

GNG 2101: Intro to Product Development and Management for Engineers

Library Wayfinding User Manual

Submitted by

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List of Acronyms and Glossary

Table 1. Acronyms

Acronym	Definition
URL	Uniform Resource Locators
UI	User Interface

Table 2. Glossary

Term	Acronym	Definition
Arduino		Small microcontroller capable of establishing a bluetooth connection

1 Introduction

This User and Product Manual provides the necessary information for engineers, entrepreneurs and anyone who is willing to expand the functionalities of a software based project and product. The product which will be presented is an application where users with and without impairments are able to navigate the uOttawa library in an easy to follow manner. The use of

beacons/arduinios is needed to communicate with the app to navigate users to their desired locations.

2 Overview

The University of Ottawa wants to make its library more accessible, meaning a solution that all students and faculty can benefit from. This app focuses specifically on users with visual impairments. Going to new or revisiting old buildings can leave users confused with their way around the property. Trying to figure out directions using a map on a wall can be disorienting and therefore there is a simple solution, through the app. This app allows the user to seamlessly navigate their way through the library by providing usual and auditory cues to aid in their arrival to their destination. This product, Polaris, differentiates itself from competitors as it has a built in announcements screen which allows for the admin to post messages and alerts from all users to see. Also, this app provides full auditory navigation for those who are visually impaired.

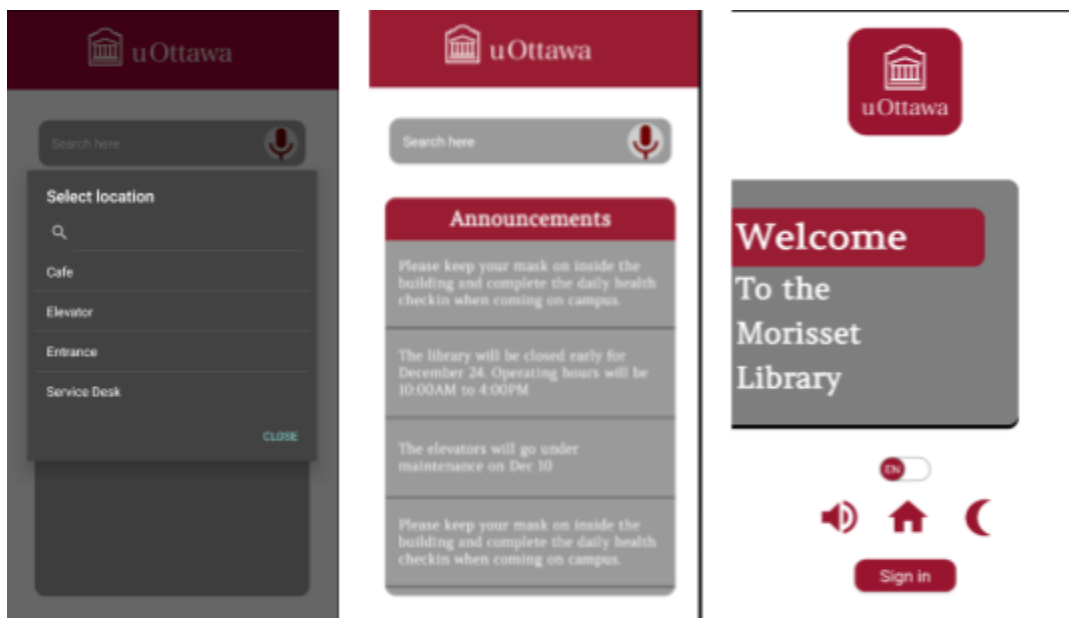


Figure 1. Screenshot of the Wayfinding app in the order of select location popup, home screen and main menu screen

When opening the application the user is greeted with the main menu screen where they can see an array of buttons and icons. The first is a English to French slider which allows the user to translate all of the audio and text to French. Next there is an audio button which toggles the text to speech function of the app. To the right of that, is the home button, this leads the user to the homescreen where they can view announcements and search for a destination using either speech to text or typing. The moon icon enables dark mode, where all bright colours are darkened

allowing for a less eye straining experience. Finally, the sign in buttons allows designated administrators to add and delete announcements.

The system is an mobile-application based product that provides navigation service within the library. It is currently only set up to run on android devices running android 7.1.1 or greater. The android application that utilizes an external database to load announcement, and building information. The system functionality layout is shown below.

