WRS Evolution

Requirements Elicitation

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[1] Introduction

1.1. Purpose

The purpose of this document is to record the decisions made and the process of this project. Giving a more in depth understanding of the preliminary plan document for the Visually Impaired Indoor Navigation System project. This will detail every aspect of this project from issues encountered to options considered to final decisions made along with rationales for decisions.

1.2. Scope

This project is aimed to help those with visual impairments. By leveraging the utilities of a simple smartphone, the users will be able to navigate indoors with ease. Helping act as a new set of eyes with built- in route navigation, this app will revolutionize the experience for the visually impaired.

This app will also be aimed for all smartphone users. Although designed to be a guide for the visually impaired, it is not required to be visually impaired to use this app. For anyone that has a smartphone and simply wishes to navigate a new indoor space easier, this app will be perfect for them as well. Allowing for anyone to simply input their desired area and be given a personal guided route for them. This will prove especially useful for new areas such as freshmen on campuses.

1.3. Objectives and Success Criteria

1. Help the visually impaired with seamless indoor navigation
   - This will be achieved through auditory feedback, precise indoor positioning technologies, real-time object detection through phone camera, and ensuring a user-friendly and empowering experience
2. Maintaining quality user experience
   - Easy integrations with phones existing accessibility features for the blind
   - Many different user configurations
     - Favorite routes, text to speech, offline mode, etc.
3. Ensuring quality navigation
   - Utilize phones camera and GPS to get real-time route navigation

1.4. Definitions, Acronyms, and Abbreviations

1.5. Overview

The first section of this document is to serve in conjunction with the project plan document as the introduction to this project. To inform the baseline goal of this project and to help quickly inform the readers of what is to be expected. The second section will shed more light on the basic issues that must be covered in order to understand the project fully. Laying the foundation for the following sections to elaborate further upon. The third section then dives fully into all the details of section two. Each section elaborating further in depth upon all of the issues this project will have to cover. Section four gives the overview of the look of the project. Showing exactly the layout of this app and providing a clear first image of the design. Following this is section 5 that will elaborate further on the intricacies of the design with section 6 then showing the instructions on how to best utilize every aspect of the app.

[2]   Preliminary Definition

2.1. Preliminary Domain

PD_ID	Preliminary Domain Description
PD1	Indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.

2.2. Preliminary Functional Requirements

P FR_ ID	Preliminary FR Description
PFR1	Generating desired sentences and representing them pictorially as well as associating with a sound/voice.
PFR2	Accepting from the user a destination location to go to.
PFR3	The system will suggest or confirm a possible destination location utilizing the user's routines/habits.
PFR4	Figuring out the routes to reach the destination.
PFR5	Inform the user of optional routes to reach the destination if there are more than one.
PFR6	Accepting the user's preference of a route to reach the destination.
PFR7	The app will tell the user to walk a specified distance (e.g. 2 minutes before turning, or walk for 30 steps, etc.)
PFR8	The app will tell the user to stop at the right place to make a turn.
PFR9	The app will use the camera and tell the user how to avoid detected obstacles to avoid collision.
PFR10	The app will place emergency calls and messages.
PFR11	The app will detect a fall or when the system has lost its current location.
PFR12	The app will figure out what actions should be next based on schedule/habit and suggest an action and accept the user's choice.

PFR13	The app should signal if foot traffic will be heavier during the time of action.

2.3. Preliminary Non-Functional Requirements

PNFR_ ID	Preliminary NFR Description
PNFR1	The system shall help the user safely navigate indoors.
PNFR2	The system shall lead the user through the fastest route.
PNFR3	The system shall lead the user through the route that the user would feel most comfortable with.
PNFR4	The system shall be usable for blind people.
PNFR5	The system shall be usable everywhere.
PNFR6	The system shall be customizable for every user in areas such as volume and the frequency of instructions.
PNFR7	The system shall be extensible to accommodate standard variations between hardware, languages, interface, and needs of the user as well as for the potential addition of features.
PNFR8	The system shall be secure.

