

Design Project User and Product Manual

[Accessible Speech]

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Table of Contents

List of Figures	iv
List of Tables	v
List of Acronyms and Glossary	vi
Introduction	1
Overview	2
Cautions & Warnings	4
Getting started	5
Set-up Considerations	7
User Access Considerations	7
Accessing the System	8
System Organization & Navigation	8
3.4.1 The Home/Main Screen	9
3.4.1.1 Disability button	9
3.4.1.2 Add a Recording button	9
3.4.1.3 Frequently played recordings	10
3.4.1.4 Categories	10
3.4.2 Text-to-Speech Screen	10
3.4.3 Settings Screen	10
Exiting the System	10
Using the System	10
4.1 Home Page	11
4.1.1 Frequently Used Recordings	11
4.1.2 Categories	11
4.1.3 Disability Button	12
4.1.4 Add Recording Button	12
4.2 Add a Recording Page	13
4.2.1 Disability checkbox	13
4.2.2 Recording and play/stop buttons	13
4.2.3 Save Button and category	13
4.2.4 Cancel Button	14
4.3 Text to Speech Page	14

4.4 Setting Page	15
Troubleshooting & Support	15
Error Messages or Behaviors	15
Special Considerations	16
Maintenance	16
Support	17
Product Documentation	18
Final Prototype	18
BOM (Bill of Materials)	18
Equipment list	19
Instructions	19
Testing & Validation	20
Conclusions and Recommendations for Future Work	25
Bibliography	26

List of Figures

Figure 1. Screenshots of the three main pages of the final prototype	2
Figure 2. High-level system architecture	3
Figure 3. Activity diagram of different user actions	4
Figure 4. (a) Main/Home Screen (b) List of recording under Shopping (c) Text-to-Speech Screen	5
Figure 5. Add a Recording Screen	6
Figure 6. Settings Screen	7
Figure 7. Bottom tab navigation through pages	9
Figure 8. Frequently Played List	11
Figure 9. Categories	12
Figure 10. Disability button and add recording button	12
Figure 11. Disability checkbox	13
Figure 12. Popup of category selection to save	14
Figure 13. Text to speech screen	14
Figure 14. Settings screen with theme options	15
Figure 15. Error message (A) displayed	16
Figure 16. UML class diagrams of two model classes: Recording and Category	19

List of Tables

Table 1. Acronyms	vi
Table 2. Glossary	vi
Table 3. Bill of Materials	18
Table 4. Measurements from this prototype	24

List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
API	Application Programming Interface
dB	Decibel
MB	Megabyte
nm	Nanometer
xml	Extensible Markup Language

Table 2. Glossary

Term	Acronym	Definition
Extensible Markup Language	XML	A language that allows users to define their own customized markup languages in order to display documents.
Toast	-	A toast is a non-clickable object that provides simple feedback about an operation in a small popup.

1 Introduction

This User and Product Manual (UPM) provides the information necessary for all users to effectively use the Android application AccessibleSpeech and for prototype documentation. The AccessibleSpeech app is designed to help users with speech disabilities communicate, especially during non-verbal episodes. It allows users to play pre-recorded messages of common phrases when they are not able to say them in the moment. It also allows them to do text-to-speech conversions and explain their disability when they need to. This manual describes the overall structure of the application, its main features and how to use them as well as how the app was developed. The intended audience of this document are the users of the AccessibleSpeech application.

2 Overview

This product was developed to aid users with speech disabilities and make communication during non-verbal episodes easier for them. It is important to eliminate barriers to communication as much as possible for everyone and our product aims to do that and aid accessibility for all.

The user needs to be able to communicate effectively and efficiently while minimizing stress.

There are some applications already that aim to solve a similar problem but our product solves it in a different way that brings the users more benefits. We provide the user with several unique features like a frequently played recordings list, disability button and colour themes. The frequently played list makes it faster for the user to access recordings that they often use. The disability message button is particularly important because it allows for the user to inform the people, who they are communicating with, of their disability/condition. This reduces the risk of a misunderstanding occurring before the user is able to find and play a recording during an episode. For the theme selection, we chose colours and tones that do not induce stress and give the product a more aesthetic look.