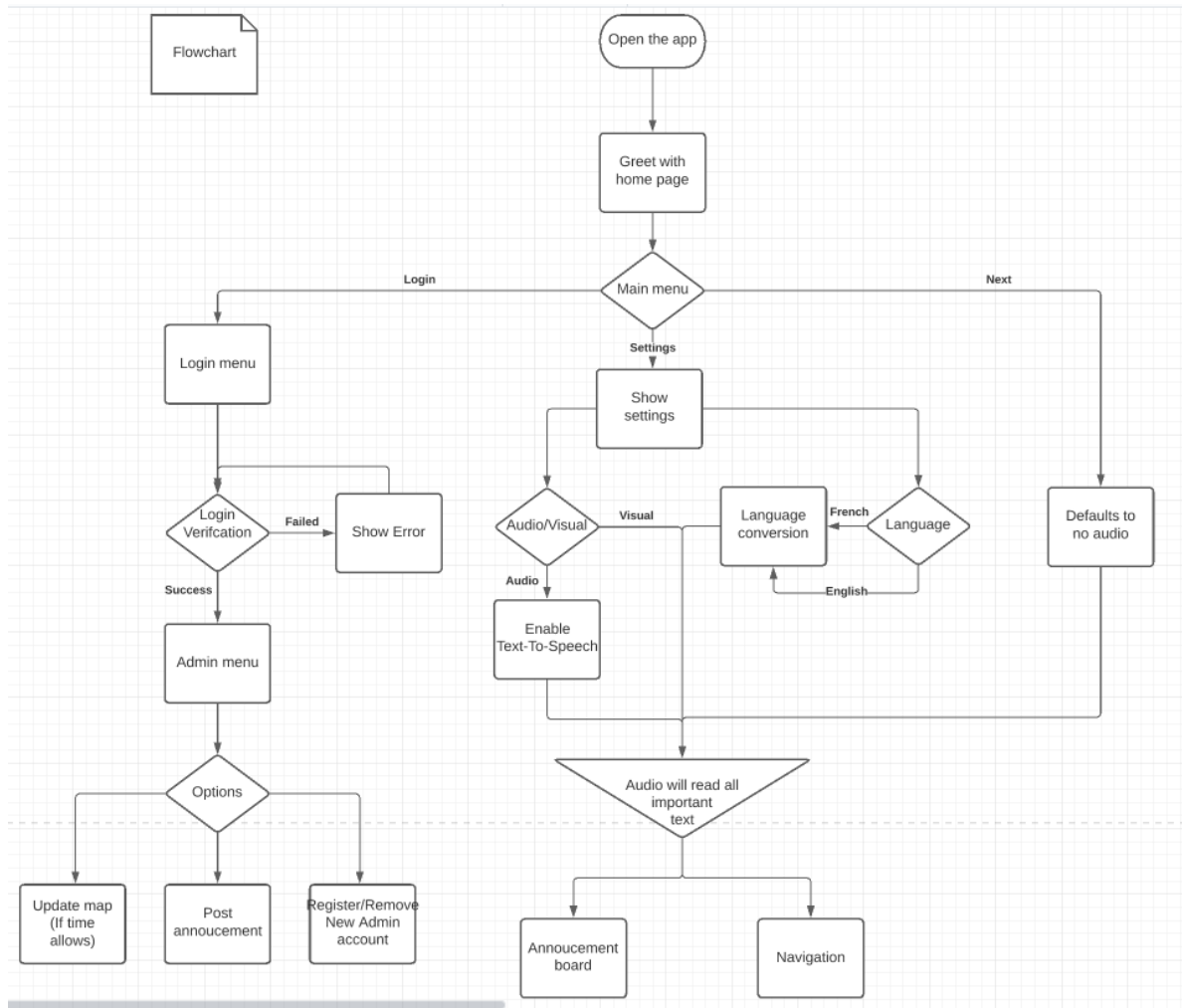


Figure 2. Flow chart diagram of Wayfinding application

2.1 Cautions & Warnings

Be aware of your surroundings while using Polaris, look up from the screen to ensure you are headed in the right direction. For users with severe visual impairment, this app does not replace other devices used for visual impairment.

3 Getting started

To begin using the app, first download the source code located on <https://github.com/Aduno/Library-Navigation-Android>. Open the folder containing the source code through android studio and to go to the HomePageActivity.java. run the program. On line 50, the ip address will have to be changed to match the server's address which will vary from device to device. If running a windows local server to host the database, call the ipconfig in the command terminal and retrieve the IPv4 address and paste it into the URL. If it is an external server, contact who is responsible for the server and ask for the ip address. Once complete, the APK can be generated from Build->Build Bundle(s)/APK(s)->Build APK(s). The APK will be located in /app/build/outputs/apk/debug. Take the APK file and transfer it into the device where it can be installed using the phone's software installer.