[3]   Issues with the Preliminary Definition Given

3.1. Domain Issues

Domain Issue ID	Domain Issue Description	
DI1	PD_ID	PD1. Indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.
	1. Ambiguous or incomplete. By the definition given the domain appears to be intended for school or office buildings, but indoors includes a variety of different areas that could not necessarily be navigated with an app.	
	Option 1	Map out every building in the world using systems similar to google maps.

	Option 2	Limit the range of the application to specific campuses or work environments that would be able to work with the app and provide us with detailed information regarding the buildings in the area.
	Option 3	Map buildings over time continuously adding more as the ability for them to be added becomes available and viable.
	Choice	Option 2
	Rationale	With a limited budget and time to produce the application there is only so much we would be able to map. Starting with specific campuses and work environments allows us to get the app created and grow support with the potential of expanding our range later.

3.2. Functional Requirements Issues

FR Issue ID	Description	
FRI1	PFR_ID	PFR1. Generating desired sentences and representing them pictorially as well as associating with a sound/voice.
	1. How to decide between picture and sound for that particular sentence?	
	Option 1	Use common sentences and associate them with sound (for the blind) or pictures (for the deaf).
	Option 2	Allow the user to select whether to associate words with pictures or with sounds at runtime.
	Option 3	Allow the user to configure the system to play sounds and/or associate pictures with sentences.
	Choice	Option 3
	Rationale	If the user wants to see the sentence in the form of a picture (or) in the form of sound he/she will have an option at run-time to choose from. This should be able to be adjusted in options as needed (if a user enters a

		noisy room, they may want to switch from sounds to pictures, for instance).
Satisfied by	FR1, FR2	

FRI2	PFR_ID	PFR2. Accepting from the user a destination location to go to.
	1. How will the user accept the destination location? 2. How will the user know the recommended destination location is accurate?	
	Option 1	Verbally articulate the destination location and surrounding landmarks as well as information about the travel time, distance, etc. Users will confirm verbally as well.
	Option 2	Verbally articulate the destination location and surrounding landmarks as well as information about the travel time, distance, etc. User will confirm using a physical device.
	Choice	Option 1
	Rationale	We won't add any more complexity by requiring the user to use a physical device. Instead, the information will be relayed and conveyed verbally.
Satisfied by	FR3, FR4	

FR Issue ID	Description	
FRI3	PFR_ID	PFR3. The system will suggest or confirm a possible destination location utilizing the user's routines/habits.
	1. How do we accommodate variability of schedule? 2. How will the user know the suggested destination location is an accurate and reliable location?	

	Choice	The app will verbally articulate a destination location and relevant nearby landmarks for the user to verbally confirm or deny.
	Rationale	The verbal nature of these suggestions and user decisions are vital to the nature of the app.
Satisfied by	FR3, FR4	

FR Issue ID	Description	
FRI4	PFR_ID	PFR4. Figuring out the routes to reach the destination.
	1. How do we recognize safety hazards and features and factor them into potential routes?	
	Choice	Utilize and database routes generated from other Maps services to build on and add to our own collection.
	Rationale	We need the data infrastructure to generate reliable and safe routes.
Satisfied by	FR3, FR4	

FR Issue ID	Description	
FRI5	PFR_ID	PFR5. Inform the user of optional routes to reach the destination if there are more than one.
	1. The user must decide which route to take. 2. Verbose route descriptions can give information about the different routes regarding stairs, escalators, etc.	
	Option 1	Ask the user for a default suggestion or verbose mode.
	Option 2	Suggest verbose routes to users.
	Choice	Option 1
	Rationale	Giving the user the option to decide between a default normal suggestion and verbose suggestions gives them flexibility of choice.

