CptS 484: Software Requirements

WRS Evolution

Requirements Elicitation

Team Bagel

Revision History

Date	Version	Changes	Editor
10/05/2025	1.0	Initial setup, preliminary definitions, and requirements	Grace Anderson
10/06/2025	1.1	Problems and goals	Nick Vendeland
10/11/2025	1.2	Introduction sections (1.x in the document), and continued fleshing out of problem and goal sections	Grace Anderson, Nick Vendeland
10/12/2025	1.3	Functional and non-functional requirements issues, improved domain and requirement descriptions, final touches such as revision history and traceability	Grace Anderson, Jaeger Nelson, Aaron Howe, Arlo Roos, Josh Evans
11/26/2025	1.4	Phase II KAOS models added	Aaron Howe

[1] Introduction

1.1. Purpose

Theia is an indoor navigation system designed to provide blind and visually impaired individuals with safe, independent, and confident navigation capabilities within multi-floor building environments. The system comes from the Greek goddess of sight and vision, reflecting the application's purpose of providing vision through technology.

Blind and visually impaired individuals face significant challenges when navigating unfamiliar or complex indoor spaces. Current solutions have critical limitations that prevent truly independent navigation. GPS technology is unreliable or completely unavailable indoors, making smartphone-based outdoor navigation applications ineffective. Existing mobility aids, such as white canes and guide dogs are invaluable for detecting immediate obstacles through touch, but they cannot provide advance route planning or turn-by-turn directions to unfamiliar destinations. Building signage relies entirely on visual information and remains inaccessible to blind users. While human assistance from sighted individuals can help, it is not always available and fundamentally reduces the independence that many blind individuals seek in their daily lives. Perhaps most critically, the lack of real-time obstacle detection creates ongoing safety concerns as users navigate through dynamic indoor environments.

Theia addresses these challenges by providing comprehensive navigation support. The system enables users to navigate from their current location to any destination within a building without requiring sighted assistance, giving them true independence in indoor environments. Through proactive guidance, the system provides turn-by-turn audio instructions with advance warnings for turns, obstacles, and landmarks, allowing users to navigate confidently. Safety assurance comes through real-time obstacle detection in the user's path with timely warnings to prevent collisions. Emergency support features automatically detect falls or distress situations and facilitate emergency communication with designated contacts. The system ensures accessibility compliance by routing users along paths that accommodate their specific needs, such as using elevators instead of stairs and avoiding narrow passages. Ultimately, Theia aims to provide user empowerment through reliable and consistent navigation support that builds confidence and independence.

1.2. Scope

The Theia system would serve as a smartphone-based indoor navigation assistant designed specifically for blind and visually impaired users. The system's core scope includes providing safe and reliable navigation capabilities within multi-floor buildings. Its main purpose is to guide users from their current position to a desired destination while avoiding all obstacles using audio instructions.

The focus of Theia will be exclusively on indoor navigation. The environments will consist of schools, offices, shops, subways, etc, where normal GPS is unreliable. It will accomplish this through a combination of smartphone sensors, including the camera, microphone, and accelerometer. It will then combine this sensor input with the database of internal building maps to deliver the most accurate positional awareness. The system will also include emergency detection and response features, such as automatic fall detection and distress alerts, to ensure user safety.

The main interactions through the Theia app will be voice-based. The app would allow users to issue commands as well as receive guidance through speech synthesis and recognition. Voice-based assistance will provide navigation, emergency assistance, and real-time obstacle avoidance.

The interactions that will not be supported by the Theia app would be things like an outdoor GPS navigation system, integration with other hardware such as smart canes, or real-time map updates for building interiors.

1.3. Objectives and Success Criteria

- Navigate indoors using a mobile application with voice recognition and speech synthesis.
- Provide a user with the most optimal shortest path to a desired destination with obstacle detection.
- Give a secondary user (caretaker, parent, etc.) intuitive accessibility options to configure the application to suit the primary user's needs.
- Support alerts for EMS, successfully sending an emergency call after a user fails to respond after an incident or has gotten lost.

1.4. Definitions, Acronyms, and Abbreviations

Term	Definition
Voice Recognition	Voice or speaker recognition is the ability of a machine or program to receive and interpret dictation or to understand and perform spoken commands.
Speech Synthesis	The process of generating spoken language by a machine on the basis of written input.
GPS	An accurate worldwide navigational and surveying facility based on the reception of signals from an array of orbiting satellites.
Accelerometer	A device that measures the proper acceleration of an object.
Bluetooth	A standard for the short-range wireless interconnection of mobile phones, computers, and other electronic devices.
PNG	“Portable Network Graphic” is a raster-graphics file format that supports lossless data compression.
JPEG	“Joint Photographic Experts Group” is a commonly used method of lossy compression for digital images, particularly for those images produced by digital photography.
SVG	“Scalable Vector Graphics” is an XML-based vector graphics format for defining two-dimensional graphics, having support for interactivity and animation.

1.5. Overview

This WRS Evolution describes the Theia project’s preliminary definition in section 2, containing the preliminary domain, preliminary functional requirements, and preliminary non-functional requirements. In Section 3, we define issues with the preliminary definition. This is then followed by section 4 for the problem domain and goals of the project that defines the “what” and further subsections for system functional and non-functional requirements and specifications. The remaining sections are for the project’s preliminary prototype, mockup designs, and a list of references.

[2] Preliminary Definition

2.1. Preliminary Domain

PD_ID	Preliminary Domain Description
PD1	Blind and visually impaired individuals who require assistive technology to navigate safely and independently in indoor environments.
PD2	Individuals with other mobility or sensory impairments, such as elderly users with limited vision, hearing, or muscle strength) who may also benefit from hands-free navigation assistance.
PD3	Caregivers, accessibility coordinators, or staff members responsible for supporting visually impaired individuals and ensuring compliance with accessibility standards.
PD4	Public indoor environments, such as universities, hospitals, malls, airports, and government buildings, where accessibility and navigation present ongoing challenges.
PD5	The assistive technology ecosystem includes smartphone platforms, accessibility APIs, and sensor-based navigation frameworks that enable real-time environmental awareness and guidance.

2.2. Preliminary Functional Requirements

P FR_ ID	Preliminary FR Description
PFR1	The system will provide indoor navigation guidance to users by generating accessible, step-by-step audio directions to reach a chosen destination within a mapped building.
PFR2	The system will accept user input through voice commands to determine navigation goals and interact with the application hands-free.
PFR3	The system will detect obstacles in the user's path using smartphone sensors like the camera, microphone, or accelerometer and issue real-time audio alerts.
PRF4	The system will support safety monitoring by automatically detecting falls or distress situations and initiating emergency contact protocols.

PRF5	The system will provide accessible route planning that prioritizes elevator access, avoids stairs, and keeps track of any environmental accessibility constraints.
PRF6	The system will communicate progress, directions, and hazard warnings to the user using text-to-speech.
PRF7	The system will store and retrieve preloaded building maps and floor plans to provide accurate routes and indoor positioning.

2.3. Preliminary Non-Functional Requirements

PNFR_ ID	Preliminary NFR Description
PNFR1	The system will provide real-time feedback with minimal delay between sensor input and user audio output for safe and responsive navigation.
PNFR2	The system will maintain high accessibility standards, fully adhering to the WCAG (Web Content Accessibility Guidelines) and mobile accessibility best practices.
PNFR3	The system will operate effectively in indoor environments with limited or no GPS signal, using only local sensors and stored maps.
PNFR4	The system's audio interface will use clear, natural-sounding speech as well as adjustable volume to accommodate all different hearing abilities and environmental noise.
PNFR5	The system will maintain a strict level of data privacy by securely handling user location and emergency contact information according to standard data protection practices.
PNFR6	The app will function smoothly on common smartphone hardware (Android and iOS) without the need for external devices.
PNFR7	The system will maintain a high level of reliability, being able to continue operation in the case of intermittent sensor or network failures whenever possible.
PNFR8	The system will be intuitive and simple in setup to minimize the learning curve for the user and maximize its accessibility to users with little tech experience.

