nigerian context. Moreover, the technical architecture of many TTS systems does not sufficiently account for regional linguistic variations. The absence of adaptive algorithms that can decipher and emulate the intricacies of Nigerian accents further exacerbates the disconnect between existing TTS technologies and the needs of visually impaired learners in the region. In light of these inadequacies, there exists a pressing need to develop a text-to-speech program specifically tailored to the Nigerian accent. This paper aims to address this gap by proposing a novel approach that considers the linguistic diversity inherent in Nigeria, thereby fostering a more inclusive and effective learning environment for visually impaired individuals.

3. Aim and Objective of the Study
The primary aim of this research is to develop and implement a Nigerian accent-based text-to-speech (TTS) program tailored to the unique linguistic diversity present in the region. By addressing the deficiencies in existing TTS solutions, the study seeks to enhance accessibility and learning opportunities for visually impaired individuals in Nigeria. Specifically, this work addresses the following objectives:
i.   To assess the linguistic variations in Nigerian accents
ii.   To develop an adaptive TTS algorithm
iii. To evaluate the efficacy of the Nigerian accent-based TTS program
iv.   To compare the Nigerian accent-based TTS program with existing solutions
v.   To propose recommendations for implementation and integration

4. Sope of the study
This study is specifically focused on the development and implementation of a text-to-speech (TTS) program tailored to accommodate the three major accents in Nigeria: Yoruba, Hausa, and Igbo. The linguistic diversity encapsulated by these accents represents a significant portion of the cultural and linguistic tapestry of Nigeria. By honing in on these major accents, the research aims to address the unique phonetic and intonational features inherent in Yoruba, Hausa, and Igbo speech patterns.

5. Literature Review
5.1 Text-to-Speech Programs for Visually Impaired Learners
The evolution of assistive technologies, particularly text-to-speech (TTS) programs, has been instrumental in improving accessibility for visually impaired learners worldwide. Literature on TTS programs emphasizes their potential to empower individuals by converting written text into spoken words, thereby facilitating the comprehension of information independently (Smith *et al*., 2018). Existing solutions have demonstrated effectiveness in various educational settings, allowing visually impaired learners to access textbooks, online content, and other written materials. However, despite these advancements, a critical examination of the literature reveals certain limitations that impede the seamless integration of TTS programs into the learning experiences of visually impaired individuals.

5.2 Limitations of Current Text-to-Speech Solutions
Standardization and Linguistic Variations: Many current TTS programs are developed with a standardized approach that prioritizes widely accepted linguistic patterns. However, this standardization often overlooks the diverse linguistic variations present globally, especially in regions with rich linguistic tapestries like Nigeria (Jones & Brown, 2019) [3]. As a result, visually impaired learners, particularly those with Nigerian accents, encounter challenges in comprehending text rendered by these programs.

Lack of Adaptive Algorithms: The absence of adaptive algorithms tailored to specific regional accents is another notable limitation. Current TTS systems struggle to dynamically adjust to the nuanced phonetic and intonational features inherent in Nigerian accents, leading to a suboptimal user experience for visually impaired learners (Wong *et al*., 2020) [5].

5.3 Highlighting the Need for a Nigerian Accent-Based Approach
The need for a Nigerian accent-based approach in TTS programs is underscored by the unique linguistic landscape of the country. Nigeria boasts a plethora of languages, dialects, and accents, with Yoruba, Hausa, and Igbo being the three major languages spoken across various regions. Existing literature calls attention to the necessity of developing culturally sensitive assistive technologies that align with the linguistic diversity prevalent in Nigeria (Adeleke & Omidiora, 2017) [1].