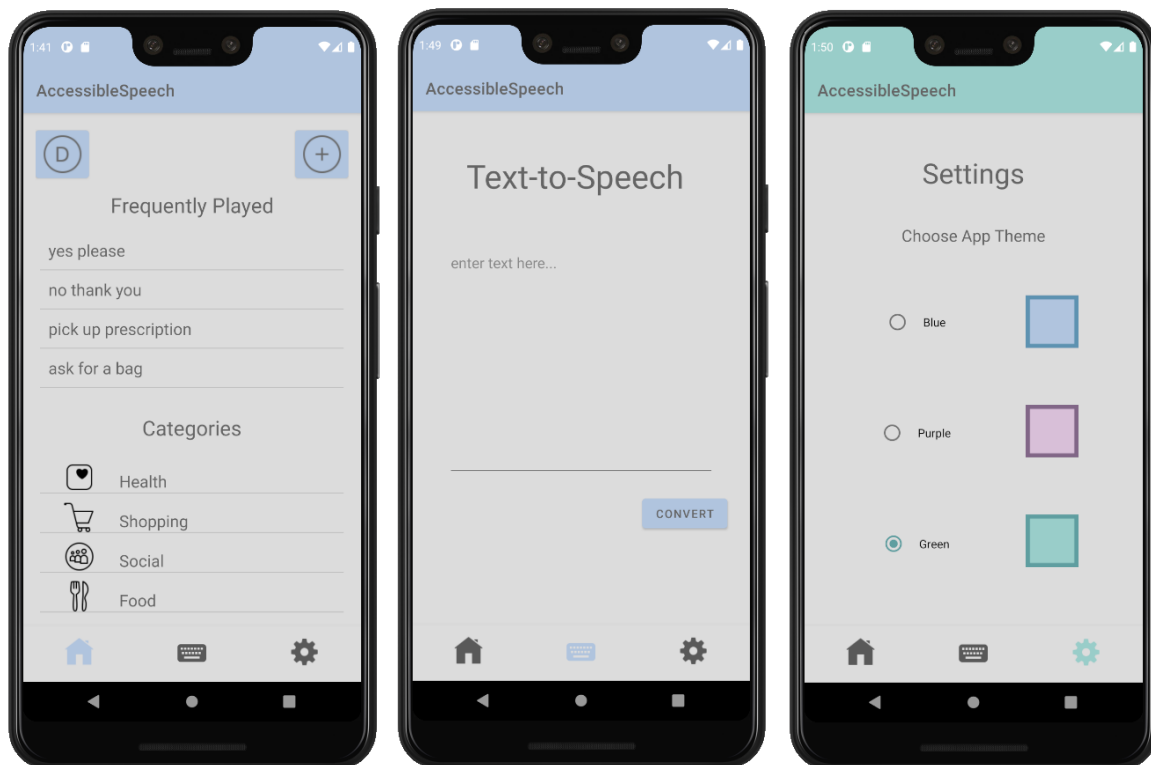


Figure 1. Screenshots of the three main pages of the final prototype

In addition to the aforementioned special features, our product has a recording feature that lets users record and save messages. It also has a screen for text-to-speech conversions.

The system is not web-based. It has three main components: the installed application, the device and a Firebase database. Information about the recordings and categories are stored in the database while the actual recording files are stored on the user's device. *Figure 2* shows the high level system architecture and *Figure 3* shows the process of different actions the user can do.

