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Master of Science in
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Design Project Booklet

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AR Museums Accessibilty for People With Tunnel Vision

Designing an AR Mobile Application for Visitors with Tunnel Vision

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Dipartimento Pianificazione, Design, Tecnologie dell'architettura
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Title:
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Abstract

This design project explores how augmented reality (AR) can be harnessed to improve museum accessibility for visitors with tunnel vision. Building on research into visual impairments, assistive technologies, and scenario-based design, the project translates theoretical insights into a practical prototype developed for Android devices.

The work addresses a persistent challenge in cultural spaces: while museums have increasingly invested in inclusive content delivery, such as audio guides or tactile exhibits, the fundamental task of navigating the space remains difficult for visitors with restricted visual fields. Tunnel vision users must rely heavily on head movements and scanning to maintain orientation, a process that is cognitively demanding and often discouraging. This project responds to that challenge by proposing a multimodal AR system that combines visual overlays, vibration feedback, and contextual audio guidance.

The design process follows a structured progression: defining the problem, identifying user needs, mapping the visitor journey, and iteratively developing and refining a prototype. Particular attention is given to vibration-based navigation strategies and the integration of audio-haptic feedback, which together provide subtle but reliable orientation cues.

Beyond its technical aspects, the project demonstrates the value of user-centered and scenario-based design methods in creating meaningful accessibility solutions. By situating the work in the lived experience of tunnel vision users, the design avoids generic "one-size-fits-all" solutions and instead develops a system tailored to specific perceptual challenges.

The result is not a finished product but a design proposal and working prototype that illustrates a pathway toward more inclusive museum environments. It offers a framework that can be expanded in future research, tested with users, and adapted to other accessibility contexts. Ultimately, the project highlights how digital technologies can play a transformative role in opening cultural spaces to wider audiences, ensuring that museums become environments where everyone can navigate, learn, and engage independently.

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CHAPTER 01

Introduction

01. Introduction

1. Introduction to the Design Project

Museums serve as repositories of culture, art, and history, offering visitors the opportunity to explore, learn, and engage with diverse narratives. Yet, for certain audiences, these spaces remain challenging to access. In particular, visitors with tunnel vision—a visual impairment that limits peripheral vision—often face difficulties navigating galleries, locating exhibits, and interacting with informational content.

This design project focuses on creating an inclusive, technology-driven solution that addresses these challenges. By combining augmented reality (AR), multimodal feedback, and user-centered design principles, the project aims to enhance accessibility for tunnel vision users, ensuring they can navigate and experience museum spaces confidently and independently.

1.1 Problem Statement

Museums are spaces of learning, cultural engagement, and discovery. However, for visitors with visual impairments, particularly those with tunnel vision, these environments can present significant challenges. Tunnel vision restricts peripheral vision, leaving visitors with a narrow central field of view, which can make navigation difficult, increase the risk of disorientation, and limit the ability to fully experience exhibits. Traditional accessibility solutions, such as standard audio guides or static signage, often fail to address these challenges effectively, as they rely on assumptions of normal peripheral awareness and spatial perception.

The problem is compounded by the complexity of museum layouts, which may include irregular gallery arrangements, temporary exhibits, crowded corridors, and variable lighting conditions. Visitors with tunnel vision must constantly scan their surroundings to detect obstacles, locate points of interest, and interpret exhibit information, which can lead to fatigue, reduced autonomy, and a diminished cultural experience. Current navigation aids often provide either too much information, causing sensory overload, or too little, leaving critical spatial gaps.

This project identifies a clear need for an accessible, adaptive, and user-centered solution that enables tunnel vision visitors to navigate museums independently and confidently while engaging fully with exhibits. The goal is to design a system that provides precise, context-sensitive guidance without overwhelming the user, bridging the gap between current assistive technologies and the specific needs of this audience.

By addressing this problem, the project seeks not only to improve mobility and orientation within museums but also to enhance the overall inclusivity and quality of the visitor experience, ensuring that cultural spaces can be enjoyed by everyone, regardless of visual ability.

1.2 Design Goals

The primary goal of this design project is to create an AR-based navigation system that enhances accessibility for tunnel vision users in museum environments. This system aims to combine technology, user-centered design, and multimodal feedback to provide guidance that is both precise and intuitive, allowing visitors to navigate independently while engaging meaningfully with exhibits.

Several specific objectives support this overarching goal:

1. Facilitate Independent Navigation – The system should empower users to move through museum spaces without relying on constant assistance from staff or companions. By delivering clear directional cues, obstacle alerts, and contextual information, the solution aims to reduce disorientation and increase confidence.

2. Implement Multimodal Feedback – To accommodate the

unique perceptual challenges of tunnel vision, the design integrates audio and haptic feedback. This approach ensures that guidance is perceivable even in noisy or visually complex environments, providing redundancy and reinforcing spatial awareness.

3. Enhance Engagement with Exhibits – Beyond navigation, the system seeks to enrich the visitor experience by presenting exhibit-related content through AR overlays, audio narration, or tactile cues. The goal is to ensure that tunnel vision users can fully access educational and cultural information, promoting inclusive learning.
4. Support Adaptability and Personalization – Recognizing the diversity of tunnel vision experiences, the system should allow users to adjust feedback settings, choose preferred guidance methods, and receive context-specific information tailored to their needs.
5. Integrate Seamlessly with Existing Museum Environments – The design must be compatible with current museum layouts, technological infrastructure, and operational practices. It should leverage smartphones and AR capabilities to provide a practical, scalable solution that requires minimal additional hardware.