Satisfied by	FR3, FR4

FR Issue ID	Description	
FRI6	PFR_ID	PFR6. Accepting the user's preference of a route to reach the destination.
	1. How many input mediums do we allow for the user input?	
	Option 1	Default to voice selection, allow for touch selection via the app for able-sighted persons interacting with the user.
	Option 2	Only allow for voice selection.
	Choice	Option 1
	Rationale	It makes more sense to give flexibility to the user to choose to select for themselves or allow nearby people to help them make a selection.
Satisfied by	FR3, FR4	

FR Issue ID	Description	
FRI7	PFR_ID	PFR7. The app will tell the user to walk a specified distance (e.g. 2 minutes before turning, or walk for 30 steps, etc.)
	1. The user has decided what route to take. 2. The app will inform the user of any safety hazards in the way.	
	Option 1	The app will only verbally convey this route information.
	Option 2	The app will convey both visual and verbal information about the route.
	Choice	Route 2
	Rationale	We need visual information to be present as well.

Satisfied by	FR3, FR4

FR Issue ID	Description	
FRI8	PFR_ID	PFR8. The app will tell the user to stop at the right place to make a turn.
	1. What kind of feedback will we give the user to make sure they stop? 2. What if the user walks past their critical point?	
	Option 1	Give the user verbal information about when to stop.
	Option 2	Give the user haptic feedback when it is time to stop.
	Option 3	Reroute back to the critical point.
	Choice	1+2+3
	Rationale	Give the user multiple types of feedback so they are aware of the critical point and reroute them back to the critical point if they overshoot.
Satisfied by	FR3, FR4	

FR Issue ID	Description	
FRI9	PFR_ID	PFR10. The app will place emergency calls and messages.
	1. How will the app get emergency contact information? 2. How will the app detect a situation that requires emergency calling?	
	Option 1	The app will pull emergency contact information from the user's contacts.
	Option 2	The app will request access to the user's phone dialer and messages app.

	Option 3	The app will detect physical changes indicative of an accident.
	Option 4	The user may request verbally that the app send emergency messages and make emergency calls
	Choice	1+2+3+4
	Rationale	In the case of an emergency, we need as much detection and handling as possible.
Satisfied by	FR5	

3.3.Non-Functional Requirements(NFR) Issues

NFR Issues ID	Description	
NFRI1	PNFR_ID	PNFR1. The system shall help the user safely navigate indoors. PNFR2. The system shall lead the user through the fastest route. PNFR3. The system shall lead the user through the route that the user would feel most comfortable with.
	What is prioritized first when the safest, fastest, and most comfortable routes are not the same?	
	Option 1	Allow the user to customize what is prioritized when giving directions.
	Option 2	Give multiple route options and allow the user to choose from them.
	Option 3	Prioritize safety first, comfortability second, and speed third.
	Choice	1 + 3
	Rationale	Safety of the users should always be a priority, so that should always be the first thing considered by the system. Comfortability being a

		priority over speed will be the default system state, but a user can change a customization setting to have the system prioritize speed if that is desired.
Satisfied By:	NFR1	

NFR Issues ID	Description	
NFRI2	PNFR_ID	PNFR3. The system shall lead the user through the route that the user would feel most comfortable with.
	How is comfortability defined for the purposes of our system?	
	Option 1	Comfortability is ease of travel, defined as how simple and straightforward the route is.
	Option 2	Comfortability is frequency, defined as if the user has traveled the route before.
	Option 3	Comfortability is communally agreed on, users will be allowed to vote on how well the route suited their needs and routes will be recorded by comfortability.
	Choice	1 + 2
	Rationale	Routes frequently taken or saved by the user would be routes they are familiar with and would be easier for them to navigate. For new routes the system should consider the easiest route to navigate as the most comfortable.
Satisfied By:	NFR1	

NFR Issues ID	Description	
NFRI3	PNFR_ID	PNFR4. The system shall be usable for blind people.

