Mobile Base Sinhala Book Reader for Visually Impaired Individuals - Optical Character Recognition (OCR)
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Project Proposal Report

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DECLARATION

To the best of our knowledge and belief, this proposal does not contain any previously published or written by another person material, except where the acknowledgement is made in the text. I hereby declare that this is my own work and that no material previously submitted for a degree or diploma in any other university or Institute of higher learning has been incorporated without acknowledgment.

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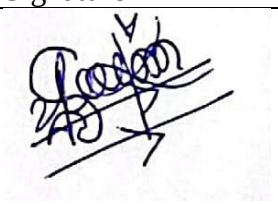
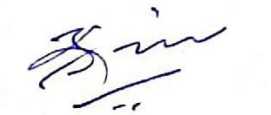
Semini J.P.D.L.	IT20241346	

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.



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Signature of the supervisor Date

ABSTRACT

The Android-based mobile solution developed for this study aims to satisfy the community of blind people's and/or visually impaired people's reading requirements. The initiative intends to offer an alternative to the outdated readers for printed documents in Sinhala. The accuracy of the prosodic features can be added to the voice to further enhance the naturalness of the Optical Character Recognition (OCR) synthesizer. By using haptic signals and audio-based support built into the picture acquisition module, a user with vision impairments can simply use the book reader on their smartphone. For humans to acquire knowledge for the majority of their daily tasks, reading is a crucial skill.

As my part, I will be doing the Optical Character Recognition (OCR).Optical Character Recognition (OCR) technology is a tool that can be used to help blind and visually impaired people access printed text. OCR software can analyze images or scanned documents and extract the text from them, which can then be read aloud by a text-to-speech program or displayed in braille. OCR technology can also be used to convert printed books, articles, and other documents into accessible digital formats such as e-books or audio books, which can be easily accessed and navigated using assistive technology .The optical character recognition (OCR) component is a key feature of the mobile-based Sinhala book reader for visually impaired individuals. This component allows the user to take a picture of a printed, typed, or handwritten text and converts it into machine-encoded text that can be read aloud by the app .OCR is the process of identifying and classifying optical patterns in a digital image and translating them into machine-readable text. The OCR component of the app uses advanced algorithms and image processing techniques to extract text from an image, such as a page from a book or a newspaper.

The extracted text is then processed and converted into an electronic or mechanical format, which can be read aloud by the app's text-to-speech feature or displayed on the screen. This component supports the Sinhala language, providing visually impaired individuals with access to a wide range of Sinhala literature.

By incorporating OCR technology into the mobile-based Sinhala book reader, visually impaired individuals can now access printed and handwritten materials with ease, promoting their independence and enhancing their reading experience. The OCR component is a critical feature that enables users to access and enjoy a wealth of literary resources that were previously inaccessible to them.

Optical Character Recognition (OCR) technology can also be used for Sinhala character identification and word formation. OCR software can analyze images or scanned documents containing Sinhala text and extract the text from them, which can then be used for further processing. With the help of machine learning and image processing , OCR technology can be trained to accurately recognize Sinhala characters, even when they are handwritten or in non-standard fonts. This can greatly improve access to Sinhala literature and other printed materials for blind and visually impaired individuals who use assistive technology.

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1. INTRODUCTION

1.1. Background & Literature survey

Optical Character Recognition (OCR) technology is a powerful tool that can convert images of text into machine-encoded text that can be read by computers [2]. This technology has revolutionized the way we interact with written content, enabling us to digitize printed materials and make them accessible to a broader audience. One of the most significant applications of OCR technology is in creating inclusive technology that benefits visually impaired individuals [6] . By using OCR technology, visually impaired individuals can scan and recognize text from images or documents using the camera of their smartphone. The text can then be converted into spoken words, allowing visually impaired individuals to access and understand the content.

Overall, the history of Sinhala OCR technology for visually impaired individuals is a relatively short one. However, with the increasing prevalence of smartphones and other mobile devices, there is significant potential for the development of new and innovative OCR apps that can significantly improve the quality of life for visually impaired individuals in Sri Lanka.

However, most existing OCR programs are designed for English and industrial use, leaving languages like Sinhala underrepresented. [10] Some OCR systems are available in other languages [1] . Developing an OCR application for Sinhala language presents unique challenges, including the complex combination of characters and variations in font styles and image quality. Despite these challenges, developing inclusive technology for all individuals is critical, and we are committed to providing visually impaired individuals with the tools they need to access information and enhance their quality of life. This report will explore the development of an OCR app for the Sinhala language, including the challenges involved, the potential use cases, and the impact on the lives of visually impaired individuals in the community.

In today's world, access to information is crucial for personal growth, education, and career development. Unfortunately, for visually impaired individuals, accessing printed materials can be a significant challenge [14] . OCR technology offers a solution by providing a means to convert printed materials into digital text that can be accessed using assistive technologies such as text-to-speech readers.

However, the vast majority of OCR technology is designed for the English language and may not work as effectively for other languages [6]. For languages with complex character sets like Sinhala, the challenges of developing an OCR app are even greater. Despite these challenges, the need for inclusive technology for all individuals remains, and we are committed to developing an OCR app that can benefit Sinhala-speaking individuals who are visually impaired.
The OCR app we have developed for the Sinhala language is based on a machine learning algorithm that has been trained to recognize Sinhala characters. Our OCR app is designed to provide a reliable and accurate means of recognizing text from digital images, making it easier for visually impaired individuals to access printed materials. In this report, we will provide an overview of our OCR app's development process, including the challenges we faced and the

solutions we implemented. Additionally, we will discuss the potential use cases of the OCR app and its impact on the lives of visually impaired individuals in the Sinhala-speaking community.