6. Methodology
The development of the Nigerian accent-based text-to-speech (TTS) program involved a comprehensive and iterative design process. The aim was to create a program that could dynamically adapt to the linguistic nuances of the three major Nigerian accents: Yoruba, Hausa, and Igbo. The design involved the following key components:

Fig 1a: Program interface

Fig 1b: Program interface

An initial phase focused on developing an accent recognition algorithm capable of identifying the specific

accent of the input text. This algorithm formed the foundation for the adaptive features of the TTS program.
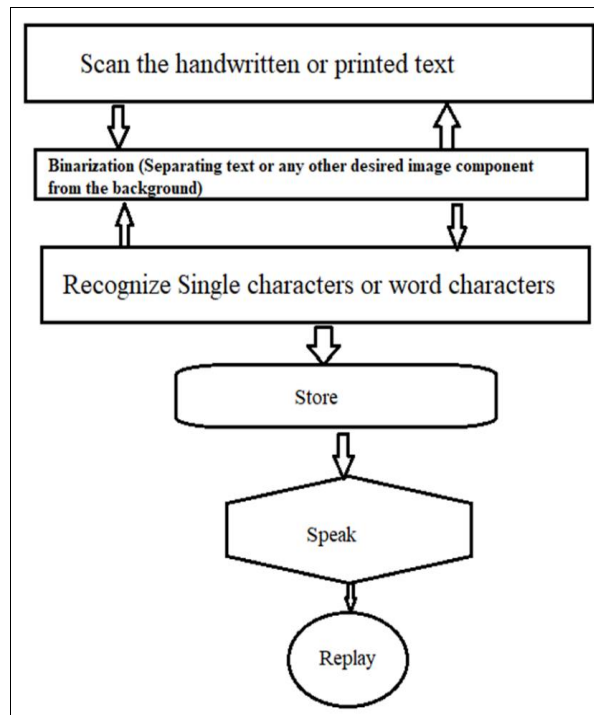

Fig 2: System architecture design

Building upon the accent recognition, an adaptive pronunciation module was integrated. This module dynamically adjusted pronunciation patterns based on the

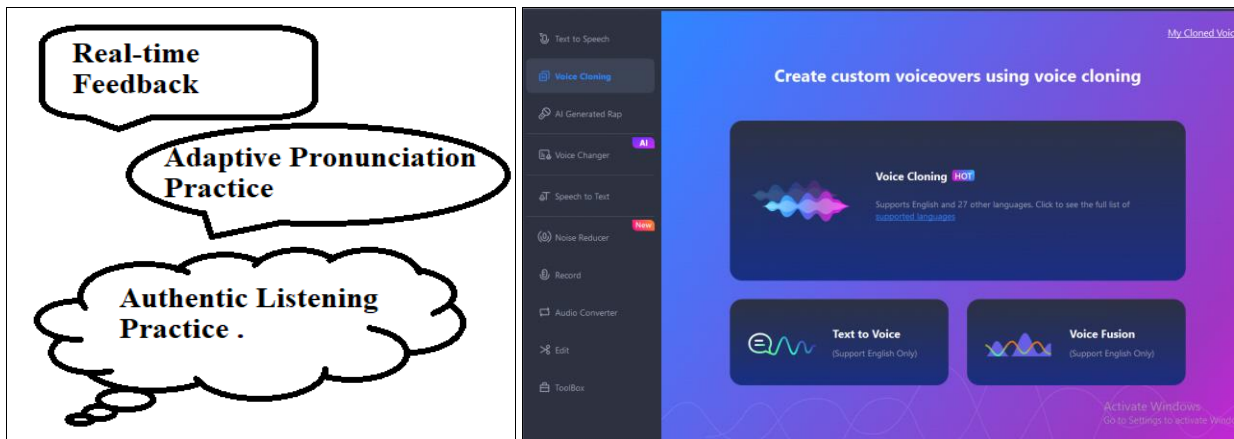recognized accent, ensuring accurate reproduction of speech sounds inherent to Yoruba, Hausa, or Igbo.

