Vision and Scope Document

Version 1.2

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CPTS 484_THEIA

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Revision History

Name	Date	Reason for Changes	Version
Andrew Neal	11/13/25	Initial draft; Section 1	1.0
Julia Lee	11/20/25	Section 2	1.1
Shaya Arya	11/27/25	Section 3	1.2

1. Business Requirements

1. Create a mobile application that provides blind or visually impaired users with reliable and safe navigational assistance in indoor environments.
2. Provide users with step-by-step route navigation from point A to B using text to speech and audio output with minimal user interaction.
3. Ensure core navigational features operate with standard connectivity assumptions. Offline operation is out of scope for the initial release.
4. Detect objects using the user's mobile device's camera and inform the user of their surroundings and how to proceed safely.
5. Evaluate fall detection as a candidate feature for later releases using on-device motion sensors.
6. Maintain user privacy by minimizing collection and storing data locally where feasible. Core functions assume standard connectivity; full offline operation is not required for the initial release.

1.1. Background

Theia's inception began as a response to the ongoing accessibility challenges that blind or visually impaired individuals face when navigating indoor environments such as buildings. Traditional navigation tools such as canes or guide dogs work well in familiar scenarios but provide little to no assistance in new and unfamiliar locations. This often leaves the visually impaired individuals to require assistance from another individual to reach their destination safely and efficiently.

Theia aims to provide users with an additional layer of guidance and safety to these existing methods rather than replace these traditional resources completely. By offering real-time navigation and safety alerts, Theia provides its users with more confidence and independence when attempting to navigate an unfamiliar indoor environment.

1.2. Business Opportunity

Reliable indoor navigation remains a significant barrier to accessibility for blind and visually impaired individuals. Indoor environments such as schools, offices, health buildings, and airports often have complex and unique layouts that cannot be navigated easily without assistance. Other forms of navigation assistance, such as Google Maps, often only provide users with outdoor GPS navigation that requires constant, stable internet access to operate. As a result, many blind and visually impaired individuals must rely on other, more traditional, forms of guidance indoors such as canes and guide dogs which do not always provide the user with enough sensory information to confidently navigate themselves from point A to B.

Theia presents an opportunity to address these shortcomings of other modern navigational applications while also providing the user with candidate features such as fall detection and elevation change warnings which allow the user to feel more confident and comfortable navigating new environments by themselves. By utilizing detailed and up to date floor plan models, Theia enables users to navigate complex indoor environments without any additional hardware outside of their mobile device. This provides users with reliable and accurate indoor navigation and ensures that Theia is accessible to all who may benefit from the application if they have a smartphone.

1.3. Business Objectives

Theia aims to provide blind and visually impaired individuals with a cost effective and accessible indoor navigation solution that empowers them to navigate indoor environments freely. By utilizing built-in sensors in the user's mobile device and digital floor plans that can be downloaded by the user, Theia can function independently of any external hardware or systems. Theia aims to also provide users with increased safety such as fall detection and elevation change warnings, preventing the overall risk of harm to blind and visually impaired individuals navigating unfamiliar indoor environments alone.

1.4. Success Metrics

To determine the success of Theia, we have developed a list of metrics and their target values. These metrics reflect the primary goals of Theia which are usability, accessibility, safety, and performance.

No.	Metrics	Target
1	Accuracy of navigation from users' current location to target destination	≥ 95% accuracy
2	Accuracy of object detection	≥ 90% accuracy
3	Accuracy of floor plan parsing	≥ 90% accuracy
4	Accuracy of user location based on their movement	≥ 85% accuracy
5	Functionality of application without any visual interaction	100% functionality

6	Time to generate users’ desired route	≤ 2 seconds
7	Time for Theia’s auditory guidance to respond to users' movement during navigation	≤ 1 second
8	Time for route recalculation if user deviates from route	≤ 3 seconds
9	Time for application to initially load on user device	≤ 3 seconds
10	Time for device to detect object and inform user	≤ 5 seconds
11	Minimal number of device sensors required to function	5: Camera, microphone, speaker, gyroscope, accelerometer
12	Options for user interaction	Audio prompts, voice response, tap via UI elements

1.5. Vision Statement

Theia aims to provide blind and visually impaired individuals with enhanced navigation in indoor environments through real time step by step directions while simultaneously advancing safety, with candidate features such as fall detection and elevation-change warnings planned for later releases.

1.6. Business Risks

The primary business risks associated with Theia are potential issues with user acceptance, inconsistencies in navigation, and unreliability of object detection. As this app is designed to be used by blind or visually impaired individuals, an inconsistency with navigation or object detection could severely harm both the user and the public’s view of Theia. The table below outlines each risk, its level of severity, and the mitigation strategy that the team will use to manage it effectively.

