CptS 484: Software Requirements

Phase 2 WRS

Requirements Elicitation

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Revision History

Date	Version	Changes	Editor
9/28	0.1	Created document	Nasen Wilson
9/31	0.2	Documented Issues	Nasen Wilson
10/03	0.3	Finished W	Nasen Wilson
10/04	0.4	Implemented RS	Justin Lawrence
10/05	0.4.2	Finished RS	Justin Lawrence
10/10	0.5	Designed Prototype Mockup	Kevin Nguyen
10/12	0.6	Added User Manual Initial Design	Linh Nguyen
11/18	.7	Improved WRS	Justin Lawrence/Nasen Wilson
12/3	.8	Defined list of Kaos models to be created.	Justin Lawrence/Nasen Wilson
12/5	.9	Implemented Kaos Models	Justin Lawrence/Nasen Wilson
12/8	.10	Finalized WRS Phase 2	Justin Lawrence/Nasen Wilson

[1] Introduction

1.1. Purpose

This project's objective is to develop a smartphone application that assists and guides blind users through indoor buildings through the usage of voice recognition and commands. This app allows blind users to safely navigate through buildings via the fastest available route comfortably, with the app using text to speech to tell the user when to walk and when to turn. This app will also notify users if there is an upcoming obstacle that would interfere with their travel.

1.2. Scope

The scope of this project aims to allow the user the following functionality:

- Ability to upload and read map of building
- Accept user destination via voice commands
- Calculate the fastest route from the users current position to the users target location.
- Assist the user in navigating to their location via voice commands
- Notify the user of any obstacles they are approaching

This would mean our developers would need to implement systems such as

- Shortest path calculation through the ability to translate user uploaded maps.
- Obstacle detection through utilizing the users smartphone camera
- Implementing voice recognition for commands
- Notify users of directions and turn commands utilizing smartphone speakers.
- Device GUI setup for caretaker device setup

1.3. Objectives and Success Criteria

For this application to be successful, it needs to accomplish the following criteria:

- Ability to upload and read map of building
- Successfully calculating shortest available path to target destination
- Successfully telling the user the correct places to turn and correct places to walk.
- Safely guide user to their destination
- Correctly accept user voice input
- Correctly notify user of upcoming possible collisions
- Successfully giving user alternate routes in case of obstacles or path closures

1.4. Definitions, Acronyms, and Abbreviations

Term	Explanation
GUI	Graphical User Interface (User's view of the app interface)
Obstacle	Physical blockage of a route (Construction or Path Closure)
Voice Commands	The commands the user or device inputs or outputs to the other.

1.5.Overview

Section 2 defines our preliminary definitions for the domain, functional requirements, and non-functional requirements. In Section 3, we define our issues with the definitions given to us, such as if there are any ambiguities, unclearness, or requirements that are impossible to accomplish. Section 4 will explain our solutions to the unclearness and define our new definitions for the domain, functional requirements, and non-functional requirements. Section 5-7 includes early mockups of the application, basic user manual, and the prototype of our application.

1.6. Changes from Previous WRS Iteration

The change in preliminary definition put an emphasis on focusing on the following requirements:

- Safety
- Technical feasibility
- Maximal utilization of sensors
- The system shall abide by the HIPAA policies and regulations; or there must be a disclaimer.

Our previous WRS iteration already covers many of these new requirements, as seen below:

WRS Phase 2 - Focus	**Relevant Acknowledgement in Phase 1 WRS**
Safety	INFRO1, INFRO2, INFRO3, INFRO6, IFRO3, IFRO4
Maximal utilization of sensors	INFRO4, IFRO5

Technical feasibility	NFRI5, NFRI9

This leaves our new primary focus to be on abiding the HIPAA policies and regulations. Corresponding sections can be seen below:

WRS Phase 2 - Focus	Relevant Acknowledgement in Phase 1 WRS
HIPAA Policies	PNFR8, NFRI11, P11, G10, INFRO7, NFR7

[2] Preliminary Definition

2.1. Preliminary Domain

PD_ID	Preliminary Domain Description
PD1	The domain will be indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.
PD2	Functional objectives would include foremost navigating indoors, primarily going from one location to another in the same or different buildings that are connected to each other.
PD3	The primary stakeholder would be a blind person who needs to navigate indoors.
PD4	Non-function objectives would include safe navigation, fast navigation, and comfortable navigation.
PD5	For both functional and non-functional objectives, use of as many sensors that are available on an advanced smartphone would make your app more helpful.

2.2.Preliminary Functional Requirements

P FR_ ID	Preliminary FR Description
PFR1	Accepting from the user the destination location to go. It might even be able to suggest or confirm a possible destination location, utilizing the user's routine schedule or habit.
PFR2	Figuring out the routes to reach the destination and informing the user of the options (if there are more than one) and accepting user's preference.
PFR3	Telling the user to walk a distance (e.g., 2 minutes before turning, or walk for 30 steps, etc.)
PFR4	Telling the user to stop at the right place to turn.
PFR5	Detecting obstacles and telling the user what to do to avoid collision.
PFR6	Placing emergency calls and messages, possibly after detecting a fall or when the system has lost its current location.
PFR7	Figuring out what the next action(s) would be, based on the user's schedule or habit, and suggesting/accepting the user's choice.
PFR8	More that you can think of.

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 the most comfortable with.
PNFR4	The system shall be usable for blind people.
PNFR5	The system shall be ubiquitous.
PNFR6	The system shall be customizable to every user: e.g. volume, the interval of instructions, etc.
PNFR7	The system shall be easily extensible to accommodate the following typical variations: variations in interface, language, definitive needs of the user, new features, new sensors and hardware, etc.
PNFR8	The system shall remain HIPPA compliant at all times.

[3] Issues with the Preliminary Definition Given

3.1. Domain Issues

Domain Issue ID	**Domain Issue Description**	
DI1	PD_ID	PD1. The domain will be indoors, which can consist of multiple floors, each of which possibly hosts multiple classrooms, offices, bathrooms, lounges, elevators, etc.
	1. Ambiguous or incomplete definition of locations or places the user can navigate to.	
	Option 1	Consider which locations we can easily support with the minimum number of functional requirements and prioritize functional requirements to target those first.
	Option 2	Consider which locations that the visually impaired would most commonly access first and leave the specific locations to the staff members for assistance.
	Option 3	Design around the currently listed examples of locations in the domain description, and plan for easy extendibility of locations.
	Choice	Option 3
	Rationale	Option three provides the most complete domain and allows better extendibility of the software.
Revised wording		The domain includes pre-mapped indoor buildings, including any rooms or pathways that are mapped and uploaded to the application on the user's smartphone device. Some of these places include but are not limited to: offices, classrooms, bathrooms, elevators, etc.

Domain Issue ID	Domain Issue Description	
DI2	PD_ID	PD2. Functional objectives would include foremost navigating indoors, primarily going from one location to another in the same or different buildings that are connected to each other
	1. Ambiguous or incomplete definition of navigating between connected buildings in an all-indoor domain. If two buildings are connected by an outdoor path, we don't have information on if we are to plan for that or not.	
	Option 1	Only design around indoor navigation
	Option 2	Additionally, plan around outdoor navigation between buildings.
	Choice	Option 1
	Rationale	Option one better applies to the domain that is strictly indoors, so planning for outdoor navigation, however short the duration, is out of scope.
Revised wording		Functional objectives would include foremost navigating indoors, primarily going from one location to another in the same or different buildings that are connected to each other by an indoor route.

Domain Issue ID	Domain Issue Description	
DI3	PD_ID	PD3. The primary stakeholder would be a blind person who needs to navigate indoors.
	1. Unclear what tools the blind person has access to.	

	Option 1	Design around a blind person with tools such as a guide dog, walking stick, etc.
	Option 2	Design around our app being the sole guidance system.
	Choice	Option 2
	Rationale	These tools were not mentioned in the documentation and may interfere with our smartphone sensors and accidently be picked up as an obstacle that is forever present.
Revised wording		The primary stakeholder would be a blind person (who may or may not have other blind accessibility tools) who needs to navigate indoors.

Domain Issue ID	**Domain Issue Description**	
DI4	PD_ID	PD4. Non-function objectives would include safe navigation, fast navigation, and comfortable navigation.
	1. Unclear on the definition of comfortable navigation.	
	Option 1	Define comfortable navigation as the routes that prioritize comfort for a blind person, which would be routes that prioritize elevator usage over stairs if available.
	Option 2	Define comfortable navigation as the route that would avoid the most foot traffic.
	Choice	Option 1
	Rationale	This definition would better allow for fast navigation.

Revised wording		Non-function objectives would include safe navigation, fast navigation, and comfortable navigation (prioritization of routes using elevators over stairs).

