

**DIGITAL ASSISTANT TO AID INDIVIDUALS WITH
PRINT DISABILITIES TO
INTERPRET PRINTED MATERIALS**

Project Id: 2022-024

Project Proposal Report

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B.Sc. (Hons) Degree in Information Technology

Department of Computer Science and Software Engineering

Sri Lanka Institute of Information Technology

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January 2022

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A declaration, copyright statement, and the statement of the supervisor.

We declare that this is our work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning, and to the best of our knowledge and belief, it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Name of co-supervisor: Ms. Shashika Lokuliyana

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Date:

Signature of co-supervisor:

Date:

Abstract

When we evaluate the global population, we can see that there are a large number of people with disabilities.[1] Furthermore, "print difficulties" refer to a visual, physical, or learning impairment. People with this impairment confront numerous challenges. Although visually challenged people can read using braille, not every document or text can be read by them. Some topics, such as graphs, tables, and math equations, cannot be transformed into braille, so they must enlist the assistance of a third party. Some of it may not be the best method to provide someone with a legal or sensitive document.[2] New technology approaches for recognizing photos in printed documents and words are being developed as a solution. Graphs, tables, and math equations, on the other hand, have no answer.

So, to detect paragraphs, sentences, tables, diagrams, and mathematical calculations, we created this digital assistant tool.

This tool includes everything you need in one place, and it's also a user-friendly tutorial, so it'll be simple to use.

It will also evaluate the table data, identify the equations, and deliver the exact information via voice aid to the print-disabled client.

Therefore, this study is especially considering about to interpret tabular data from printed materials and giving better solutions for those vision impaired people to get an idea about the tables and other needed data in printed documents.

The major goal of creating this tool is to create an algorithm that will explain text, graphs, and tables to the user, as well as complex mathematical formulas.

Keywords: Print Disability, Tabular Data, digital design tool

Table of Contents

A declaration, copyright statement, and the statement of the supervisor.	i
Abstract	ii
LIST OF FIGURES	iv
1. Introduction	1
1.1. Background	1
1.2. Literature survey	2
1.3. Research Gap	6
1.4. Research Problem	8
2. Objectives	10
2.1. Main Objective	10
2.2. Specific Objectives	10
3. Methodology	11
3.1. System Architecture	11
3.1.1. Software Solution	11
3.2. The flow of the project	12
3.2.1. Requirement gathering and analysis	12
3.2.2. Feasibility study	13
3.2.3. Implementation	13
3.2.4. Testing	14
3.3. Project requirements	14
3.3.1. Functional requirement	14
3.3.2. Non-functional requirement	14
3.3.3. User	15
4. Budget and justification	16
REFERENCE LIST	17
5. Appendices	19
5.1. Gantt chart	19
5.2. Work Breakdown Structure	20
5.3. Online Survey	21

LIST OF FIGURES

	Page
Figure 1.1: <i>Summary of responses for what people think that table reading process.</i>	03
Figure 1.2: <i>Summary of responses for what people think that there is a tool for table reading process.</i>	04
Figure 1.3: <i>Summary of responses about known tools.</i>	04
Figure 1.4: <i>Responses about what are the requirements needed for a tool.</i>	05
Figure 1.5: <i>System overview</i>	12
Figure 1.6: <i>Grant chart</i>	19
Figure 1.7: <i>Work breakdown structure</i>	20

LIST OF TABLES

	Page
Table 1.1: The comparison with former research and system	7
Table 4.1: Budget and budget justification	16

1. Introduction

1.1. Background

We can identify a large number of people with disabilities, among the world population. Moreover, "print difficulties" refer to a visual, physical, or learning disability which hinders the ability of a person to read print materials. This can include blind, dyslexic or people with motor disabilities and low vision. These kind of people with this impairment face countless challenges in day-to-day life, while trying to achieve tasks which are normal for other people.[3] Braille has been a successful method used by visually impaired people since 1824 which was introduced by Louis Braille who was blinded at age 3.[4] Although this method has been a successful system, in modern times not every document or text can be read using this method. This method can only be used in manual reading of hard copies. Also, multiple handicapped individuals may find this method inefficient. Specific content such as charts, graphs, tables, figures and math or algebraic equations, cannot be expressed in braille system, leaving these people to find the assistance of a third party. This allows legal, confidential, personal or sensitive information in untrustworthy hands leading to be unsecure.