Risk	Severity	Mitigation Strategy
Limited user acceptance or trust	Low	Iteratively perform usability testing with visually impaired individuals, refining auditory feedback clarity and voice command recognition

Inaccurate navigation instructions	Medium	Conduct regular testing across different floor plans and ensure fallback behavior such as route recalculation
Difficulty parsing floor plan accurately	Medium	Standardize floor plan formats and implement preprocessing to ensure floor plan quality before allowing upload to Theia by buildings
Computer vision fails to identify an object as a risk	High	Refine object detection model and provide warnings if detection confidence is low

1.7. Business Assumptions & Dependencies

Assumptions:

- User will have access to a modern, mobile device that is equipped with the following sensors:
  - Camera
  - Microphone
  - Speaker
  - Accelerometer
  - Gyroscope
- Participating buildings are willing to provide floor plans for areas that are open to the public for navigation
- Users may download floorplans for improved performance, but offline operation is not required for the initial release
- Visually impaired users prefer auditory prompts and vocal command inputs
- Google Gemini’s environmental analysis API will remain available and functional for mobile device cameras

Dependencies:

- React.js 19 for cross platform development
- React TTS for text to speech conversion
- React sensors for access to device sensors such as camera, accelerometer, and gyroscope
- Device local storage for storing downloaded floor plans, saved routes, and user information
- Google Gemini API for real time object detection

2. Scope & Limitations

2.1. Major Features

- Voice-activated navigation on command: The system uses the concept of natural-language processing to recognize pre-programmed spoken commands to activate navigation activities, to repeat instructions and query status displays, and to cancel current operations.
- Differentiated alert obstacle detection: The operating system distinguishes between stationary and dynamic impediments, providing context-specific auditory and haptic feedback depending on the nature of the specific obstacle.
- Description of live view environment: The verbal description of the visual appearance of the surrounding terrain is achieved through real-time image-analysis algorithms that construct verbal descriptions of the spatial features and architectural constructions, i.e., structural features and paths.
- Emergency assistance request: The emergency mode is activated, and geospatial coordinates and user identifiers are transmitted to the set emergency contacts or emergency stations of the campus.
- Status update of progress: The system can present the user with navigational information such as the distance covered, future turns, and expected arrival time either on demand or automatically as the user moves.
- UI focused on accessibility: Visual elements are used in the user interface with high contrast, typography is made bigger, the interface is compatible with screen readers, and accessibility is customizable.
- Privacy and consent control: The service provides fine-tuning of the consent settings and a configuration tool, which allows users to control how user geolocation and personal data are processed.
- Power optimization: Adaptive control of camera and sensor use is also adopted that varies the activity depending on locomotor context and environmental steadiness to save energy.
- Candidate features: Fall detection and elevation-change notifications will be introduced into the product roadmap and will be implemented with the help of accelerometers and gyroscopes.

2.2. Scope of Initial Release

This first release focuses on the core features and quality attributes needed to ensure that immediate improvements can be made in the independent indoor mobility of visually impaired users. The target audience includes visually impaired students, campus accessibility coordinators, and security staff, each of whom will find it valuable in their own way: it will help them move around independently by providing indoor route directions and obstacle notifications; it will help them react to emergencies much faster by sending emergency alerts; it will help them use it practically and conveniently with its accessibility-focused interface.

Included Features

- Activation and control of voice route instructions. A user can start navigation, repeat instructions, ask for the distance left, or just stop or terminate the navigation process by voice commands.
- Detecting fixed and moving barriers with audio and haptic feedback based on the context.
- Live environmental description through live view. Camera analysis gives instant voice descriptions of the structures and things that are in the vicinity.
- Request for emergency assistance. The individuals can send their personal data and location to the designated contacts or campus security using voice or via a specific button.
- Providing progress status reports. The remaining distance, directional guidance, and estimated time of arrival are given on user request or automatically depending on contextual assessment.
- Setting and user interface based on accessibility. The system is characterized by large text, high-contrast visualization, the ability to use with a screen reader, the speed of the voice can be adjusted, and privacy authorization can be configured.

Initial Quality Characteristics and Objectives

- Usability and accessibility: Full functionality available without visual screen interaction. Interface complies with accessibility guidelines. Target metrics are 100% non-visual operation and accessibility compliance.
- Performance responsiveness. The generation of a route ought to be done within 2 seconds, movement response guidance should take less than 1 second, and deviation re-routing should take less than 3 seconds.
- Recognition accuracy. Navigation accuracy is 95 percent; object recognition 90 percent.
- Power efficiency. Through adaptive resource management, battery consumption is reduced.