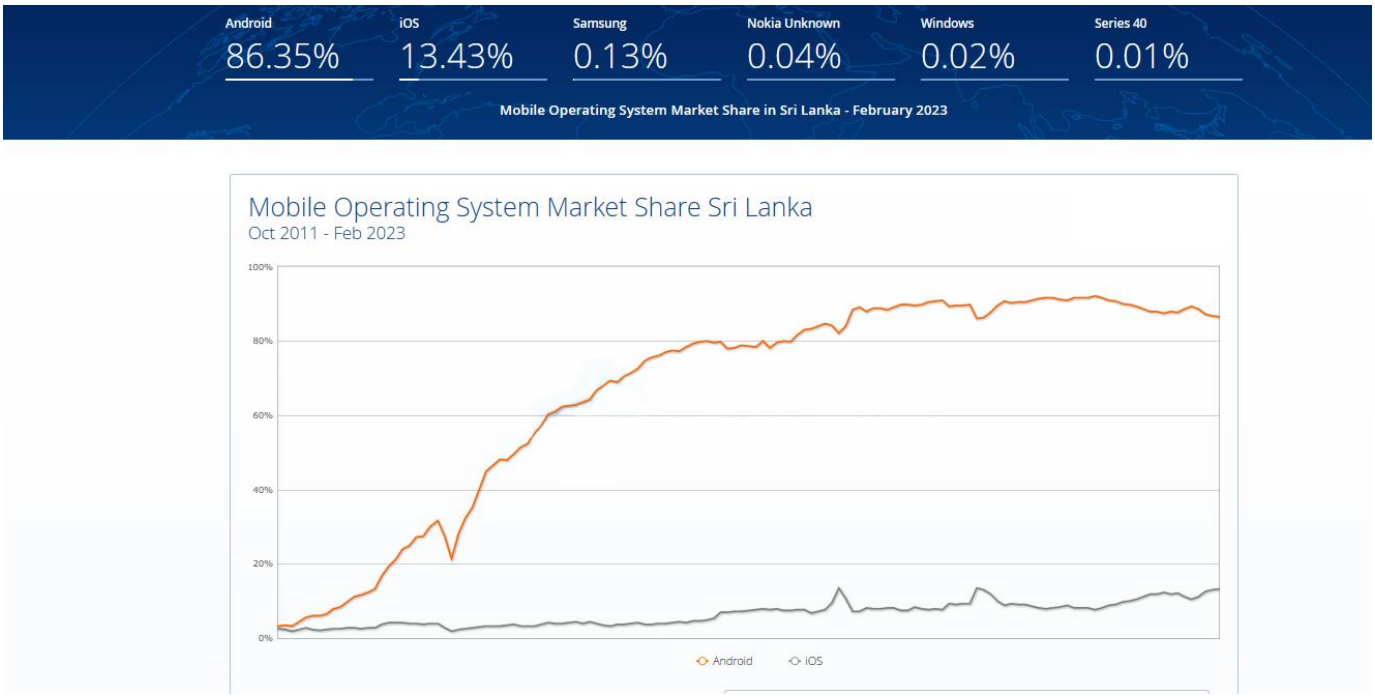

Figure 1-Mobile Operating System Market Share Sri Lanka

Developing a mobile-based Sinhala book reader app for visually impaired individuals can greatly enhance their reading experience and accessibility to literature. The app can use OCR technology to convert scanned images of Sinhala books into editable and searchable text, which can then be read out loud using a text-to-speech (TTS) engine.

To develop such an app, the following steps can be taken:

- Gather requirements: Conduct research to identify the requirements of visually impaired individuals and their needs when it comes to reading Sinhala literature. This can include the ability to adjust font size, background color, and reading speed, among others.

- Design user interface: Design a user-friendly interface that is accessible and easy to navigate for visually impaired individuals. The interface should include options to adjust font size, background color, and reading speed, among others.

- Develop OCR engine: Develop an OCR engine specifically designed for Sinhala script that can accurately recognize characters and convert scanned images into editable and searchable text.

- Integrate TTS engine: Integrate a TTS engine that can read out the converted text aloud, providing an immersive and convenient reading experience for visually impaired individuals.

- Test and optimize: Test the app with visually impaired individuals and gather feedback to identify areas for improvement. Optimize the app to provide a seamless and accessible reading experience.

- Publish the app: Publish the app on the Google Play Store, making it accessible to a wide audience of visually impaired individuals.

Overall, a mobile-based Sinhala book reader app for visually impaired individuals can greatly enhance their accessibility to literature and provide a convenient and immersive reading experience.

2. RESEARCH GAP

One possible research gap in the OCR component is the need for a more accurate and efficient OCR engine specifically designed for the Sinhala language. While there are existing OCR programs for English [10] and other widely used languages [5], there is a lack of OCR tools available for Sinhala and other less commonly used languages. Thus, developing an OCR engine that can accurately recognize and classify Sinhala characters and fonts of various sizes would be a significant contribution to assistive technology for visually impaired individuals in Sri Lanka and other Sinhala-speaking communities. Another possible research gap is the need to incorporate machine learning techniques to improve the accuracy and speed of the OCR engine. By using a large dataset of Sinhala characters and fonts, the OCR engine can be trained to better recognize and classify different variations of Sinhala text, resulting in a more reliable and efficient tool for visually impaired individuals.