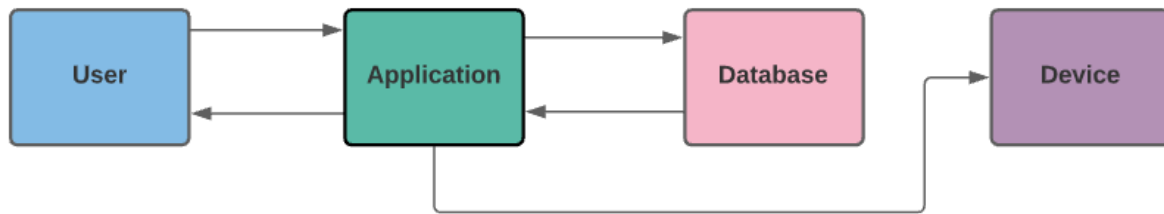


Figure 2. High-level system architecture

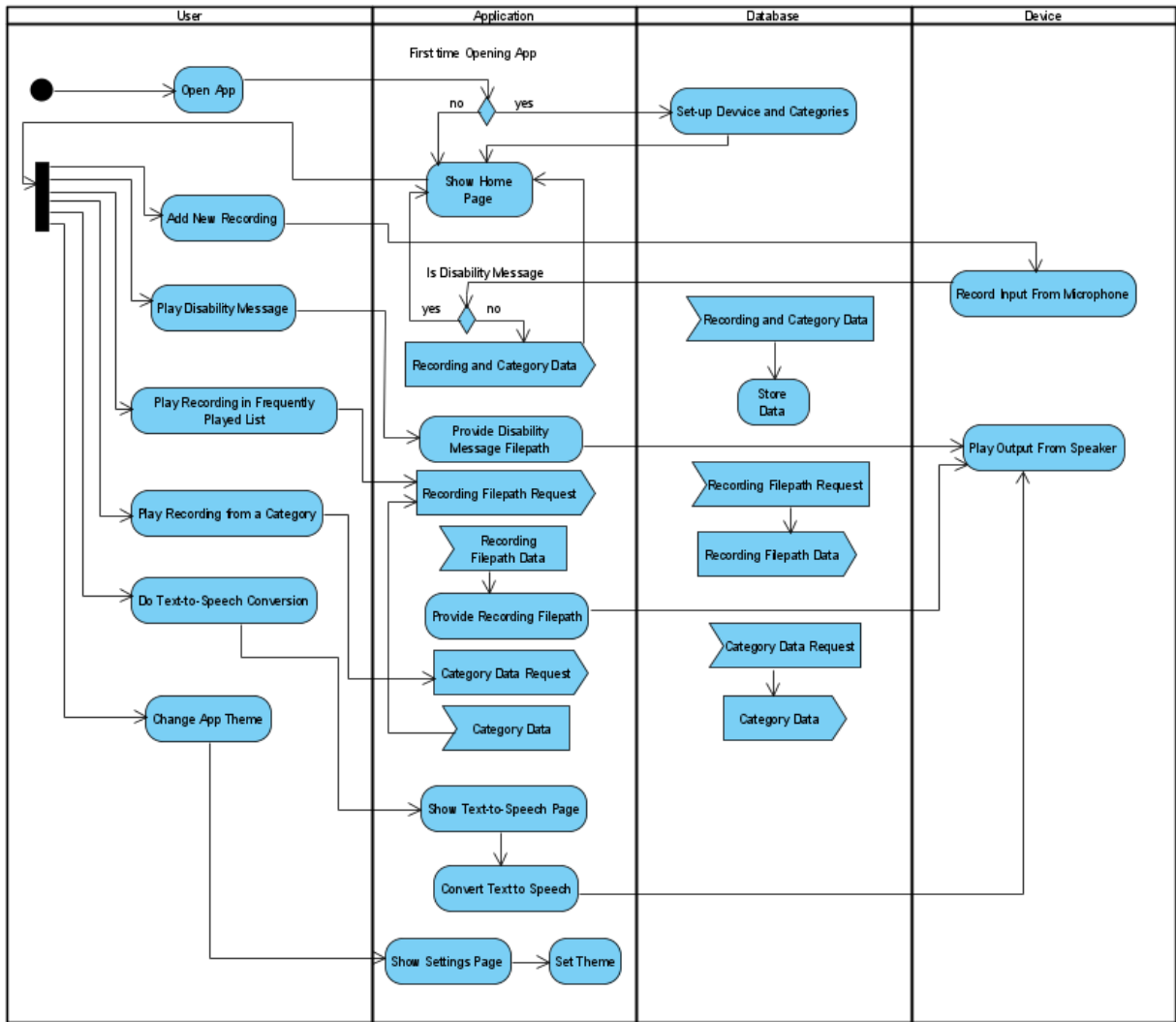


Figure 3. Activity diagram of different user actions

2.1 Cautions & Warnings

The application's content is suitable for all ages. It may however contain minimal cartoon, fantasy and/or infringement, use of mild language through advertisements.

Use of third party tools by the users to avoid advertisements in the free version are not consented by the developers. It is expected of the users to be responsible technology users and only use the application for the sole purpose of benefiting from it in an ethical way.

3 Getting started

The main/home (*Figure 4a*) screen of the application displays frequently played recordings and specific categories under which different recordings have been saved. To play a recorded message from the frequently played recording, the user will have to click on that name and the message will play. To play a recording under a specific category, the user will need to click on that category and then select the desired recording from a displayed list (*Figure 4b*). To access text to speech functionality, the user will need to click on the keyboard icon displayed in the bottom tab of the screen that opens a new screen with a column to type in text (*Figure 4c*). After typing in the text, the user can click on “convert” to make a conversion of the written text to speech. The “D” button on the top left corner of the main/home screen plays a disability message when clicked (The procedure to add this message is described in the next paragraph).

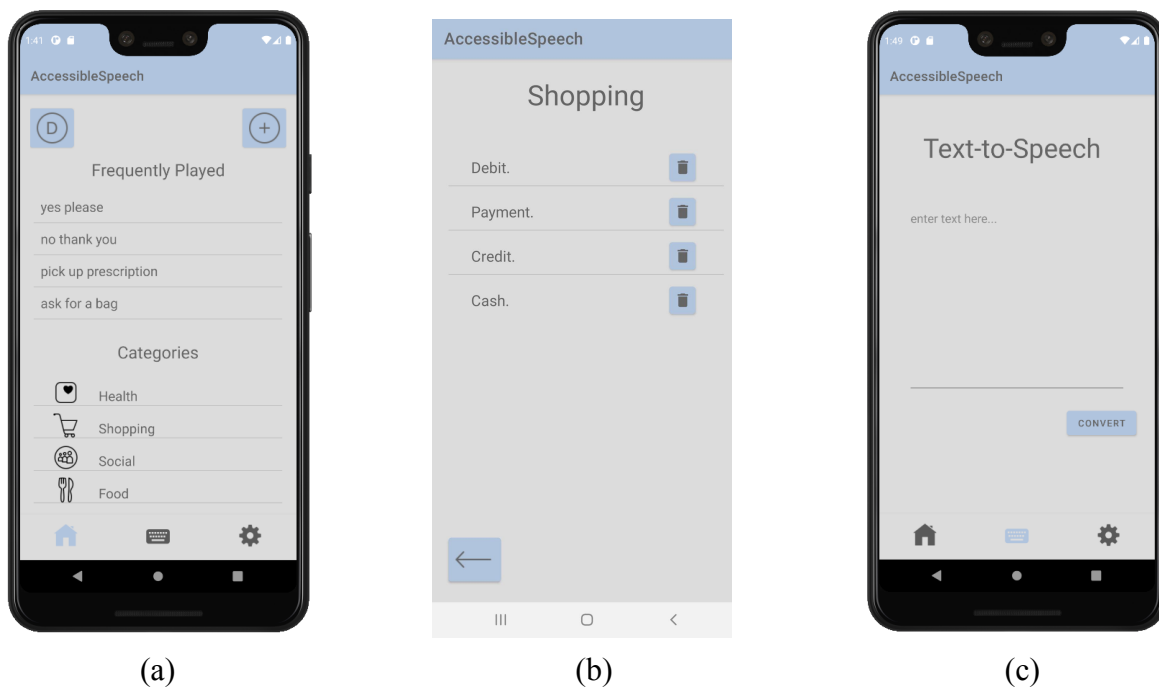


Figure 4. (a) Main/Home Screen (b) List of recording under Shopping (c) Text-to-Speech Screen

To add a new recording under a specific category, the user can click on the “+” icon on the top right corner of the main screen. A new screen (*Figure 5*) titled “Add a Recording” will appear where the user should initially assign a name to the recording that he/she/they plan to record. Following this, the user can click on the microphone to start recording and then click on it to stop. To save it, the user will need to click on the “save” icon on the bottom right and then click on the

category they wish to save it under. In order to save a disability message, the user will need to click on the “check box” in front of the text “Disability Message” on the same screen and then record the message without naming it and then clicking on the “save” button. To go back to the main screen, the user can click on the “cancel” button on the bottom left of this screen.