Domain Issue ID	**Domain Issue Description**	
DI5	PD_ID	PD5. For both functional and non-functional objectives, use of as many sensors that are available on an advanced smartphone would make your app more helpful.
	1. Unclear on what sensors we should use and have access to. 2. Unclear what sensors would be on an advanced smartphone vs. a normal smartphone	
	Option 1	Utilize only the back facing camera and speakers on a phone. Additionally use the IMU Sensors for fall detection.
	Option 2	Research and utilize possible advanced sensors on more advanced smartphones.
	Choice	Option 1
	Rationale	Utilizing sensors that come standard on most modern smartphones would allow more users to use the application and be more standard to develop for.
Revised wording		For both functional and non-functional objectives, use the back facing camera, IMU, and microphone and speakers to create a system designed for blind users.

3.2. Functional Requirements Issues

FR Issue ID	Description	
FRI1	PFR_ID	PFR1. Accepting from the user the destination location to go. It might even be able to suggest or confirm a possible destination location, utilizing the user's routine schedule or habit.
	1. Unclear how the app would know when to accept users' destination.	
	Option 1	Make the app always be listening for voice commands.
	Option 2	Make the app record the users' commands only when they are pressing down anywhere on the screen.
	Choice	Option 2
	Rationale	This option would better ensure that no voice mis-inputs could interfere with the app.
Satisfied by	FR1	

FR Issue ID	Description	
FRI2	PFR_ID	PFR1. Accepting from the user the destination location to go. It might even be able to suggest or confirm a possible destination location, utilizing the user's routine schedule or habit.
	1. Unclear how the app would possibly suggest locations based on the user's routine.	

	Option 1	Not support the app tracking user habits or schedule, instead support canceling/changing routes.
	Option 2	Track and record the times when the user goes to certain places and suggest the destination at that time.
	Choice	Option 1
	Rationale	Habit tracking is unnecessary when the user can cancel and change their route whenever they find necessary.
Satisfied by	FR2	

FR Issue ID	**Description**	
FRI3	PFR_ID	PFR2. Figuring out the routes to reach the destination and informing the user of the options (if there are more than one) and accepting the user's preference.
	1. Unclear what routes the system would find for the user 2. Unclear how many different routes should be offered, 3. Unclear why we would want to offer other routes.	
	Option 1	Only offer a single fastest route.
	Option 2	Offer a single fastest route, with options to recalculate if a path is blocked off (elevator outage, the user thinks a hallway is too busy).
	Option 3	Offer a fastest route, a route with the least amount of people, and a route with staff nearby.

	Choice and Rationale	Option 2 would be the greatest way to calculate paths to not confuse the user and also provide them the fastest path. This would allow for the user to tell us what paths (nodes) are blocked on the route, and give alternative routes to the users destination.
Satisfied by	FR3	

FR Issue ID	**Description**	
FRI4	PFR_ID	PRR3. Telling the user to walk a distance (e.g., 2 minutes before turning, or walk for 30 steps, etc.)
	1. Unclear on the way the application would keep track of the distance the user has traveled 2. Unclear the way that the app would tell the user how to traverse the distance.	
	Option 1	Only tell the user to walk forward and when to turn, without needing to tell them the amount of time or steps to take to get there.
	Option 2	Tell the user the amount of paces to walk before needing to turn or arrive.
	Choice	Tell the user to walk for a set amount of time before needing to turn or arrive.
	Choice and Rationale	Option 1 would be the best way to account for the variance of the users walking speed or stride length.
Satisfied by	FR4	

FR Issue ID	Description	
FRI5	PFR_ID	PFR4: Telling the user to stop at the right place to turn.
	1. Unclear how the software would determine when the user is at the right place to turn	
	Option 1	Use the phones GPS location
	Option 2	Use Bluetooth of Wifi beacons in correlation with the system to determine when the user has reached their location.
	Choice	Calculate the distance the user has traveled via the phone's IMU system.
	Choice and Rationale	Option 2 would be best to ensure the user is exactly where they need to be when they turn, reducing room for possible harmful and errors.
Satisfied by	FR5	

FR Issue ID	Description	
FRI6	PFR_ID	PFR5: Detect and map obstacles and tell the user what to do to avoid collision.
	1. Unclear how the software would detect obstacles.	

	Option 1	Assume the user is using a device such as a dog or cane to tell them about collisions.
	Option 2	Use the phone's camera system and speakers to tell the user about objects and how to avoid them if possible, otherwise tell the user to reroute.
	Choice and Rationale	Option 2 is the better option as it would inform and reroute automatically if a route is impassable, and informs the user of the traffic or immovable objects they are approaching.
Satisfied by	FR6	

FR Issue ID	**Description**	
FRI7	PFR_ID	PFR6: Placing emergency calls and messages, possibly after detecting a fall or when the system has lost its current location.
	1. Unclear on when or when to send a message or send a call once a fall was detected.	
	Option 1	Once a fall is detected, we immediately call emergency services and message the primary caretaker.
	Option 2	Once the fall is detected, we immediately call the caretaker that a fall occurred, and if there is no response within an emergency call is placed.
	Option 3	Once the fall is detected, we ask the user to verbally speak the command or hold down on the screen for a set period of time if they wish to contact emergency services/caretaker or if a call is unnecessary, and if no response is given, then emergency services are called and the caretaker is messaged.

	Choice and Rationale	Option 3 best covers all situations. If the fall detection software was set off when a fall had no occurred, it gives the user the ability to not call for services, and if a fall does occur the user can either choose who they wish to call or if unconscious emergency services are called and the caretaker is notified.
Satisfied by	FR7	

FR Issue ID	**Description**	
FRI8	PFR_ID	PFR7: Figuring out what the next action(s) would be, based on the user's schedule or habit, and suggesting/accepting the user's choice.
	1. Unclear what "next" means in this context.	
	Option 1	Remove this requirement.
	Option 2	Analyze the user's schedule to determine what to do next.
	Choice and Rationale	Option 1, as this choice lets the user choose where to go on their own time.
Satisfied by	FR8	

FR Issue ID	**Description**	
FRI9	PFR_ID	PFR8: More that you can think of.

	1. This is not a requirement	
	Option 1	Remove this requirement
	Choice and Rationale	Option 1, remove this requirement as it is not defined.
Satisfied by	FR9	

3.3.Non-Functional Requirements(NFR) Issues

NFR Issues ID	**Description**	
NFRI1	PNFR_ID	PNFR1. The system shall help the user safely navigate indoors.
	1. What does it mean to help safely navigate indoors?	
	Option 1	Help the user avoid falls such as with stairs or drops.
	Option 2	Helps the user avoid area with heavy foot traffic that could cause them to trip or walk into someone.
	Choice	1
	Rationale	We should ensure the users' physical safely by ensuring they do not get lead to stairs without extensive warning in scenarios where elevators are not present. Hallways with high foot traffic would be very difficult to track while also greatly interfering with the users route.

Satisfied by	NFRI1

NFR Issues ID	**Description**	
NFRI2	PNFR_ID	PNFR2: The system shall lead the user through the fastest route.
	1. What if the fastest route is currently not available? 2. What if the fastest route includes stairs?	
	Option 1	Mark the unavailable location as blocked and recalculate the route from the user's current position.
	Option 2	Always preferably select routes that utilize elevators over stairs.
	Choice	1 + 2
	Rationale	Ensures that the user is always taking a fast and comfortable route.
Satisfied by	NFRI2	

NFR Issues ID	**Description**	
NFRI3	PNFR_ID	PNFR3: The system shall lead the user through the route that the user would feel the most comfortable with.
	1. Unclear on what would make a route more comfortable.	
	Option 1	A route with less foot-traffic

	Option 2	A route that prioritizes elevators over stairs.
	Choice	Option 2
	Rationale	Foot-traffic would be very difficult to calculate and may end up forcing the user to take a long route, interfering with PNFR2.We also want to ensure that the user does not have to climb stairs and can take the elevator for increased safety.
Satisfied by	NFRI3	

NFR Issues ID	**Description**	
NFRI4	PNFR_ID	PNFR4: The system shall be usable for blind people.
	1. Unclear on what ‘usable for blind people’ means?	
	Option 1	Design the app around voice commands for the blind user.
	Option 2	Design the app around commands triggered from button press durations.
	Choice	Option 1 + Option 2
	Rationale	Both of these options in tandem would ensure the best user experience, such as speaking voice commands on locations to go to, and features like a short press on the screen pausing the directions for the user to take a break.
Satisfied by	NFRI4	

NFR Issues ID	Description	
NFRI5	PNFR_ID	PNFR5: The system shall be ubiquitous.
	1. Unclear meaning of system ubiquity.	
	Option 1	Functional for all indoor buildings.
	Option 2	Always able to track the user and update them while they are using the app.
	Choice	Option 2
	Rationale	Option 2 makes the most sense, as the app should constantly be able to keep track of the user and never go offline mid-guide. Option 1 is impossible.
Satisfied by	NFRI5	

NFR Issues ID	Description	
NFRI6	PNFR_ID	PNFR6: The system shall be customizable to every user: e.g. volume, the interval of instructions, etc.
	1. Unclear on details of customization	
	Option 1	Allow for customization of volume, interval of instructions, and speaker voice.
	Option 2	Allow for customization for caretakers to change caretaker phone numbers and their ability to suggest future customizations.