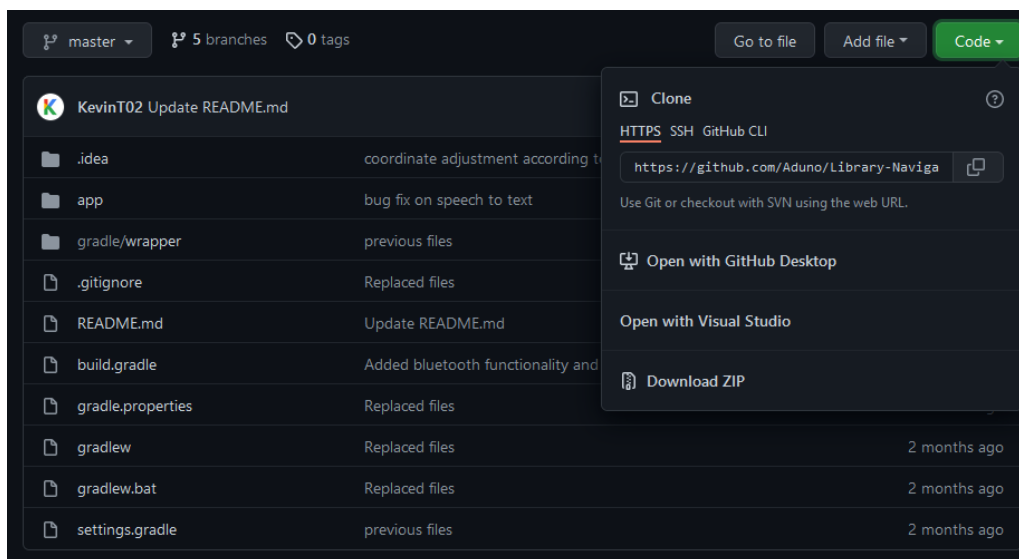


Figure 3. Github repository for wayfinding application

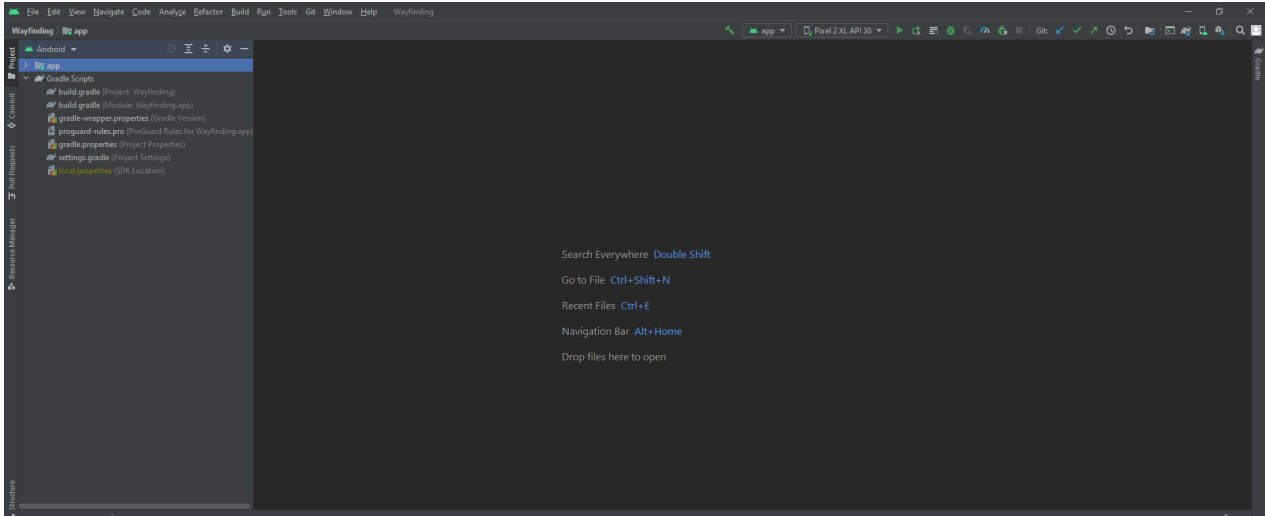


Figure 4. Android studio after opening up the downloaded files

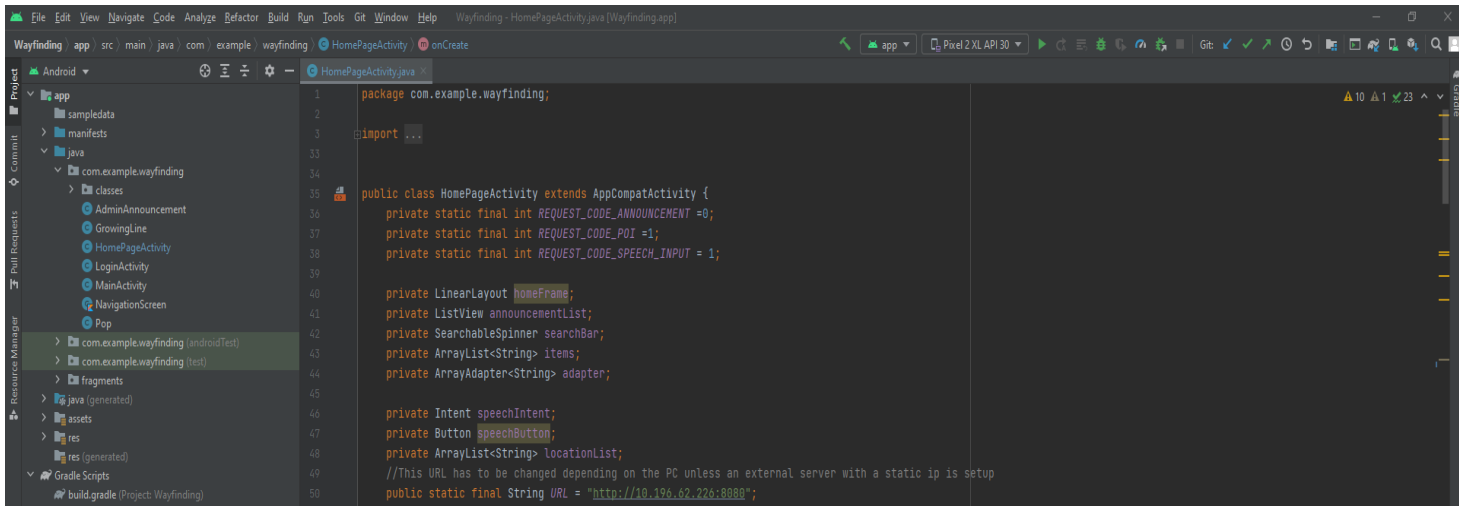


Figure 5. Opening up the HomePageActivity.java file in android studio

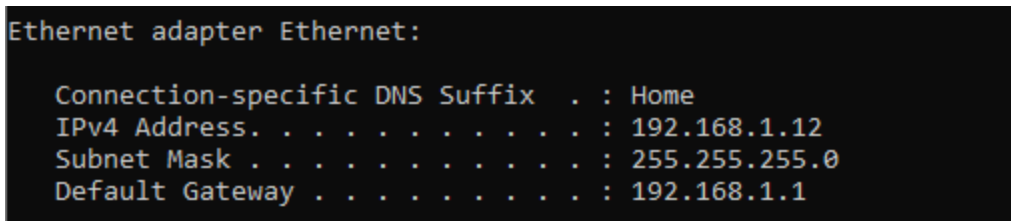


Figure 6. Command line output after entering ipconfig

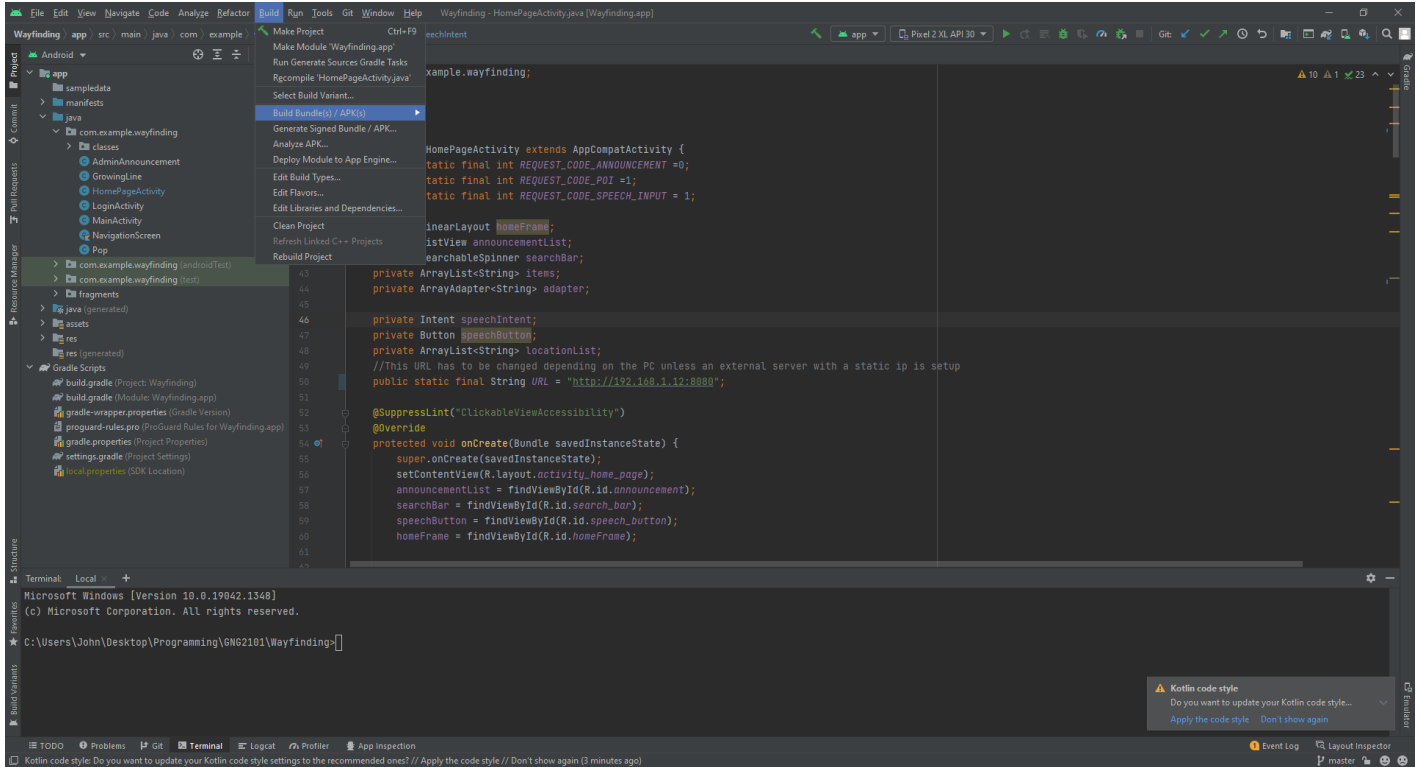


Figure 7. Navigating to build APK on android studio

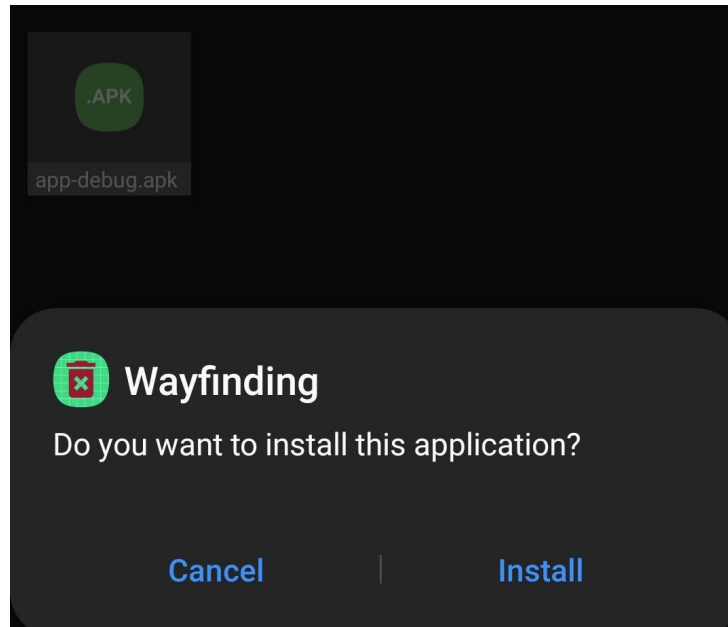


Figure 8. Installing application on device

3.1 Set-up Considerations

To begin using the application, the beacon and server must be initialized around the map. The distance between the beacons is recommended to be within 25m to provide an accurate distance measurement. This will need to be decreased if there are a lot of obstacles obstructing the view between the beacon and device path

3.2 User Access Considerations

The user type aside from admin is the guest. The guest is any user of the application that is not logged in. They are only able to view the announcements, enable/disable sound and dark mode, switch language, and a map, navigating the user to a selected point of interest.

3.3 Accessing the System