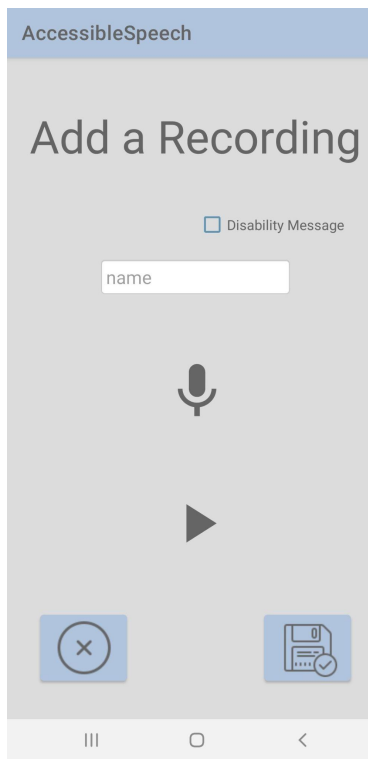


Figure 5. Add a Recording Screen

To change the theme of the application, the user will need to click on the gear like “Settings” icons in the tab on the bottom of the screen. The user can simply click on the name of the desired colour and that theme of that colour will be applied to the whole application. The appearance of the screen is shown in *Figure 6*.

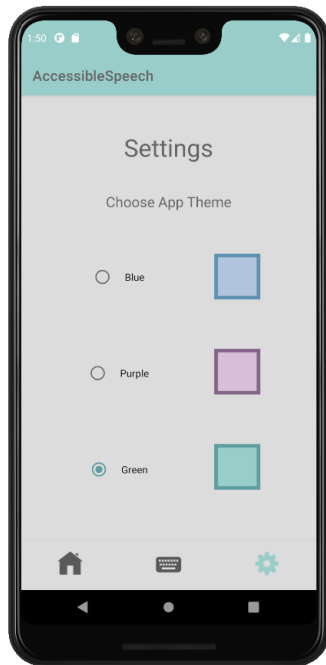


Figure 6. Settings Screen

3.1 Set-up Considerations

To access the application, the user requires an android mobile phone or tablet with a version 4.3 (API level 18) or above. The device should have a working microphone to record the messages. Also, a good quality inbuilt speaker is suitable for better sound quality of recordings and conversion of text into speech through text-to-speech tool.

For recording a message, the microphone is essential to get the input voice and the speaker is essential to provide output sound. To access different features of the application, the input can be given by clicking on the touch screen.

3.2 User Access Considerations

The app is available to any Android users. It is not available for iOS users. The recordings are device installation specific and cannot be accessed from a different device.

The user's device must have an internet connection to add a new recording or play pre-recorded messages. If a disability message has been previously recorded when the device was connected to the internet, then it can be played from the disability button while the device is offline. The text-to-speech conversion and theme changing functionalities work offline.

3.3 Accessing the System

To set-up the application the user needs to install it from the Google Play Store or alternatively, reach out to one of the developers to receive the application file.

For the first option, the user needs to be logged into the Google Play Store with a valid account and should open the Google Play Store and search for AccessibleSpeech. Then, the user should click the install button.

For the second option, the user should email michal.ridner@gmail.com to ask for the application file. The user will then be sent the .apk file. They should download the file. To be able to install it on their device, the user must go into their device Settings → Security Settings and then enable the Install from Unknown Sources option. Then the user should navigate to where the .apk file is downloaded and click the file to install the application.

After the installation process is complete, the user can find the AccessibleSpeech app in their list of apps.

On opening the application for the first time, the application will ask for permission to use the microphone and the user will need to select “Allow only while using the app”. Permission can be manually granted by this process: Settings → Privacy → Permission manager → AccessibleSpeech → Microphone → Allow only while using the app.

3.4 System Organization & Navigation

The application has three main tabs: the home page, the text-to-speech page and the settings page. The user can use the tabs at the bottom of the application to navigate between these pages, as shown in *Figure 7*.