Also, the traditional pre-existing methods are quite slow and time consuming. University students, professionals etc. may not have time to be dealing with an inefficient method with the amount of work load they have to keep up with. Some publishers do already provide digital copies of their books or even universities can provide text books in digital format. This still leaves the problem of inability to identify figures. During the recent times, new technology approaches for identifying images in printed materials and content has been introduced as a solution. Recognition of graphs, charts and math equations are yet to be discovered leaving it an unanswered problem.

So, to detect paragraphs, sentences, tables, diagrams, and mathematical calculations, we are introducing this digital design tool.

This tool includes everything you need in same place, and it's also a user-friendly tutorial, so it'll be very easy to utilize.

This tool will also evaluate the table data, recognize the equations, and give away the exact information via voice aid to the print-disabled user.

The major goal of creating this tool is to create an algorithm that will explain text, graphs, and tables to the user, as well as complex mathematical formulas.

1.2.Literature survey

Through the above explanation we have gained a surface idea about the prevailing situation regarding print disabilities and their current solutions. Here we will dig deeper into the actual information which we can find through already existing research and our surveys. It is important to analyse the situation before we discuss our new solutions. If not for having a print disability many people at least get to interact with those who suffer from such disabilities.[5] Not just those people with disabilities but also their loved ones look for solutions to help with this problem. We conducted an online survey to gather information from the community. First, we identified that majority of people have interacted with visually impaired people. Through our survey we were able to collect some important information.

Even though many people mentioned the Braille method as a well-known tool, when asked the question about its efficiency in reading different materials, many people answered that it couldn't be used on all occasions. [6]

A considerable amount of people doesn't have an idea whether it is effective or not. In above explanations we have concluded that Braille cannot be used as a method to identify mathematical expressions, graphs, diagrams etc. Therefore, some people are not aware or haven't come across the idea that Braille cannot help in reading specific information as tables, charts etc. But as the majority responded we can realize that the experiences with Braille method are not 100% effective.

Respondents also mentioned tools such as "Orbit Reader" and "Be my eyes".

Clearly, many agreed that visually impaired people might need guidance in handling a mobile tool as they cannot recognize the interface visually. Therefore, we can implement such a guiding procedure through our tool.

According to the survey we were able to understand that input voice recognition is the best method for visually impaired people to access the process. Also, a fair amount suggested of a gesture system and magnification of text by zooming or altering font size.

When inquired about the ability to present data in tables and charts using literal reading many responded that it is a possible method.

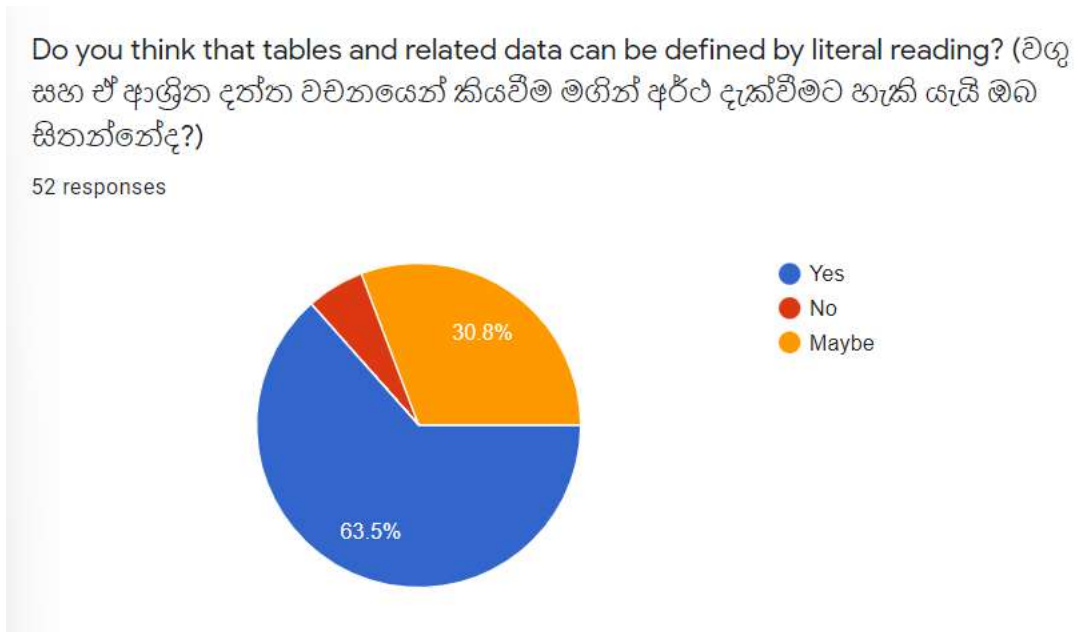


Figure 1.1- Summary of responses for what people think that table reading process.