To access the admin system, click on the 'sign in' button located in the main screen and use the username and password "admin". This will lead to the page where announcements can be posted and deleted as desired.

To access the database system, the admin must login to the phpMyAdmin using the username: **root**, password: **usbw**. From there, the database can be manually edited to change the points of interest coordinates and names. It is also possible to edit the announcements here as well, though it is a lot easier to add and remove announcements through the admin login in the application.

3.4 System Organization & Navigation

The application consists of 4 major parts. Welcome page, main page, navigation page, and admin page.

3.4.1 Welcome page

When the app is first opened, the welcome page will be presented first where the user is able to adjust the settings of the app such as text to speech, language, and dark mode. From that page, either the main page or the admin login page can be accessed. Pressing on the home button or swiping left will send the user to the main page and pressing on the 'sign in' button will send the user to the admin login page.

3.4.2 Home page

This page consists of the announcements and a search area to input their desired destination. The input can be by text or speech. By selecting a desired location to navigate to, the user is sent to the navigation page.

3.4.3 Navigation page

The navigation page displays a bird's eye view of the building with a line showing the way to their destination from their current position. The user will be tracked using a dot throughout the library to give the user an idea of the approximate distance from their destination.

3.4.4 Admin page

The admin page is accessed by logging in through the admin login page with the username and password "admin". Here, new announcements can be posted for all users of the app to view. It also allows the admin to delete announcements that have been posted.

3.5 Exiting the System

The application may be exited at any stage of the screen. If navigation has been started and the user exits the application, the user will have to re-enter the navigation destination once it is restarted.

4 Using the System

When the user first opens the application, he is greeted with a welcome message. In the mainpage, he has access to five different shortcuts.

This figure represents the main page of the application.

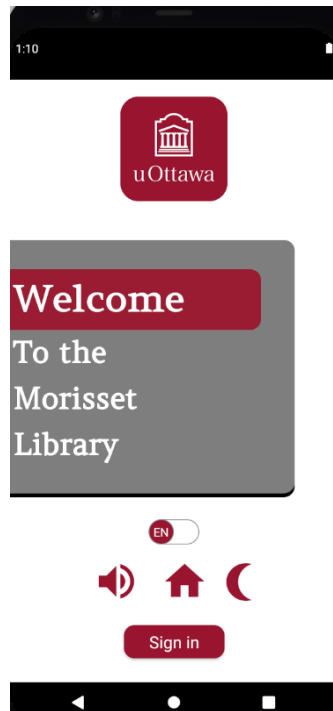


Figure 9. Screenshot of the “Main Screen” in English

4.1 The language setting

The user can choose whether he wants the app to be in French or English.



