Senior Design Final Report

Campus WayFinder Mobile App

Version 1.0 - 12/12/2022

Team Members:

Morayo Ogunsina
Tanmay Sure
Yatri Thoria
Ju Zi Hein

Faculty Advisor:

Professor Jungsoo Lim

Table of Contents

1. Introduction:

1.1. Background:

The process or activity of accurately ascertaining one's position and planning and following a route. The application will serve as an aid to students and staff and lead in navigation through the campus, as we selected an area in our CAL STATE LA campus for our study. We propose a navigational system that combines both outdoor and indoor capabilities, which will enable a student to find their way around campus and find their classrooms.

1.2. Design Principles:

The majority of people find it difficult to prospect new areas or unknown locations by themselves. The existing maps of campus can be slightly confusing, sometimes inadequate especially when the classrooms listed in GET are abbreviated. The purpose of this project is to implement a navigation system, as a mobile application that can be used on CalStateLA campus by students and staff, especially newcomers. For this project, all the buildings and landmarks on the CalState LA campus will have to be mapped out individually, especially for the indoor navigation stage of our solution, including the rooms within them. As this is not feasible given the time constraints, only 1 - 2 buildings will be selected as potential destinations, with a selected few rooms and floors that users can choose from. We will explore the use of augmented reality / textual delivery for the indoor wayfinding stage of our solution. The mobile app makes it easy for students and visitors to discover new places.Users are able to download high-resolution maps of campus so that they can better understand the specific layout of the map and reorient themselves if they get lost. Finally, App needs to be simple in design so that future maintenance and expansions will not be too complicated.

1.3. Design Benefits:

By defining requirements that help connect users to find their destination, we do not need to worry about using a mobile app to enhance the physical map experience. Instead, our app will inform users about indoor and outdoor locations in Cal State LA campus. Since the existing maps of campus can be slightly confusing, the purpose of this project is to

implement a navigation system, as a mobile application that can be used on campus by students and staff, especially newcomers not to get lost and reorient themselves by using the app. The App, on the other hand, is designed with simplicity in mind. Since the map does provide routes for indoor navigation by setting up augmented reality visualization, the App just has to concentrate on mapping out the floor plan on Unity 3D engine, and providing a nice user interface. In this way, we keep the App simple and scalable, and this allows it to improve along the features of AR core which is still under active development.

1.4. Achievements:

Over the course of the academic year, our team successfully developed a fully functional mobile app for launch. Through experimentation and research on existing mobile apps, our team was able to find core features that we felt were essential for a navigation mobile app on campus. These features include localization, mapping, route information, GPS information, QR scanning, AR technology and more.

After several design iterations, our team was able to create a simple, beautiful user interface. The app includes many high resolution image backgrounds of maps along with sophisticated and friendly technology provided by AR and 3D geometric location.

2. Related Technologies:

2.1. Existing Solutions:

There are many ways to build a mobile app. The traditional way to build a mobile is called building an app natively. To build an app natively, one must build separate versions of mobile apps for both iPhone and Android phones. By building a native app, the developer has access to more features and the app will usually run faster and take up less phone storage than non-native apps. The downside to building native apps is development time. Because the app has to be built separately for iOS and Android, developers spend twice as much time developing each feature.

First, since our app is simple and we need to develop very quickly, we initially looked into some existing frameworks for creating augmented reality visualization applications. These include Unity Engine, Google's ARCore, and Vuforia. While these solutions do allow us to reach our goal with this project, they come with certain restrictions and limitations.

Google's ARCore is in beta form, and it is very constrained in terms of performance. A very powerful Android device is necessary in order to run ARCore at reasonable performance. Furthermore, ARCore is only available on Android version 8.0 and upward, and again, much like Apple's ARKit, it is limited to only a few devices.

Vuforia is a reliable and proven multi platform AR framework. However, we decided against using it initially because of their approach to AR and because there is a licensing cost.

Finally, our team considered some frameworks for both indoor and outdoor navigation. We used QR code scanning for localization and 3D mapping of the building floor rendered in Unity3D. For the Path navigation, a 3D AR Object is utilized to navigate Mapped space. For outdoor development, we focus on using Google MapIntents for launching the maps app package and starting on the turn by turn navigation.Text Input Layout and Auto Complete Text View (an inbuilt Library) are well-written for using dropdown menus.