When a certain Sinhala book is photographed with a camera and sent to the TTS, the OCR will identify it . Only a few studies in Sri Lanka have been done to create a synthetic Sinhala voice. Most character recognition systems use a scanner and a monitor to capture input images. The system and scanner are a concern because they take up less room. The issue of the computer and scanner taking up too much space was addressed by an optical character recognition system (OCR) built on an Android 14 phone. 14 Digital camera images differ from scanned documents or photos in several ways. In addition, they contain flaws such edge distortion and bad illumination, which inhibits the majority of OCR solutions from successfully identifying the text. The Tesseract OCR engine was selected for the study due to its extensive acceptability, extensibility, and accessibility, as well as its engagement in building culture and its ability to function as intended[18] .

One major gap is the lack of high-quality datasets for training OCR models for Sinhala characters. While there are some publicly available datasets, they are often limited in size and scope. To improve the accuracy of OCR technology for Sinhala, larger and more diverse datasets are needed. Another challenge is the complexity of Sinhala script, which includes a wide range of ligatures and diacritics that can make character recognition more difficult. Further research is needed to develop OCR algorithms that can accurately identify and recognize these complex character forms. There is also a need to develop better methods for word formation in Sinhala. This is particularly important for handwritten text, which can often contain variations in spelling and word structure. Improved word formation methods could help improve the accuracy of OCR technology for Sinhala. Finally, while machine translation technology has improved significantly in recent years, there is still a need for further research on translating Sinhala text into other languages. This is particularly important for languages with limited linguistic resources, where the quality of machine translation can be a significant barrier to cross-linguistic communication.

Overall, while OCR technology has the potential to greatly improve access to Sinhala literature and facilitate cross-linguistic communication, there is still much work to be done to improve its accuracy and effectiveness for Sinhala character identification and word formation.

Sinhala character identification, word generation using an engine, voice translation, and transmission to TTS are all steps in the process. Users can read the time using a background process even when the app is not open. When a user starts the software using voice instructions, the camera should also be able to start. When the user runs the program, it need to be able to scan the document rapidly. The software must be able to focus automatically on the piece of paper in front of the camera. The system should notify the user vocally as soon as the document enters the capture frame. whenever the document is entirely within the capture frame, capture it and get the image. The acquired image should be kept in the device's storage. The OCR system must first identify and rectify skew before receiving data.

Application Reference	OCR system for identifying the included texts of a image which supports for visually impaired people	Support for Sinhala Language	Until the document is within the capture frame, the system should alert the user audibly.	Uses for multi-font and multi size fonts identification,supported by segmenting the characters	Mobile Application
Research A	✗	✗	✗	✓	✗
Research B	✗	✗	✗	✗	✗
Research C	✓	✗	✗	✓	✗
Research D	✓	✗	✗	✓	✓
Proposed System	✓	✓	✓	✓	✓

Figure 2 - Comparison Table

3. RESEARCH PROBLEM

The main research problem is that most visually impaired people in Sri Lanka do not have access to a platform that enables them to capture the text they need and read it.
To address this problem, it is important to first understand the limitations that visually impaired people face when using smartphones. One major limitation is the lack of accessibility features that cater to their needs. For example, many smartphones do not have built-in screen readers or other assistive technologies that make it easier for visually impaired individuals to use the device. Additionally, some visually impaired individuals may have limited knowledge about how to use these technologies and may require additional training and support to take full advantage of them. Another limitation that visually impaired individuals face is the quality of digital images captured by smartphone cameras. In order for OCR technology to work effectively, the text needs to be captured in high resolution and with proper lighting. Many smartphones do not have cameras that are suitable for capturing high-quality images, which can make it difficult for visually impaired individuals to use OCR apps to capture and read text.

By exploring these limitations and identifying potential solutions, it may be possible to develop a platform that meets the needs of visually impaired individuals in Sri Lanka, enabling them to capture and read the text they need using their smartphones. This could have a significant impact on the quality of life of visually impaired individuals by providing them with greater access to information and opportunities for personal growth and development.

As another problem I have identified is related to the development of an Optical Character Recognition (OCR) system that can accurately identify Sinhala characters and form words using an engine, and then translate the text to speech. This is a challenging problem because Sinhala is a complex language with a unique set of characters that require specialized algorithms for recognition and word formation.

Some of the specific research questions that could be addressed in this project include:

1. What are the most effective algorithms for accurately identifying Sinhala characters using OCR technology?
2. How can these algorithms be optimized for different fonts, styles, and sizes of Sinhala text?
3. What are the best techniques for combining identified characters into words using an engine?
4. How can the system be trained to recognize Sinhala words in different contexts and accurately translate them to speech?
5. What are the most effective approaches for integrating the OCR, word formation, and text-to-speech technologies into a cohesive system?

To address these research questions, the project would likely involve a combination of machine learning, natural language processing, and computer vision techniques. It would also require a large dataset of Sinhala text and audio recordings for training and testing the system. The end result would be a valuable tool for people who are visually impaired or have difficulty reading Sinhala text.