Figure 10. Language Toggle Button



Figure 11. Screenshot of the “Main Screen” in French

4.2 The audio feedback

When clicking on the audio button, the user hears “Welcome to the Morisset library wayfinding application. Click on the home button to search for directions.” And if the user stees the app in french, he will hear “Bienvenue dans l’application qui vous aide à vous orienter dans la bibliothèque Morisset. Cliquez sur le bouton d'accueil pour trouver votre direction.” This feature helps visually impaired users to navigate through the app.



Figure 12. Audio button / Text-to-Speech button

4.3 The dark mode

When the user clicks on the dark mode button the UI changes.

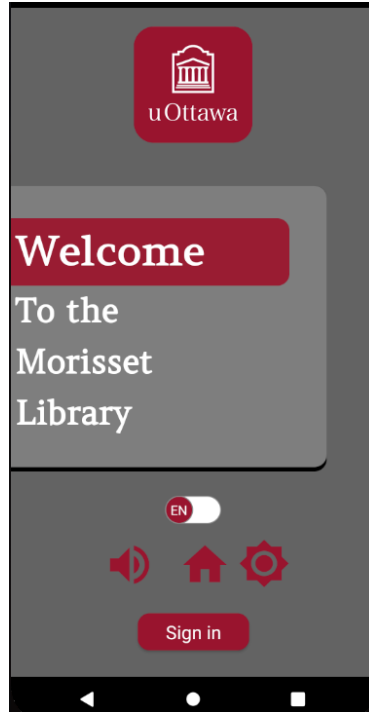


Figure 13. Screenshot of “Main Screen” in darkmode

The user can get back to the light mode by clicking on the light mode button.



Figure 14. Dark mode and light mode icons for the dark mode toggle button

4.4 The administrator features

Only the administrator can use the sign in button to login to his account. He has to enter his credentials(username and password). After that, he will access the admin page where he can see published announcements, add new announcements by clicking the add announcements button and retrieve announcements by long pressing them. When done, the administrator can sign off.



Figure 15. Admin sign in button

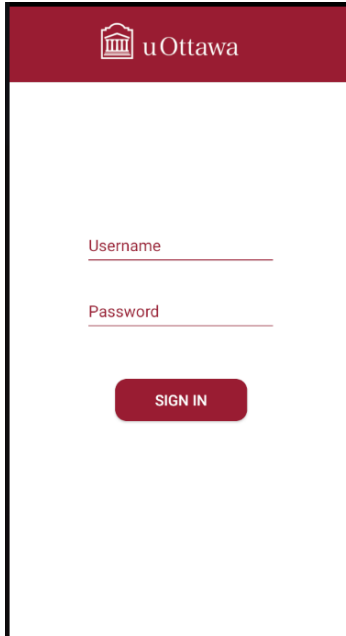


Figure 16. Page where the administrator has to input their credentials

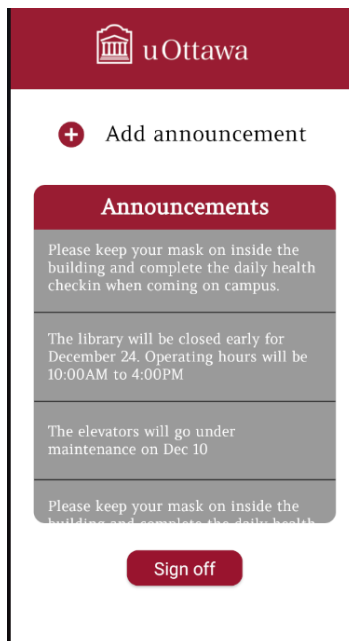


Figure 17. Administrator page

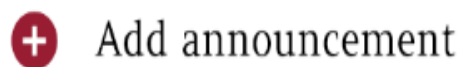


Figure 18. Add announcement button

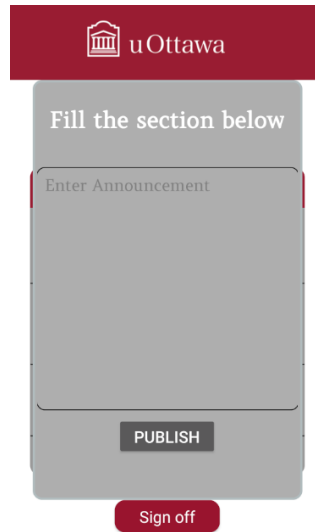


Figure 19. The pop up where announcements can be typed and published



Figure 20. Sign off button

4.5 The home page

When clicking on the home page button, the user is directed to the homepage. He can see the announcements and a search bar where he can input the location he wants to get to whether by typing it or using text to speech .