1.3 User Persona and Needs

To ensure that the design solution addresses real-world challenges, the project focuses on a representative user persona: Marta Rinaldi, a 56-year-old art teacher whohas tunnel vision, which limits her peripheral sight while leaving her central vision largely intact. Despite her visual impairment, she maintains an active lifestyle, enjoys cultural experiences, and frequently visits museums to explore art and history.

Marta's experiences illustrate the typical barriers faced by tunnel vision users. Navigating complex galleries can be stressful and disorienting, especially when signage is minimal, corridors are crowded, or exhibits are arranged in irregular layouts. She often relies on companions or museum staff for guidance, which can reduce her sense of independence. Even when using traditional audio guides, Marta sometimes misses important spatial cues or contextual information because these tools are not tailored to her restricted field of view.

From these challenges, Marta's core needs emerge:

1. Independent Navigation – She requires a system that allows her to move confidently through galleries without continuous external assistance, reducing anxiety and increasing autonomy.
2. Clear, Focused Guidance – Given her limited peripheral vision, Marta benefits from directional cues and notifications that are precise, timely, and easy to interpret within her central field of view.
3. Multimodal Feedback – Audio and haptic signals help compensate for restricted visual input, enabling Marta to perceive changes in direction, locate exhibits, and avoid obstacles effectively.
4. Contextual Information – Marta seeks accessible access to exhibit details, including artwork descriptions and historical context, without overwhelming her with unnecessary or scattered information.
5. Adaptability and Personalization – She values a system that can adjust to her preferences, whether through vibration intensity, audio volume, or navigation style, accommodating her individual perceptual needs.

By centering Marta's experiences and requirements, the design process ensures that the AR navigation system not only addresses functional accessibility but also enhances enjoyment, learning, and engagement. Marta's persona guides decisions throughout concept development, prototyping, and evaluation, ensuring that the final solution is genuinely user-centered.

CHAPTER 02

Design Methodology

02. Design Methodology

2. Design Methodology

Designing an effective AR navigation system for tunnel vision users requires a structured approach that bridges research insights with practical implementation. The methodology for this project combines user-centered design principles, scenario-based planning, and iterative prototyping to ensure that every decision responds to real-world needs.

This chapter outlines the process through which research findings were translated into actionable design strategies. It describes how the team leveraged previous studies on visual impairments, assistive technologies, and indoor navigation systems to inform concept development. It also explains the tools and technologies selected for implementation, the integration of multimodal feedback, and the iterative workflow that guided prototype testing and refinement.

By documenting the design methodology, the project demonstrates a transparent and systematic approach, highlighting how theoretical insights, user personas, and technological possibilities converge to create a practical, accessible, and engaging museum experience for tunnel vision visitors.

2.1 Research-to-Design Transition

The design process begins with a careful translation of research insights into practical design decisions. Findings from the research booklet—including scenario-based design frameworks, literature on visual impairments, and analyses of navigation assistive technologies—serve as the foundation for creating a solution tailored to tunnel vision users like Marta Rinaldi.

Research highlights the specific perceptual and navigational challenges faced by tunnel vision users, emphasizing the need for focused guidance, multimodal feedback, and context-sensitive information. These insights informed the core objectives of the design project, ensuring that every feature of the AR navigation system addresses real user needs. For example, studies on indoor positioning technologies (BLE, Wi-Fi, VPS) guided the selection of reliable tracking methods, while evidence on haptic and audio cues shaped the multimodal feedback strategy.

Scenario-based design, as discussed in Rosson & Carroll (2002) and Carroll's Five Reasons for Scenarios, played a central role in bridging research and design. By developing user scenarios around Marta, I could anticipate real-world interactions, test navigation flows, and refine feedback mechanisms before building prototypes. These scenarios served not only to inform design choices but also to communicate complex requirements clearly, ensuring that the solution remained practical, user-centered, and adaptable.

The transition from research to design also emphasizes iterative learning. Insights from literature reviews and case studies, such as the Louvre 3DS guide, were continuously evaluated against the persona's needs and museum context. This approach allowed me to identify gaps, explore technological possibilities, and make informed decisions about feature prioritization, user interface design, and interaction patterns.

In summary, the research-to-design transition represents a systematic translation of knowledge into action. By grounding decisions in both evidence and user needs, I ensured that the resulting AR navigation system is not only technologically robust but also meaningful and empowering for tunnel vision visitors.

2.2 Tools and Technologies Used (Unity, AR, Android)

The implementation of the AR navigation system relies on a combination of software tools, hardware platforms, and development frameworks that together enable a seamless, interactive, and accessible experience for tunnel vision users.

02. Design Methodology

Unity serves as the primary development environment. Its versatility and robust AR support make it ideal for creating immersive applications that integrate 3D models, interactive navigation cues, and multimedia content. Unity's cross-platform capabilities also allow for rapid prototyping and iterative testing, ensuring that the application can be refined continuously based on user feedback.

Augmented Reality (AR) technology is central to the project's design. AR overlays digital information onto the physical environment, providing real-time guidance and context-sensitive cues directly within the visitor's visual field. This approach allows tunnel vision users to receive directional prompts, obstacle alerts, and exhibit information without relying solely on peripheral awareness, creating a more intuitive and inclusive experience.

The system is designed for Android smartphones, chosen for their wide availability, affordability, and built-in sensors that support AR functionality, including cameras, gyroscopes, and vibration motors. Leveraging standard mobile hardware ensures that the solution is scalable and accessible to a broad audience, minimizing the need for additional equipment.

Additional tools and frameworks support multimodal feedback integration. Audio cues are generated and spatialized to provide directional guidance, while vibration patterns are programmed to convey turns, proximity alerts, and points of interest. These technologies work in tandem to address the specific perceptual challenges of tunnel vision, ensuring reliable and intuitive guidance throughout the museum environment.