4. OBJECTIVES

4.1. Main Objective

The study's key goal is to develop a speech synthesis system for visually impaired individuals using festival and speech tools to read Sinhala books .A Sinhala book reader for the visually impaired is a software program designed to make reading accessible for individuals with visual impairments. It combines various technologies to provide a seamless reading experience. The device utilizes optical character recognition (OCR) technology to convert the text from a physical book into a digital format. Then, a text-to-speech synthesizer reads the text out loud in the Sinhala language, making it easier for visually impaired users to follow along. to provide visually impaired individuals with an accessible and convenient way to read Sinhala literature and to enhance their access to literature. The app aims to achieve this by using OCR and TTS technology and providing visually impaired individuals with customizable settings to enhance their reading experience. A Sinhala book reader for the visually impaired is a software program designed to make reading accessible for individuals with visual impairments. It combines various technologies to provide a seamless reading experience. The device utilizes optical character recognition (OCR) technology to convert the text from a physical book into a digital format. Then, a text-to-speech synthesizer reads the text out loud in the Sinhala language, making it easier for visually impaired users to follow along .In addition to the text-to-speech synthesizer, the device also includes audible guidance to help navigate the app and identify the distance to the book being read. This makes it easier for visually impaired users to find their place in the book and keep track of their progress.

4.2. Sub Objective

To accurately create computer-readable text from collected photos using the right image preprocessing. to put in place a Sinhala text-to-speech synthesizer that can translate text into speech. to evaluate the Sinhala language system's effectiveness. Create a user-friendly, accessible interface that is simple to navigate and suitable for those who are blind. Assuring that visually impaired people can use the app on a number of mobile devices requires designing the app to be flexible to diverse device sizes and screen resolutions. Convert scanned photos of Sinhala books into editable, searchable text by creating an OCR engine that can correctly recognize Sinhala characters. By testing it with a focus group of people who are blind and collecting feedback, the software may be improved to offer a seamless and accessible reading experience for people who are visually impaired.