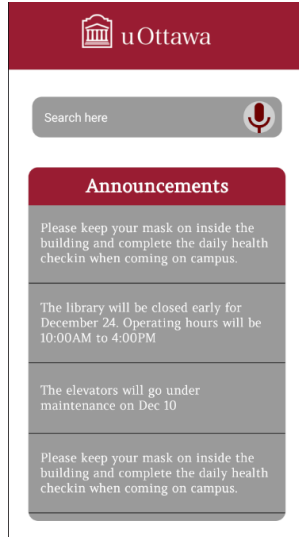


Figure 21. The home page



Figure 22. Search bar that has both typing and speech to text options

This figure shows the pop up of the typing option

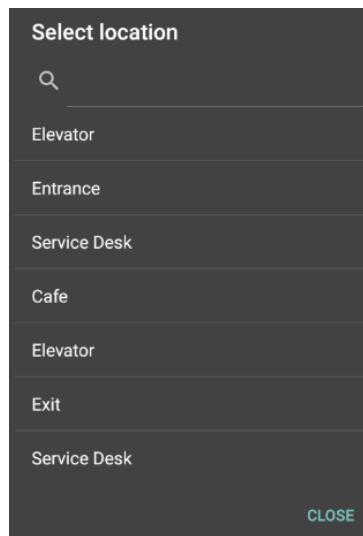


Figure 23. The pop up of the typing option for the search bar

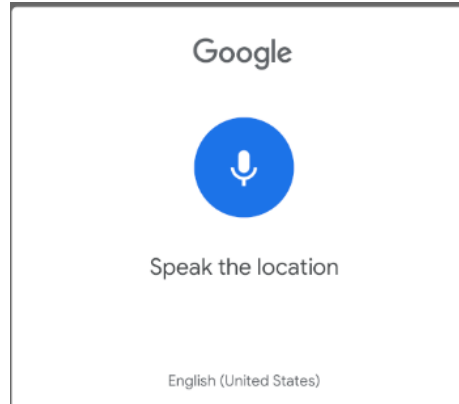


Figure 24. The pop up of the speech to text option for the search bar

4.6 The map

After choosing a location, the app calculates your route using bluetooth beacons that are placed in different parts of the library. Then it displays a map showing your current location, your final destination and tracks your position while you are moving.

This figure shows the map: the red circle is the current location, the white circle is the final destination, the red line is the path to follow and the black dot is the user

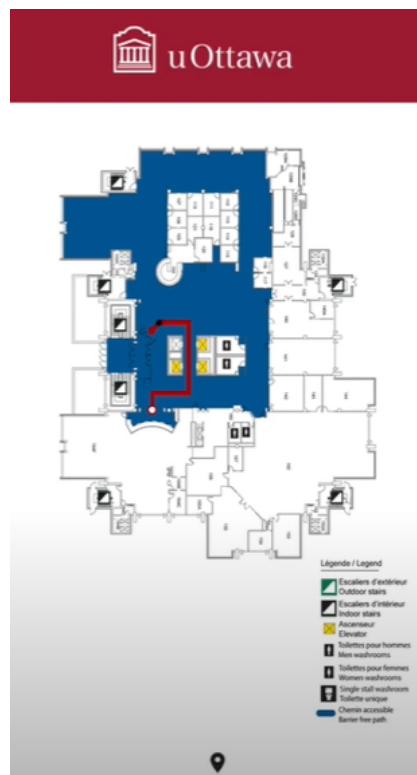


Figure 25. Map showing your current location

This figure shows a zoom of the map while the user is moving (the app tracks the user's position)



Figure 26. Zoom of the map

5 Troubleshooting & Support

There are three general possible points of failure that may occur with the use of this app. First, it is on the device end. This can range from unsupported version of android (ie. android 6.0) or faulty bluetooth module. Second can be beacon issues. Last is the server end. If the server is incorrectly set up, the application will not have access to the information stored in the database.

5.1 Error Messages or Behaviors

When troubleshooting any issues with the application, it is important to view the Logcat output in android studio. This can be found in the bottom left in android studio. It is difficult to pinpoint if an issue is on the device end, application end, or database so different possible behaviors will be discussed and how to resolve those issues.

5.1.1 Database not loading

This may be caused by misconfiguration on the application end or server issue. As mentioned in section 3, the program must be set to the correct ip address prior to use, else, the application will not be updated with the information from the database. The ip address for the database can be checked with the ipconfig as previously mentioned. If that does not resolve the issue, it may be a network configuration issue. If the server is located externally in a different network without a static ip, the application will not have access to the server. To resolve this, a DDNS (Dynamic Domain Name System) management provider or contacting the IPS to set up a static ip will be required to guide the application's request to the server. This is beyond the scope of this application and will not be explained here, but a guide to this can be found through google or contacting the ISP.