2.2. Reused Products:

Both the Application and AR Framework are developed in Java and XML, using the Android SDK. The Android SDK provides facilities such as Sensor Access, UI Elements, Camera Access, Network Access, and OpenGL es Drawing Routines. Google Map Intent provided us with all the routes for searching for location and helping people find their way more easily.

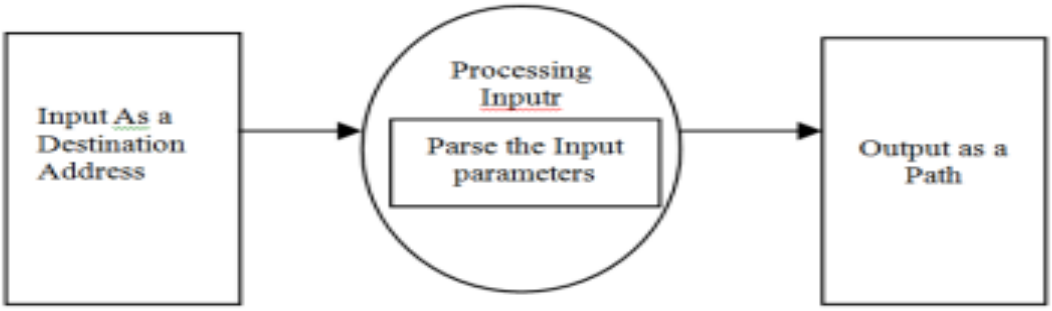
3. System architecture:

3.1. Overview:

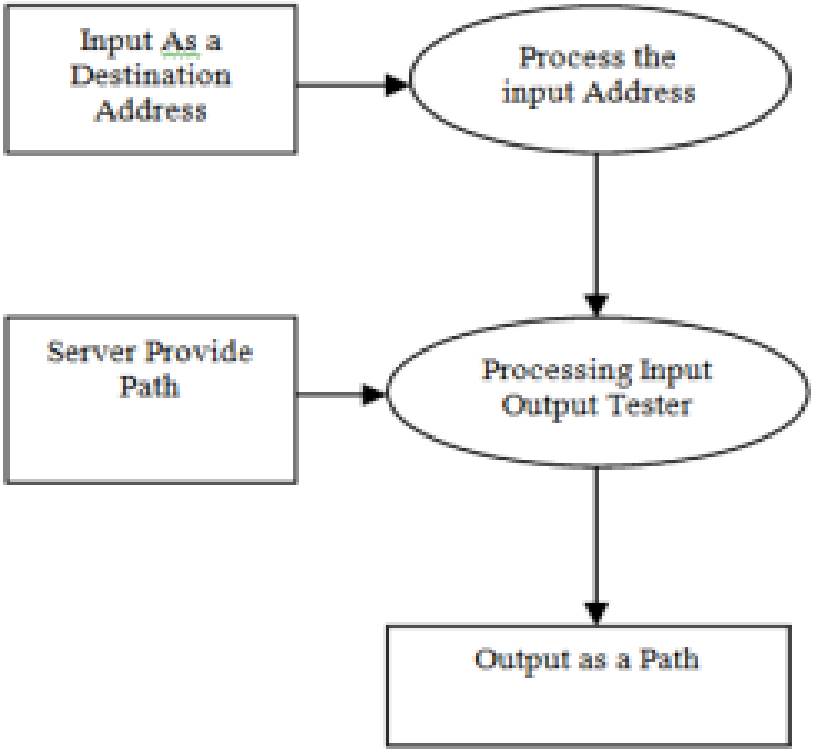
The architecture for the mobile app can be broken down by each of the screens. Since all search features have similar functionality, they are not all included in our DFD.

Here is a diagram (DFD level 0) that shows how this architecture works at a high level:

DFD 0


Input As a Destination Address
Processing Inputr
Parse the Input parameters
Output as a Path

DFD 1


Input As a Destination Address
Process the input Address
Server Provide Path
Processing Input Output Tester
Output as a Path

3.2. Data Flow:

Here is an overview of the mobile app search features work as a system, and how it connects to the App (Implementation Activity):

2.1 Google Map Intent : This is controlled by the Android module. This is the highest-level module that interacts with every screen in the app. When the user enters the routes for getting information or navigating screens, this will communicate with screens as necessary. When modules need to communicate with each other, they will send the information to Google Map Intent and it will relay the map information as necessary.