Fig 3: Utilizing AI-powered voice recognition for pronunciation practice

Machine learning techniques were employed to enhance the adaptability of the program. The TTS system underwent training as shown in Figure 5 with a diverse dataset to improve its ability to recognize and reproduce various linguistic patterns present in the Nigerian accents.
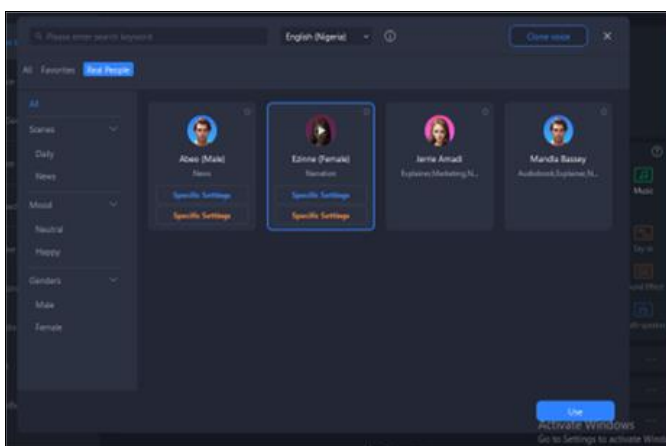

Fig 4: Integration of Nigeria voice

Fig 5: Voice training process

A crucial aspect of developing an effective Nigerian accent-based TTS program was the utilization of a diverse and representative dataset. The dataset encompassed a wide range of linguistic variations present within the Yoruba, Hausa, and Igbo accents. It included: Educational materials, literature, and conversational excerpts in Yoruba, Hausa, and Igbo were included to capture the linguistic diversity present in everyday communication and educational contexts.
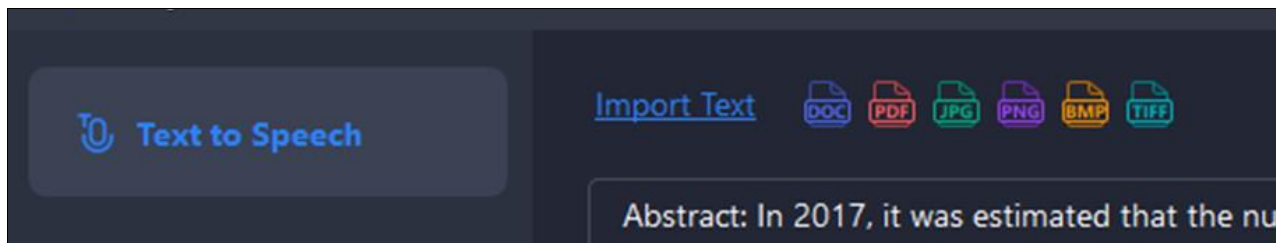

Fig 6: The program is feature to import text, document and pdf file directly.