However, a minority was not sure about using this method to deliver and define the exact data in such charts, graphs etc. As for the question regarding awareness of such tools to read tables and charts we identified that many have not come across this kind of a tool. Only a little amount as 9.6% responded that they are aware about such a tool concluding the importance of creating a new method for visually impaired people.

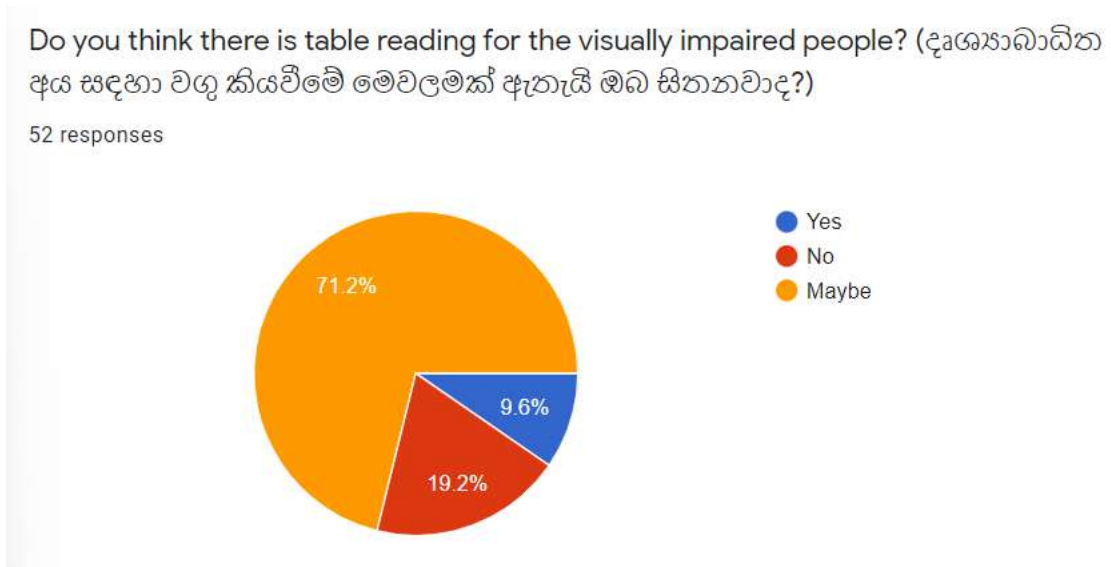


Figure 1.2- Summary of responses for what people think that there is a tool for table reading process.

A considerable amount of respondent mentioned “E-reader”. Only about 20% of respondents replied with Screen reader and Voice assistant.