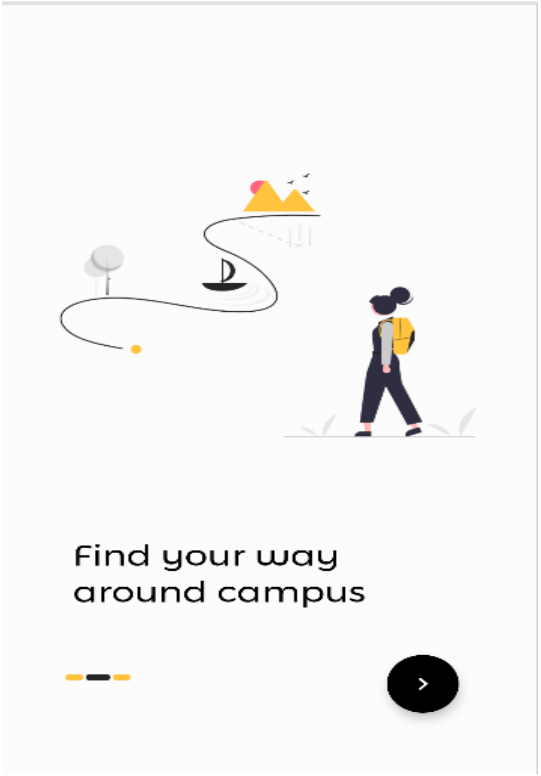
2.2 Localization and mapping: This interacts with the map to search for routes based on specific user specifications like location, landmarks, and more. Position marking is used by QR code scanning, ZXing library and for mapping,a full 3D map of the building floor is rendered in Unity3D and Point of Interests (POIs) hardcoded into the map.

2.3 Output in Textual/Graphical : After arriving at a destination, the user will be notified by a text message or in graphical structure using Augmented Reality(AR). This information includes a success message and route ending.

3.3. Implementation:

The project is split into screens with multiple feature tabs accessible from the home page. Some pages are reused for similar functions such as outdoor searching and indoor searching.

Home Page

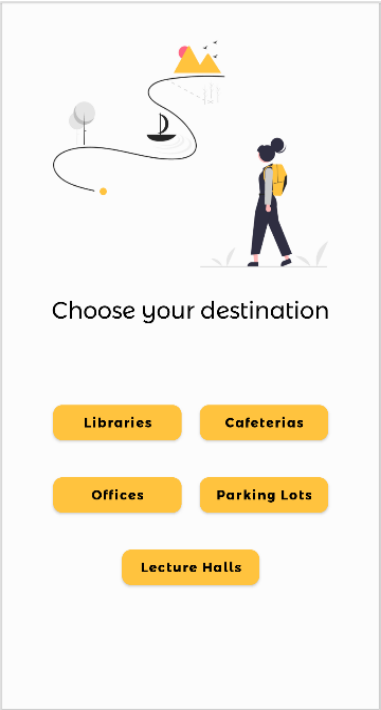


This is the first page the user will see when using the app. This is the navigation page for users to get to the main features of the app.

The user can navigate to:

- Outdoor location: Search a building or parking or academic department using selection box input.
- Indoor location : Search a room inside the building or floor within the landmark with a map that shows all indoor locations.

Destination Screen

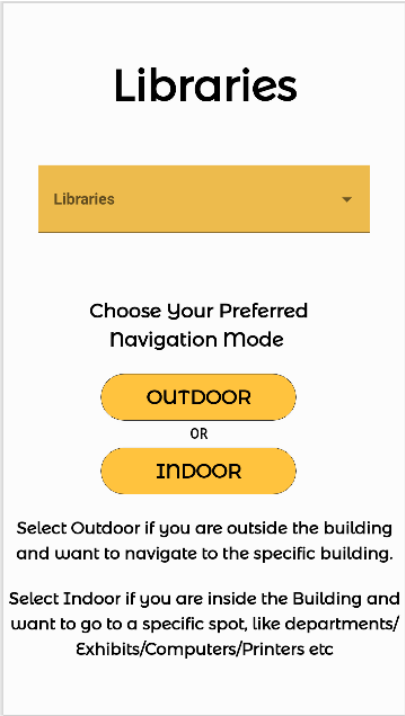


This is one of the map searching options. The user can choose a location such as library, cafeteria, offices or lecture halls, sorted by distance to the entered location.