	Choice	Option 1 + Option 2
	Rationale	Using the customizations provided in the plan as well as giving the caretakers and user the ability to provide feedback for future customization.
Satisfied by	NFRI6	

NFR Issues ID	**Description**	
NFRI7	PNFR_ID	PNFR7: The system shall be easily extensible to accommodate the following typical variations: variations in interface, language, definitive needs of the user, new features, new sensors and hardware, etc.
	1. Unclear on the meaning of “variations in interface”.	
	Option 1	Changing the phrases that users need to say to activate different commands.
	Option 2	Changing of visuals for the app when launched.
	Choice	Options 1 + 2
	Rationale	Both of these options should be easily extensible and updated in the future.
Satisfied by	NFRI7	

NFR Issues ID	**Description**	
NFRI8	PNFR_ID	PNFR8: The system shall be easily extensible to accommodate the following typical variations: variations

		in interface, language, definitive needs of the user, new features, new sensors and hardware, etc.
	2. Unclear on the variations of definitive needs of the user.	
	Option 1	Settings for users unable to hear.
	Option 2	Assistance for users in wheelchairs.
	Choice	Option 2
	Rationale	Option 2 would be necessary in case the user may need to use a wheelchair permanently or for a short amount of time in the day.
Satisfied by	NFRI8	

NFR Issues ID	**Description**	
NFRI9	PNFR_ID	PNFR9: The system shall be easily extensible to accommodate the following typical variations: variations in interface, language, definitive needs of the user, new features, new sensors and hardware, etc.
	1. Unclear on the meaning of “new sensors and hardware”.	
	Option 1	The application will still be able to work on the newest models of phones.
	Option 2	The application will be able to be used on any and all smartphones.
	Choice	Option 1

	Rationale	Option 2 is impossible due to technology constraints on older generation phones, Option 1 is necessary to keep functionality when the user upgrades to a new device.
Satisfied by	NFRI9	

NFR Issues ID	**Description**	
NFRI10	PNFR_ID	PNFR10: The system shall be easily extensible to accommodate the following typical variations: variations in interface, language, definitive needs of the user, new features, new sensors and hardware, etc.
	1. “Etc” is not something that can be a requirement.	
	Option 1	Only plan for extensibility on provided features.
	Option 2	Plan for extensibility on all possible aspects.
	Choice	Option 2
	Rationale	Planning for extensibility is good for design and would better allow us to patch and update the application to better assist blind people.
Satisfied by	NFRI10	

NFR Issues ID	**Description**	
NFRI11	PNFR_ID	PNFR11: The system shall remain HIPPA compliant at all times.

	1. Need clear guidelines for HIPPA	
	Option 1	Integrate third-party HIPAA compliance tools or software into the system for compliance checks
	Option 2	Conduct regular in house audits for HIPPA compliance
	Option 3	Hire compliance consultant.
	Choice	Option 2.
	Rationale	Option 2 provides the greatest means of control for following HIPPA guidelines. The team can tailor compliance measures to the requirements of the system rather than relying on generic tools or external expertise
Satisfied by	NFRI11	

[4] WRS

4.1. W

4.1.1. Problem

Problem ID	Problem Description	Corresponding Goals

P1	How does the blind user interact with the system?	G1
P2	How does the system navigate the user?	G2, G4
P3	How does the caretaker set up the app for the blind user?	G3
P4	How does the system obtain the building layout?	G8
P5	How does the caretaker or emergency services get notified if the blind user has gotten lost or injured?	G7
P6	How does the system find the optimal path for the user that is fast, safe, and comfortable?	G5, G6, G9
P7	How does the system keep track of where the user is currently at and when the user should turn, enter an elevator, etc.	G6, G9
P8	How does the system deal with stairs?	G9, G4
P9	How does the app detect obstacles? How soon does it notify the user?	G9, G2
P10	How does the system know if the user has been injured or lost?	G6, G7

P11	How does the system remain HIPPA compliant?	G10

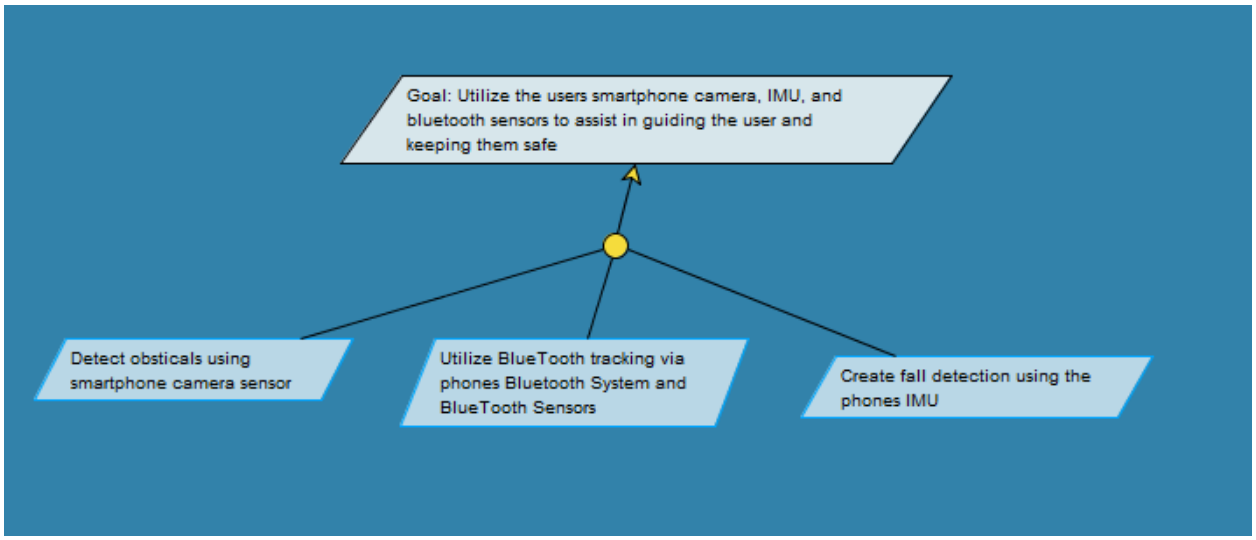

Figure 1. Goal model for phone sensor utilization

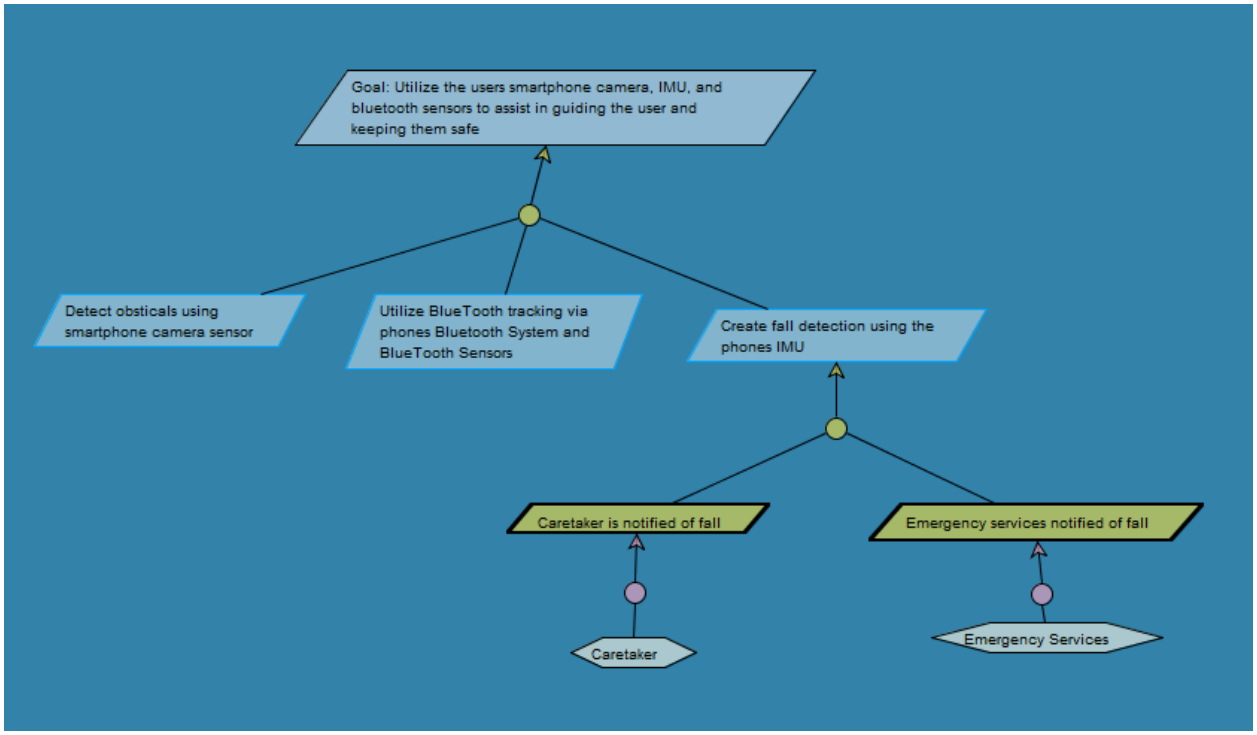

Figure 2. Goal model for sensor utilization with expectations of use.