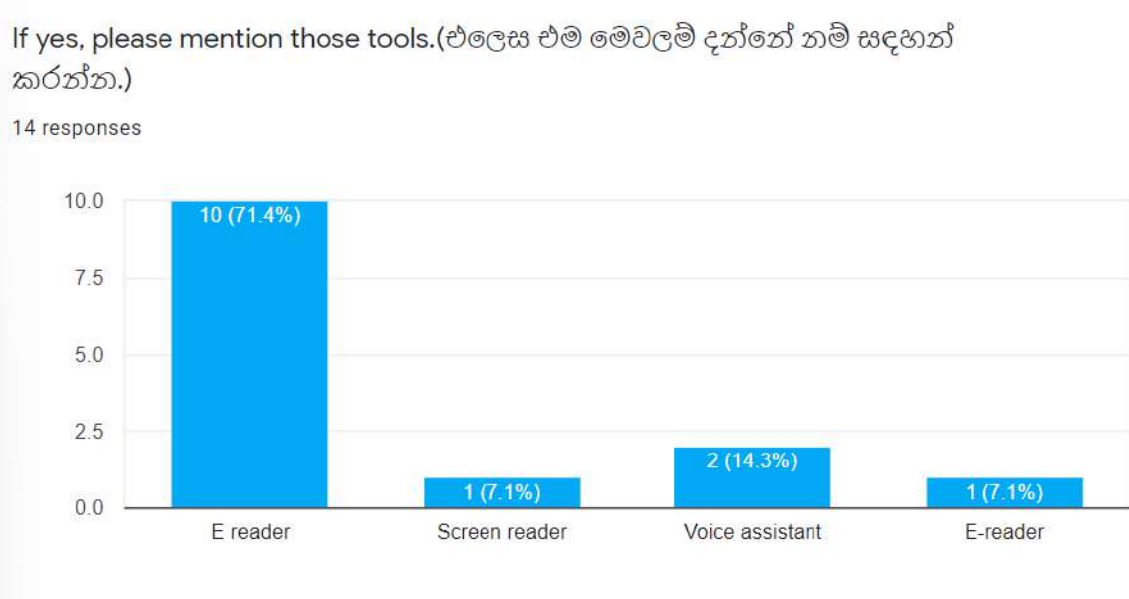


Figure 1.3- Summary of responses about known tools

When posed the question about the essentiality of a tool to read tables the majority agreed on the necessity of a method for visually impaired people to recognize such information, confirming the need of implementing this new system. We consulted our respondents for their ideas about the requirements that must exist in such a tool. Voice assistance was suggested by many while a reasonable amount mentioned screen reader.

If yes, what are your requirements for it? (එසේ සිතන්නේ නම් එයට අවශ්‍ය ඔබ සිතන අවශ්‍යතා මොනවාද?)

15 responses

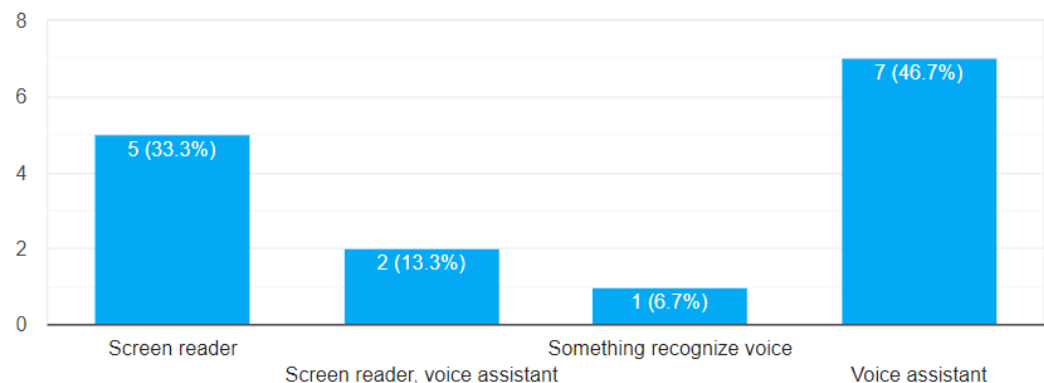


Figure 1.4 - responses about what are the requirements needed for a tool

Accordingly, we can conclude that the implementation of a new tool is important in the current society. It is a lacking area that we have not focused on even when the technologies are quite advanced. In such a time it is important to give attention to the needs of visually impaired individuals. Also, according to the information, we can use voice assistant, gesture usage as well as screen readers. A simple improvement as user guidance in using such a tool can enhance their experience by a great deal.

1.3.Research Gap

Following a review of the literature, it is obvious that certain studies and applications have been applied to assist persons with print difficulties. However, much investigation was conducted in order to identify the text. There are also some frequent applications for this. Every blind person has the right to have a volunteer voice describe every object."Be my eyes" is the name of this program [7]. However, they are unable to read legal documents or other private documents on their own. They have to ask help from someone else. For them, it's a bit of a risky solution. When it comes to the braille language, there are just a few things that can be converted, and converting a table or a math problem to braille is challenging. Reading a braille text is a difficult task. As a result, it is simple to implement in this particular application.