To use the page, the user can:

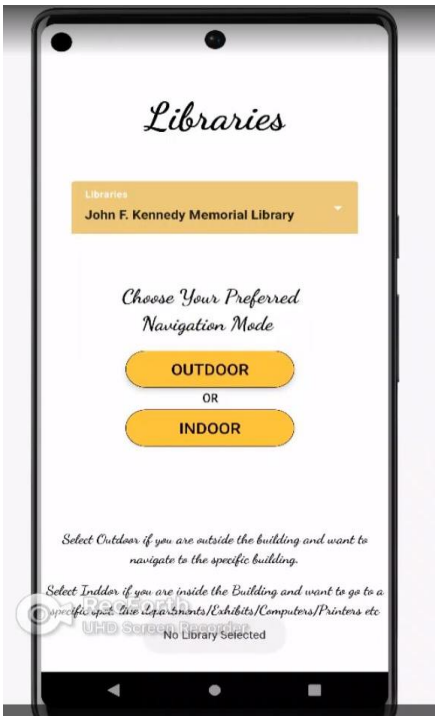
- Choose one destination from the lists given and click the icon to find the specific location in the next step.

Library Search Results



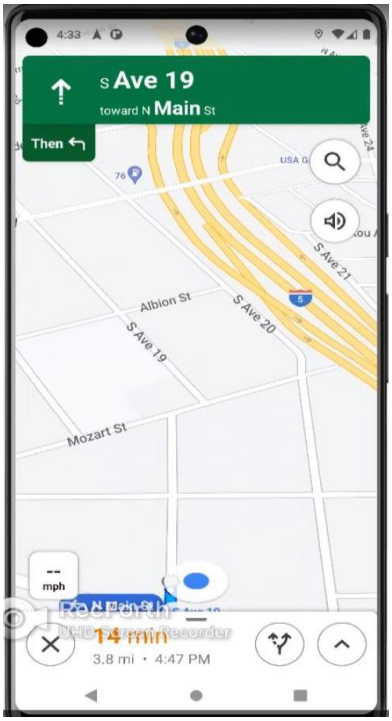
After the user searches for a location, they will go to this page. Here, the user can scroll through the library results. By showing the user two options which are outdoor and indoor, they will get a general idea of choosing their desired destination. If the user is interested in going outside the building and wants to navigate to the specific building, they can tap the outdoor box which will show them a new outdoor page. Otherwise, the user has to tap on an indoor icon to destinate them to a specific spot like departments, exhibits, computers or printers, etc.

Outdoor Screen



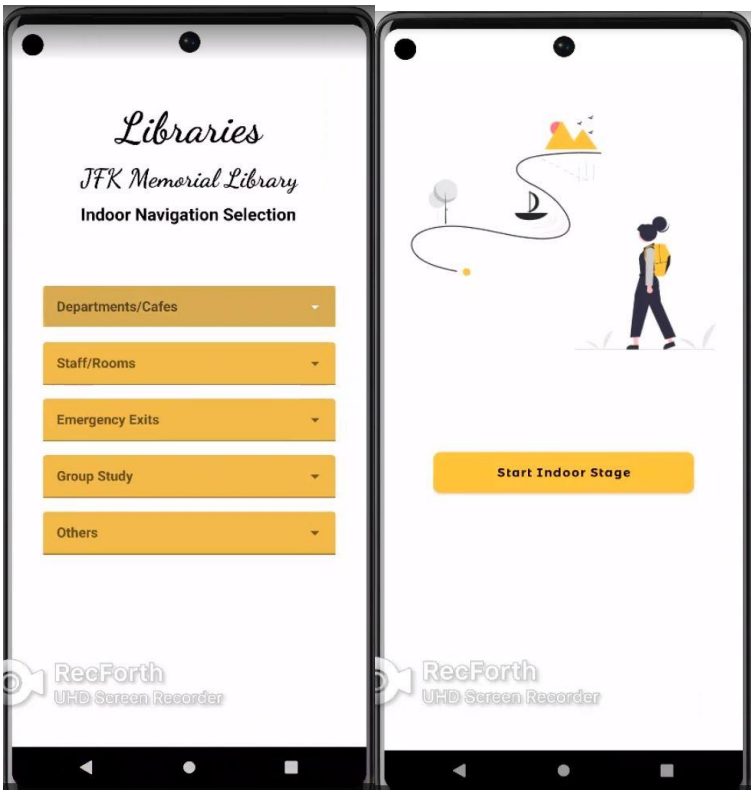
Here, the user chooses the specific library name with an outdoor navigation mood. This page makes it easy for the users to select navigation mood. The user can tap the name to see the desired location.