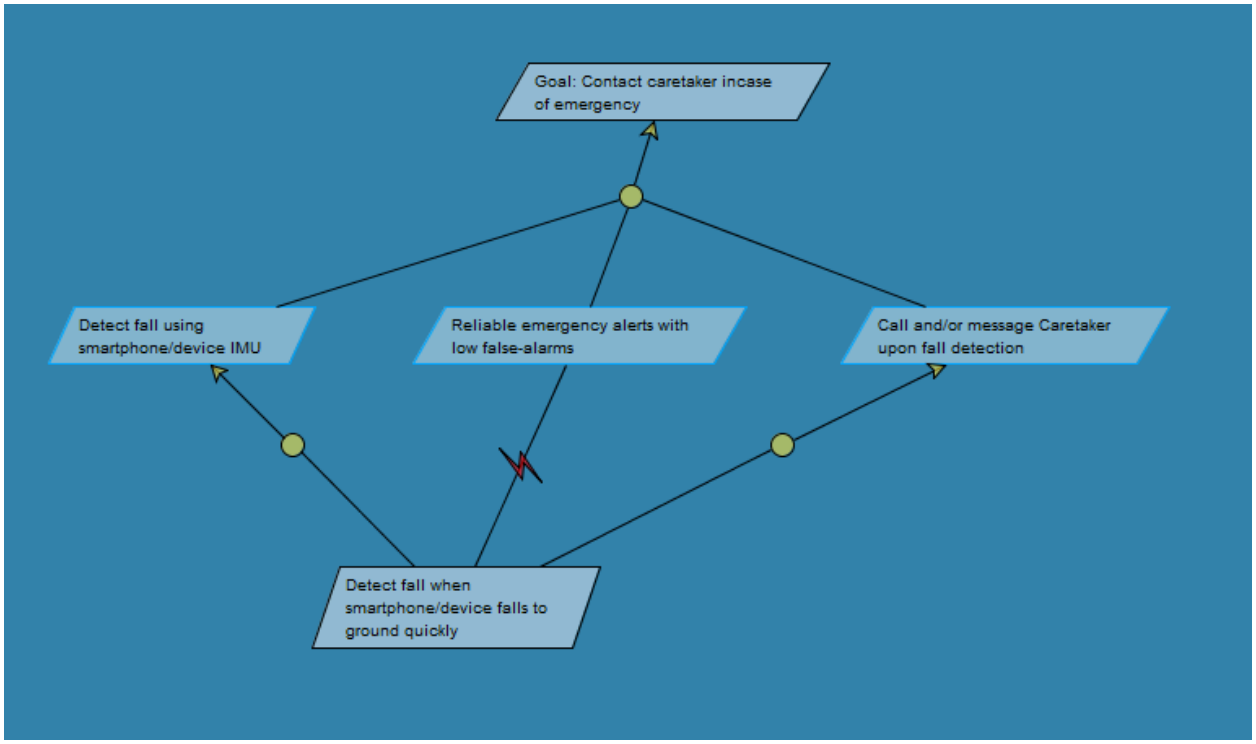

Figure 3. Goal model for contacting caretaker

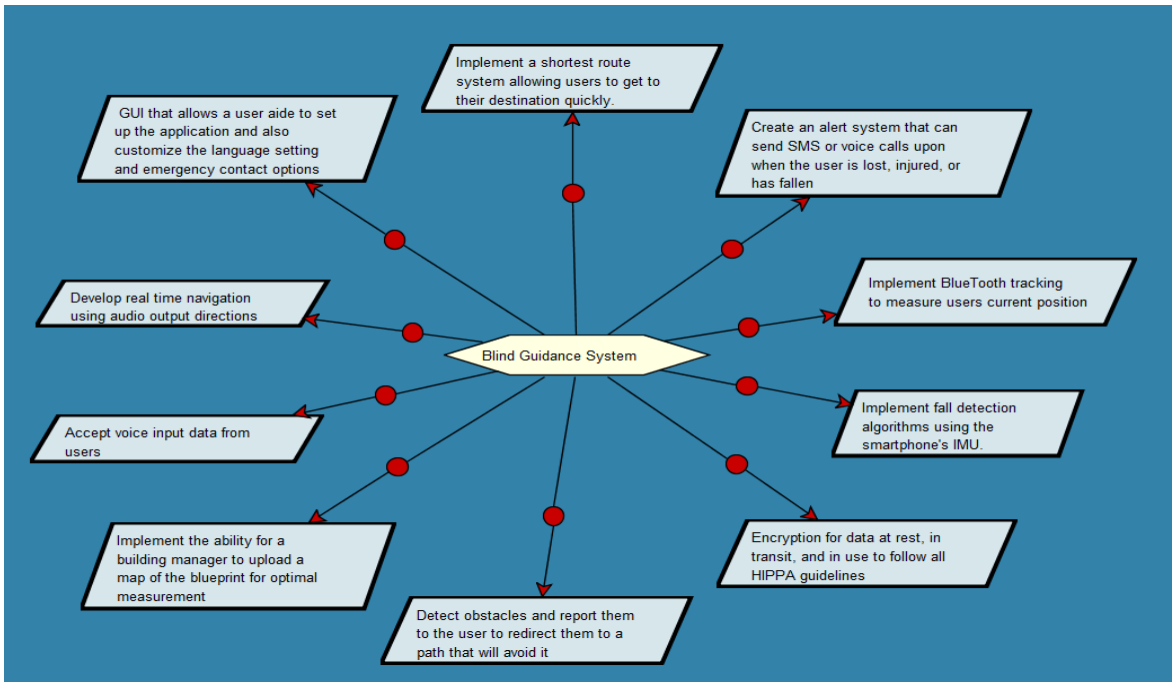

Figure 4. Responsibility model of the whole system.

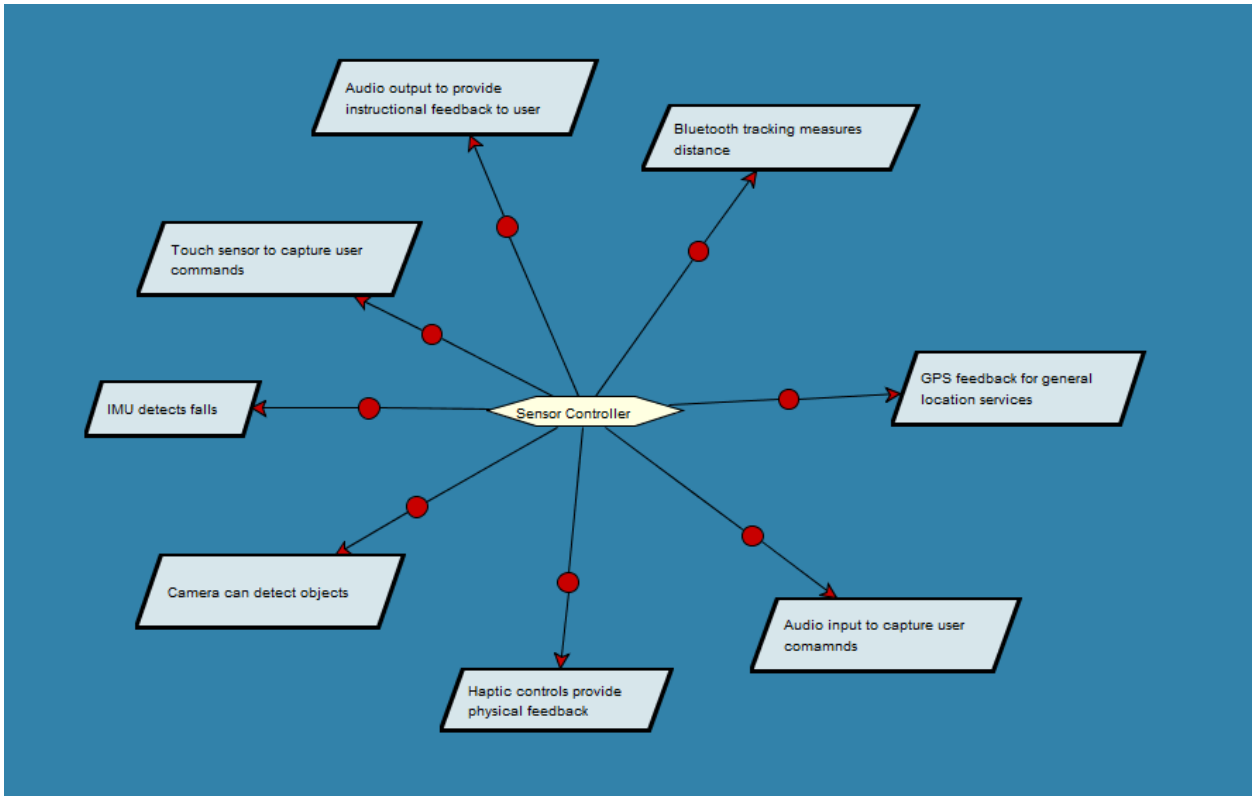

Figure 5. Responsibility model of Sensor Controller.