New technologies have been developed in this period to make human existence easier on a daily basis. Humans can also use apps to upload or scan images or documents to have them transformed to speech. As I have stated, no app exists for those with print disabilities to utilize. As a result, we developed "Be My Eyes" as a study project. And, despite the fact that there are few programs, we discovered that they are a bit difficult to use for a fully blind person because there are so many analyzing portions and variants on scanning a printed page to convert it to a voice output. Some of them featured uploading components, such as photographs, that were converted into vocal output. For a blind person, this approach is difficult to employ. However, for a blind individual, this program, "Be my eyes," is quite simple to use.

Users can read a printed document in a few steps using this software since it can scan texts, tables, or photographs, and the user can receive a quick impression of what they've scanned because it's so simple to use. With a voiceover, this app will take you from beginning to conclusion. Because it is user-friendly, the user retains their privacy by not allowing others to view their private or legal documents for them. It is a fantastic benefit for someone who is blind.

S.S. Paliwal et al.[8] (Research A) proposed the table detection and extraction model called “TableNet” which is a deep learning model for end-to-end table detection and tabular data extraction from scanned document images. Namysl, M. et al.[9](Research B) conducted a table recognition and semantic interpretation system and it suppose to recognize most frequent table formats. Hashmi, K. A. et al.[10] (Research C) published that analysis of table recognition in document images with deep neural networks.

	Research A	Research B	Research C	Our Solution
Assist documents scanning	✗	✗	✗	✓
Detect tables in the document	✓	✓	✓	✓
Detect table structure of the table	✓	✓	✓	✓
Realtime scanning method	✗	✗	✗	✓
Detect text and data in the table	✗	✓	✗	✓
Explain the data in the table in a simple way	✗	✗	✗	✓
Using gestures and voice recognition for navigate menus	✗	✗	✗	✓

Table 1.1: The comparison with former research and system

1.4. Research Problem

Technology is growing at a breakneck speed in today's environment. To be a useful and connected part of the community, everyone is required to learn and stay current on advances. Visually challenged people lag behind in this area due to their inherent limitations.[11] Technology must be adjusted to make it easier for these people to participate as active members of their communities. Because access to new knowledge is both a trending fact and a necessity, most blind people, as well as illiterate people, suffer a significant challenge as a result of this fact. Because converting everything we see into braille is a difficult effort, the blind, as well as print-disabled people, have many difficulties comprehending the fundamental notions presented. There are a few research level applications that have been created to read text and paras, but there is no way to convert pictures, mathematical equations, graphs, and tables to braille. So, they need help from a third party.

Strangers, friends, and family members who can see are often delighted to assist a visually impaired person. This behavior typically assumes that the blind or low-vision person requires assistance, even if that is not the case. A blind person may complete a standard task at a slower pace, but that does not mean they cannot complete it. Rushing to help the blind without first asking or being asked may make them feel helpless rather than autonomous. Furthermore, denying a visually impaired person the ability to complete a task independently prevents them from learning how to do so.[12] When it comes to reading legal documents, however, this poses a fresh problem because it infringes on the privacy of people who are affected.

Smartphones and technology have become a necessary component of everyday life. By 2022, there are estimated to be nine billion smartphone users. As a result of the increasing use of cellphones, people's learning patterns have altered considerably. According to studies, one-third of smartphone users use their devices for educational purposes.[13] Despite the fact that smartphone usage has soared, people with visual impairments still have a hard time using them. A number of challenging accessibility challenges must be solved in order for this community to be fully involved. Accessibility concerns have become a popular research topic in recent years, resulting in the creation of thousands of smartphone apps to help individuals with visual impairments, such as voiceover services, talkback services, screen readers, and navigators.

The number of visually impaired mobile applications continues to rise over time. There are a variety of smartphone apps available to help these folks who are impaired. Text,

phone, contacts, SMS, alarms, calendars, email, and the web can all be converted to braille with ease, but photos, graphs, and diagrams are more complex. In this case, though, we've concentrated on creating a new digital design tool that can describe photographs, graphs, tables and math equation and solve them using this interface and this making life easier for the blind.

These tools and settings are designed specifically for blind and visually impaired people. A user-friendly guiding system and a plethora of other functions are also included. For vision challenged people, this will surely be a new adventure, allowing them to be differently abled.

2. Objectives

2.1. Main Objective

The major purpose of developing this program was to help people who have difficulty reading and writing. Also, there is no way to finish their function without enlisting the assistance of another individual to act as their eye. Furthermore, there is no publicly available program or application for reading photos, tables, diagrams, and math equations and converting them to braille.