	What specific actions are taken to make the system usable?	
	Option 1	Instructions generated in multiple methods including text, pictures, audio, and haptic feedback.
	Option 2	The user interface of the system is completely navigable using only vocal prompts.
	Option 3	The system includes a help button that can get the user assistance, as well as instructions and other materials available in physical braille form so users can learn the system.
	Choice	1 + 2 + 3
	Rationale	All of these features are important for accessibility and greatly improve the usability of the system.
Satisfied By:		

NFR Issues ID	Description	
NFRI4	PNFR_ID	PNFR5. The system shall be usable everywhere.
	Everywhere is unrealistic for the scope of our project, everywhere includes a variety of different areas that could not necessarily be navigated with an app.	
	Option 1	Map out every building in the world using systems similar to google maps.
	Option 2	Limit the range of the application to specific campuses or work environments that would be able to work with the app and provide us with detailed information regarding the buildings in the area.
	Option 3	Map buildings over time continuously adding more as the ability for them to be added becomes available and viable.

	Choice	Option 2
	Rationale	See domain issue 1. This is the same issue and the decision comes from the same rationale.
Satisfied By:		

NFR Issues ID	Description	
NFRI5	PNFR_ID	PNFR8. The system shall be secure.
	What is the definition of security?	
	Option1	Confidentiality
	Option2	Integrity
	Option3	Authentication
	Choice	1
	Rationale	For this particular system confidentiality seems to be the most relevant considering legal protections like HIPAA.
Satisfied By:		

[4]   WRS

4.1.W

4.1.1. Problems

Problem ID	Problem Description	Corresponding Goals
P1	Blind or visually impaired people do not have a method of seeing and avoiding potential obstacles in their path.	G1

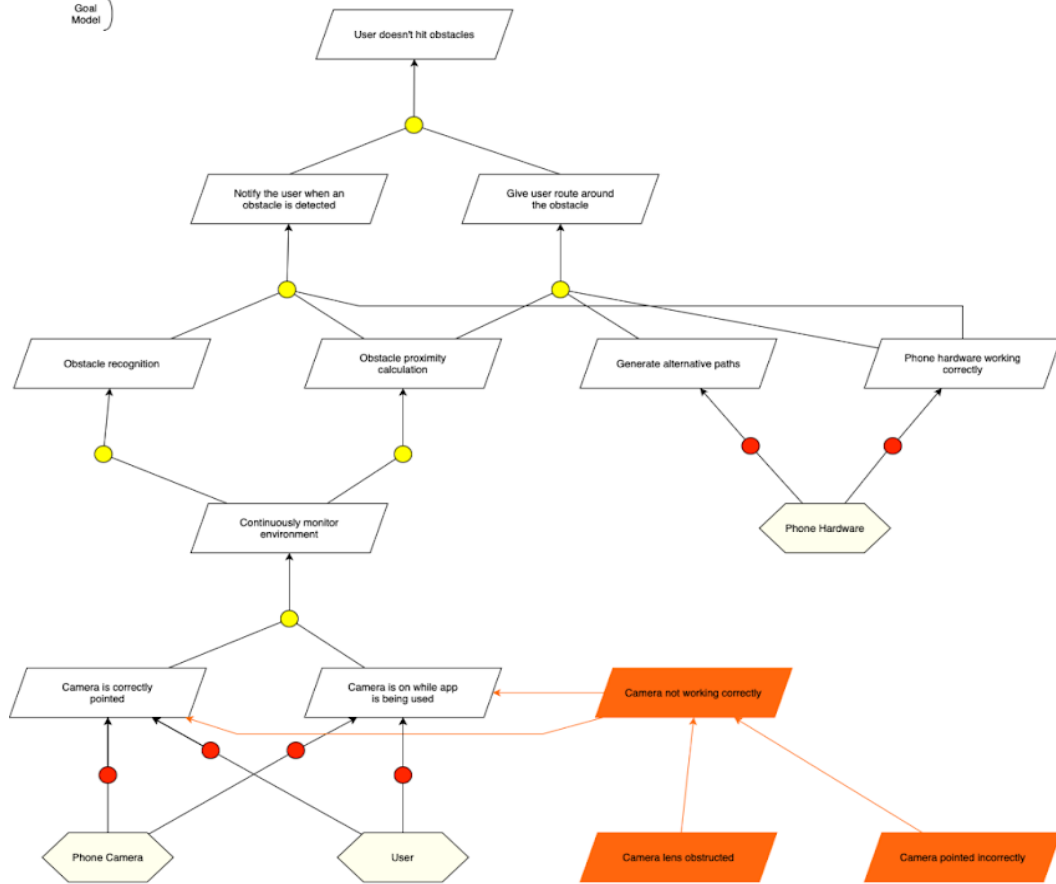| P2	Blind or visually impaired people do not have a reliable way to navigate unfamiliar buildings.	G1, G2
P3	Blind or visually impaired people do not have the ability to use a phone application with conventional means.	G4
P4	How much information should be conveyed to the user verbally regarding potential routes to take?	G4
P5	How should a user affirm/deny potential routes verbally?	G5
P6	Should we allow for traditional touch interfacing with the app for non-visually impaired individuals in contact with the user?	G7
P7	Users may not start navigation at consistent places or need navigation from unusual parts of a building.	G3, G6
P8	The visually impaired can be at risk for more injury and more serious injury due to travel and potential difficulty communicating in case of emergency.	G8