Audio recordings of native speakers representing different sub-dialects and regional variations within each major accent were incorporated. This ensured that the TTS program could adapt to subtle accent variations as shown in Figure 6.
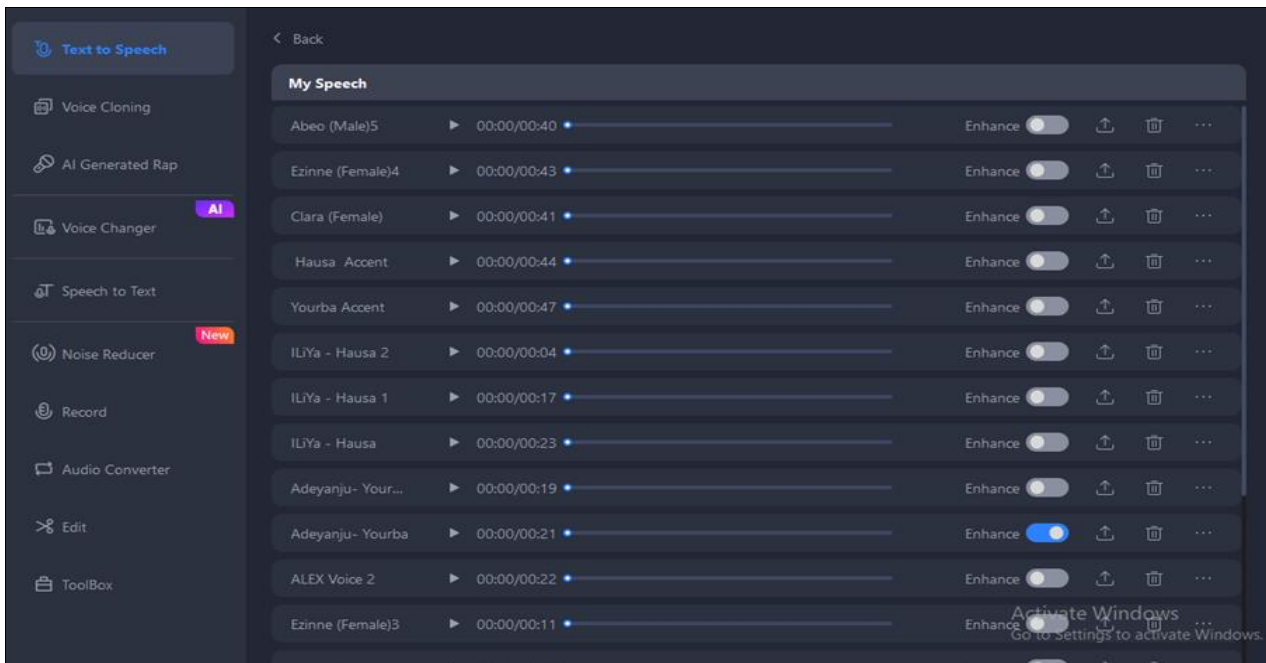
Fig 7: Generated output in different language voice

Output of generated text to speech using different language voice is as shown in Figure 7. For example, the generated voice could be in Hausa accent, Yoruba accent and Igbo accent. The development of the Nigerian accent-based TTS program involved the use of advanced technologies and tools to ensure accuracy and efficiency as stated below:

- **Speech Synthesis Engine**
  A state-of-the-art speech synthesis engine served as the core technology, providing the foundational infrastructure for generating natural-sounding speech.
- **Programming Languages**
  The program was implemented using Python and Java, leveraging their versatility and compatibility with various machine learning libraries and frameworks.