As a result, our purpose in developing this digital design tool was to assist people with print disabilities in resolving their challenges.

The scanning of a tables and the conversion of its text to speech using an engine are the main features of this application. such that by simply listening to the recording, the user can acquire a rapid summary of the situation.

2.2. Specific Objectives

In addition to the main objective, there are some more specific objectives related to this execution.

- By scanning the table, the user may recognize the table heading, as well as the table rows and columns.
- It uses a speech engine to automatically transform the text to audio after scanning the table. After the conversion is complete, the user has the opportunity to listen to the audio and obtain a basic understanding of what it is because this tool provides a brief description of the table.
- Because it is a user-friendly guide, the user receives assistance on how to scan the graph, diagram, or math equation using this tool. After the scanning process is completed, it uses a text-to-speech engine to convert the text file into an audio file, which the user can listen to. As a result, the end user gets a general understanding of the entire procedure in only a few simple steps.

3. Methodology

3.1. System Architecture

3.1.1. Software Solution

The research approach provides an overview of the proposed framework's strategy and technology, as well as the methods used to achieve its goals. Steps and processes are in place to reach better solutions to research problems and implement new methods. In this research the main aim is to scan the printed document and interpret the tables, as well as the text inside the tables.

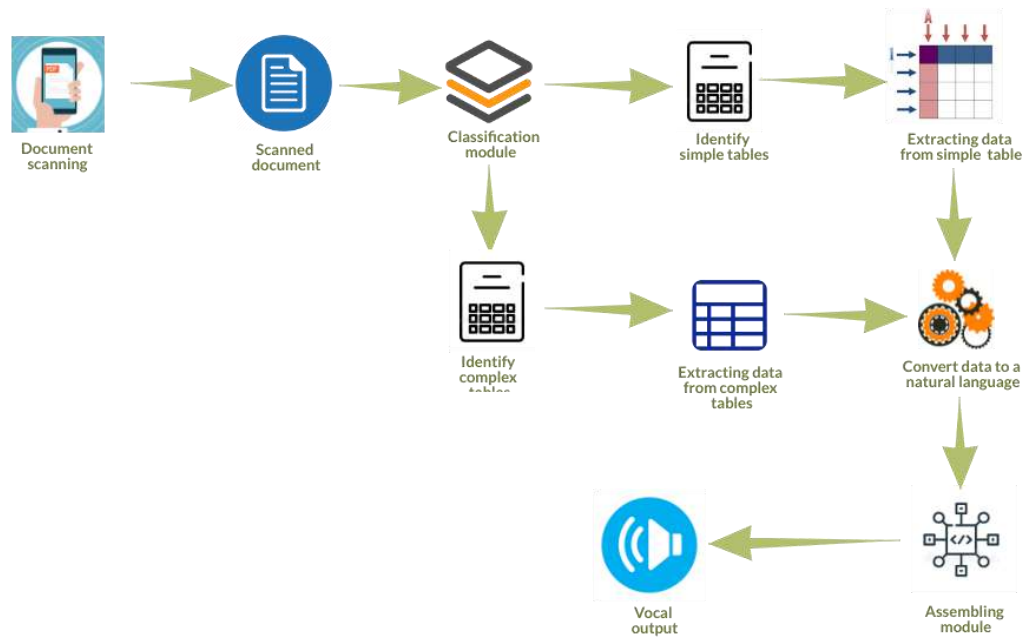


Figure 1.5 - System overview

According to that, we are creating a framework that uses the camera of a smartphone as the actual scanner to perform the scanning process.

An important aspect of this work is to develop a software that will allow us to acquire these documents and manage them in an effective way, so that later we can use them in a practical application.

In this first of all necessary guidance will be provided for the user to scan the document and we are planning to make gestures and voice recognition system for the users. Because of that any blind or normal user can direct to any menus of functionalities very quickly and with a very user friendly manner. Using the classification model, we will be able to recognize tables from the document. After that rows and columns will be determined. When classifying the tables system can identify the complex tables and simple tables by own. The texts inside the cells will also be identified. The data will be sent to the model to be interpreted as a natural language. Then user can get a proper idea of the table by the explanation.