5.1.2 Application crashing

First check the android version of the device. It cannot be below 7.1.1. If not there are many issues that may cause this issue so android studio will be required to diagnose this issue. Enable USB debugging on the android device and view the Logcat output as the application is run on the device. Once the application crashes, the logcat will display where the program crashed with an underlined blue text that can be clicked to observe what caused the issue. Read the instructions provided by the android studio and attempt to resolve the issue by searching the error code online or if it is a simple fix, apply the fix. If it cannot be resolved send an email to slee305@uottawa.ca with the error message along with file name and line number where the crash occurred.

5.1.3 Map path not loading

On the device end, ensure the location and bluetooth settings are enabled and the application is permitted to access those settings. Also, check that the bluetooth beacons are powered on and in the planned locations.

5.2 Maintenance

The navigation system does not need a lot of maintenance. The beacons should be checked from time to time to make sure they are working and the app may have some bugs that needs to be fixed

5.3 Support

If the issue cannot be resolved following the troubleshooting steps provided, send an inquiry/bug report to slee305@uottawa.ca. Please describe the problem, error messages displayed, and steps attempted to resolve the issue along device information like android version and model.

6 Product Documentation

The final prototype was built using Android Studio and Arduino microcontrollers. This is true for all the prototypes. The majority of the time spent on the project was used in Android Studio. The only hardware that was needed was the Arduino Nano. These micro controllers were used as checkpoints in order to navigate the users. The uOttawa Library had access to a large number of outlets where the Arduino microcontrollers were plugged into for direct power. These

microcontrollers do not form a subsystem of their own since they only need to be plugged in. The Arduino Nanos act more as an extension of the software subsystem.

6.1 Software Subsystem

The software section of the project is the most complex and where most of the time was spent.

6.1.1 BOM (Bill of Materials)

Table 3. Bill of materials

#	Item	Description	Cost (CAD)	Use	Link (to buy it)
1	Android studio	IDE for android application development	0.00	It is used to develop an android application which enables the user to find his way in the library.	https://developer.android.com/studio
2	Arduino Nano 33 IoT	Microcontroller board with bluetooth	\$32.99	It sends signals to the mobile devices	https://amzn.to/3iHlocA

6.1.2 Equipment list

The only equipment needed is a laptop or PC with Android Studio installed.

6.1.3 Instructions

This subsystem is already built. The only step required is to visit the github repository in order to download the code.

6.2 Testing & Validation

The accuracy of the bluetooth signals is one of the most important aspects of the Polaris application. Microcontrollers were used to output the signals. The Arduino Nano acts as the beacon and an Android mobile device detects the signals and prints out the distance in meters.

Eight different tests were performed to test out the accuracy of the signals. The beacon was placed at four different lengths from the mobile device, 0.5m, 1.0m, 2.0m, 4.0m. For each length, the accuracy was tested without any obstacles in the way of the devices, and with a person standing between the devices at an equal distance from both the mobile device and the beacon.

The table below shows a summary of the results from the accuracy testing. The values on the left show the measured distance between the Arduino Nano/Beacon and the mobile device. The remainder of the values show the calculated distance both with nothing blocking the signals and with a person between the two devices.

Table 4. Summary of tests at various locations

Actual distance	No obstruction	Obstruction
0.5m	0.74m	2.00m
1.0m	1.76m	2.74m
2.0m	1.60m	4.16m
4.0m	2.96m	3.32m

7 Conclusions and Recommendations for Future Work

This application showed the group how to overcome obstacles and how the group needed to adapt in order to complete the project. Some of the group members have little to no programming knowledge and therefore a well balanced team is able to conquer this project. In the future, the first action that should be prioritized is implementing a triangulation algorithm in order to determine the user's exact position while using the app as well as a gyroscopic feature to aid in directioning. Other features wished to be implemented is a casing for the beacon itself which allows it to be out of sight and protected. Finally, more locations of where the app can take the user within the library.

APPENDICES

8 APPENDIX I: Design Files

Table 5. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Project Deliverable A	https://bit.ly/3DIDTuJ	9/16/21
Project Deliverable B	https://bit.ly/3rHsVxg	9/23/21
Project Deliverable C	https://bit.ly/3IqeAes	9/30/21
Project Deliverable D	https://bit.ly/3pyaMQ1	10/7/21
Project Deliverable E	https://bit.ly/3rBsuEC	10/13/21
Project Deliverable F	https://bit.ly/3Eu1J8K	11/11/21
Project Deliverable G	https://bit.ly/31n6Olf	11/18/21
Project Deliverable H	https://bit.ly/3px8sZc	12/1/21
Project Deliverable I	https://docs.google.com/document/d/17uyXs4yhuVai8vMrth7u0Ikj3V2NliY0/edit?usp=sharing&oid=118320713184949070819&rtpof=true&sd=true	12/5/21
Project Deliverable J	https://bit.ly/3oyUXJD	11/26/21

9 APPENDIX II: Other Appendices

Github Repository

<https://github.com/Aduno/Library-Navigation-Andriod>