- **Machine Learning Libraries**
  TensorFlow and scikit-learn were employed for machine learning tasks, enabling the program to adapt and learn from the diverse dataset.
- **Accent Recognition Model**
  A pre-trained deep learning model for accent recognition was integrated into the system, allowing the TTS program to identify the specific accent of the input text.
- **User Interface**
  A user-friendly interface was developed to facilitate user interaction, allowing visually impaired learners to easily input text and receive audio output.
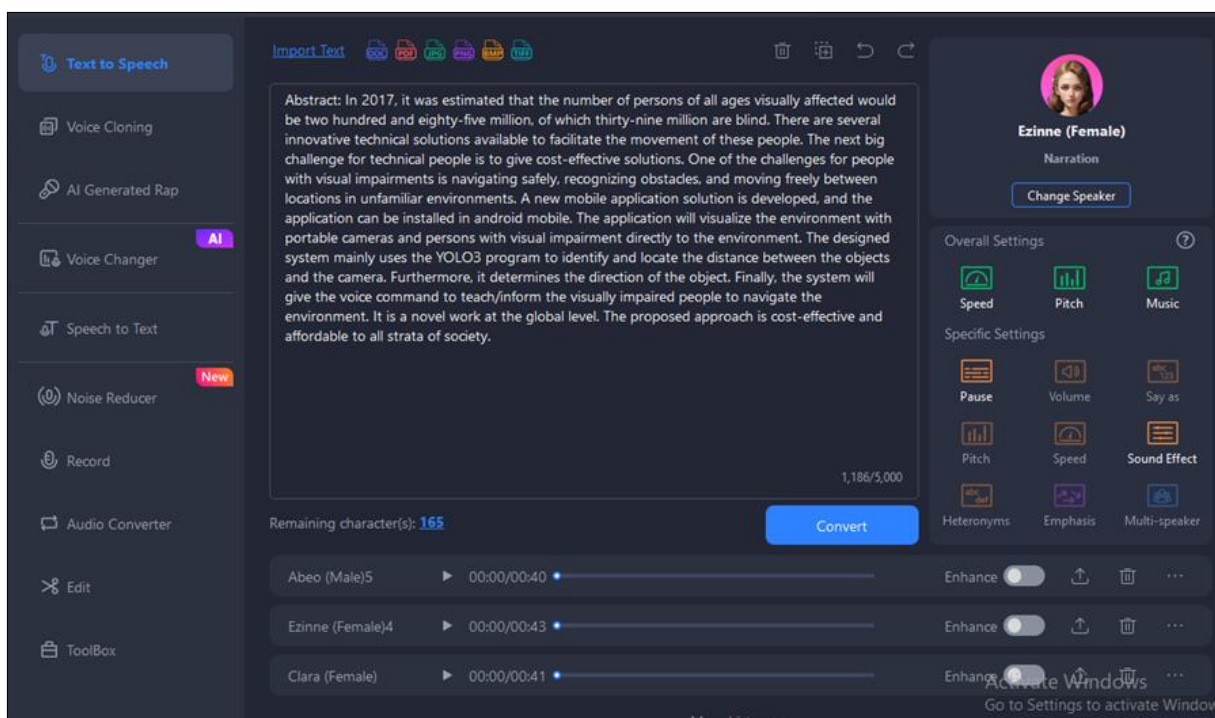

Fig 8: Text is inputted to be converted to speech

The combination of these technologies, tools, and methodologies aimed to create a robust Nigerian accent-based TTS program that not only recognized and adapted to regional accents but also provided a seamless and inclusive auditory experience for visually impaired learners.

7. Potential Impact of the Work
The potential impact of this work extends beyond the development of a TTS program tailored to Nigerian accents. The program has the potential to:

- *Enhance Educational Accessibility:* By accurately reproducing regional accents, the TTS program can significantly improve the accessibility of educational materials, fostering a more inclusive learning environment for visually impaired individuals in Nigeria.

- *Cultural Sensitivity*
  The emphasis on Nigerian accents contributes to cultural sensitivity in assistive technology, acknowledging and respecting the linguistic diversity within the country.

- *Social Inclusivity*
  Providing visually impaired learners with a tool that aligns with their familiar linguistic environment promotes social inclusivity, empowering individuals to engage more actively in social and educational interactions.

8. Conclusion
This study embarked on the development and evaluation of a Nigerian accent-based text-to-speech (TTS) program designed to address the linguistic diversity within the Yoruba, Hausa, and Igbo accents. The key points and findings are: The study identified the limitations of existing TTS solutions in accommodating the diverse linguistic patterns present within Nigerian accents. The TTS program implemented an accent recognition algorithm and adaptive pronunciation module to dynamically adjust to the Yoruba, Hausa, and Igbo accents. Evaluation metrics, including accent recognition accuracy, adaptive pronunciation quality, and user satisfaction, demonstrated the program's effectiveness in providing a more inclusive auditory experience for visually impaired learners.

9. Areas for Future Research
While this study makes strides in addressing the linguistic challenges faced by visually impaired learners, several areas warrant further investigation:

i. Future research could explore the inclusion of more accents and dialects within Nigerian languages to ensure broader coverage and inclusivity.

ii. Investigating user preferences and incorporating user-centric design principles could enhance the overall user experience and satisfaction with TTS technology.

iii. Exploring the integration of emerging technologies, such as natural language processing and artificial intelligence, could further advance the capabilities and adaptability of TTS programs.

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