[3] Issues with the Preliminary Definition Given

3.1. Domain Issues

<table>
<tr><th>Domain Issue ID</th><th colspan="2">Domain Issue Description</th></tr>
<tr><td rowspan="5">DI1</td><td>PD1</td><td>Blind and visually impaired individuals who require assistive technology to navigate safely and independently in indoor environments.</td></tr>
<tr><td colspan="2">Ambiguous or incomplete. Shouldn’t we consider that most campuses include multiple buildings that a user needs to travel to and from? Is outdoor navigation less important than indoor navigation?</td></tr>
<tr><td>Option 1</td><td>Extend the app’s navigation features from within the perimeter of a building to the perimeter of a college campus. This would include navigation instructions and obstacle detection outdoors.</td></tr>
<tr><td>Choice</td><td>Option 1</td></tr>
<tr><td>Rationale</td><td>If a user wants to use the application to help arrive at a classroom both safely and on time, they would want to set their destination from the moment they arrive on campus and be guided to their class when traveling outdoors and indoors. Otherwise, a user could make unsafe collisions outdoors and/or get lost trying to find the building where the app can be used.</td></tr>
</table>

Domain Issue ID	Domain Issue Description	
DI2	PD2	Individuals with other mobility or sensory impairments, such as elderly users with limited vision, hearing, or muscle strength) who may also benefit from hands-free navigation assistance.
	Ambiguous: Some visually impaired users may also be audibly impaired, which would negate the application's primary communication function.	
	Option 1	Implement a configuration option to add communication via device vibrations, utilizing vibrations that signal different directions and alerts.
	Choice	Option 1
	Rationale	Being both blind and visually impaired makes a user unable to interact with the app visually and unable to listen to commands and prompts provided from in-app speech synthesis. By using option one, the user can use their sense of touch to communicate with the application.

Domain Issue ID	Domain Issue Description	
DI3	PD3	Caregivers, accessibility coordinators, or staff members responsible for supporting visually impaired individuals and ensuring compliance with accessibility standards.
	Ambiguous. Do we just assume that users will have a person assigned to caring for them?	

	Option 1	Provide default voice recognition and speech synthesis upon first launch so a primary user may have the ability to configure accessibility and application personalization themselves.
	Choice	Option 1
	Rationale	Option 1 allows impaired users who, unfortunately, do not have a secondary user that is responsible for supporting them to configure the app's accessibility and personalization settings via verbal commands.

3.2. Functional Requirements Issues

FR Issue ID	Description	
FRI1	PFR3	The system will detect obstacles in the user's path using smartphone sensors like the camera, microphone, or accelerometer and issue real-time audio alerts.
	Can the system detect hidden hazards such as fluid spills or holes in the ground?	
	Assumptions: • Solid obstacles that impede a path will be detected.	
	Option 1	The application can optionally come with a secondary sensor device that can be attached at the foot level, which can detect pathway hazards that aren't solid and large.
	Choice	Option 1
	Rationale	This particular issue is rather difficult to solve. You can always rely on the phone's camera to identify a spill on the ground, but it isn't guaranteed that the user will have the camera pointed at the floor at all times. Using a sensor device that is Bluetooth connected to the phone with application access can provide the user with a sensor that is always detecting hazards that are low to the ground that may otherwise go unnoticed.

Satisfied by	FR1, FR2

<table>
<tr><th>FR Issue ID</th><th colspan="2">Description</th></tr>
<tr><td rowspan="6">FRI2</td><td>PFR5</td><td>The system will provide accessible route planning that prioritizes elevator access, avoids stairs, and keeps track of any environmental accessibility constraints.</td></tr>
<tr><td colspan="2">Will the system recognize when elevators are closed for maintenance?</td></tr>
<tr><td colspan="2">Assumptions:
● The system will know if there are elevators or not.
● The system will not avoid stairs if elevators are not available.
● The system’s obstacle detection will be able to deduce if a hallway is closed for construction/maintenance/cleaning.</td></tr>
<tr><td>Option 1</td><td>The system can be made intelligent enough to listen for voice prompts that state that an elevator is “not working” or “is closed” from the user, and subsequently update this for a certain time interval that is defined as an estimate for how long the elevator will be out of service.</td></tr>
<tr><td>Option 2</td><td>The system does not discriminate against stairs and chooses its path based on the shortest/fastest route. This method simply chooses fewer elevators, avoiding wasting time pathing towards one in case it is closed.</td></tr>
<tr><td>Choice</td><td>Option 1</td></tr>
</table>

<table>
<tr><td></td><td>Rationale</td><td>Option 1 is the more difficult option to design and implement, but it is the more user-friendly and inclusive option. A user with visual impairment should always prioritize elevator access, and giving the ability to mark an elevator as out of use can allow for the path-finding algorithm to be modified to not discriminate against stairs until the elevator is in service.</td></tr>
<tr><td>Satisfied by</td><td colspan="2">FR3, FR4</td></tr>
</table>

<table>
<tr><th>FR Issue ID</th><th colspan="2">Description</th></tr>
<tr><td rowspan="5">FRI3</td><td>PFR7</td><td>The system will store and retrieve preloaded building maps and floor plans to provide accurate routes and indoor positioning.</td></tr>
<tr><td colspan="2">“Building maps and floor plans” is ambiguous. What kind of data will the system be able to ingest? Will they be basic image files, such as PNG or JPEG, or should it be limited to a more technical standard like SVG floor plans?</td></tr>
<tr><td colspan="2">Assumptions:
The system will be able to accept a floor plan of some kind
The system will additionally be able to accept latitude and longitude data for the building
The floor maps provided should be official documents from the campus or accessibility department, rather than random images provided by the user.</td></tr>
<tr><td>Option 1</td><td>Limit users to uploading only SVG vector-based images, as these would be the simplest to analyze and add to the navigation storage.</td></tr>
<tr><td>Option 2</td><td>Allow users to upload any kind of image file, and perform the necessary processing and recognition steps automatically within the app to recognize rooms, doors, stairs, and elevators.</td></tr>
</table>

	Option 3	Require a custom data type, possibly provided by an external program, where the user must manually denote key points of interest.
	Choice	Option 2
	Rationale	Although the hardest to implement, option 2 is by far the most user-friendly, and for an accessibility-first application such as this, it should be able to handle slightly older or less polished datatypes and floor maps. Although this means the app’s route generator and floormap intake algorithms will have to be much more sophisticated, it’s worth it from the user's perspective. On top of this, some buildings may not have perfectly crafted SVG digital layouts at the ready, and basic floorplan images may be the only resource available to the configurator of the application. The third option, using a custom datatype and external application or editor, is similarly unwieldy and may be difficult to use for less tech-proficient users.
Satisfied by	FR5	

3.3. Non-Functional Requirements(NFR) Issues

NFR Issues ID	Description	
NFRI1	PNFR1	The system will provide real-time feedback with minimal delay between sensor input and user audio output for safe and responsive navigation.
	What if the sensor is blocked in some way, like the user’s finger in front of the camera?	
	Option 1	Provide an audio notification when something is clearly blocking the phone camera, and the responsiveness of the sensors is clearly affected.
	Choice	Option 1
	Rationale	This issue is a relatively easy one to detect and solve. In order to maintain real-time feedback and minimal sensor delay, a

		process for detecting sensor interference and notifying the user is critical to maintain safety and usability.
Satisfied by		