3.2. The flow of the project

3.2.1. Requirement gathering and analysis

For the requirement gathering and analysis we did a literature review and a survey based on these vision-impaired people, and we found out that there are few apps that have been created for them. However, there are some exceptions. Some texts and tables can be read by blind people, but for people with vision impairment, they can't read a printed document manually. We conducted research on this problem, and we just came up with the idea of creating this mobile app as a helping hand for them.

The customer can use this app to read a text or table. Within this, there is user-friendly guidance and an automatic guide with a speech that directs the user to scan the document.

3.2.2. Feasibility study

Everything has been scheduled according to the Gantt chart in terms of scheduling feasibility. By the deadline, all presentations, implementation, and reports will be completed. And the task will be performed according to our plans.

- Technical Feasibility

1. To design this software, we, the team members, draw on our knowledge and experience. In addition, to construct this valuable tool for the visually handicapped, we used mobile applications, side technologies, and machine learning algorithms. To make this, we also had to go through a period of hard learning.

2. We, the team members, use our knowledge and experience to create this app. Furthermore, we use mobile applications, side technology, and machine learning algorithms to create this useful application for the visually impaired. We also went through a period of intense learning.

- Economy Feasibility

We will do our best to produce this mobile application without incurring excessive costs, as it is a mobile application. However, if we are required to pay for something, we will do so as team members. Given a result, since this is a mobile application, we are doing our best to complete the task on the same mobile device that the user is using. And this will be really beneficial to the consumer.

3.2.3. Implementation

According to the gathered information implementation stage performs the process of scanning tables and interpret those data into voice output. All the functions are divided into phases and some of them are scanning and table recognition, column and row detection, text inside cells detection and generating text to speech etc. After finishing

each process there will be a process that testing those functions by verifying and validating. So from this part every phase will be covered by this process.

We are planning to use mockflow wireframe drawing tool for design GUIs and there will be two parts of the system. The first part is about the frontend part that vision-impaired people can use the mobile application through the mobile phone. The other part is the backend and it is supposed to use mainly python because of creating new algorithms and designing REST APIs for connecting the system with the user interfaces.

3.2.4. Testing

To evaluate the prediction accuracy of our proposed recommendation system, we employed a variation of a publicly accessible dataset for a genuine vision-impaired setting. We must test the system for both functional and non-functional criteria before releasing it to the client to guarantee that it satisfies the requirements and is safe to use. Because adequate testing ensures that flaws and issues are found early in the appliance's life cycle, the product will be tested using several testing methodologies such as unit testing, integration testing, and user acceptability testing. Regardless of the testing, it should be released. If any concerns arise during the testing phase, they should be addressed before the product is released.

3.3. Project requirements

3.3.1. Functional requirement

- The tables should be identified properly by the system.
- After identifying the tables, the system should detect the table structure and rows and columns separately.
- There should be proper instructions when the user enters to the system and specially the system should guide to scan the printed document.
- The system should identify gestures and voice inputs from the user and direct into the menus and functionalities.
- There should be a simple explanation of the table in plain English.

3.3.2. Non-functional requirement

- Reliability – User can ensure his privacy by scanning the document by Himself.
- Availability – Any user can use this application from anywhere

anytime.

- Usability – This application can use anyone without any trouble and it gives all the instructions as well.
- Compatibility – There's no any required tool for use this system. Only user can access by there own smart phone

3.3.3. User

- User should follow guidelines given by voice assistant tool.
- The user must provide the gestures and voices properly to the system.
- User should have the basic knowledge to open an application.

4. Budget and justification

Description	Estimated Budget(Rs)
Domain name	4000.00 (per year)
Hosting cost	1200.00 (per month)
Interface Design	10000.00
Programming	35000.00
Testing	25000.00
Other	7500.00
Total Budget	82700.00