By combining Unity, AR, and Android technologies, the project creates a flexible, user-centered system capable of delivering precise, multimodal navigation support. This technological foundation enables designers to implement, test, and refine solutions that meet the needs of tunnel vision users while maintaining practicality, accessibility, and engagement.

CHAPTER 03

User Journey &
Ecosystem Map

03. User Journey & Ecosystem Map

3. User Journey & Ecosystem Map

Understanding the full experience of a tunnel vision visitor in a museum is essential for designing an effective AR navigation system. The user journey captures the sequence of interactions from initial awareness of the museum to post-visit reflection and feedback, highlighting opportunities to improve accessibility and engagement. Complementing this, the ecosystem map visualizes the network of touchpoints, technologies, and stakeholders that collectively shape the visitor's experience.

The journey begins long before the visitor enters the museum. Online resources, social media campaigns, and digital advertisements serve as initial points of contact, informing users about accessibility options and the availability of the AR guide. When the visitor downloads the app, the home interface introduces the system's features, guiding users on how to activate navigation, access audio and haptic feedback, and explore interactive content tailored to their needs.

Upon arrival, physical touchpoints—such as signage, QR codes, and museum staff—interact seamlessly with the digital system. The ecosystem map illustrates how these elements work together, showing how information flows from the AR app to the visitor and, when necessary, back to staff. For instance, scanning a QR code may trigger exhibit-specific AR content, while staff can provide assistance or verify positioning within the gallery.

Inside the museum, the AR app serves as the central hub for guidance. Through the camera view, directional cues and contextual information are overlaid on the physical environment. Audio and haptic feedback ensure that tunnel vision visitors can navigate independently, receiving real-time information about turns, obstacles, and points of interest. Labels and exhibit panels complement these digital cues, providing additional context and educational content.

Finally, post-visit feedback mechanisms complete the journey. Visitors can share their experiences, submit suggestions, and receive tailored recommendations for future visits. Mapping this journey alongside the ecosystem highlights the interdependencies between technology, human support, and environmental design, guiding iterative improvements and ensuring that every touchpoint contributes to a cohesive, accessible, and enriching museum experience.

By carefully analyzing the user journey and ecosystem, designers can identify gaps, optimize interactions, and create a system that supports tunnel vision visitors from the first interaction to post-visit reflection, ensuring a truly inclusive cultural experience.

3.1 Touchpoints (Digital Ads → Museum Experience → Feedback)

A comprehensive understanding of touchpoints is critical to designing an effective AR navigation system for tunnel vision users. Touchpoints represent the moments where the visitor interacts with the museum, both digitally and physically, and each provides opportunities to enhance accessibility, engagement, and user satisfaction.

The first touchpoint occurs before the visit, through digital ads, social media campaigns, and the museum's website. These channels inform potential visitors about the AR guide and its accessibility features, setting expectations and encouraging preparation for a smooth experience. Clear, concise messaging at this stage ensures that users understand the availability of guidance tailored to tunnel vision needs.

The next touchpoint is the download and onboarding of the AR app. The home interface introduces key functionalities, guiding users on how to activate navigation, enable audio and haptic feedback, and interact with exhibit content. Thoughtful onboarding reduces confusion and prepares visitors to navigate confidently, addressing common challenges associated with tunnel vision.

Upon entering the museum, physical touchpoints—such as signage, QR codes, and staff assistance—interact with the digital system to

03. User Journey & Ecosystem Map

support orientation and navigation. QR codes allow users to access exhibit-specific content seamlessly, while staff can provide guidance when needed. The AR system integrates with these touchpoints to maintain continuity in navigation and information delivery.

During the visit, the AR app becomes the central touchpoint. The camera view overlays directional cues and contextual information onto the real-world environment, while audio and haptic feedback ensure real-time awareness of turns, obstacles, and points of interest. By providing guidance directly within the user's perceptual field, the system minimizes disorientation and enhances independence.

The final touchpoint occurs after the visit, when users can provide feedback, reflect on their experience, and receive recommendations for future visits. This stage completes the loop, offering designers valuable insights into usability, effectiveness, and areas for improvement.

By mapping and analyzing these touchpoints, the project ensures that the AR navigation system addresses the full spectrum of the visitor experience, creating a cohesive, accessible, and engaging journey for tunnel vision users.

3.2 Service Blueprint / Ecosystem Map

The service blueprint, or ecosystem map, provides a holistic view of the interactions between the visitor, digital systems, museum staff, and the physical environment. For tunnel vision users like Marta Rinaldi, understanding these interdependencies is crucial to designing a seamless and accessible experience.

At the center of the ecosystem is the AR navigation app, which serves as the primary interface for guidance and engagement. The app interacts with multiple layers of the museum environment. Sensors, such as cameras and location tracking technologies (BLE beacons, Wi-Fi triangulation, or Visual Positioning Systems), feed real-time information to the system, enabling accurate navigation and context-sensitive prompts.

Surrounding the app are the physical touchpoints, including signage, exhibit panels, and QR codes. These elements provide additional cues and context, complementing the AR overlays and ensuring that information is accessible even if the user encounters technical limitations or environmental constraints. Museum staff form another essential layer of the ecosystem, offering guidance, troubleshooting, or reassurance when needed. Their role is particularly important during complex navigation or when visitors require additional explanations about exhibits.

The blueprint also highlights the flow of information and feedback. Digital inputs—such as user location, app interactions, and preferences—inform the system's behavior, while output mechanisms deliver audio, haptic, and visual guidance. Post-visit feedback loops allow the museum to capture user experiences, identify pain points, and refine the system iteratively.