4.1.2. Goals

Goal ID	Goal Description	Backward Traceability	Forward Traceability
G1	Design the system to accept voice input data from users as the primary input source.	P1	IFRO5, INFRO5, INFRO4
G2	Develop real time navigation using audio output directions.	P9, P2	IFRO2, INFRO5
G3	Create a setup GUI that allows a user aide to set up the application and also customize the language setting and emergency contact options.	P3	IFRO6, INFRO3

G4	Implement a shortest route system allowing users to get to their destination quickly.	P2, P8	INFRO1,
G5	Create an alert system that can send SMS or voice calls upon when the user is lost, injured, or has fallen.	P6	
G6	Implement BlueTooth tracking to measure users current position.	P10, P7, P6	IFRO5
G7	Implement fall detection algorithms using the smartphone's IMU.	P10, P5	IFRO5
G8	Implement the ability for a building manager to upload a map of the building based off of the true building blueprint for optimal measurement.	P4	IFRO1
G9	Be able to detect obstacles and report them to the user to redirect them to a path that will avoid it.	P9, P8, P7, P6	IFRO3, IFRO4, INFRO2
G10	Implement encryption for data at rest, in transit, and in use to follow all HIPPA guidelines.	P11	INFRO8

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	The domain includes pre-mapped indoor buildings, including any rooms or pathways that are mapped and uploaded to the application on the user's smartphone device. Some of these places include but are not limited to: offices, classrooms, bathrooms, elevators, etc.

4.1.3.2. Stakeholders

Primary Stakeholders:

- The blind users using our application to navigate pre-mapped indoor locations

Secondary Stakeholders:

- The primary stakeholders registered caretaker(s)
- Emergency services (911)
- Developers

4.1.3.3. Improved Functional Objectives

Improved FR Objective ID	Objective Description	Alleviates Problems	Achieves Goals
IFRO1	Guide blind users through a pre-mapped indoor building from their current position to a target destination.	P4	G8
IFRO2	Find a route for the blind user to take to get them from their current position to their target destination using audio output.	P9, P2	G2

IFRO3	Detect and notify users of upcoming obstacles	P9, P8, P7, P6	G9
IFRO4	Prevent the user from injuring themselves due to faulty directions of the system	P9, P8, P7, P6	G9
IFRO5	Utilize the users smartphone camera and IMU, bluetooth sensors to assist in guiding the user and keeping them safe	P10, P7, P6	G6, G7
IFRO6	Allow caretakers to download mapped building plans for the blind user to utilize.	P3	G3

4.1.3.4. Improved Non-Functional Objectives

Improved NFR Objective ID	**Objective Description**	**Alleviates Problem**	**Achieves Goal**
INFRO1	Find the user the fastest route that prioritizes their safety first.	P2, P8	G4
INFRO2	Ensure that the provided route prioritizes the comfort and safety of users by providing paths that prioritizes elevators over stairs, if relevant and available in the current building.	P6	G6, G9
INFRO3	Allow both users and caretakers to customize the language settings and set	P3	G3

	up the emergency contact options for the user.		
INFRO4	Allow users to change the volume and frequency of instructions without the assistance of a caretaker.	P1	G 1
INFRO5	Ensure that the blind user is able to use the primary guidance functionality.	P1, P2,P9	G1,G2
INFRO6	Ensure that the application is available at all times that the user is using the device, ensuring they are never stranded without assistance.	P8	G6
INFRO7	Ensure that the application remains HIPPA compliant at all times.	P11	G10

4.2.RS

4.2.1. Functional Requirements

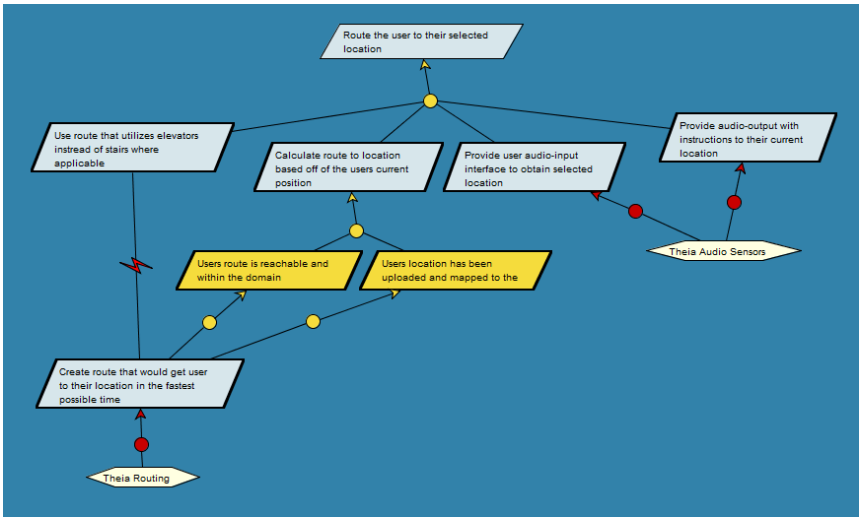

Figure 6: Goal Model for routing user to location

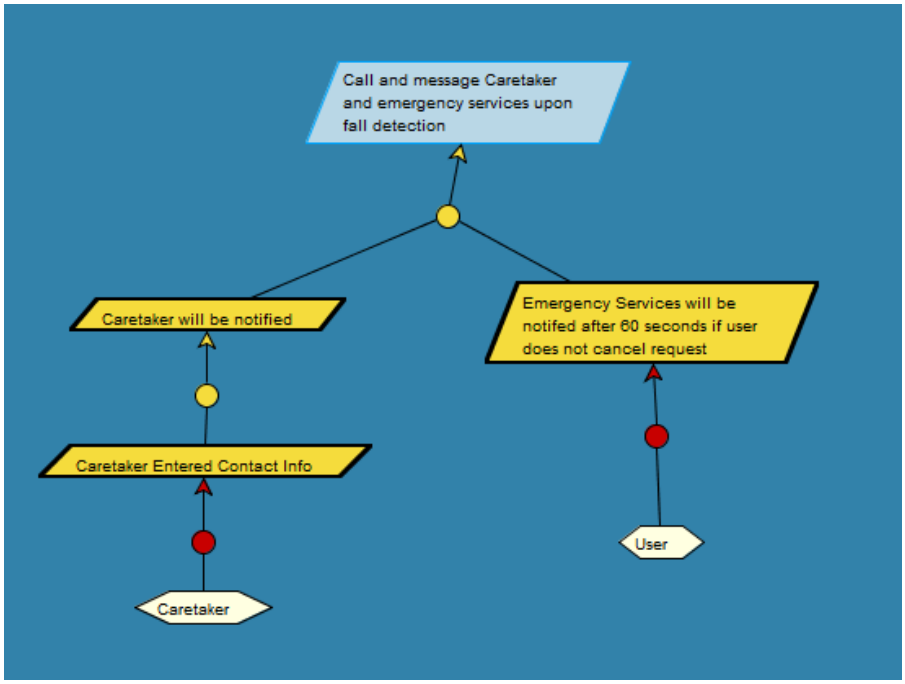

Figure 7: Responsibility model depicting expectation for caretaker and user.

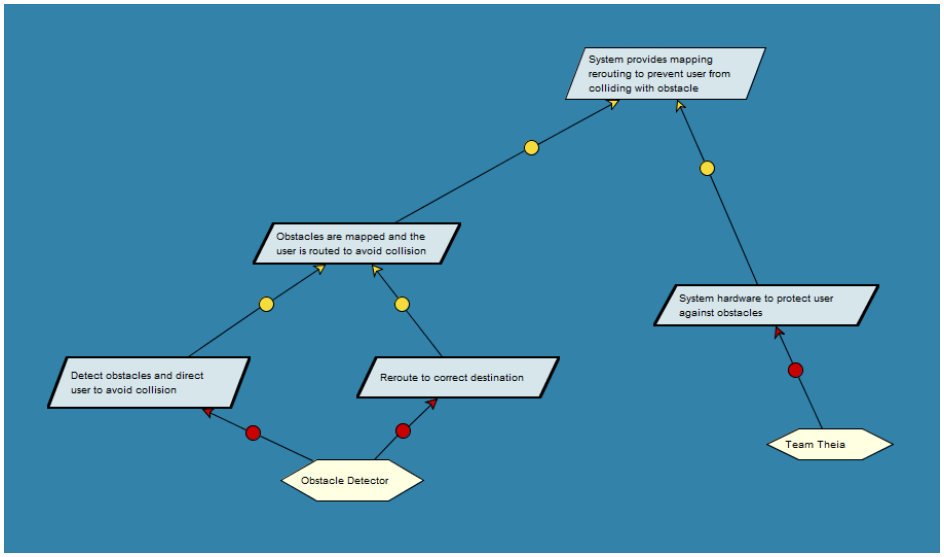

Figure 8. Goal model depicting requirements for system obstacle detection.