Table 4.1: Budget and budget justification

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5. Appendices

5.1. Gantt chart



Figure 1.6- Grant chart

5.2. Work Breakdown Structure

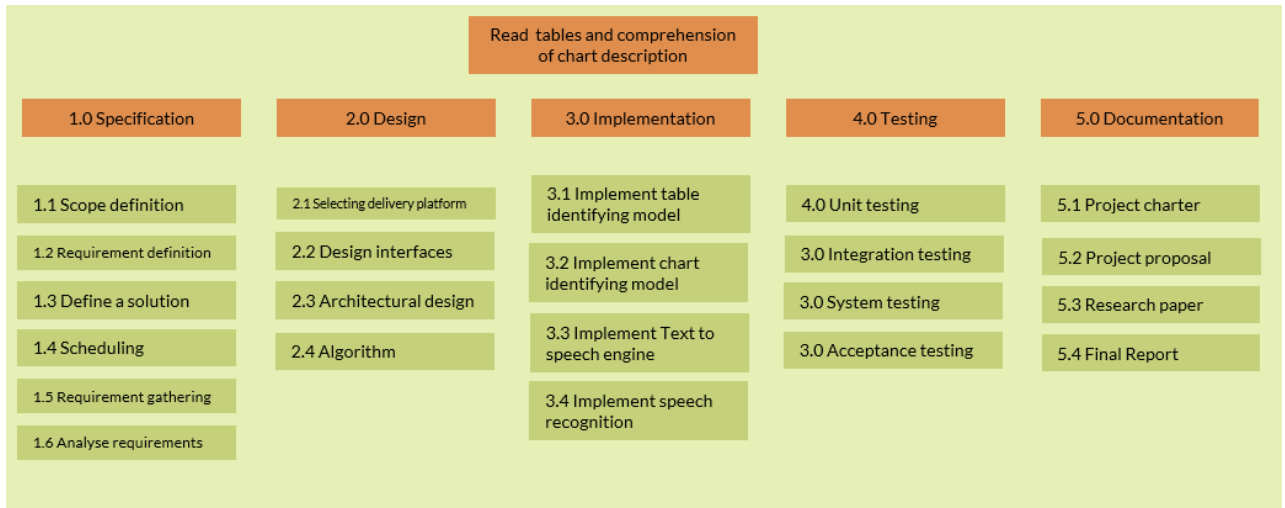


Figure 1.7- Work breakdown structure

5.3. Online Survey

[illegible]

Have you ever tried to read the warranty and related data from your mobile phone? (ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି? କିମ୍ବା ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି?) *

☐ Yes
 ☐ No

Do you think that tables and related data can be defined by (oral reading)? (କିଛି ତଥ୍ୟ ପଢ଼ିବା ପାଇଁ ଆପଣଙ୍କର ମନେ କରାଯାଇଥିବା ଉପକରଣର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି? କିମ୍ବା ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି?) *

☐ Yes
 ☐ No
 ☐ Maybe

Do you think there is table reading for the visually impaired people? (ଦୃଷ୍ଟିବ୍ୟତୀତ ଲୋକଙ୍କ ପାଇଁ ତଥ୍ୟ ପଢ଼ିବା ପାଇଁ ଆପଣଙ୍କର ମନେ କରାଯାଇଥିବା ଉପକରଣର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି? କିମ୍ବା ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି?) *

☐ Yes
 ☐ No
 ☐ Maybe

If yes, please mention those tools. (ହେଉ, ତଥ୍ୟ ପଢ଼ିବା ପାଇଁ ଆପଣଙ୍କର ମନେ କରାଯାଇଥିବା ଉପକରଣର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି? କିମ୍ବା ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି?) *

Your answer:

Do you think such a tool is essential for them? (କିଛି ତଥ୍ୟ ପଢ଼ିବା ପାଇଁ ଆପଣଙ୍କର ମନେ କରାଯାଇଥିବା ଉପକରଣର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି? କିମ୍ବା ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି?) *


☐ Yes
 ☐ No
 ☐ Maybe

If yes, what are your requirements for it? (ହେଉ, ତଥ୍ୟ ପଢ଼ିବା ପାଇଁ ଆପଣଙ୍କର ମନେ କରାଯାଇଥିବା ଉପକରଣର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି? କିମ୍ବା ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି?) *

Your answer:

In addition, if you have an idea about reading tables and data, please let us know. (ତଥ୍ୟ ପଢ଼ିବା ପାଇଁ ଆପଣଙ୍କର ମନେ କରାଯାଇଥିବା ଉପକରଣର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି? କିମ୍ବା ଆପଣ କେଉଁ ପ୍ରକାରର ଉପକରଣର ସେବାରେ ଆପଣଙ୍କର ସ୍ୱାଧୀନତା ଉପରେ ପ୍ରଭାବ ପଡ଼ିଛି?) *

Your answer:



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