5. METHODOLOGY

5.1. Overall system architecture

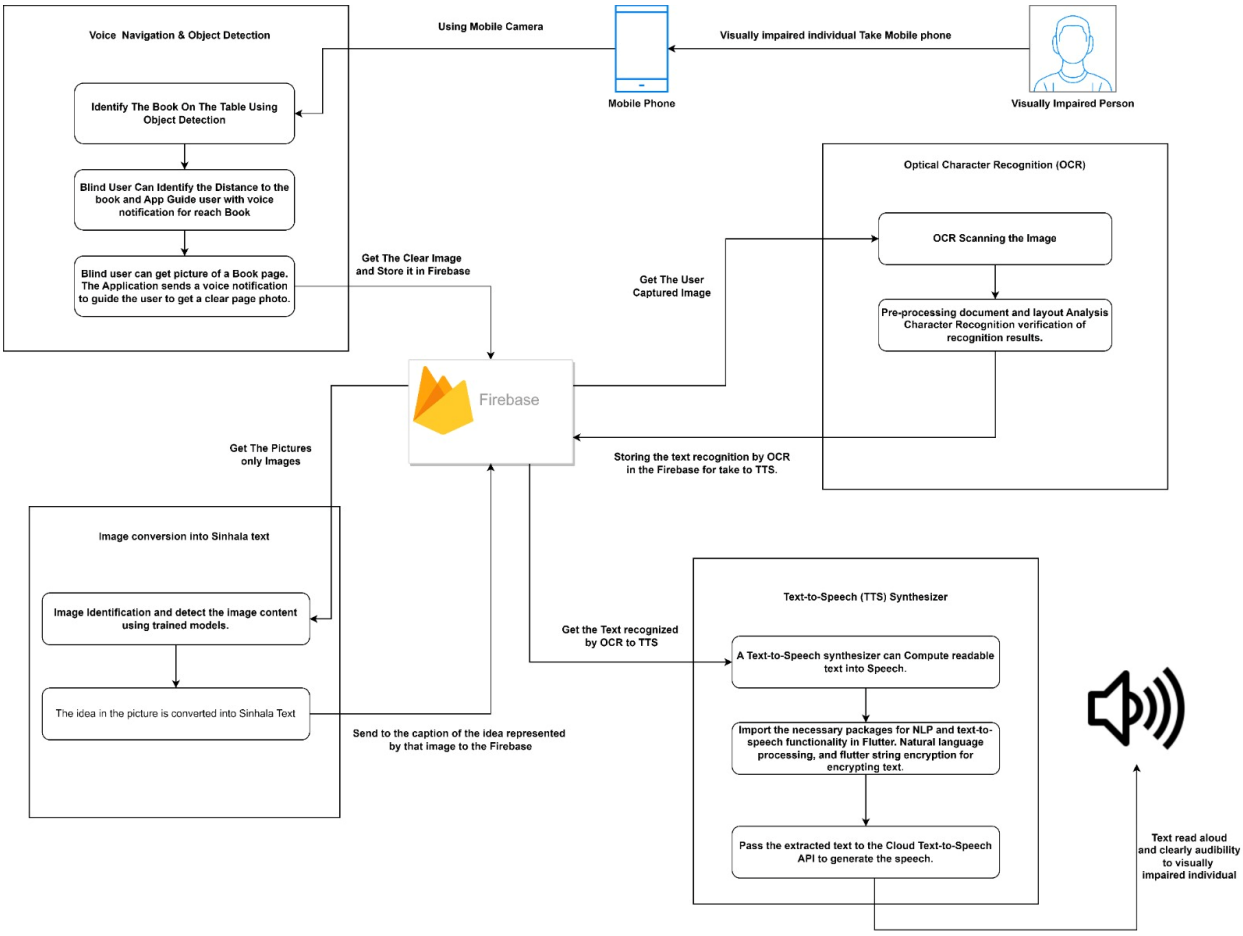

Figure 3-Overall system diagram

Audible guidance helps the user navigate the app through the functions the app and get a clear idea and guidance whenever the user faces difficulty performing a task. When a user wants to find a book on the table, he opens the camera through the app and points it toward the table or desk and the app identified the user's hand and navigates to the book. Using real-time Image processing technology identifying the dangerous object near the blind user and the distance to the object will notify verbally to the user and identify the probability of occurring an accident the user. Users will navigate in a pristine environment evading dangers and harmful things.

Sinhala Character Identification and word formation through the engine and translate to the speech then send to the TTS. When the app is not running, users can read the time using a background process. The program should also be able to start the camera when the user launches it using voice commands. The program should be able to quickly scan the document when the user launches it. On the paper in front of the camera, the app needs to be able to automatically focus. Until the document is within the capture frame, the system should alert the user audibly. When the user wants to capture an image on the book the app alerts and navigates the user to capture the image onto the frame of the phone. The device's storage should be used to store the image that was captured. Before submitting information to the OCR system, the system must detect and correct skew.

A computer vision system that uses cutting-edge methods to recognize and describe objects and scenes in real-time is an image detection software for blind students. The program takes pictures of the user's surroundings using the camera on a smartphone or tablet. The objects and their characteristics are then identified from these photos using image processing techniques like edge detection, color analysis, and feature extraction. After locating the things in the image with the use of object detection algorithms, machine learning models are used to identify and categorize the objects. These models use methods like convolutional neural networks (CNNs) to recognize objects in real-time and are trained on massive datasets of annotated photos.

Here, the main purpose of using Text to speech (TTS) technology is to give a blind person the ability to access the written text of a Sinhala book. This allows them to easily listen to the valuable content of Sinhala books. TTS technology allows the written text in a Sinhala book to be read out loud in a natural-sounding voice, which makes it easier for visually impaired people to understand the content. The technology uses computer algorithms to analyze the Sinhala text and generate an appropriate pronunciation, intonation, and rhythm for each word and sentence..

5.2. OCR methodology and system diagram

• Sinhala Character Identification and word formation through engine and translate to the speech then send it to the TTS.
• When the app is not running, users can read the time using a background process. The program should also be able to start the camera when the user launches it using voice commands.
• The program should be able to quickly scan the document when the user launches it.
• On the paper in front of the camera, the app needs to be able to automatically focus.
• Until the document is within the capture frame, the system should alert the user audibly.
• The system should be able to automatically capture and obtain the image whenever the

document is completely within the capture frame.
• The device's storage should be used to store the image that was captured.
• Before submitting information to the OCR system, the system must detect and correct skew