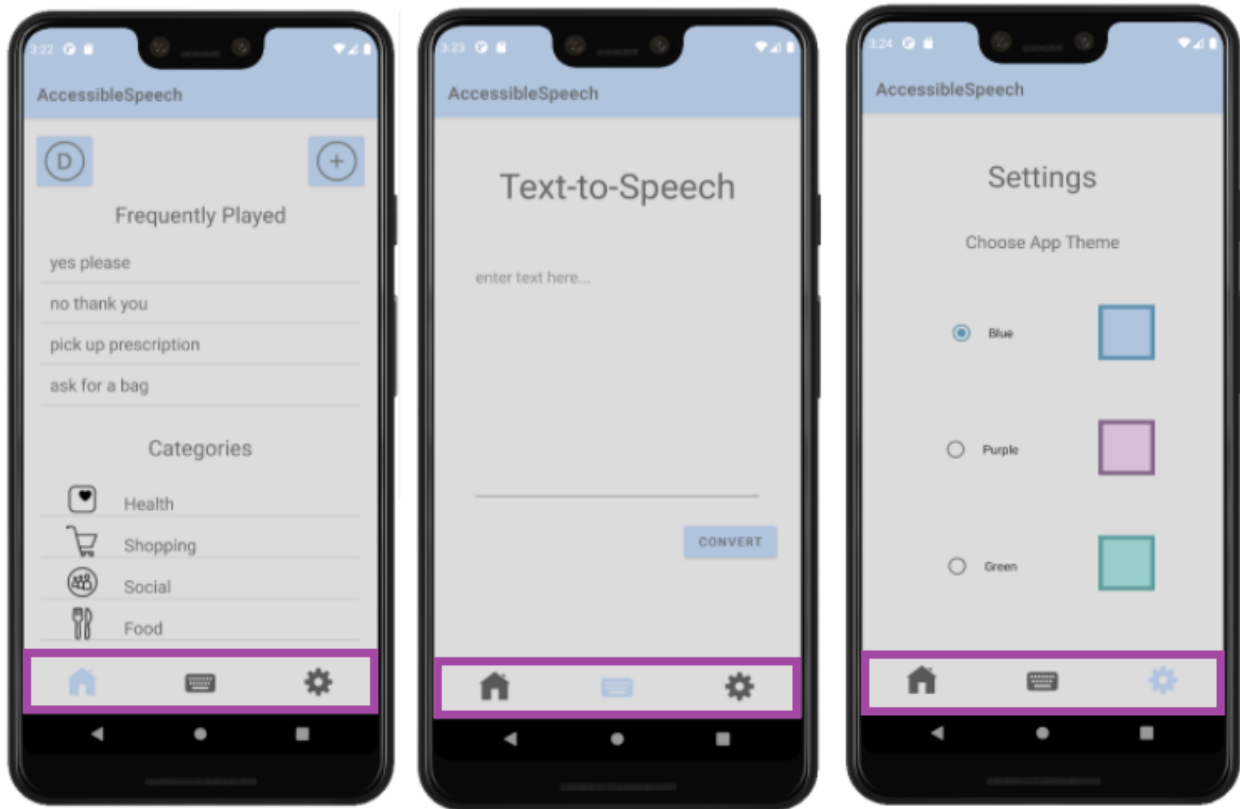


Figure 7. Bottom tab navigation through pages

3.4.1 The Home/Main Screen

This is the screen that shows up when the application is opened. Its elements and their navigation and connections are described below.

3.4.1.1 Disability button

This button on the top left corner of the screen plays the disability message that has been pre-recorded. The user would stay on the home screen after clicking on it.

3.4.1.2 Add a Recording button

On clicking this button, the "Add a recording" screen opens up and the disability message or new recordings can be added. To go back to the main screen, the user can click on the "cancel" button at the bottom left corner of the screen or simply click on the device's back button.

3.4.1.3 Frequently played recordings

This list displays all the recordings that have been played frequently by the user. Any recording from this list can be played by clicking on its name. The user stays on the main screen after clicking on it.

3.4.1.4 Categories

The list of categories that have different recordings saved under them is displayed on the main screen. On selecting any category, the list of recordings under that particular category is displayed. To get back to the main screen, the user can click on the back button on the bottom left corner of the screen or the device's back button itself.

3.4.2 Text-to-Speech Screen

On selecting the "Keyboard" icon from the bottom tab, this screen with text to speech conversion functionality opens up. To get back to the main screen, the user can click on the "Home" icon from the bottom tab or click the back button on the device being used.

3.4.3 Settings Screen

This screen opens when the user clicks on the gear like "Settings" icon from the bottom tab. This screen can be used to change the theme of the application. To go back to the home screen, the user can select the "Home" icon from the bottom tab or click the back button on the device being used.

3.5 Exiting the System

The user can exit the application by clicking the home button of the device. The app can be cleared from the recents tab as the user would do for any other application.

4 Using the System

As the application is opened the user will see the recordings screen. There are many useful functions on this screen such as the most frequently used recordings and recording categories. Below we go further in depth on how these functions work.

4.1 Home Page

This is the screen that shows up when the application is opened. Its elements and their navigation and connections are described below.

4.1.1 Frequently Used Recordings

The frequently used recordings feature is an extremely useful and straight forward part of the application. When you start up the app for the first time you will notice that this section is blank. However, this will change as you start adding and playing new recordings! Once you start playing recordings you will notice that they will be listed here. You will be able to play these recordings straight from the frequently used section. Lastly, the recordings listed here will be updated as you play more recordings. They are also listed from most plays at the top and decreasing in plays as the list descends.

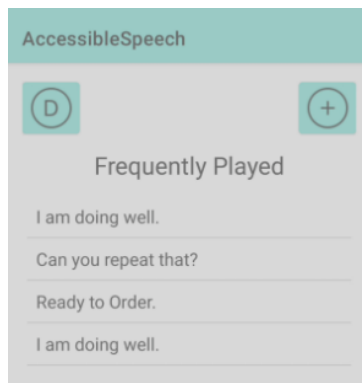


Figure 8. Frequently Played List

4.1.2 Categories

Directly below the frequently used recordings section of the recordings page you will find the recording categories section. In here you will find preset categories that you will be able to add to in the add recording page. You can play these recordings by pressing the category in which the recording is located in and then pressing the recording.

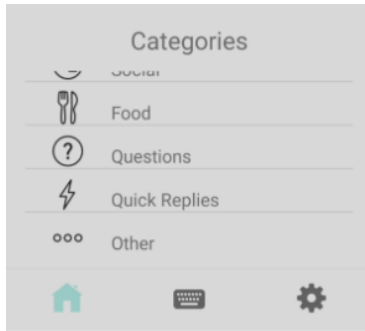


Figure 9. Categories

4.1.3 Disability Button

When this button is pressed (Top left corner of *Figure 10*) plays the most currently saved disability message. To add a disability message you must go to the add recording page and check the disability button checkbox before saving the recording.

4.1.4 Add Recording Button

This button in the top right corner of *Figure 10* will take the user to the add recording page when pressed.