By mapping these components, the service blueprint illustrates how technology, human support, and physical infrastructure converge to facilitate an inclusive museum experience. It highlights points where interventions—such as vibration alerts, audio instructions, or interactive signage—can improve navigation and engagement. This systemic perspective ensures that all aspects of the visitor journey work together, creating a cohesive and supportive environment for tunnel vision users.

03.
User Journey & Ecosystem Map

Marta Rinaldi

“ I used to enjoy exploring museums and learning about their exhibits but now that I have tunnel vision its not easy and enjoiable anymore.

Confidence in Navigation

Tech Reliance

Cultural Engagement

Accessibility Awareness

Emotional Frustration

Tech Dependency

Profile

- **Age**: 56
- **Occupation**: Retired language and literature teacher
- **Location**: Bologna, Italy
- **Vision condition**: Diagnosed with retinitis pigmentosa → severe tunnel vision
- **Tech familiarity**: Moderate - comfortable with smartphones, uses accessibility features
- **Cultural interest**: Passionate about museums, art, and historical storytelling
- **Living situation**: Lives with her partner; occasionally visits museums with her adult daughter

Activity

- Visits small exhibitions or less crowded museums a few times a year
- Uses her phone with voice assistant, text enlargement, and screen reader
- Relies on guided tours or family members to access most visual content
- Occasionally listens to museum podcasts or audioguides
- Participates in local cultural associations for older adults

Motivation

- She deeply misses the joy of independent exploration
- Her identity is tied to learning, teaching, and appreciating culture
- She wants to feel like she still belongs in intellectual, artistic spaces
- Her curiosity remains strong, even as her vision fades
- She values tools that restore freedom and dignity

Goals

- Visit museums independently and confidently despite her limited vision
- Discover artworks and exhibits without needing a companion
- Access clear and meaningful information (visually or via audio)
- Reignite her passion for cultural learning in a new, inclusive way
- Feel valued and welcomed in museum spaces — not overlooked or pitied

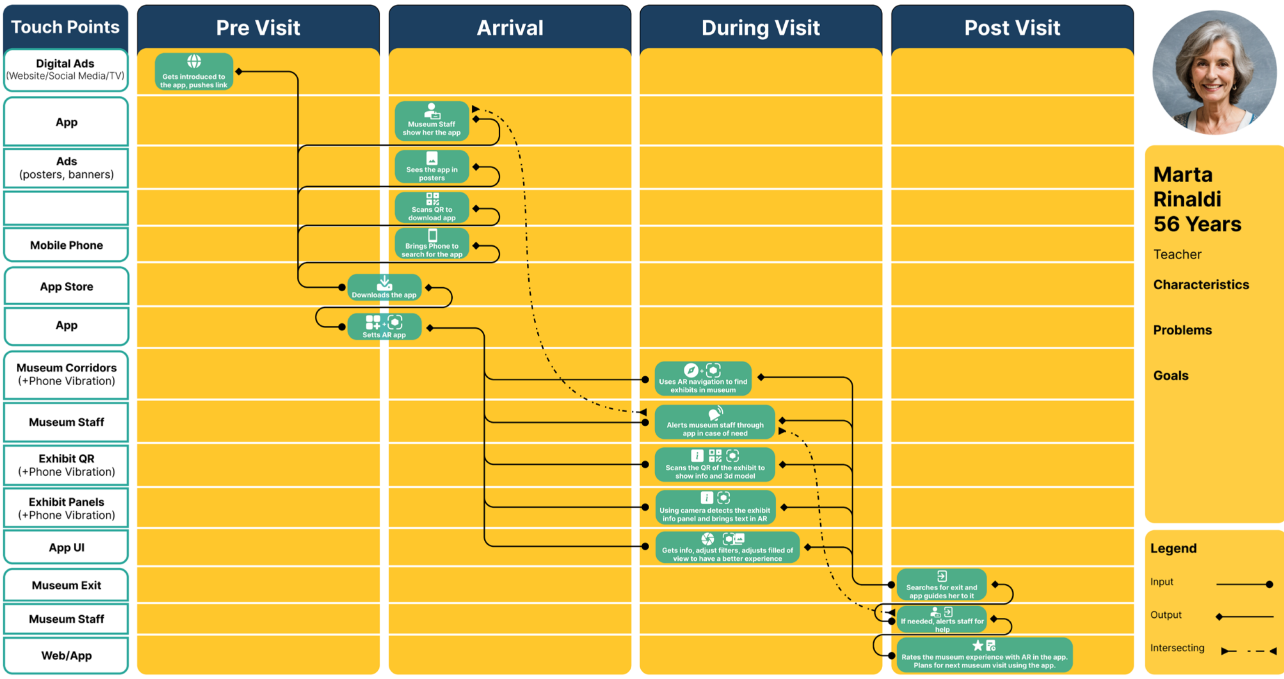
Questions

- Will I be able to use this app easily with my limited field of vision?
- Will it guide me physically through space or just describe objects?
- Can I rely on it alone, or will I still need someone with me?
- Will it overwhelm me with notifications or visuals I can't focus on?
- Is it respectful of my pace and ability, or is it one-size-fits-all?