NFR Issues ID	Description	
NFRI2	PNFR3	The system will operate effectively in indoor environments with limited or no GPS signal, using only local sensors and stored maps.
	How should the system determine the current user location without GPS, for use in routing?	
	Option 1	The system can query the user if it detects an inconsistent or nonexistent GPS signal, asking approximately where they are as well as their destination.
	Option 2	The system can attempt to determine the current location itself using some form of photoscan and camera data
	Choice	Option 1
	Rationale	Although possibly inconsistent, the first option would be vastly easier to implement, and would at least give the application a starting point when determining a route. The second option would be a much more difficult choice from an implementation standpoint and would have to rely on image recognition and other sophisticated

		techniques. It would also most likely involve more input on the part of the user, since they may be asked to spin around and scan the environment with a camera, a more annoying and less user-friendly task than answering a voice prompt.
Satisfied by	NFR3	

NFR Issues ID	Description	
NFRI3	PNFR4	The system's audio interface will use clear, natural-sounding speech as well as adjustable volume to accommodate all different hearing abilities and environmental noise.
	What about significant environmental noises, such as active construction zones?	
	Option 1	At any point during interaction with the application, the user should be able to say, "I didn't hear that. Could you repeat it?"
	Choice	Option 1
	Rationale	Since there's always a chance the user is in a loud area, or simply missed a voice prompt, there should always be an option to repeat directions and warnings. This increases the safety and reliability of the app
Satisfied by	NFR2	

[4] WRS

4.1. W

4.1.1. Problem

Problem ID	Problem Description	Corresponding Goals
P1	Inability to detect obstacles ahead of time in familiar spaces.	G1
P2	When users fall or experience a medical emergency, they lack a reliable method for help or location sharing.	G2
P3	Users struggle to navigate unfamiliar indoor areas and must rely on others for assistance.	G3
P4	Outdoor navigation tools are not optimized for voice-only or visually impaired users, causing delays or disorientation.	G4
P5	Current mapping software often falls short when navigating indoors, and many floor plans or maps are not supported	G6

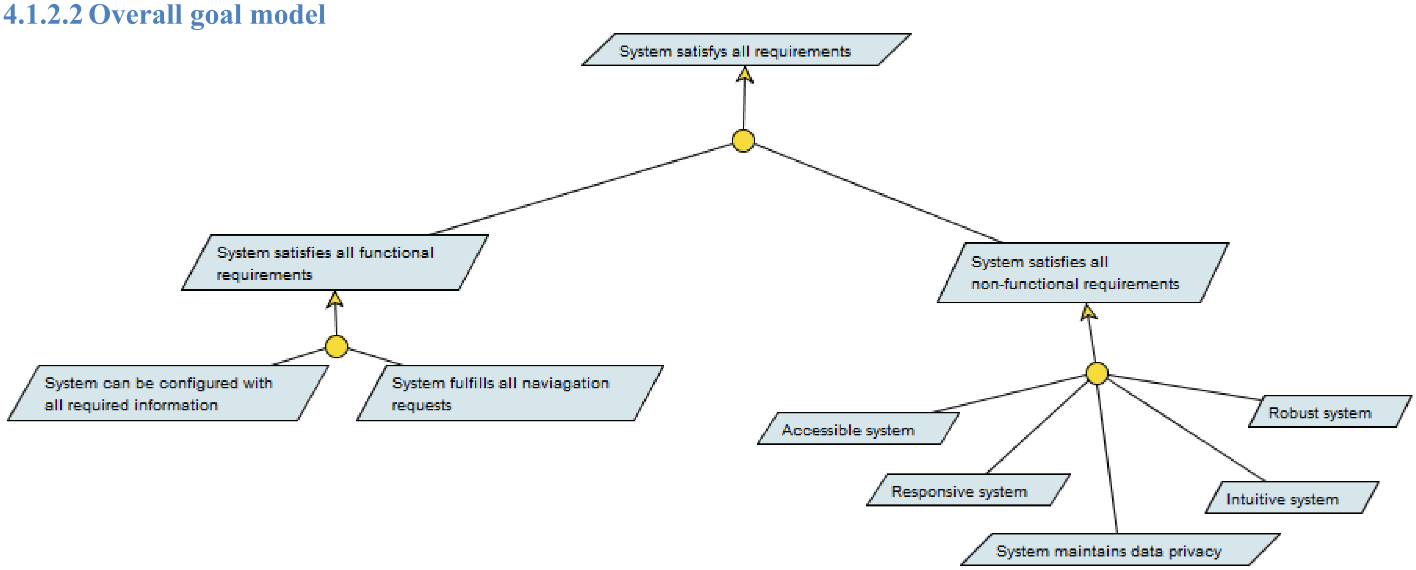
4.1.2. Goals

4.1.2.1 Goal descriptions

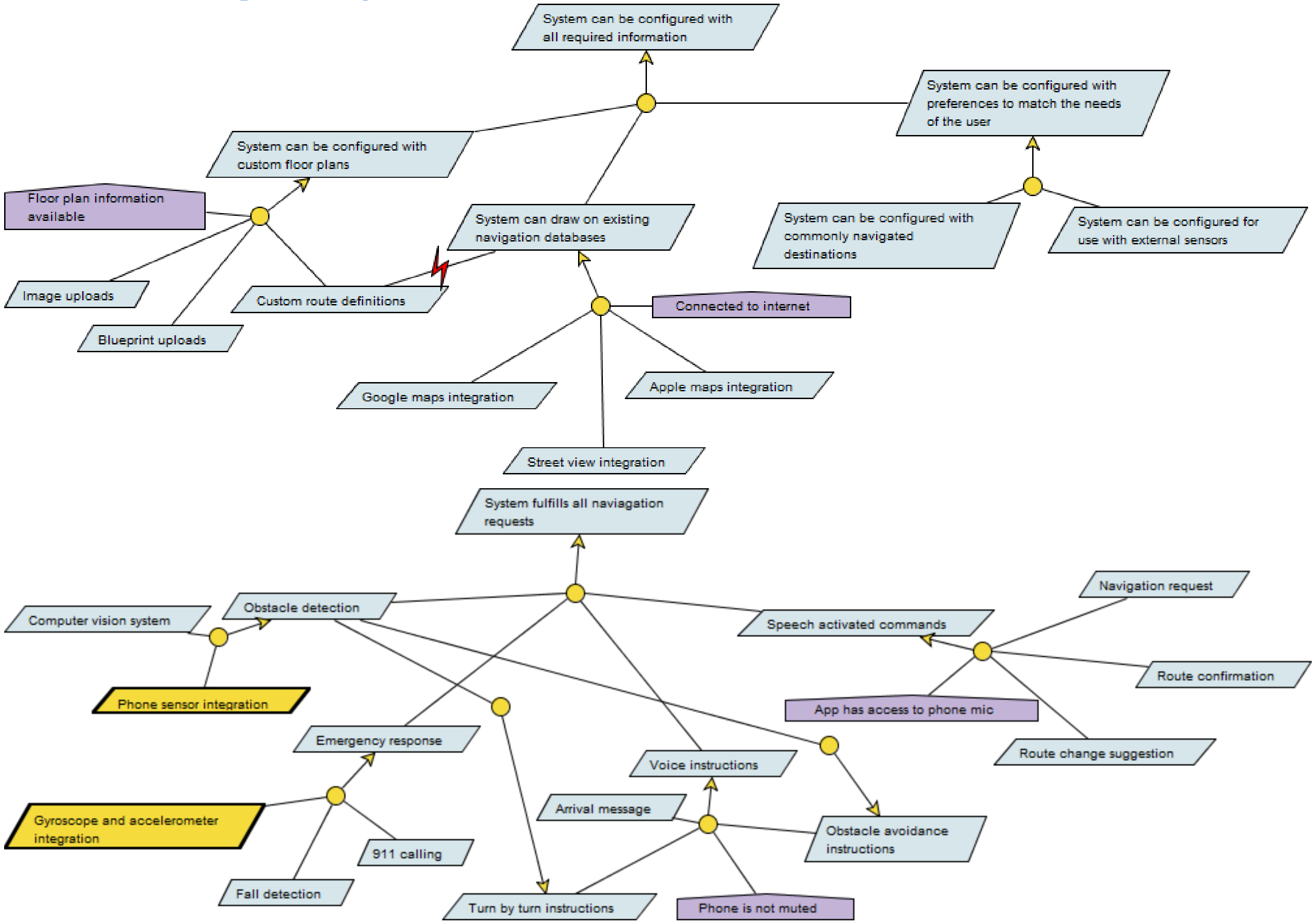
Goal ID	Goal Description	Backward Traceability	Forward Traceability
G1	The system shall provide real-time obstacle detection and warning alerts.	P1	IFRO4
G2	The system shall include an automatic emergency response feature that detects falls, prompts the user, and contacts an emergency contact if needed.	P2	IFRO1