4.1.2. Goals

Goal ID	Goal Description	Backward Traceability	Forward Traceability
G1	Allow navigation of unfamiliar buildings and avoidance of obstacles.	P1, P2	FO1, NFO1
G2	Maps of buildings are put into a repository.	P2	FO1
G3	Directions of buildings are generated based on current location and the building map.	P7	FO1
G4	App instructions are delivered through multiple means, including complete verbal instructions and menu narration.	P3, P4	FO2, NFO2

G5	Confirmations of actions, such as beginning navigation, will be read out and ask for a verbal or button press "yes/no" confirmation.	P5	FO2, NFO2
G6	Domain knowledge not needed from the user.	P7	FO1, NFO1
G7	App navigation and input must accommodate verbal and traditional means.	P6	FO3, NFO2
G8	The app will make travel safer and more reliable for the visually impaired.	P8	FO4

User doesn't hit obstacles

Notify the user when an obstacle is detected

Give user route around the obstacle

Obstacle recognition

Obstacle proximity calculation

Generate alternative paths

Phone hardware working correctly

Continuously monitor environment

Phone Hardware

Camera is correctly pointed

Camera is on while app is being used

Camera not working correctly

Phone Camera

User

Camera lens obstructed

Camera pointed incorrectly

User is safe from falling

User's emergency contact notified

Phone starts ringing

Fall recognition

Phone speaker

Gyroscope working correctly

Acceleration detection

Fall detection pattern

User didn't actually fall

Phone gyroscope

Phone is always on

Constant environment monitoring

User drops the phone

Phone

User

4.1.3. Improved Understanding of Domain, Stakeholders, Functional, and Non-Functional Objectives

4.1.3.1.   Improved Domain

Improved Domain ID	Improved Domain Description
ID1	Selected indoor environments across various campuses or public/corporate buildings where the app is available for use. This can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.

4.1.3.2.   Stakeholders

Visually impaired individuals
- Primary and goal beneficiaries. This app is designed specifically to help this audience

Healthcare professionals
- There are many different kinds of healthcare professionals who would also directly be affected by this app. This app would allow a new form of free guidance for their patients

Government and regulatory bodies
- This app would have to be rather extensively monitored as it could cause huge data breaches that could threaten security in certain buildings and spaces

Accessibility experts
- This app would be a direction for accessibility and would greatly intrigue these teams to further develop upon

Educational institutions/general building owners
- This app was primarily centered around helping navigate around things like campuses and would greatly impact student life. This can also be easily said for anyone that owns a building and would like to make itself more accessible

4.1.3.3.   Improved Functional Objectives

Based on the above information and our goals, the functional objectives of Thecia are:

Functional Objective ID	Objective Description	Alleviates Problems	Achieves Goals
FO1	Theia will provide functions that allow the visually impaired to navigate unfamiliar buildings by providing directions using the systems maps of the buildings and the device's current location.	P1, P2, P7	G1, G2, G3, G6

FO2	Theia will provide basic information about planned routes to the destination and ask for verbal confirmation from the user to begin navigation.	P3, P4, P5	G4, G5
FO3	Theia will also support standard application navigation for users without or with partial vision impairment.	P6	G7
FO4	Theia will provide safety features in case of an emergency for the user.	P1, P3, P6, P7	G8
FO5	Theia will provide users with multiple ways of communicating and conveying information including verbal, haptic, and traditional means.	P1, P3, P4, P5, P6	G4, G8

4.1.3.4.   Improved Non-Functional Objectives

Improved NFR Objective ID	Objective Description	Alleviates Problem	Achieves Goal
NFO1	Theia will allow for safe, quick, and comfortable navigation of unfamiliar buildings by finding direct and frequently traveled routes through a building.	P1, P2, P7	G1, G6
NFO2	Theia will be completely navigable using only vocal commands, but also provide standard application navigation as well as options to call for help.	P3, P6	G4, G5, G7

4.2. RS

4.2.1. Functional Requirements

FR ID	Description
FR1	If a user makes a sound to the system, the system shall make a sentence from the detected sound.

Satisfies Functional Requirement Issue	FRI1
Satisfies Objectives	FO1, FO2, FO3
Satisfied by prototype feature	

FR ID	Description
FR2	User input shall be processed and handled to inform the system of decisions to make.
Satisfies Functional Requirement Issue	FRI1, FRI2, FRI6, FRI10
Satisfies Objectives	FO1, FO2, FO3
Satisfied by prototype feature	

FR ID	Description
FR3	The system shall suggest routes for the user to take, accept a route from user input, and navigate the user along that route.
Satisfies Functional Requirement Issue	FRI2, FRI3, FRI4, FRI5
Satisfies Objectives	FO1, FO2, FO3
Satisfied by prototype feature	

FR FR ID	Description
FR4	The system shall convey and handle information using a multitude of mediums including verbal, haptic, and traditional.

Satisfies Functional Requirement Issue	FRI1, FRI2, FRI3, FRI4, FRI6, FRI7, FRI8,
Satisfies Objectives	FO1, FO2, FO3
Satisfied by prototype feature	

FR ID	Description
FR5	In the case of injury or emergency, emergency contacts will be notified of the user's location.
Satisfies Functional Requirement Issue	FRI9
Satisfies Objectives	FO1, FO2, FO3
Satisfied by prototype feature	

4.2.2. Non-Functional Requirements

NFR ID	Nonfunctional Requirement 1
NFR1	The system shall lead the user through the safest route prioritizing speed, direct routes, and familiar routes. Settings can be changed to optimize routes for speed or comfortability over the other.
Operationalized Functional Requirements	FR3
Satisfies Nonfunctional Requirement Issue	NFRI1, NFR2
Satisfies Non-functional Objective	NFO1
Constrains	N/A
Satisfied by prototype feature	

NFR ID	Nonfunctional Requirement 2
NFR2	The system will have accessibility features including: instructions generated in multiple methods, vocal navigability of the application, and a help button.
Operationalized Functional Requirements	FR1, FR4
Satisfies Nonfunctional Requirement Issue	NFRI3
Satisfies Non-functional Objective	NFO2
Constrains	N/A
Satisfied by prototype feature	

NFR ID	Nonfunctional Requirement 3
NFR3	The system shall be usable everywhere in the indoor environments described in the domain.
Operationalized Functional Requirements	FR3
Satisfies Nonfunctional Requirement Issue	NFRI4
Constrains	FR3
Satisfied by prototype feature	