Outdoor Navigation Page



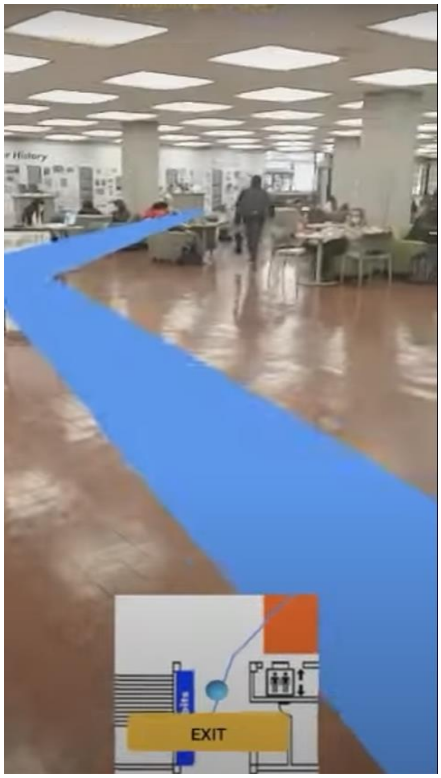
The outdoor navigation page allows the user to see the map offline. The user can just walk through or drive to their destination by keeping their eyes on the map routes. Once the user arrives at the destination, it will notify the user and the app will return to the final page. As an amenity, the user can click the ‘Close’ icon at the bottom left to return to the search results page.

Indoor Result Page



The indoor page loads information about the selected library including cafes, rooms, emergency exit and study rooms. The user can scroll between information and select a particular destination they want to locate. From this page, the user can also see a variety of locations offline.Finally, the route begins once the user clicks on the Start Indoor Stage button.

Indoor Navigation Page



The user can use this page to see the route for the indoor stage. First, they will enter their designated building and a right direction will be provided along with AR features. Once the user arrives at the location, a textual or graphical output will be displayed.

4. Conclusions:

4.1. Results:

We have created an Android app which allows users to search for their destination based on location offline and also provided a feature for being able to filter the location inside the building mainly on CAL STATE LA campus. They are able to access high-resolution maps of location so that they can better understand the layout of the map and reorient themselves if they get lost. Users are also able to find the way by using better graphical output with AR features.
Finally, all these parts have been brought together with an aesthetically pleasing and well-designed user interface that is flexible to use.

4.2. Future:

Although many features were implemented into these applications there were a few that can be planned for future iterations. Here are a few ideas that were brainstormed at the beginning phase of the application but did not make the final cut.

- Many academic buildings and landmarks have to be counted on map for full localization
- Need to work more on AR mapping to print out the nicer UI
- Probably switch to online and expect more upgrades on map
- Allow a user to enter his current location to search for apart from retrieving the location automatically from the map
- Interactive Review System

5. References:

[1]https://ijarcce.com/wp-content/uploads/2012/03/IJARCCE8H-A-pritam-the-campus-navigator.pdf

[2] Susovan Jana, Matangini Chattopahyay “An Event Driven University CampusNavigation System based on Android Platform”IEEE Conference on application and innovation in mobile computing, pp-182-187, 2015

[3]https://www.researchgate.net/publication/312057435_Design_and_Implementation_of_a_Navigational_System_for_the_University_of_Ilorin

[4]https://calstatela.instructure.com/courses/80664/files?preview=12588680