FR ID	Description
FR1	Break down the route into verbal instructions using smartphone sound output.

Satisfies Functional Requirement Issue	FRI1
Satisfies Objectives	IFRO1
Satisfied by prototype feature	Instruction queue

FR ID	**Description**
FR2	Detect the most suitable route using the building blueprint uploaded by the building owner.
Satisfies Functional Requirement Issue	FRI2
Satisfies Objectives	IFRO2
Satisfied by prototype feature	Blueprint route finder

FR ID	**Description**
FR3	Detect obstacles that obstruct the path using image detection and reroute users to avoid collision.
Satisfies Functional Requirement Issue	FRI3
Satisfies Objectives	IFRO3
Satisfied by prototype feature	Collision detector

FR ID	Description
FR4	Notify users of potential collision using haptic feedback and/or sound output and reroute users in the event of an incorrect destination.
Satisfies Functional Requirement Issue	FRI4
Satisfies Objectives	IFRO4
Satisfied by prototype feature	Notifior

FR ID	Description
FR5	Access the smartphones camera, IMU sensor, accelerometer, haptic feedback and speakers to provide the user with assistance and send emergency notification.
Satisfies Functional Requirement Issue	FRI5
Satisfies Objectives	IFRO5
Satisfied by prototype feature	Hardware interface

FR ID	Description
FR6	Allow blueprint downloads to enable offline route finding in event of data outage.

Satisfies Functional Requirement Issue	FRI6
Satisfies Objectives	IFRO6
Satisfied by prototype feature	Blueprint download

4.2.2. Non-Functional Requirements

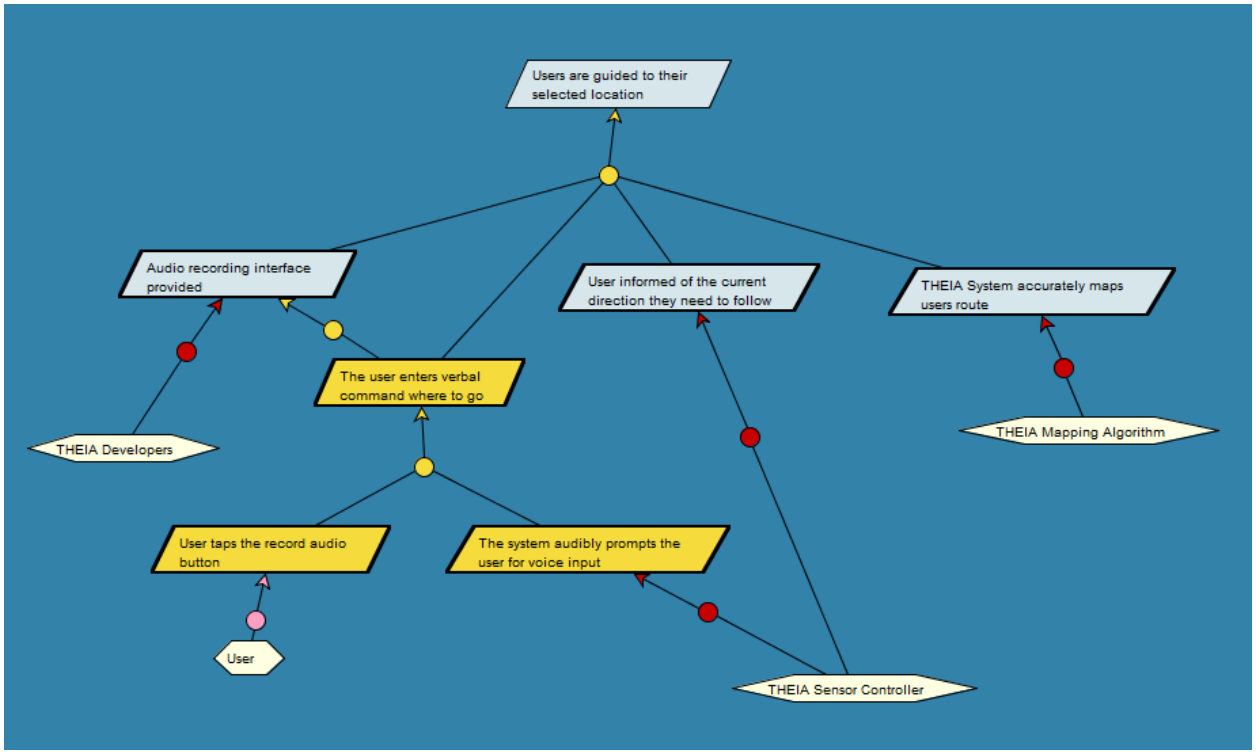

Figure 9. Model depicting the pattern of location selection.

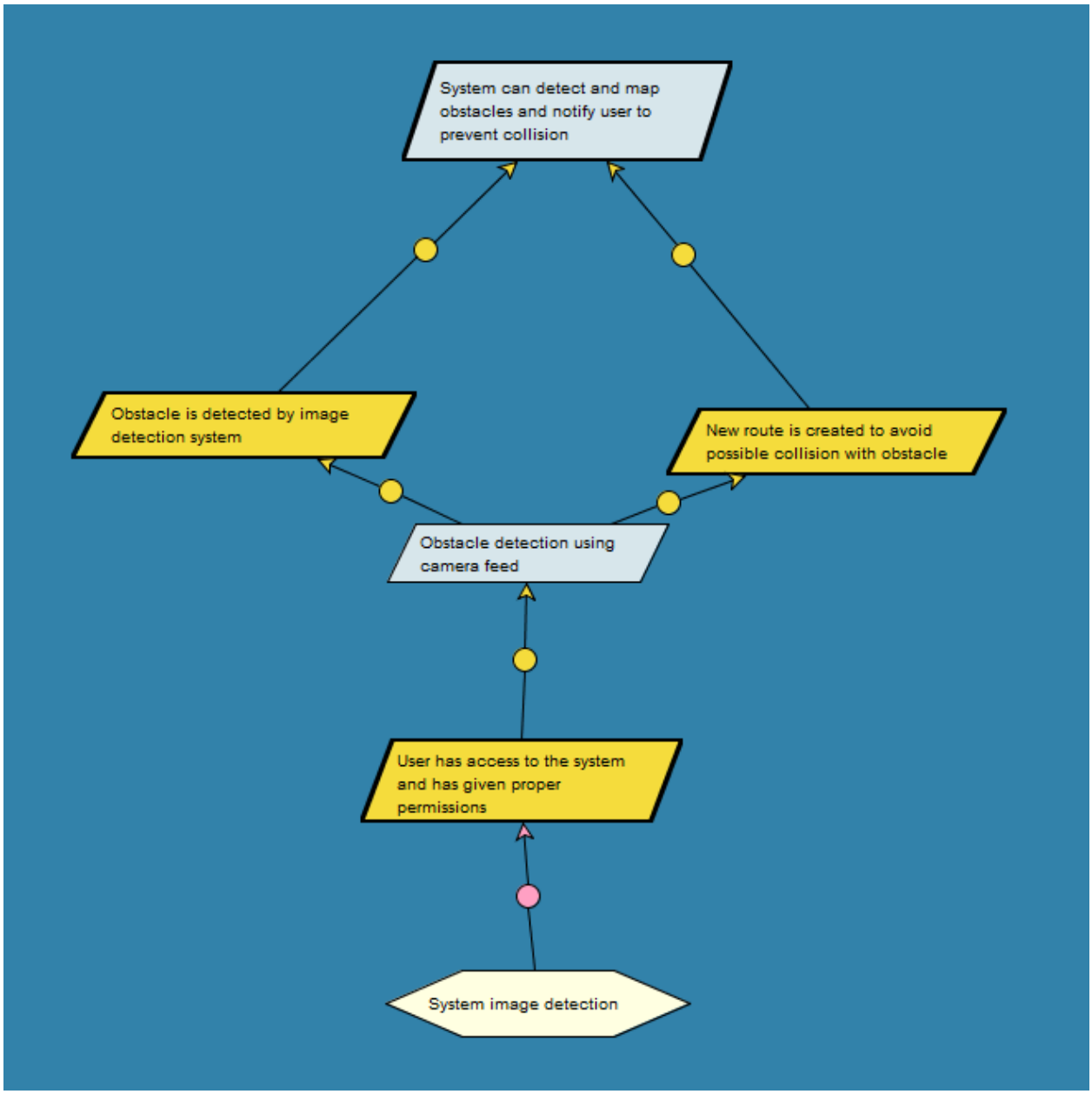

Figure 10. Responsibility model for image detection.