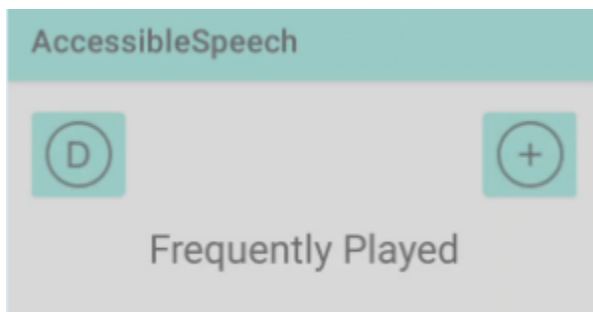


Figure 10. Disability button and add recording button

There is also a taskbar located at the bottom of the screen. This bar is here on every page in the app. Pressing one of the icons will take the user to the icons corresponding page. The three pages are recordings, text-to-speech, and settings.

4.2 Add a Recording Page

There are many features on this page. The main features are the disability checkbox, the recording button and the play/stop button, the save button, the back button, and the category checkboxes.

4.2.1 Disability checkbox

When this box is checked and a recording is saved the saved recording will be set as the new disability recording.

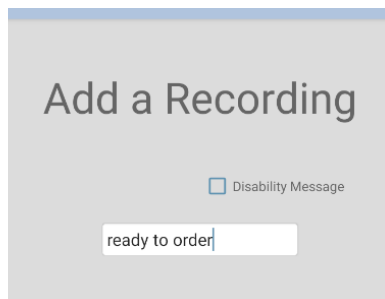


Figure 11. Disability checkbox

4.2.2 Recording and play/stop buttons

These are the buttons that the user will use to add a new recording. The user will first put in a name for the recording they will then press the record button and speak into the microphone. After they are finished the user can listen to their recording by pressing the play button.

4.2.3 Save Button and category

The save button allows the user to save their recording after they finish making it. Once the save button is pressed the user will be greeted by the select category popup. In this popup the user can check whichever box to save their recording to that box's corresponding category.

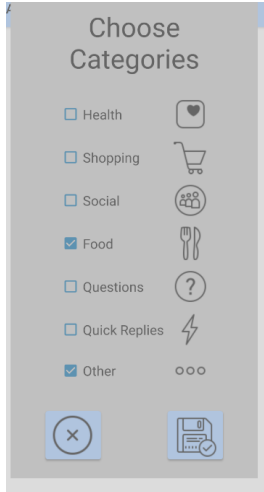


Figure 12. Popup of category selection to save

4.2.4 Cancel Button

When pressed, the cancel button will take the user back to the home page.

4.3 Text to Speech Page

To convert text to speech, you type into the space provided then when done click the button near the bottom of the screen when you are ready to play the text.

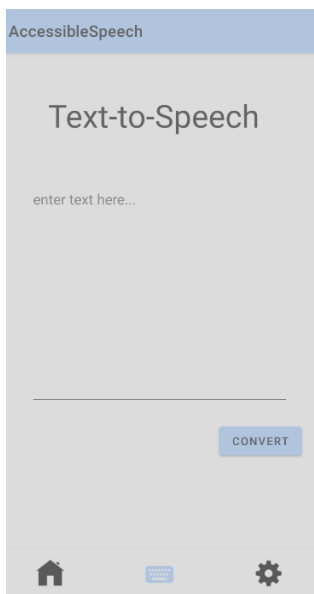


Figure 13. Text to speech screen

4.4 Setting Page

The last page in the app is the settings page. The main function of this page is to change theme colours.

To change the theme colour simply just check the box of the corresponding theme colour you desire.

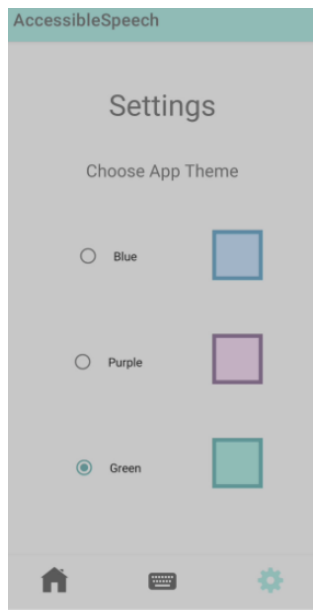


Figure 14. Settings screen with theme options

5 Troubleshooting & Support

The application has some error messages which appear in the form of a toast at the bottom of the screen. These error messages have been discussed in detail in the following sections.

5.1 Error Messages or Behaviors

- A. **Recording name exists:** The user will not be allowed to record a message if they are saving the recording under a name that they have previously used to save another recording on their device. The user should rename that recording and press 'record' again. If the user would prefer to save that recording under the same name then they could switch the case (uppercase to lowercase or vice versa) of the letters

of the existing name. If the error message displays again, please contact customer support.

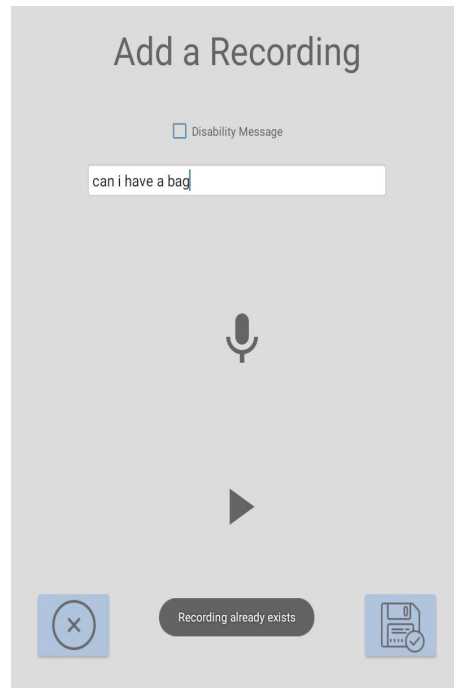


Figure 15. Error message (A) displayed

5.2 Special Considerations

‘D’ does not play anything when clicked: If nothing plays when the disability button is clicked on, then try adding a recording and saving it as a disability message by clicking on the ‘Disability message’ checkbox on the Add a recording page. That recording should play when ‘D’ is clicked on now. If not, please contact support.