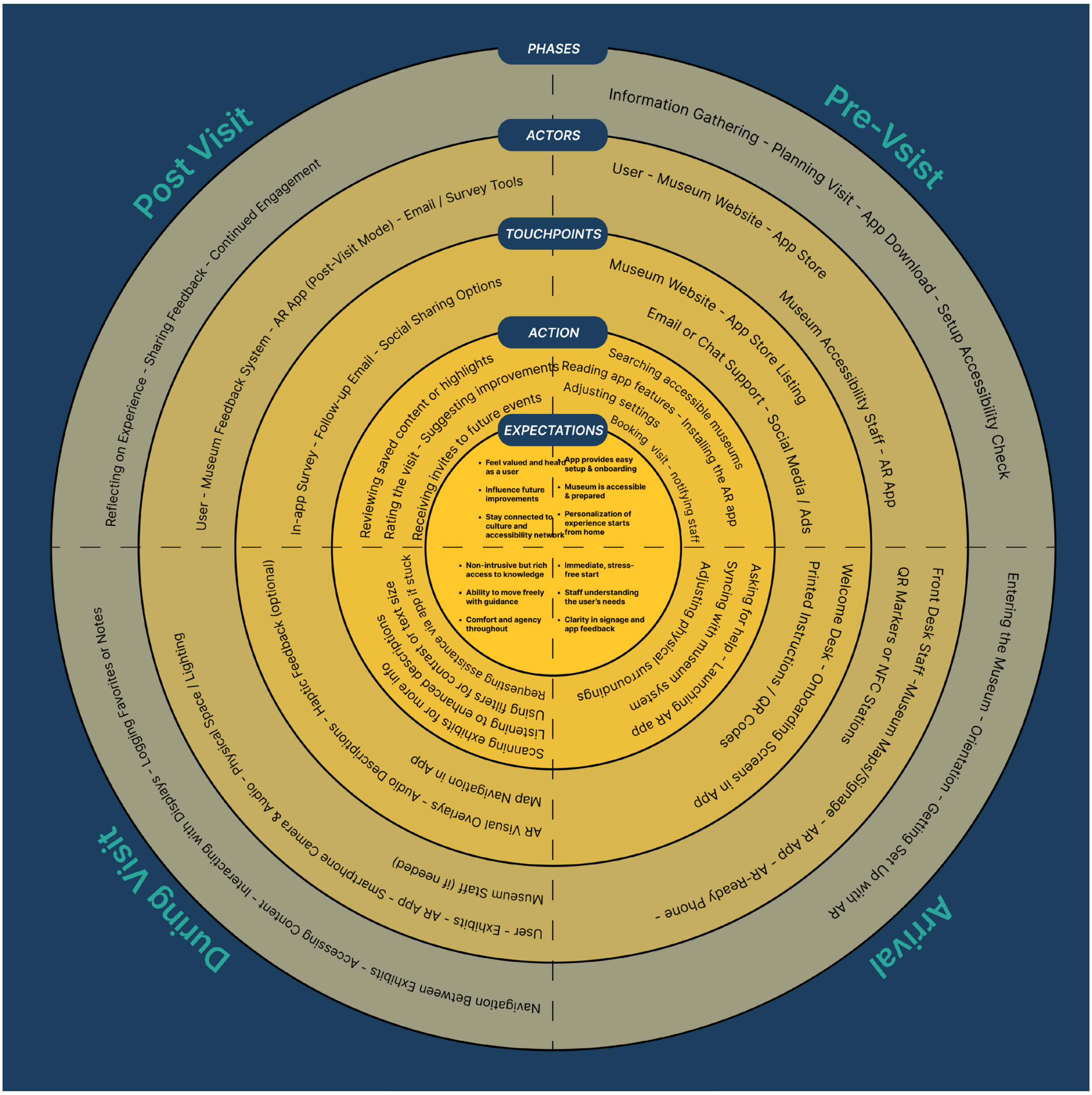
Obstacles / Pain Points

- Navigating museums with tunnel vision is disorienting and exhausting
- Exhibit labels and signs are often outside her field of view
- She avoids crowded or unfamiliar places due to mobility anxiety
- Digital screens in exhibitions are often not accessible or too small
- Feels like she's “missing out” or a burden when asking others to describe art

User Journey



03.
User Journey & Ecosystem Map



03.
User Journey & Ecosystem Map

Story Board Page

03.
User Journey & Ecosystem Map

Story Board Page

CHAPTER 04

Concept Development

04.
Concept Development

4. Concept Development

Concept development represents the stage where research insights, user needs, and technological possibilities converge into tangible design ideas. For this project, the focus is on creating an AR navigation system that is intuitive, accessible, and engaging for tunnel vision visitors like Marta Rinaldi.

This chapter outlines the process of generating, refining, and visualizing design concepts. It highlights how brainstorming, sketching, and scenario-based thinking informed early ideas, and how these ideas were subsequently translated into wireframes and navigation flows. By documenting this process, the chapter demonstrates a methodical and user-centered approach to transforming abstract requirements into functional, multimodal solutions that enhance both navigation and exhibit engagement.

4.1 Brainstorming and Sketches

Concept development began with ideation sessions and brainstorming exercises, aimed at generating diverse approaches for addressing the challenges faced by tunnel vision visitors. These sessions emphasized creativity, user-centered thinking, and technological feasibility. I considered multiple forms of guidance, interaction modalities, and visualizations to determine the most effective way to support independent navigation in museums.