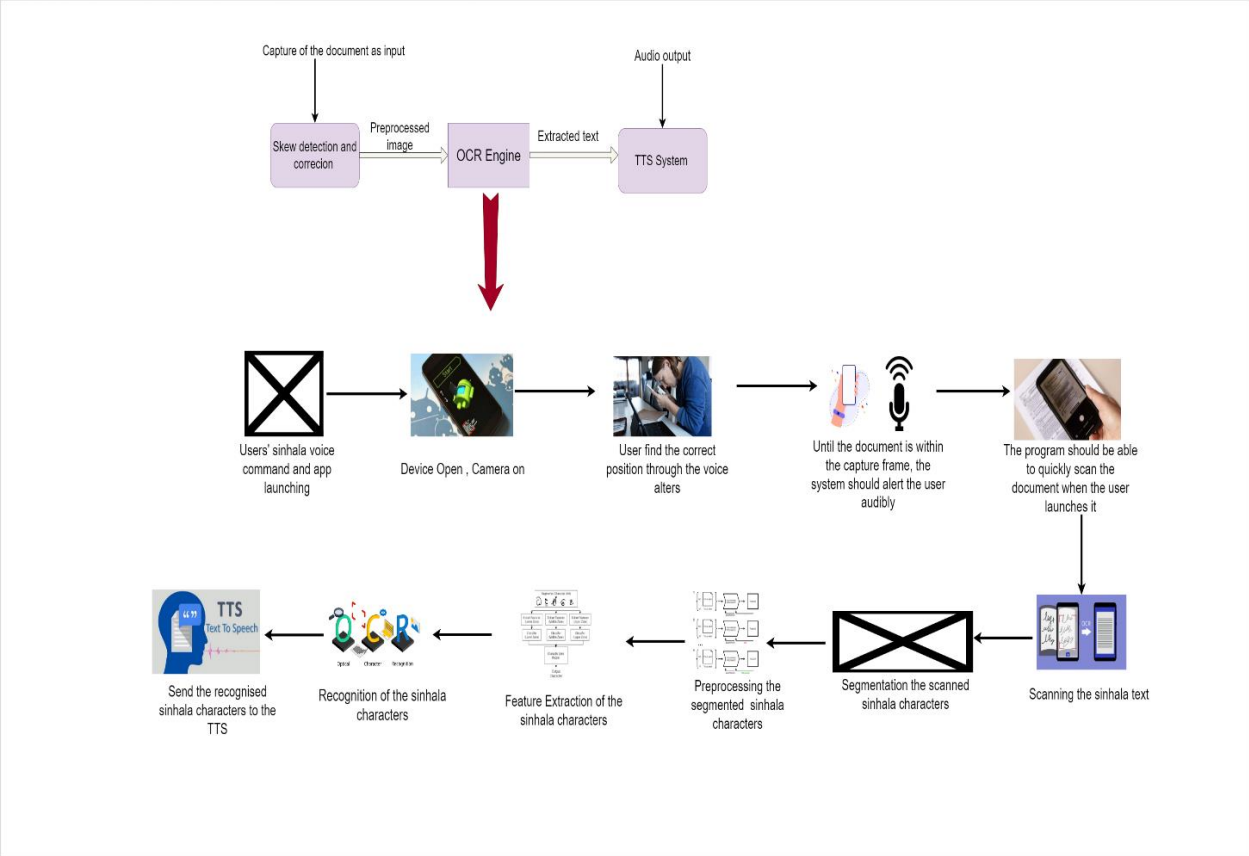

Figure 4-OCR system diagram

5.3. System overview

The OCR system for the mobile-based Sinhala book reader app for visually impaired individuals involves several components that work together to accurately recognize Sinhala characters and convert scanned images into editable and searchable text. The following is an overview of the OCR system:

- Preprocessing Component: This component involves preprocessing the image of the scanned page to improve the quality of the image. Techniques like de-skewing, binarization, noise reduction, and contrast adjustment can be used to improve the quality of the image.

- Segmentation Component: This component involves segmenting the image into individual characters that can be recognized by the OCR engine. In Sinhala script, characters are connected to each other, making character segmentation a challenging task. Techniques like line segmentation and word segmentation can be used to separate the characters.

- Feature Extraction Component: This component involves extracting features from each character to enable the OCR engine to recognize them accurately. The features can include information on stroke width, height, and orientation, among others.

- Recognition Component: This component involves recognizing the characters using machine learning algorithms or artificial neural networks. The OCR engine needs to be trained on a large dataset of Sinhala characters to improve the accuracy of the recognition.

- Postprocessing Component: After the characters are recognized, this component corrects errors and improves the accuracy of the recognition. Techniques like language modeling and spell checking can be used to improve the accuracy of the recognition.

- Text Conversion Component: This component involves converting the recognized text into digital text that can be edited and searched.

The OCR system needs to be integrated with the mobile-based Sinhala book reader app to enable the conversion of scanned images of Sinhala books into editable and searchable text. The accuracy of the OCR system is crucial to ensure a seamless and accessible reading experience for visually impaired individuals. Regular updates and improvements to the OCR system based on user feedback can enhance the accuracy and functionality of the OCR system.

6. PROJECT REQUIRESMENT

6.1. Functional requirements

1. OCR System: The OCR system should be able to accurately recognize and convert Sinhala text from printed materials into digital text that can be read by the app.

2. Offline Support: The app should be able to function offline so that users can read books and use the app without an internet connection.

3. Feedback and Support: The app should provide users with a way to provide feedback and receive support from the developer if they encounter any issues or have suggestions for improving the app.

4. Book Import: The app should allow users to import digital books in Sinhala language from external sources such as the internet or other mobile devices.

6.2. Non-Functional requirements

1. Usability:
    - The app should be easy to use and navigate, with intuitive controls and a simple user interface.

2. Accessibility:
    - The app should be designed with accessibility in mind, with features such as large buttons, high contrast mode, and adjustable text size to make it accessible for visually impaired users.

3. Performance:
    - The app should be fast and responsive, with minimal lag time between actions such as turning pages or adjusting text settings.

4. Reliability:

- The app should be stable and reliable, with minimal crashes or errors during use.

5. Security:
    - The app should be secure and protect user data, with features such as encryption of sensitive information and secure storage of user data.

6. Compatibility:
    - The app should be compatible with a wide range of Android devices, including older and newer devices with varying screen sizes and hardware specifications.

7. Maintainability:
    - The app should be designed with maintainability in mind, with clear code organization and documentation to make it easier for developers to maintain and update the app over time.

8. Performance under low network conditions:
    - The app should be able to function with slow internet or low network connectivity, as users may not always have access to high-speed internet.

9. Multilingual OCR Support:
    - The OCR system should support multiple languages, including Sinhala, to enable the recognition and conversion of text from books written in different languages.

10. Accuracy of OCR:
    - The OCR system should be accurate in recognizing and converting printed Sinhala text, to ensure the digital text output is of high quality and readable by the app.

6.3. Software Requirement

- Mobile Operating System: The application should be compatible with Android operating systems.
- OCR Engine: The application should use a reliable and high-quality OCR engine like Tesseract OCR

6.4. Personal Requirements

- Sinhala Language Support: The application should support the Sinhala language and OCR should identify the Sinhala characters.

7. CONCLUSIONS AND RECOMMENDATIONS

Conclusions:

- The app should be designed with usability and accessibility in mind, to ensure it is easy to use and accessible for visually impaired users.
- The OCR system should be accurate in recognizing and converting printed Sinhala text, to ensure the digital text output is of high quality and readable by the app.
- The app should be fast and responsive, with minimal lag time between actions such as turning pages or adjusting text settings.
- The app should be reliable and stable, with minimal crashes or errors during use.
- The app should be secure and protect user data, with features such as encryption of sensitive information and secure storage of user data.