5.3 Maintenance

The user should try to keep up with the updates provided for the app to make optimal use of the application.

5.4 Support

For help troubleshooting or to report a problem, please send an email to:

- michal.ridner@gmail.com
- emyaitafo@gmail.com
- gurinder1730@gmail.com

The title of the email should be of the format below:

“AccessibleSpeech: <Summary of the problem>”

For emergency assistance, please prefix the above title with “URGENT: ” A detailed description of the problem should be included in the body of the email. Please provide as much detail as possible and include screenshots, if possible. A member of our support staff will be in contact with the user as soon as possible.

6 Product Documentation

For the final prototype, we had to make some decisions to focus on certain features and leave others as future work.

Initially, we had all the recordings displayed in a list on the home page, and one of our biggest decisions was made, after feedback from the client, to have categories and/or a search bar. We decided to categorize our recordings because it would be faster for the client to use than a search bar. In addition, categorizing recordings was a bigger change that would require restructuring our database so it was better done as soon as possible.

We could have used a widget so our client could play a recording without opening the app. This would not exactly reduce the amount of time it takes to access a recording because the user might still have to open the application as the widget would not show all the recordings. We decided to have a frequently played list on our main page instead. By doing this, the user has access to frequently played recordings and can get to other recordings in little to no time.

The user may have to explain their disability so one of our solutions was to have their disability message play automatically when the application was launched or to have a disability button that would always contain the message. We decided on the latter as the user might not always need to explain their disability. For example, when they are with family, there is no need for an automatic play of the disability recording.

We converted from buttons with text to image buttons after client feedback. This decision was made for user satisfaction and aesthetics.

6.1 Final Prototype

6.1.1 BOM (Bill of Materials)

The bill of materials is shown in *Table 3*.

Table 3. Bill of materials

Item	Cost	Link
Google Play Store registration fee	\$25	https://play.google.com/console/u/0/signup

6.1.2 Equipment list

All of the equipment that was used to develop the AccessibleSpeech app is listed below:

- Android Studio (free version)
- GitHub
- Firebase (free tier)
- Design Nevo website [3]
- Icons8 website [4]

6.1.3 Instructions

To reproduce this product, one would need to have knowledge of the Java programming language, Firebase Database and Android Studio. The application was developed using Android Studio. Each page was programmed individually as activities. The backend functionality of each page was programmed in the java Activity files and the layout of each page was done in the corresponding activity layout .xml files.

The information about each recording including the name, filepath and which categories it belonged to was saved in the Firebase database when a recording was added. Two model classes were created for the recordings and categories, their UML diagrams are shown in *Figure 16*. These classes were used as objects and their attributes were saved in the database in JSON format.

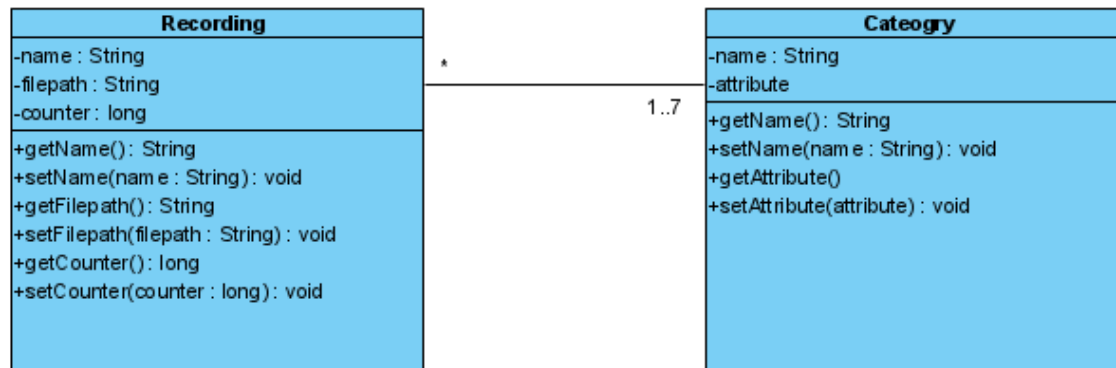


Figure 16. UML class diagrams of two model classes: Recording and Category

The recording feature was done using MediaRecorder and the text-to-speech functionality made use of the Android TextToSpeech API. Playing recordings was done using MediaPlayer. The tabbed layout was implemented using BottomNavigationView, a View layout on Android Studio.

Functionalities such as the frequently played list and the generating of a list of recordings in a category, were designed by reading from the database and implementing logic operations. ListViews were used to display the different lists.

Different themes were implemented using the themes.xml in Android Studio and the SharedPreferences file.

The button icons were downloaded from Icons8 [4] and some were available on Android Studio. The app logo was designed using Design Nevo [3].