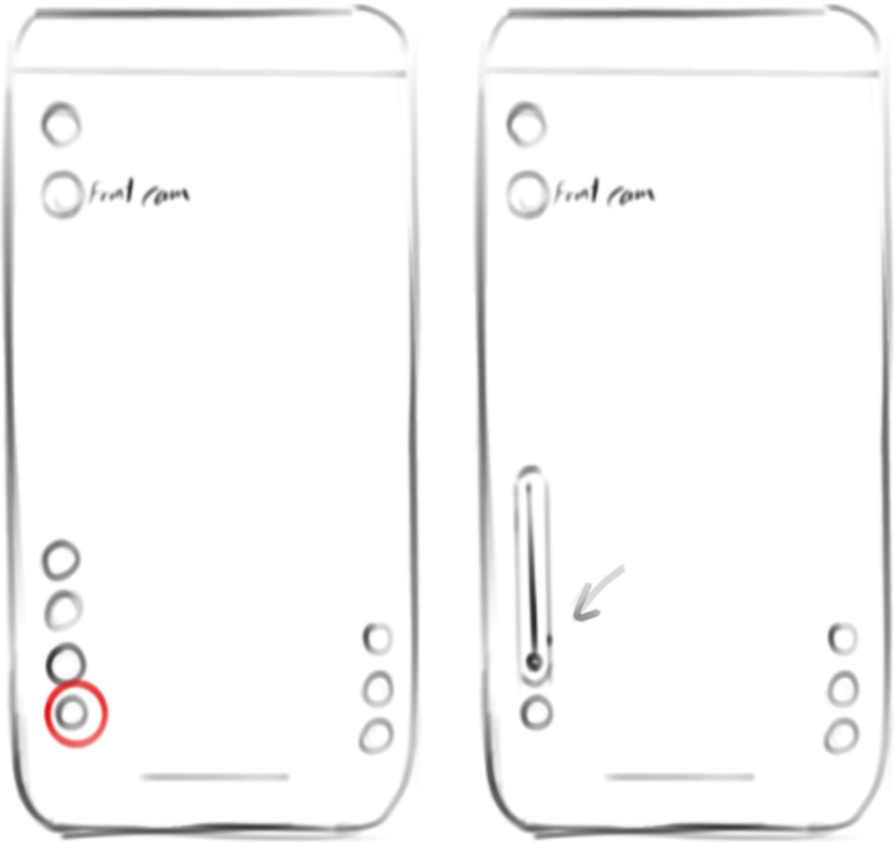
Initial concepts explored a wide range of solutions, including audio-only guides, static tactile maps, mobile-based AR overlays, and wearable haptic devices. Each idea was evaluated against user needs, particularly those of Marta Rinaldi, the representative persona. Concepts that relied heavily on peripheral vision were quickly deprioritized, while solutions leveraging central vision, audio, and haptic feedback were given greater attention.

Sketches played a critical role in visualizing early ideas. Low-fidelity drawings of app interfaces, navigation flows, and feedback mechanisms helped explore the placement of directional cues, vibration patterns, and information overlays. These sketches also made it easier to communicate ideas to others, identify potential usability issues, and iterate rapidly before committing to digital prototypes.

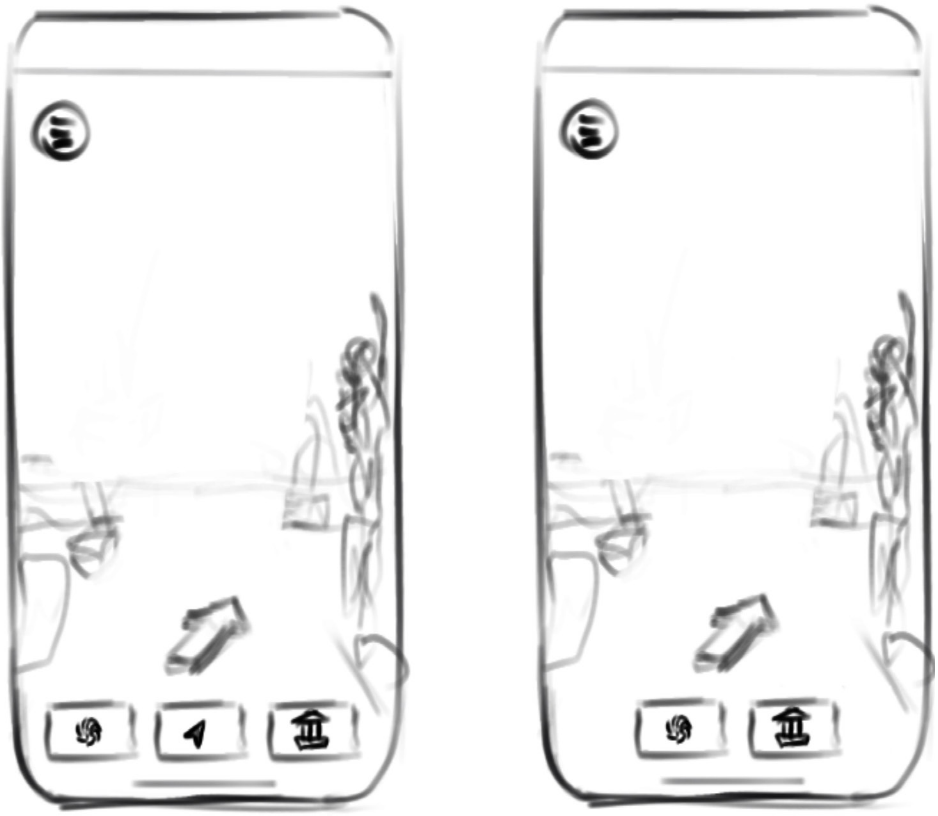
Brainstorming and sketching sessions were guided by scenario-based design principles. By simulating Marta's journey through the museum, I could anticipate interactions, environmental challenges, and the timing of guidance cues. This approach ensured that early concepts were grounded in real user experiences, balancing technological possibilities with practical accessibility needs.

Through this iterative exploration, I established a foundation of promising concepts, combining AR overlays, audio instructions, and tactile cues. These concepts informed subsequent stages, including wireframe development, navigation flow design, and scenario-based use cases, setting the stage for a user-centered, multimodal AR navigation system.