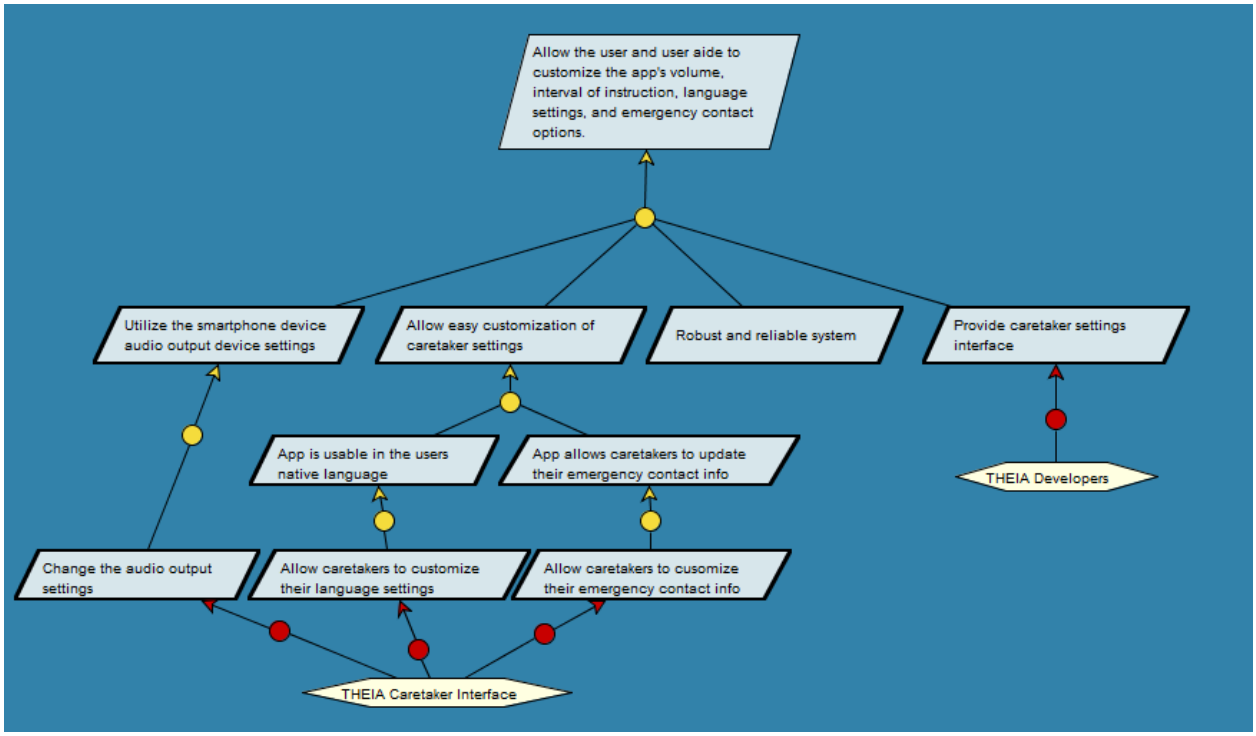

Figure 11. Responsibility model for customization of settings.

NFR ID	**Nonfunctional Requirement 1**
NFR1	The system will help the user safely navigate indoors by correctly telling the user when to turn, when an obstacle is in the way, and prioritize routes that use elevators instead of stairs for multi-floor traversal.
Operationalized Functional Requirements	FR1, FR2, FR3, FR4
Satisfies Nonfunctional Requirement Issue	PNFR1
Satisfies Non-functional Objective	INFRO1
Constrains	IFRO1, IFRO2, IFRO3, IFRO4

Satisfied by prototype feature	Blueprint route finder, collision detector, instruction queue

NFR ID	**Nonfunctional Requirement 2**
NFR2	The system shall always provide the current fastest route to the users destination while continuing to prioritize elevator traversal over stair traversal. The system will recalculate a new fastest route if the user is uncomfortable or unable to traverse the current fastest route due to obstacles or closure.
Operationalized Functional Requirements	FR1, FR2
Satisfies Nonfunctional Requirement Issue	PNFRI2
Satisfies Non-functional Objective	INFRO2
Constrains	IFRO1, IFRO2
Satisfied by prototype feature	Blueprint route finder, collision detector

NFR ID	**Nonfunctional Requirement 3**
NFR3	Allow the user and user aide customize the app's volume, interval of instruction, language settings, and emergency contact options.
Operationalized Functional Requirements	FR6

Satisfies Nonfunctional Requirement Issue	PNFRI3
Satisfies Non-functional Objective	INFRO3
Constrains	IFRO6
Satisfied by prototype feature	Settings

NFR ID	**Nonfunctional Requirement 4**
NFR4	The system will allow blind users to use the app by utilizing voice commands and touchscreen button press durations to perform the users command without the need to see the screen.
Operationalized Functional Requirements	FR5
Satisfies Nonfunctional Requirement Issue	PNFRI4
Satisfies Non-functional Objective	INFRO4
Constrains	IFRO5
Satisfied by prototype feature	Voice commands

NFR ID	**Nonfunctional Requirement 5**

NFR5	The system will be easily extendable, allowing for the application to be used and updated on newer smartphone devices, and extendable for users who may have other handicap devices that we can support in the future.
Operationalized Functional Requirements	FR1
Satisfies Nonfunctional Requirement Issue	PNFRI5
Satisfies Non-functional Objective	INFRO5
Constrains	IFRO1
Satisfied by prototype feature	Cross platform

NFR ID	**Nonfunctional Requirement 6**
NFR6	Ensure the application is always available to the user even if data interruptions do occur.
Operationalized Functional Requirements	FR1, FR2, FR3, FR4, FR5, FR6
Satisfies Nonfunctional Requirement Issue	PNFRI6
Satisfies Non-functional Objective	INFRO6
Constrains	IFRO1, IFRO2, IFRO3, IFRO4, IFRO5, IFRO6

Satisfied by prototype feature	Blueprint download

NFR ID	**Nonfunctional Requirement 7**
NFR7	Ensure the application is always HIPPA compliant at all points of use.
Operationalized Functional Requirements	FR1, FR2, FR3, FR4, FR5, FR6
Satisfies Nonfunctional Requirement Issue	PNFRI8
Satisfies Non-functional Objective	INFRO7
Constrains	IFRO1, IFRO2, IFRO3, IFRO4, IFRO5, IFRO6
Satisfied by prototype feature	User information encryption

4.2.3. Specifications

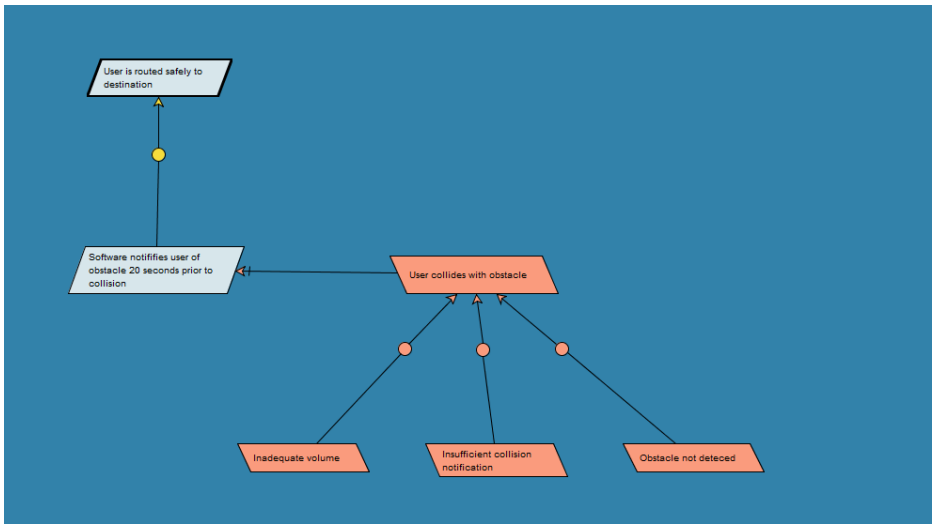

Figure 10. Obstacle model depicting collision.