G3	The system shall deliver voice-guided indoor navigation, offering spoken turn-by-turn directions and distance cues to guide users through buildings independently.	P3	IFRO2, IFRO3
G4	The system shall enable speech-activated outdoor navigation using GPS and text-to-speech output to direct users efficiently to destinations.	P4	IFRO3
G5	The system shall maintain high accessibility, responsiveness, and data privacy across all features, ensuring usability for individuals with varying degrees of visual impairment	P2, P4	IFRO1
G6	The system shall support the addition of custom floor plans that might not be available on typical mapping/navigation software.	P5	IFRO5

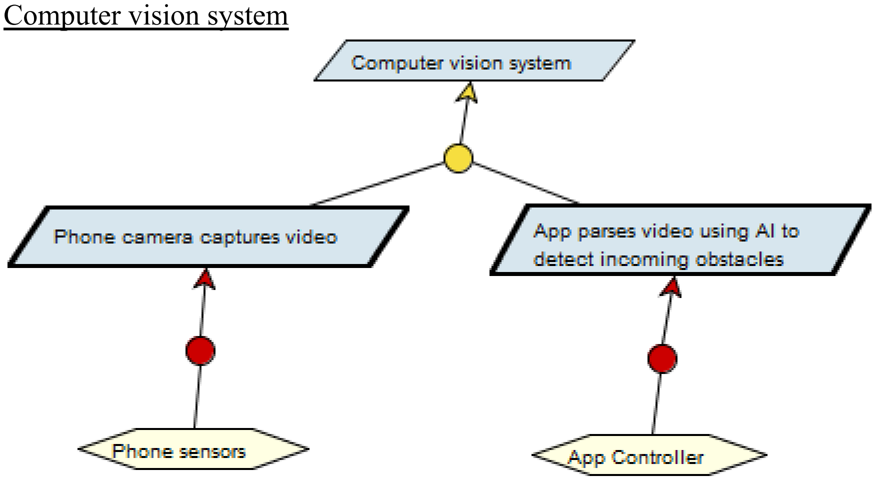
4.1.2.2 Overall goal model



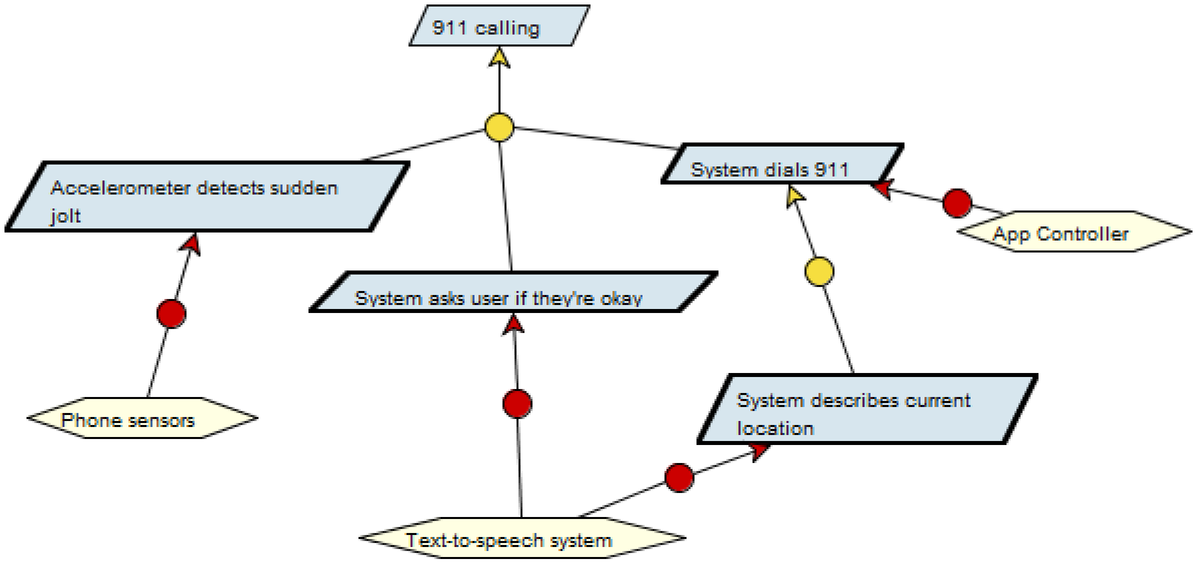
4.1.2.3 Functional requirement goal models