6.2 Testing & Validation

To test the application, test cases for each of the different functionalities: accessing a recording from a category and playing it, adding a recording, adding a disability message and playing it, and converting text to speech were made. The 12 test cases are shown below:

Test Case 1: Measure response time

1. Open AccessibleSpeech application
2. Time how long it takes to open and load

Test Case 2: Play a recording

1. Open AccessibleSpeech application
2. Press “shopping” category
3. Check that recordings are displayed
4. Press “ask for a bag”
5. Check that the message is played

Test Case 3: Record and play a message

1. Open AccessibleSpeech application
2. Press “Add Recording” button
3. Enter “test1” in the name field
4. Press “Record” button to start recording
5. Check that the record button now says “Recording”
6. Say “Hello World”
7. Press “Recording” button to stop recording
8. Check that the record button now says “Record”
9. Check that the play button now says “Play test1”
10. Press play button to play message

11. Check that the play button now says “Playing test1”
12. Check that the recorded message is played back
13. Press play button to stop playing message
14. Check that the play button now says “Play test1”

Test Case 4: Record without a name

1. Open AccessibleSpeech application
2. Press “Record” button
3. Check that the record button still says “Record”

Test Case 5: Play without a recording

1. Open AccessibleSpeech application
2. Press “Play” button
3. Check that the play button still says “Play”
4. Enter “test4” in the name field
5. Press play button
6. Check that the play button still says “Play”

Test Case 6: Add a recording to one category

6. Open AccessibleSpeech application
7. Press “Add Recording” button
8. Enter “social1” in the name field
9. Press “Record” button to start recording
10. Check that the record button now says “Recording”
11. Say “This is a social message”
12. Press “Recording” button to stop recording
13. Check that the record button now says “Record”
14. Click “Save”
15. Check that the category selection popup is shown
16. Select the “Social” category button
17. Press the “Ok” button
18. Check that the main recordings page is showing
19. Check the Firebase database that a new recording has been added to “recordings” with the name “social1”
20. Check that the recording key has been added to the category “social” in the database

Test Case 7: Add a recording to multiple categories

1. Open AccessibleSpeech application
2. Press “Add Recording” button
3. Enter “test2” in the name field
4. Press “Record” button to start recording
5. Check that the record button now says “Recording”
6. Say “This is a message”
7. Press “Recording” button to stop recording
8. Check that the record button now says “Record”
9. Click “Save”
10. Check that the category selection popup is shown
11. Select the “Shopping”, “Food” and “Questions” category buttons
12. Press the “Ok” button
13. Check that the main recordings page is showing
14. Check the Firebase database that a new recording has been added to “recordings” with the name “test2”
15. Check that the recording key has been added to the category “shopping” in the database
16. Check that the recording key has been added to the category “food” in the database
17. Check that the recording key has been added to the category “questions” in the database

Test Case 8: Add a recording without a category

1. Open AccessibleSpeech application
2. Press “Add Recording” button
3. Enter “test3” in the name field
4. Press “Record” button to start recording
5. Check that the record button now says “Recording”
6. Say “Hello World”
7. Press “Recording” button to stop recording
8. Check that the record button now says “Record”
9. Click “Save”
10. Check that the category selection popup is shown
11. Press the “Ok” button
12. Check that nothing happens, the category selection popup is still showing

Test Case 9: Check cancel and close buttons

1. Open AccessibleSpeech application
2. Press “Add Recording” button
3. Enter “test4” in the name field
4. Press “Record” button to start recording
5. Check that the record button now says “Recording”
6. Say “Hello World”
7. Press “Recording” button to stop recording
8. Check that the record button now says “Record”
9. Click “Save”
10. Check that the category selection popup is shown
11. Press the “Close” button
12. Check that the popup closes and the “Add a Recording” page is displayed unchanged
13. Click the “Cancel” button
14. Check that the main recordings page is showing
15. Check the Firebase database that a new recording has not been added

Test Case 10: Add a disability message and play it

1. Open AccessibleSpeech application
2. Press “Add Recording” button
3. Check the “Disability Message” checkbox
4. Check that nothing can be written in the name field
5. Press “Record” button to start recording
6. Check that the record button now says “Recording”
7. Say “This is a disability message”
8. Press “Recording” button to stop recording
9. Check that the record button now says “Record”
10. Click “Save”
11. Check that the main recordings page is showing
12. Press the button “D” at the top right corner
13. Check that the message that was just recorded plays
14. Press the button “D” and while the message is playing press it again
15. Check that the disability message stopped playing

Test Case 11: Convert text to speech

15. Open AccessibleSpeech application
16. Press “TTS” button
17. Type “hello world” in the text box
18. Press “Convert” button
19. Check that the typed message is said out loud

Test Case 12: Convert empty string

1. Open AccessibleSpeech application
2. Press “TTS” button
3. Click on “Convert”
4. Check that nothing happens

All 12 of the test cases passed with the expected outcomes. This means that all of the features work correctly without any unexpected behaviours.

The measurements taken from the application are shown in *Table 4*.

Table 4. Measurements from this prototype

Metric	Unit	Actual
Memory Space	MB	3.37 MB
Sound	dB	65 dB
Colour wavelength	nm	420-490 nm
Price	Canadian Dollar (\$)	\$0
Response Time	Seconds (s)	~ 1 s

7 Conclusions and Recommendations for Future Work

Our team learned the role of speed optimization and testing in software design. As speed was of top priority to our client, any code that increased the time for any functionality to work was removed or modified. Testing should be done at every stage for all prototypes. This helps avoid untraceable errors.

Another important lesson was the importance of customer feedback and how it should affect design decisions. This helps us design with user satisfaction in mind and not just functionality.

If we had more time to work on our product, we would add a search bar to make it easier to find recordings. We would also make a switch from activities to fragments. Fragments are recommended for tab layouts like ours. Currently, the application is Android-friendly only. We plan to make it available in all software environments. We used a Json-type database, Firebase, which is more of a data structure. We would like to use a relational database, like the PostgreSQL database offered by Amazon Web Services, instead.

8 Bibliography

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