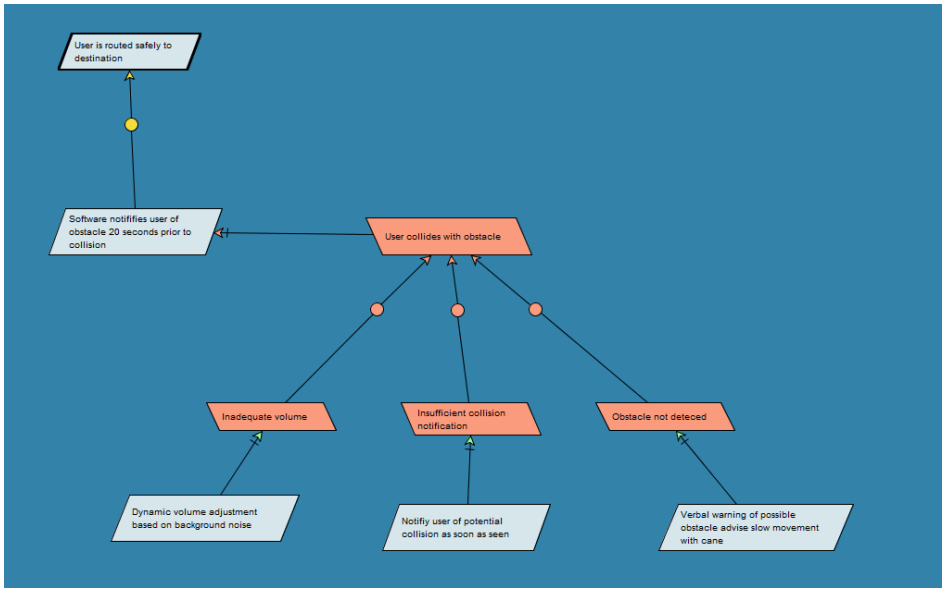

Figure 11. Obstacle model depicting collision resolution.

Functional Specification ID	**Functional Requirement**
FS1	Decompose travel routes into step by step verbal instructions using smartphone audio output. Route will follow safety protocol and match with user requirements.
Satisfies Functional Requirement	FR1
Satisfies Objectives	IFRO1, INFRO1
Satisfied by prototype feature	Instruction queue, voice command, settings, collision detection

Functional Specification ID	**Functional Requirement**
FS2	Optimize route finding utilizing the building blueprint and prioritize the safest routes, avoiding potential obstacles like stairs.

Satisfies Functional Requirement	FR2
Satisfies Objectives	IFRO2, INFRO1, INFRO2
Satisfied by prototype feature	Blueprint routefinder, collision detector, instruction queue

Functional Specification ID	**Functional Requirement**
FS3	Use live image recognition to detect potential obstacles that are obstructing the route and generate a new path to avoid obstacles staying as close to the original route as possible.
Satisfies Functional Requirement	FR3
Satisfies Objectives	IFRO3, IFRO2, INFRO2
Satisfied by prototype feature	Collision detector, blueprint route finder

Functional Specification ID	**Functional Requirement**
FS4	Use haptic feedback and audio que to notify users of potential collisions.
Satisfies Functional Requirement	FR4
Satisfies Objectives	IFRO4
Satisfied by prototype feature	Collision detector, voice command, instruction queue

Functional Specification ID	Functional Requirement
FS5	Smartphone sensors such as accelerometers, gyroscopes, and proximity sensors, along with integrated hardware like GPS and cameras and haptic feedback, will be used to guide and alert users. These technologies will facilitate real-time navigation and notification.
Satisfies Functional Requirement	FR5
Satisfies Objectives	IFRO5, INFRO4
Satisfied by prototype feature	Hardware interface

Functional Specification ID	Functional Requirement
FS6	Emergency notifications will be triggered by an accelerometer if it detects a fall. Notifications will be sent out using sms and voice call.
Satisfies Functional Requirement	FR5
Satisfies Objectives	IFRO5
Satisfied by prototype feature	Notifior

Functional Specification ID	Functional Requirement

FS7	Application settings must be adjustable to allow for changes to audio volume, haptic feedback strength, route preferences and emergency contact options.
Satisfies Functional Requirement	FR5
Satisfies Objectives	IFRO5, INFRO3
Satisfied by prototype feature	Settings

Functional Specification ID	**Functional Requirement**
FS8	Application must be cross platform and able to automatically adjust for data dead spots making it applicable even without data. This will be done using downloadable building blueprints prior to use.
Satisfies Functional Requirement	FR6, FR2
Satisfies Objectives	IFRO6, IFRO2, INFRO5, INFRO6
Satisfied by prototype feature	Blueprint download, cross platform

[5] Preliminary Prototype

[6] Prototype Interface Mock-ups

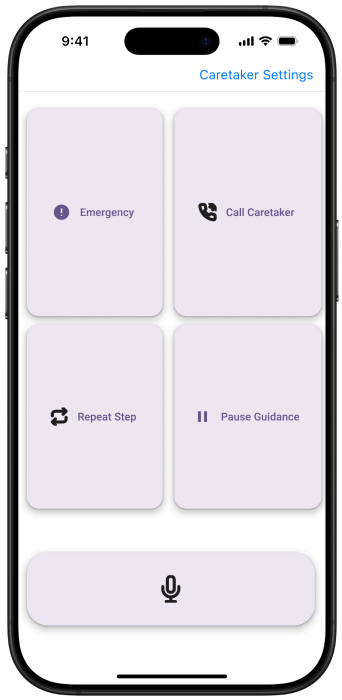

Image 2 Main App UI: The above image details how the app can be utilized to call emergency services, call the caretaker for help, repeat the last step, and pause guidance in order to do something, such as talk to someone, and voice input. The voice input listens for the user's voice commands. For example: “Take me to the bathroom” will give guidance to the nearest bathroom. The “Caretaker Settings” option will provide the following images (Image 2) accessibility setup, for the caretaker to utilize to set up the app for the user.

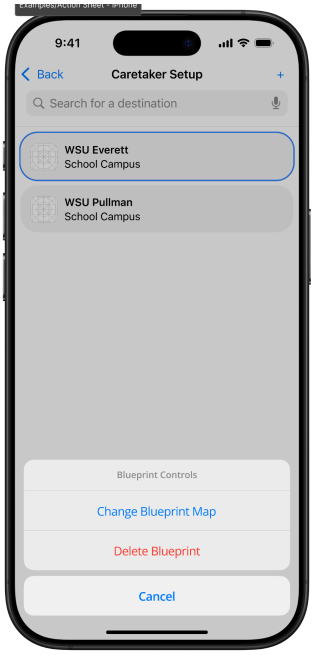

Image 2 Caretaker Setup UI: The above image details how the app can be utilized to create, search for, delete, and change a blueprint and its respective map. This is the blueprint of the building and everything inside of it.

[7] User Manual

Introduction

This mobile app is designed to assist blind or visually impaired users in navigating indoor spaces safely and efficiently. The app uses voice recognition, voice commands, and text-to-speech technology to provide real-time guidance and notifications of obstacles.

Key Features

- Voice Commands for Navigation: Users can control the app entirely with voice commands.
- Obstacle Alerts: Real-time notifications are given when obstacles are detected along the path.
- Fastest Route Finder: The app calculates the fastest and safest route to the user's destination.
- Customizable Settings: Users can personalize navigation preferences, such as route type or obstacle sensitivity.

- Call Caretaker and Emergency: When users get in an unexpected accident, this feature will be triggered.
- System encryption for data in use, data at rest and data in transit.

Installation and Setup

- Download and Install the App
- Go to the App Store or Google Play Store.
- Search for the app name (TBD).
- Tap Install and wait for the app to download.

Initial Setup (for Caretaker):

- Open the app.
- Grant necessary permissions, such as access to the microphone, location services, and notifications.
- Choose preferred language for voice commands and instructions.
- User Profile: Caretaker can set up a user profile (optional) with preferences like preferred walking speed, obstacle sensitivity, and favorite destinations (e.g., office, restroom).

Using the App

- Start the Navigation:

  Open the app and say the command: "Start navigation" or tap the button labeled Start.

  Can also use voice commands like "Navigate to the office" or "Take me to the elevator."

- Receiving Directions:

  The app will give spoken instructions, such as: "Turn left in 5 meters" or "Elevator ahead in 10 meters"

  Follow the voice prompts to move safely through the building.

- Obstacle Detection:

If obstacles are detected along the route, the app will alert you with a message like: "Caution: Object ahead, 3 meters to your right."

Can also ask for more details by saying, "What's in front of me?"

- Adjusting the Route:

If users need to take a different route, they can say: "Take me through a quieter path" or "Avoid the stairs."

- Voice Commands

  Start Navigation: "Start navigation" or "Begin route."

  Stop Navigation: "Stop navigation" or "End route."

  Find a Location: "Take me to the nearest restroom" or "Navigate to the nearest restroom"

  Request Details: "What is ahead?" or "Are there any obstacles?"

  Repeat Last Instruction: "Repeat the last direction."

- Setting Favorite Destinations:

  Save frequently visited places for easy access. Say, "Save this as my office" to save a location, and later use the command, "Take me to the office."