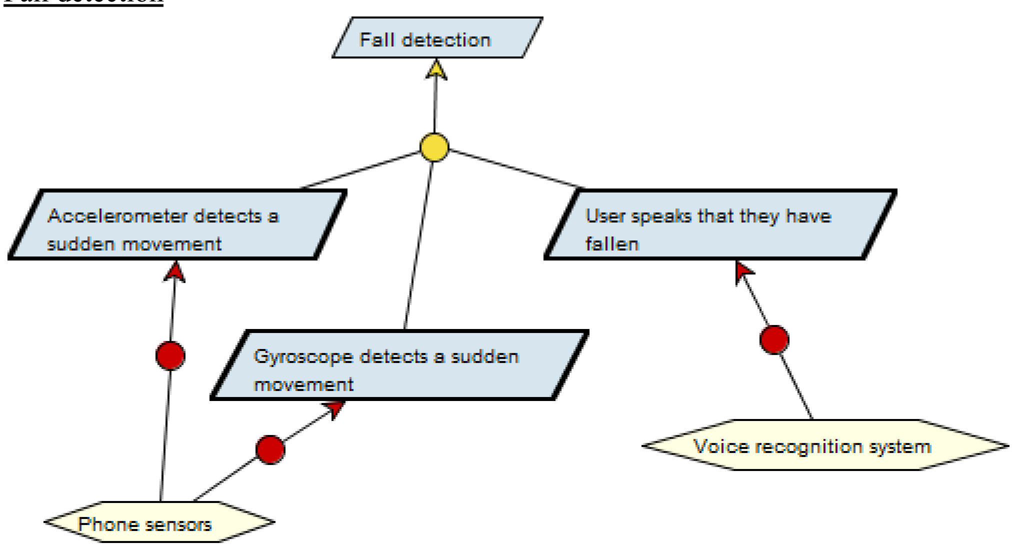
<u>Computer vision system</u>



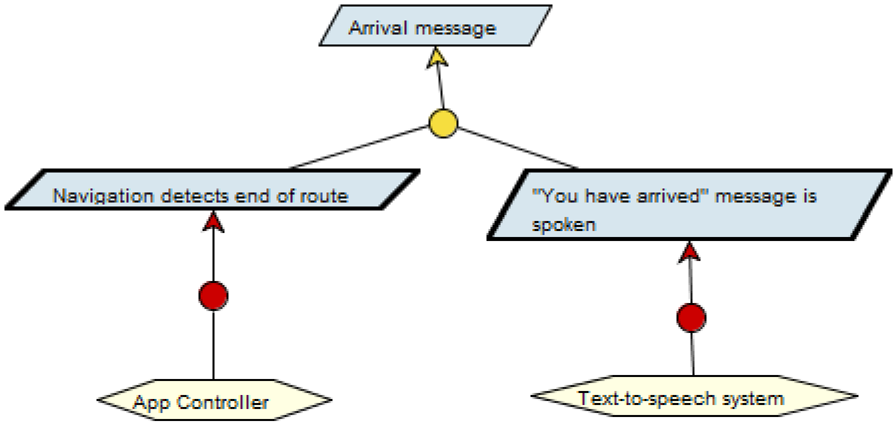
911 calling



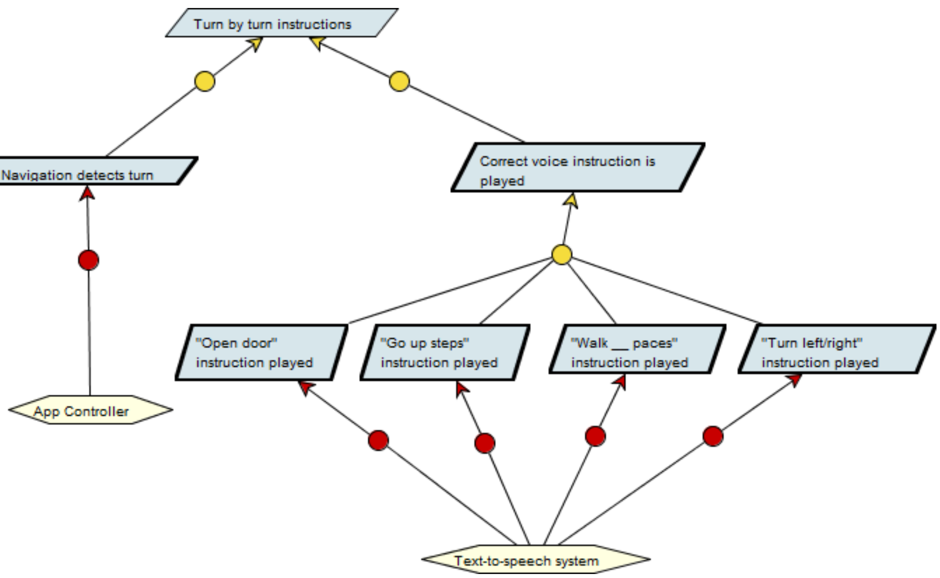
Fall detection



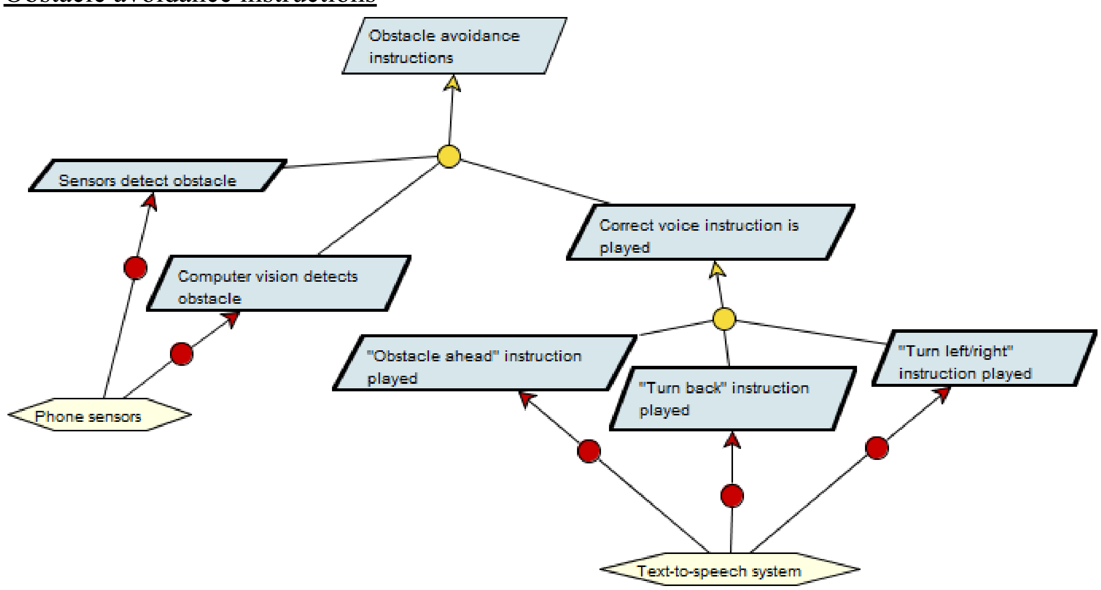
Arrival message



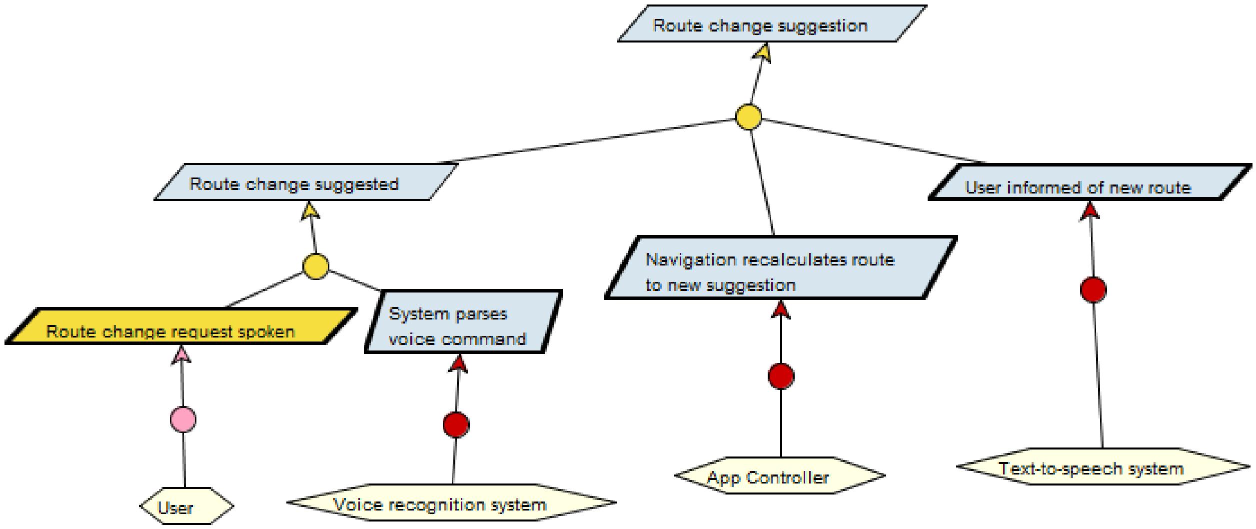
Turn by turn instructions



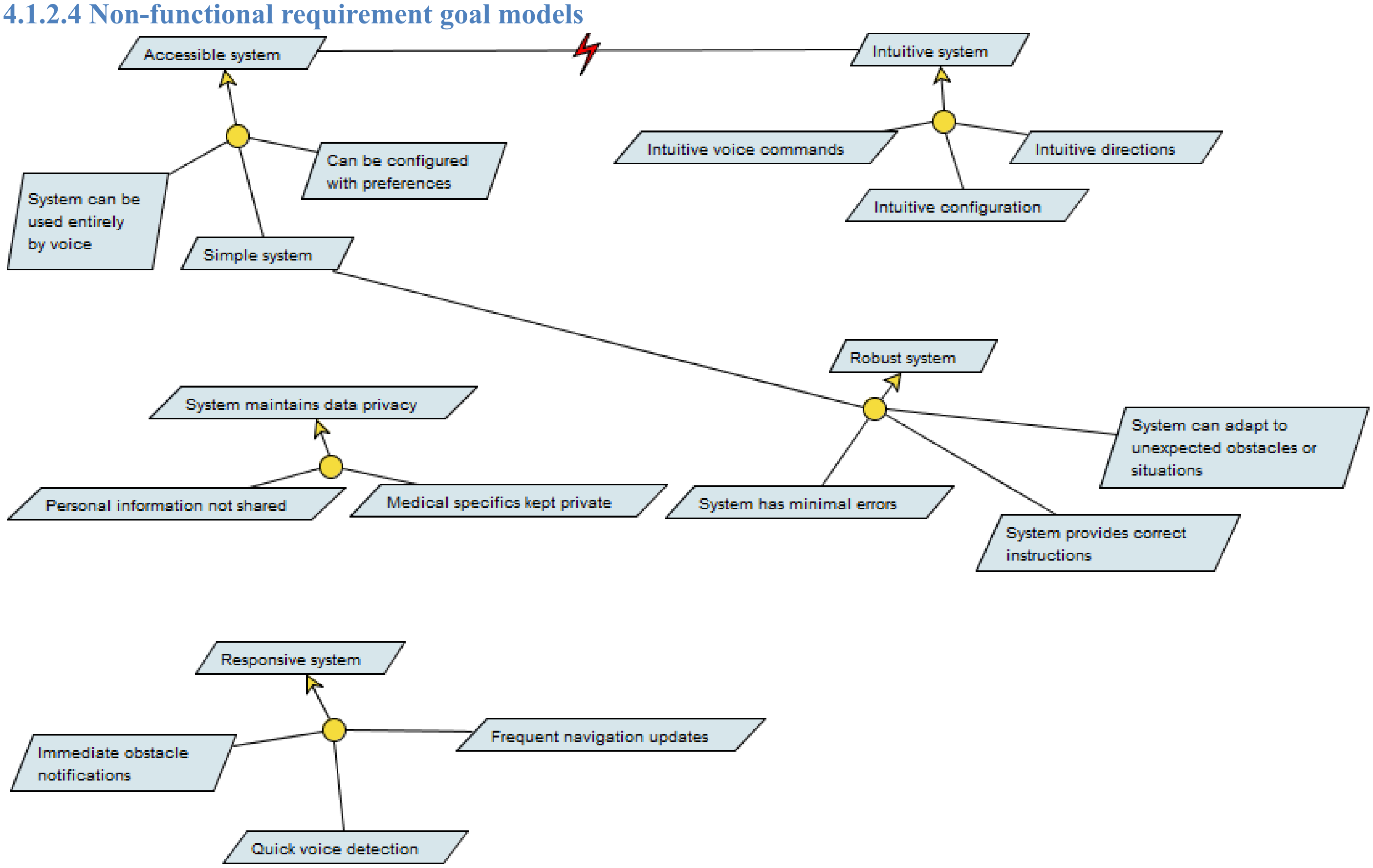
Obstacle avoidance instructions



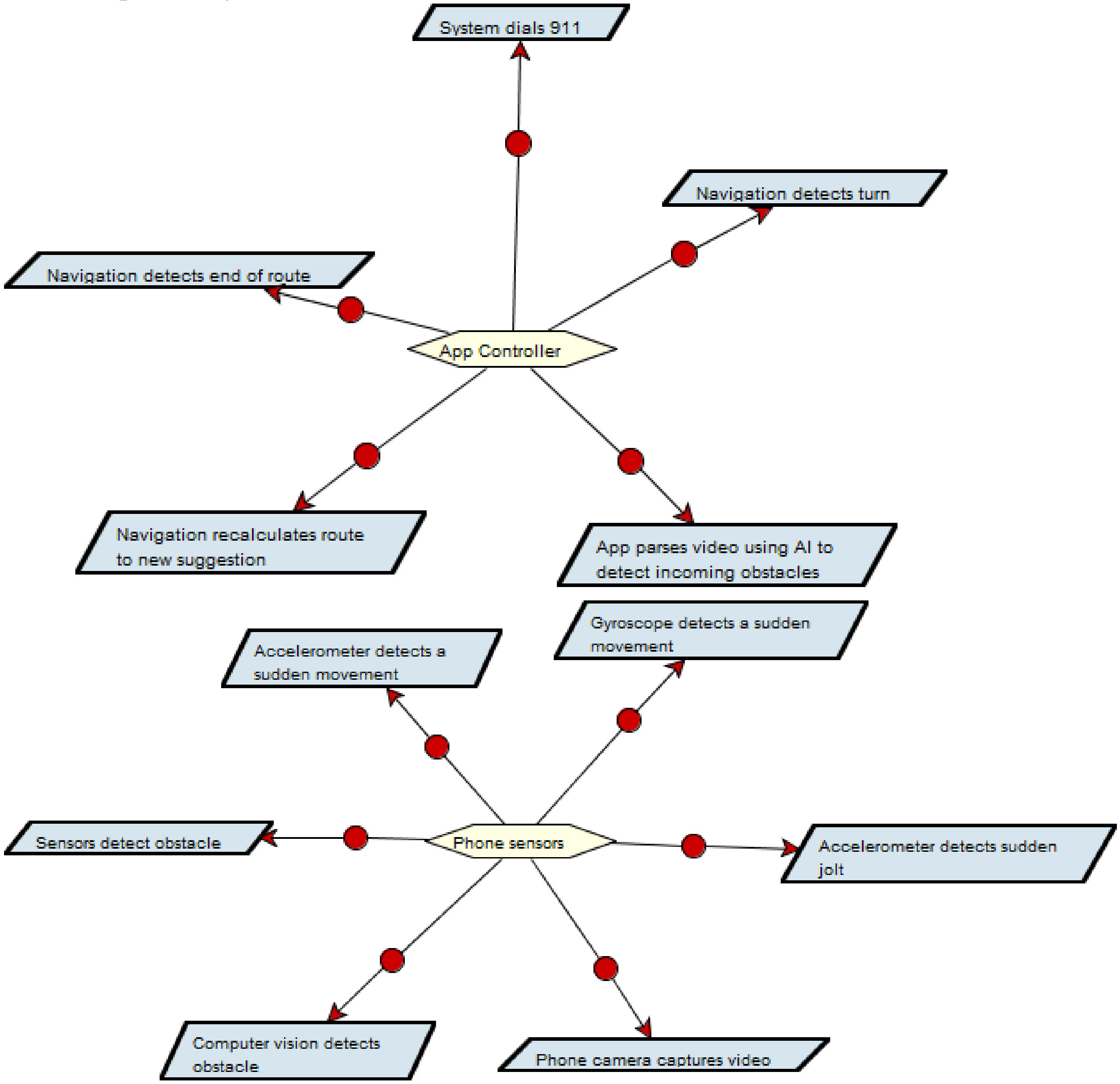
Route change suggestion

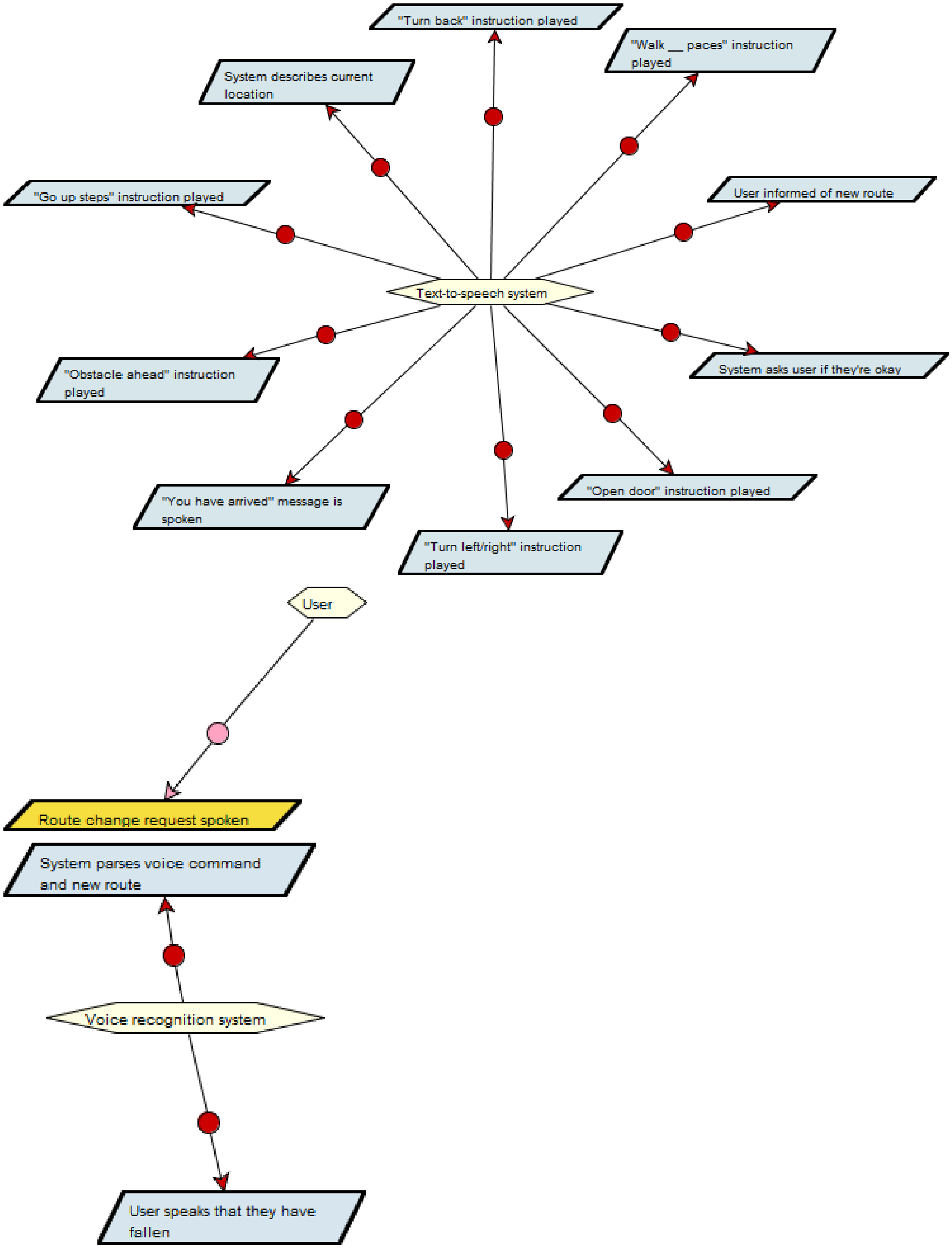


4.1.2.4 Non-functional requirement goal models

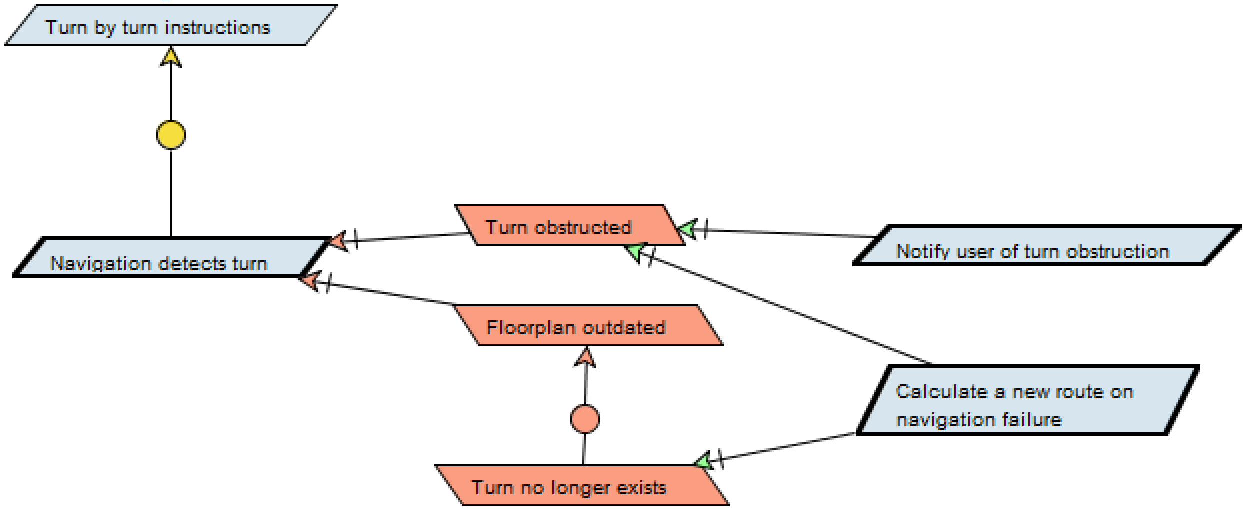


4.1.2.5 Responsibility model




"Turn back" instruction played
"Walk __ paces" instruction played
System describes current location
"Go up steps" instruction played
User informed of new route
Text-to-speech system
System asks user if they're okay
"Obstacle ahead" instruction played
"You have arrived" message is spoken
"Open door" instruction played
"Turn left/right" instruction played
User
Route change request spoken
System parses voice command and new route
Voice recognition system
User speaks that they have fallen

4.1.2.6 Example obstacle model



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	Blind and visually impaired individuals who require assistive technology in order to navigate complex indoor and outdoor spaces, but can still operate voice-activated and text-to-speech applications.
ID2	Older individuals who might require assistive technology due to vision loss or muscular problems.
ID3	Campus faculty and accessibility personnel who assist such individuals with navigation, app configuration, and accommodations.
ID4	Friends and family of the primary users who may also assist such individuals with daily tasks and navigation.
ID5	The multi-floor buildings and floorplans on campus that need to be navigated, containing complex interiors, stairs, elevators, and possible obstacles.

ID6	The movement-friendly routes are both between and inside various buildings.
ID6	Emergency services are contacted in the event of a fall or injury.