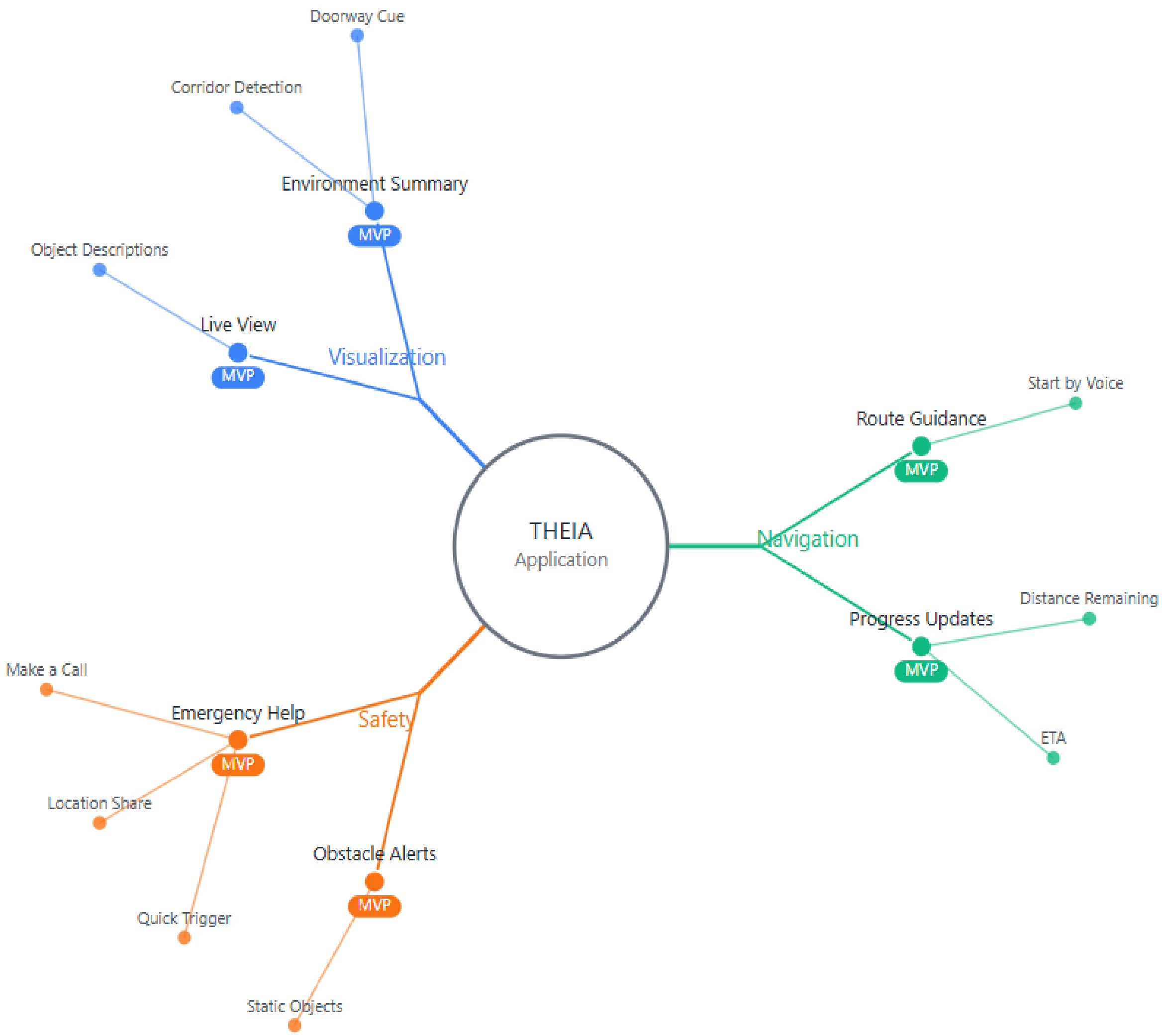

Figure 2.2.1: THEIA feature tree. Three axes: Visualization, Navigation, Safety. MVP items: Live View, Environment Summary, Route Guidance, Progress Updates, Obstacle Alerts, Emergency Help. Child nodes show examples of sub-features.

2.3. Scope of Subsequent Releases

Since the safety and usability of the first release will have to be maintained, the following features will be added gradually.

- Future official support of fall detection, with the improved workflow regarding the alerts, will be made.
- Introduce progressive offline capabilities such as cached floorplans and limited local processing for core navigation.
- The implementation of assistance in providing elevation change notifications at staircases, elevators, and similar points is to be indicated officially.