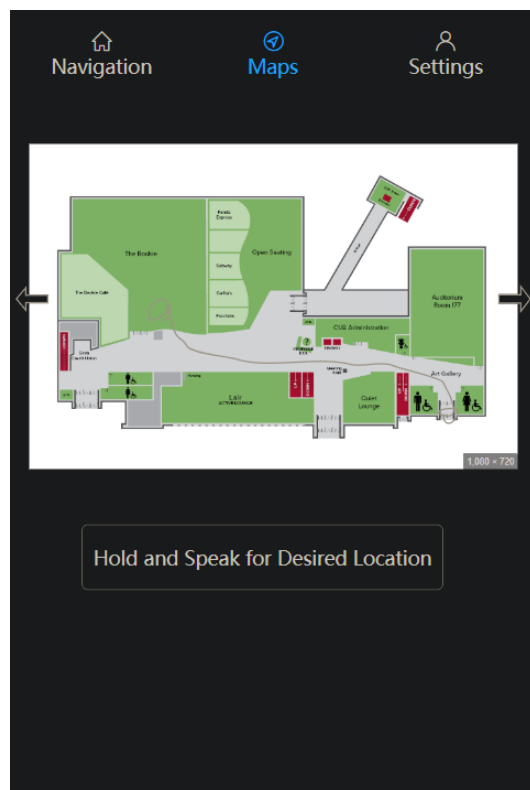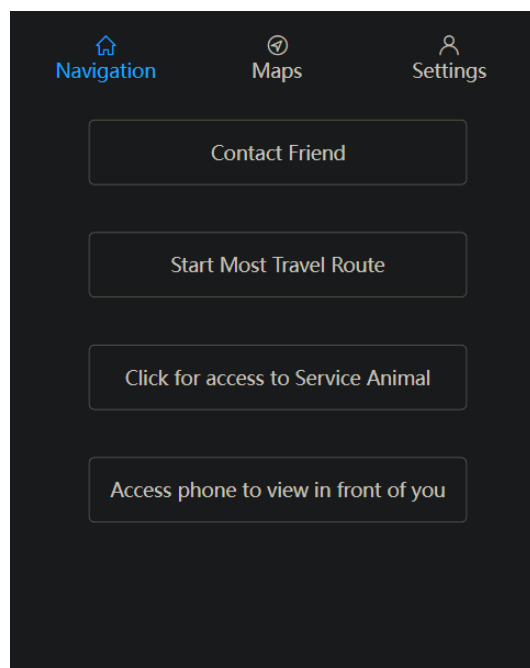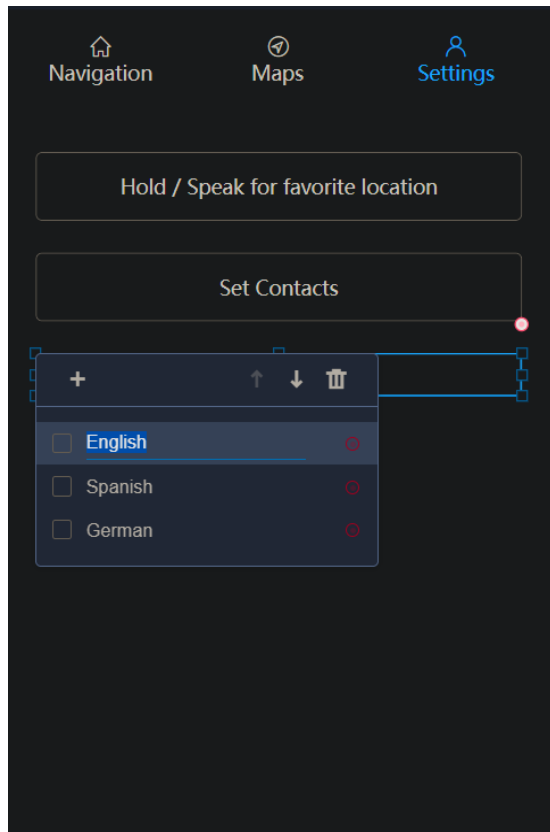| NFR ID	Nonfunctional Requirement 4
NFR4	The system will be confidential.
Operationalized Functional Requirements	FR5
Satisfies Nonfunctional Requirement Issue	NFRI5
Constrains	FR5
Satisfied by prototype feature	