Recommendations:

• Take into account adding other features to the app, including voice commands and a programmable speech speed, to make it more user-friendly.

• To increase accessibility for users who are blind or visually challenged, think about adding a high-contrast option and text magnification tools.

• Take into account introducing multilingual support so that users can switch between languages based on their preferences or the language of the book they are reading.

• Think about including a dictionary integration option that would let customers utilize an integrated dictionary to search up unfamiliar words.

• Take into account including a sharing feature that would enable users to send books or specific chapters of the book they are reading to others via email or other messaging services.

• If you want to be sure that the OCR system is accurate, think about utilizing a good OCR program and upgrading it frequently to keep it accurate.

• Think about tweaking the app to reduce data usage and load times to improve performance when there is minimal network connectivity.

• To guarantee compatibility with a variety of Android devices, think about testing the app on many gadgets and customizing it for various screen sizes and hardware requirements.

• To guarantee the app's maintainability, take into account employing clear code organization and documentation, as well as setting up a regular maintenance schedule to guarantee the app stays current and working.

8. WORK BREAKDOWN CHART

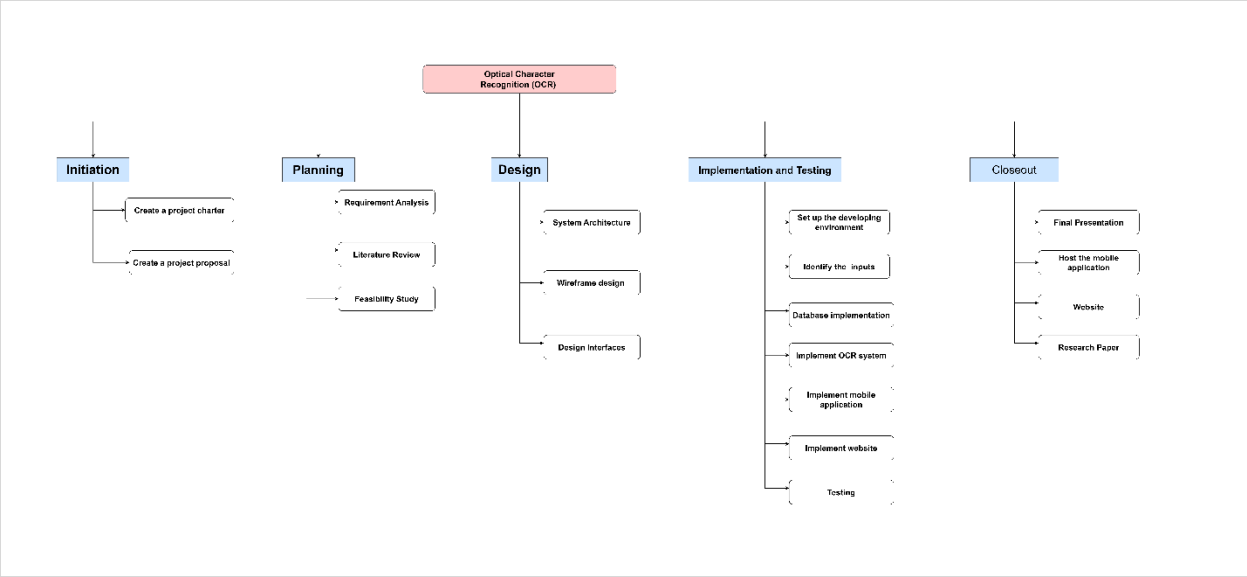

Figure 5-Work Breakdown Chart

9. GANTT CHART

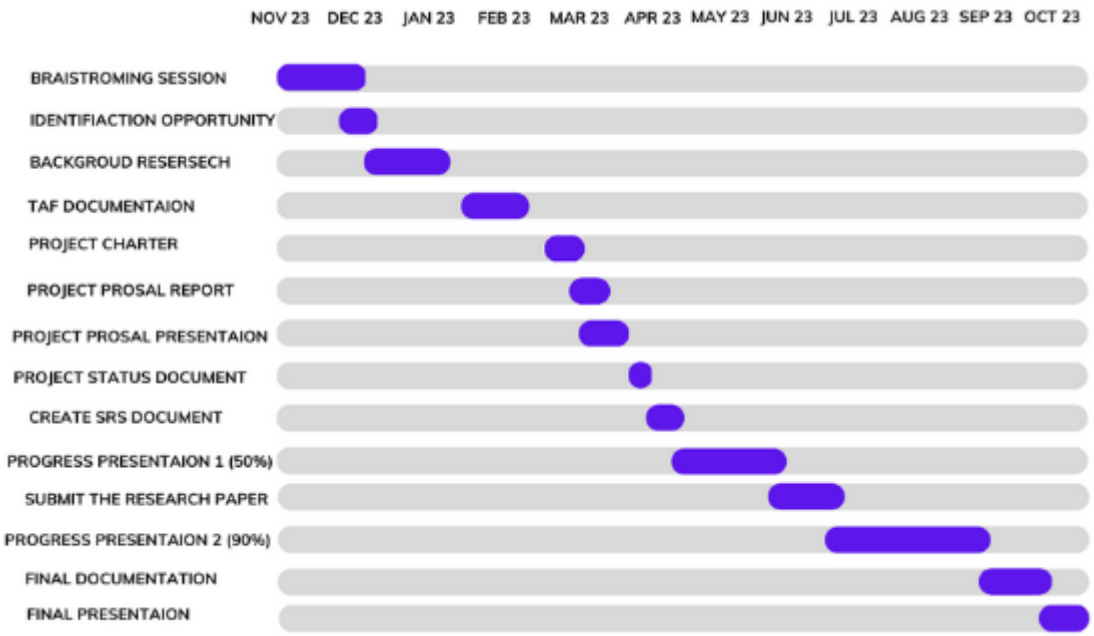

Figure 6- Gantt Chart

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APPENDIX

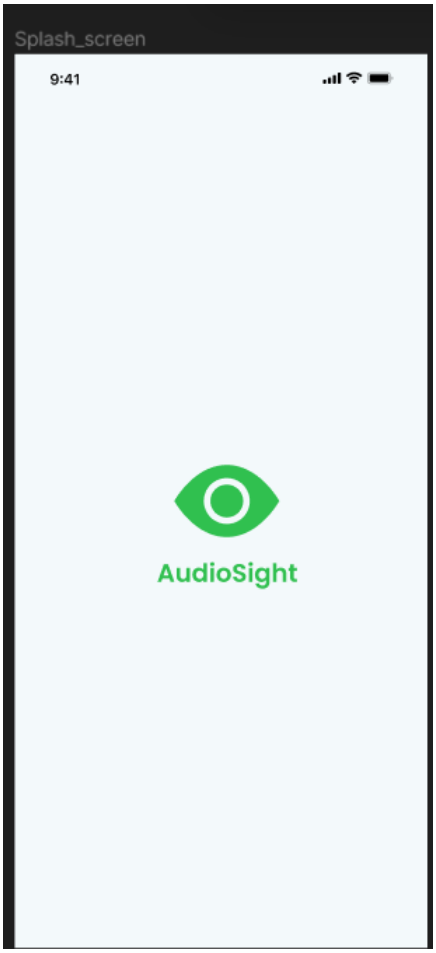

Figure 7-Splash screen

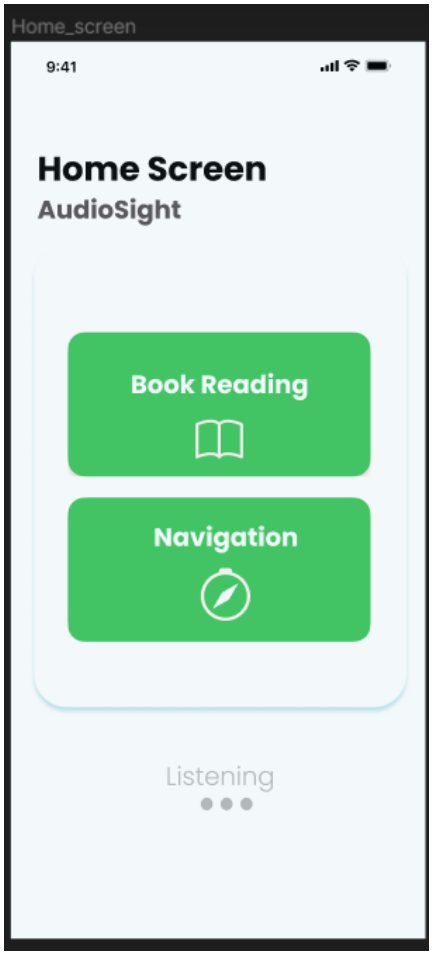

Figure 8-Home screen

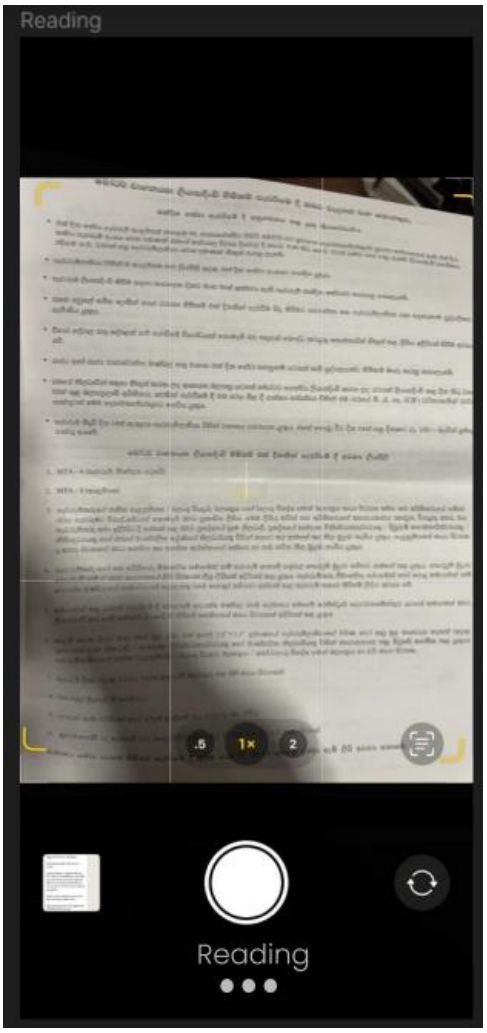

Figure 9- Reading

Figure 10-Navigation