- It will introduce advanced dynamic obstacle recognition, which will have higher detection reliability and a refined notification pattern.
- The platform will increase the provision of multilingual voice commands and provide customized command sets.
- The improved accuracy of navigation in the indoor position and less re-routing time will be used to improve the quality of offline navigation.
- Increased variability in the use of guidance will be supported by enhanced automated accessibility switching that will be complemented by variability in the use of guidance that is specific to the user's profiling of the individual user.
- Context-sensitive optimizations of power-optimization policies will also result in an increase in battery life.
- Strengthened transparency phases along with enriched privacy consent phases will be implemented as well as the introduction of granular data-sharing preferences.

2.4. Limitations & Exclusions

These are the items which may be expected by the stakeholders, but they are currently absent or limited in the product plan.

- The scope does not include outdoor navigation as well as inter-building route guidance. The product will focus on the indoor campus settings.
- Fall detection and elevation-change notifications are not planned as official features in the first release; they are planned to be introduced in the future.
- Offline operation is not included in the initial release and will be considered for future versions.
- There are no constant remote surveillance of user positioning and no third-party real-time tracking system. According to the privacy-protection principles, the least required information is used within the framework of the granular consent.
- Hardware-specific features and beacons are not implemented; the default is a set of built-in smartphone sensors.
- Mapping tools which give instant guidance, based on uploaded floor plans by users, will not be included in the initial scope and will be considered afterwards, once quality-standardization and preprocessing structures are in place.

3. Business Context

3.1. Stakeholder Profiles

The following stakeholders have been identified as key parties who will be affected by or have interest in the Theia indoor navigation application:

Stakeholders	Major Value	Attitude	Major Interests	Constraints
Blind and Visually Impaired Users	Enhanced independence and confidence when navigating unfamiliar indoor environments; improved safety through fall detection and obstacle alerts; reduced reliance on sighted assistance; empowerment to explore new locations autonomously	Highly interested but cautious; concerned about reliability and accuracy of navigation; require high trust in safety features before adoption	Accurate navigation instructions; intuitive voice-based interface; reliable performance with standard connectivity, with local caching for performance where feasible; fast response times; privacy and data security	Must function without visual interaction; requires minimal learning curve; must work with standard smartphone hardware; cannot require expensive additional equipment
Building Administrators and Facility Managers	Enhanced accessibility compliance; improved building navigation for all visitors; reduced liability from navigation-related incidents; positive institutional reputation	Moderately interested; concerned about implementation effort and ongoing maintenance	Standardized floor plan formats; easy upload and update process; minimal IT infrastructure requirements; clear documentation	Limited IT resources for implementation; need for simple, low-maintenance solution; concerns about liability if navigation fails
Accessibility Coordinators and Disability Services	Expanded service offerings for visually impaired community; reduced need for personal navigation assistance; improved accessibility metrics; enhanced	Highly supportive; eager to pilot and provide feedback	User feedback integration; customizable features; reliable emergency assistance; comprehensive user support materials	Limited budget for accessibility technologies; need for proven effectiveness; must comply with accessibility standards (ADA, WCAG)

	institutional inclusivity			

3.2. Project Priorities

The following table defines the priorities and constraints for the Theia project, identifying which dimensions serve as drivers (high priority objectives), constraints (fixed parameters), and degrees of freedom (dimensions that can be adjusted):

Dimension	Driver	Constraint	Degree of Freedom
Features & Functionality	Core navigation and safety features are essential for MVP; accessibility features are non-negotiable		
Quality	Accuracy and reliability are critical for user safety and adoption; performance targets must be met		
Schedule		Must complete by end of academic semester	
Staff		Fixed team of 3 developers; no additional resources available	
Cost		Academic project with minimal budget; must use free/low-cost	

		tools and services	
User			Can be basic

3.3. Deployment Considerations

Geographic and User Distribution

Initial rollout will focus on pilot buildings, likely starting with: Washington State University campus buildings (team's local access for testing); partner institutions willing to provide floor plans and participate in testing. Users may be distributed across different time zones, but the application performs core processing on-device where feasible and assumes standard connectivity; local caching of floorplans may be used to improve performance meaning no server-side user management; and all user data stored locally on device.

Infrastructure Requirements

Floor Plan Repository: Central repository or CDN for building floor plans (standardized format) API Dependencies: Google Gemini API for real-time object detection (must remain available and within usage limits); Consider API rate limits and costs for scaling. No dedicated server is required for route computation; core processing is performed on-device where feasible, and the app assumes standard connectivity. Optional: Analytics endpoint for anonymous usage metrics (privacy-compliant)

Data Migration and Storage

No data migration from existing systems required (new application). Local device storage requirements: Base app: ~50-100 MB; Per-building floor plans: ~10-50 MB each; User preferences and saved data: <5 MB. Automatic cleanup of unused downloaded floor plans to manage storage will be utilized.