4.2.3. Specifications

Functional Specification ID	Functional Requirement
FS1	If a textual sentence is entered to the system, the system shall make a sound corresponding to the input sentence.
Satisfies Functional Requirement	FR1
Satisfies Objectives	FO1, FO2, FO3
Satisfied by prototype feature	

[5] Preliminary Prototype

The users main focus while using the app is seeing the surrounding area by use of a camera, getting directions through new maps or from favorited ones, getting quick access to help, or configuring the app to the users preferences, this comes with limitations surrounding the initial prototype. The current prototype comes with a limited UI for multiple reasons, initially this was presented as the primary user wouldn't be able to observe any of the visuals of the app, therefore a rather bare application was made only providing functional use. Along-side this, only a few maps are available for the user, unless additional users map out routes that can be taken. The last limitation to address would be the apps primary use of buttons, this would mean every button would have a text to speech attribute, while actively listening for a user to respond verbally. This could result in user inputs being interpreted incorrectly.

[6] Prototype Interface Mock-ups

Navigation

Navigation   **Maps**   **Settings**

Contact Friend

Start Most Travel Route

Click for access to Service Animal

Access phone to view in front of you

Maps

Navigation   **Maps**   **Settings**

Hold and Speak for Desired Location

[7]   User Manual

Steps to using the application are as follows:

- Once the app is installed, you will be directed to
1. the dashboard with the following options
   a. contact a friend - if no friend contact is set, you can record a new contact by holding the button down for the app to listen to you
   b. start most traveled route - an option will present itself when you access the maps portion of the app.
   c. click for service animal - this view will call those with access to service animals and get a service animal for you as soon as possible.
   d. view in front of you - this opens the camera view of your phone or device to show you what could be in front of you.
2. the maps view with the following options
   a. a static map of the building they are trying to access will show where they need to go, this can be useful if a bystander is in the area that could click on a point to locate a user to, by clicking the arrows you can view other maps for floors to navigate too.
   b. hold and speak for desired location - when held, the user can speak into the microphone allowing for quicker navigation through the app.
3. settings view with the following options

     a.   speak for your favorite location - this will allow the user to set their favorite location which can appear on the dashboard.

     b.   set contacts - talking to the app the user can set other contacts that could help them navigate a setting

     c.   Language option - as several of these features account for text to speech or voice recognition, it was important to set the desired language in the settings view.

[8] Traceability

1. Goal 1: Improve Independent Mobility for the Visually Impaired
- Backward Traceability with Problems:
   - Problem 1: Goal 1 is directly related to addressing the issue of limited mobility among visually impaired individuals.
- Forward Traceability with Functional Objectives:
   - Objective 1: Real-time Navigation Assistance
      - This objective helps achieve Goal 1 by providing real-time directions and navigation support. This may include a button that could call friends, family, support staff from presets in the application.
   - Objective 2: Obstacle Detection and Avoidance
      - Assisting users in detecting and avoiding obstacles contributes to independent mobility. This detection can occur through a camera with active object detection. Other forms of detection may include up to date maps with obstacles routed into the users path.
2. Goal 2: Enhance Access to Information and Communication
- Backward Traceability with Problems:
   - Problem 2: Limited Access to Information and Communication
      - Goal 2 is aligned with resolving the issue of restricted access to essential information and communication.
- Forward Traceability with Functional Objectives:
   - Objective 3: Text-to-Speech and Speech-to-Text Capabilities
      - These features help in converting text-based information into speech, ensuring accessibility. This could include camera focused text, or app focused text.
   - Objective 4: Voice-Assisted Messaging and Calling
      - Enhancing communication by enabling voice-assisted messaging and calling features directly supports Goal 2. This active messaging and calling assistance would be implemented through large buttons on the apps screen for easy of access.

[9] References