4.1.3.2. Stakeholders

- **Sponsors**
  - Professor Bolong Zheng
  - Financial backers of the application
- **Development team**
  - Team Bagel
- **Potential users**
  - Visually impaired or elderly people who have trouble navigating complex indoor and outdoor spaces
  - Friends, family, and acquaintances of these primary users
  - Access center and accommodations personnel
  - Possible emergency responders

4.1.3.3. Improved Functional Objectives

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

Improved FR Objective ID	Objective Description	Alleviates Problems	Achieves Goals
IFRO1	The application shall send an alert to EMS upon command or when a user becomes unresponsive after a fall or has gone off course.	P2	G2, G5
IFRO2	The application shall provide descriptive directions to the user when navigating indoors, including forward step counts, timely turn warnings, and notifications for when to open doors or enter certain rooms.	P3	G3
IFRO3	The application shall support all functionality through text-to-speech and voice	P4	G3, G4

	recognition, allowing for users to interact with all components and functionalities of the app without having to see the screen.		
IFRO4	The application shall alert the user through the aforementioned text-to-speech system whenever an obstacle is detected in the path of the user, and it shall provide this alert with at least 10 seconds of leeway for the user to react to the obstacle.	P1	G1
IFRO5	The application shall support users uploading map and floorplan files to be used by the navigation system. This will be done during initial configuration, curated by campus officials and whoever the primary user chooses to assist during configuration.	P5	G6

4.1.3.4. Improved Non-Functional Objectives

Improved NFR Objective ID	Objective Description	Alleviates Problem	Achieves Goal
INFRO1	Maintain a response latency <0.5 seconds for obstacle or navigation feedback.	P1	G1
INFRO2	Support full accessibility through speech and optional vibration feedback.	P1-P3	G5
INFRO3	Operate reliably offline using cached maps and local sensors.	P3, P4	G3, G4
INFRO4	Maintain intuitive, low-learning-curve interaction with concise voice feedback.	P3, P5	G5

4.2. RS

4.2.1. Functional Requirements

FR ID	Description
FR1	The system will detect incoming obstacles using a dual system consisting of the phone camera, gyroscope, and accelerometer.
Satisfies Functional Requirement Issue	FRI1
Satisfies Objectives	IFRO4
Satisfied by prototype feature	Obstacle detection and route adjustments

FR ID	Description
FR2	The system will additionally detect obstacles using an optional Bluetooth-connected sensor attached at the user's foot level, so as to detect smaller or less observable obstacles.
Satisfies Functional Requirement Issue	FRI1
Satisfies Objectives	IFRO4
Satisfied by prototype feature	Obstacle detection and route adjustments

FR ID	Description
FR3	Upon receiving a destination from the user, the system will create a route from the current location to the desired one, incorporating loaded floor plan data, while prioritizing elevators and deprioritizing stairs.
Satisfies Functional Requirement Issue	FRI2
Satisfies Objectives	IFRO2

Satisfied by prototype feature	Starting navigation

FR ID	Description
FR4	Upon receiving a voice prompt from the user that a desired elevator is out of order or closed down, the system will reroute using the fastest possible alternative.
Satisfies Functional Requirement Issue	FRI2
Satisfies Objectives	IFRO2
Satisfied by prototype feature	Starting navigation

FR ID	Description
FR5	The system shall support floormap uploading of various image formats, including PNG, JPEG, and SVG. It will analyze these files automatically and add the floorplan to the internal datastore.
Satisfies Functional Requirement Issue	FRI3
Satisfies Objectives	IFRO5
Satisfied by prototype feature	Load maps

FR ID	Description
FR6	The system shall detect if a user is nonresponsive, as well as whether they have fallen or been injured, and contact emergency services to their current location.
Satisfies Functional Requirement Issue	
Satisfies Objectives	IFRO1
Satisfied by prototype feature	Emergency fall assistance

4.2.2. Non-Functional Requirements

NFR ID	**Nonfunctional Requirement 1**
NFR1	The system shall return obstacle or navigation feedback within 0.5 seconds of detecting a relevant sensor input to ensure real-time guidance.
Operationalized Functional Requirements	FR1, FR4
Satisfies Nonfunctional Requirement Issue	NFRI2
Satisfies Non-functional Objective	NFO1, NFO2
Constrains	FO4
Satisfied by prototype feature	Voice input/output interface and vibration feedback test mode

NFR ID	**Nonfunctional Requirement 2**
NFR2	The system shall be fully operable through speech, vibration, and audio cues, requiring no visual interaction.
Operationalized Functional Requirements	FR1, FR4
Satisfies Nonfunctional Requirement Issue	NFRI2
Satisfies Non-functional Objective	NFO2
Constrains	FO4
Satisfied by prototype feature	Voice input/output interface and vibration feedback test mode

NFR ID	Nonfunctional Requirement 3
NFR3	The application shall continue to function offline using cached building maps and onboard sensor data to maintain route guidance.
Operationalized Functional Requirements	FR3, FR5
Satisfies Nonfunctional Requirement Issue	NFRI3
Satisfies Non-functional Objective	NFO3
Constrains	FO3
Satisfied by prototype feature	Offline navigation simulation with stored route data

NFR ID	Nonfunctional Requirement 4
NFR4	The system shall provide short, clear spoken prompts and require minimal setup so new users can begin navigation without training.
Operationalized Functional Requirements	FR4, FR3
Satisfies Nonfunctional Requirement Issue	NFRI4
Satisfies Non-functional Objective	NFO4
Constrains	FO4
Satisfied by prototype feature	Simplified setup screen and one-command route initialization.

HIPAA Compliance Note:

The system’s emergency response features (FR6) shall handle location data and emergency contact information in compliance with HIPAA regulations for protected health information, or include clear disclaimers that emergency detection is an assistive technology feature and not a medical device. All data shall be encrypted at rest and in transit.

4.2.3. Specifications

Functional Specification ID	Functional Requirement
FS1	Detect obstacles in front of the user, warning the user as soon as the hazard is detected through a text-to-speech voice
Satisfies Functional Requirement	FR1
Satisfies Objectives	IFRO4
Satisfied by prototype feature	

Functional Specification ID	Functional Requirement
FS2	Connect through bluetooth to an external sensor mounted to the user at foot level, allowing for more fine-grained obstacle detection.
Satisfies Functional Requirement	FR2
Satisfies Objectives	IFRO4
Satisfied by prototype feature	Obstacle avoidance system

Functional Specification ID	Functional Requirement
FS3	Receive a destination voice prompt from the user, calculate the route, and guide the user step-by-step to their desired destination
Satisfies Functional Requirement	FR3, FR4
Satisfies Objectives	IFRO2
Satisfied by prototype feature	Navigation and routing

Functional Specification ID	Functional Requirement
FS4	Using an image file and location data, upload a floor map to the application, allowing it to now provide detailed instructions inside that particular building.
Satisfies Functional Requirement	
Satisfies Objectives	IFRO5
Satisfied by prototype feature	Map upload

[5] Prototype Interface Mock-ups and User Manual

The current version of our user interface mocks, as well as the user manual, can be found in this document.

[6] Traceability

Objectives/Requirements	FO1	FO2	FO3	FO4	FO5	NFO1	NFO2	NFO3	NFO4
FR1				x					
FR2				x					
FR3		x							
FR4		x							
FR5					x				
FR6	x								
NFR1						x	x		
NFR2							x		
NFR3								x	
NFR4									x

[7] References

[4] Gillis, S., Alexander (2024). *What is voice recognition and how does it work?*. Tech Target: [https://www.techtarget.com/searchcustomerexperience/definition/voice-recognition-speaker-recognition].