04.
Concept Development

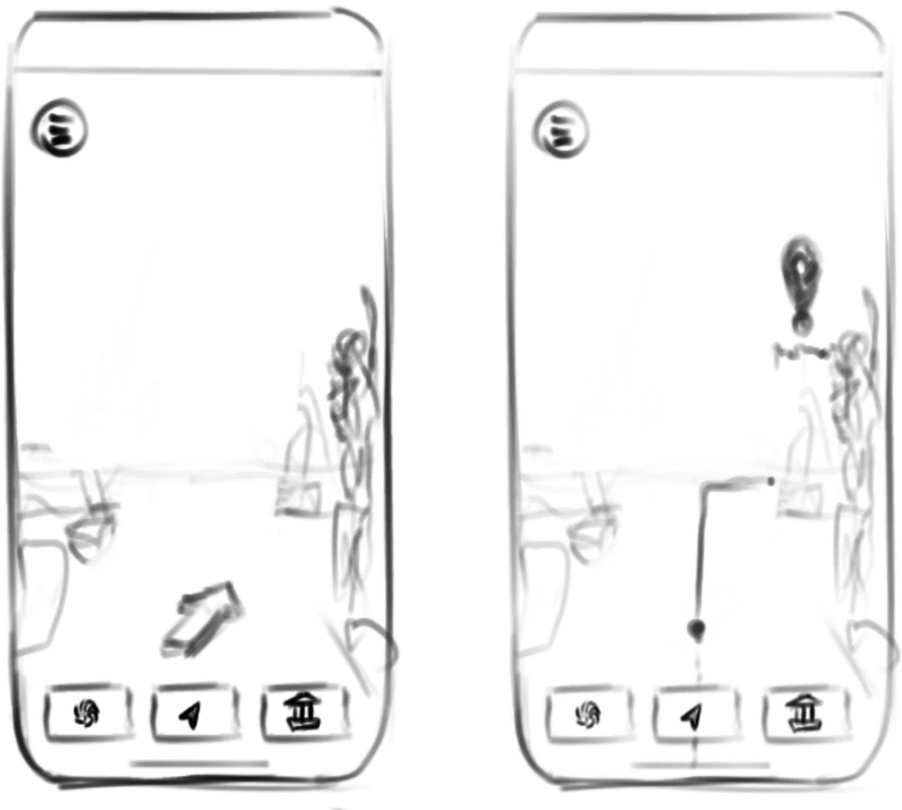


ReboKeh Inspired Home page

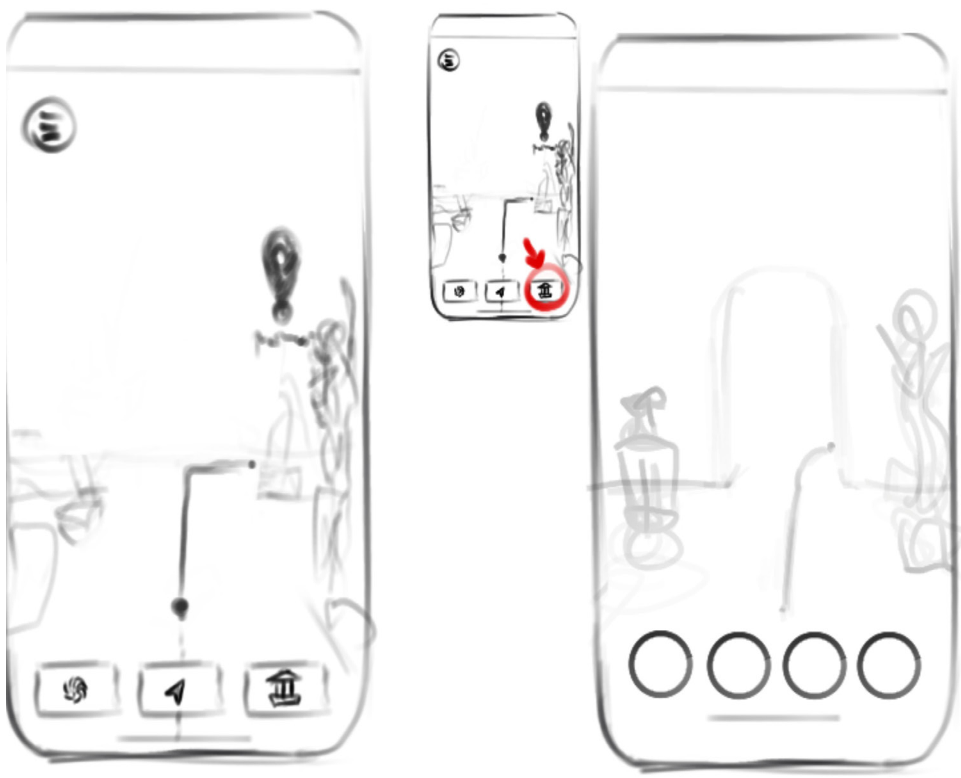


Early Home Page sketch

04.
Concept Development

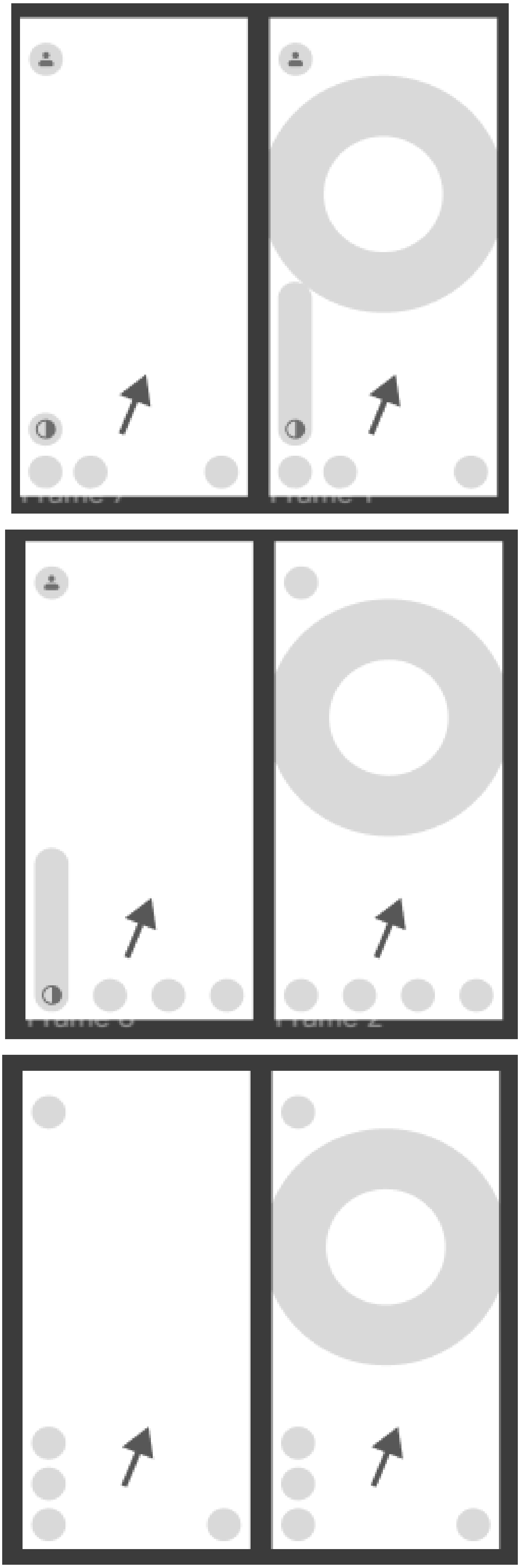


Possible AR Navigator shapes in home page



Adjustment page sketch

04.
Concept Development



Early Adjustment page sketch

4.2 Early Wireframes and Navigation Flow

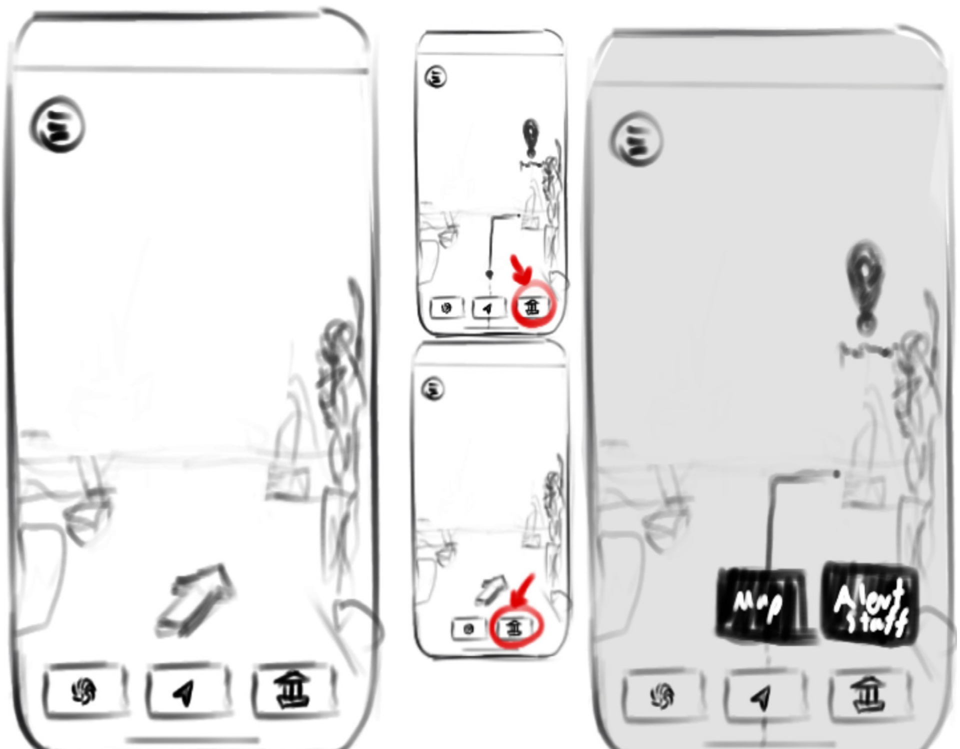
To move from abstract concepts into tangible solutions, early wireframes were created to visualize the structure and navigation flow of the application. These wireframes served as a bridge between the brainstorming sketches and the functional prototype, allowing the core interactions to be mapped before detailed visuals were developed.

The navigation flow was organized around Marta Rinaldi's journey, ensuring that the app would remain intuitive for users with tunnel vision. Each step—from launching the app, scanning a QR code at the museum entrance, and accessing AR navigation, to receiving haptic and audio feedback—was sketched in simple screens that prioritized clarity over aesthetics. By focusing on minimal elements and large interactive zones, the wireframes reflected the accessibility goals established earlier in the process.

Because the project was carried out individually, the wireframing process required iterative self-review. I tested the flows on paper and through basic digital sketches, checking whether they supported minimal visual overload and step-by-step guidance. To anticipate potential issues, I also simulated Marta's perspective by limiting my own field of view while reviewing the wireframes, which provided useful insights into how information should be structured and revealed progressively.

These early sketches highlighted three critical screens that became the backbone of the user journey: the Home Screen (a simple entry point with large buttons and clear labels), the QR Code Scan Screen (to seamlessly connect the physical museum space with the digital app), and the AR Navigation View (where visual, audio, and haptic cues converge). Each of these wireframes was tested conceptually against Marta's needs, ensuring that the app would feel guided rather than overwhelming.

These early wireframes therefore provided a practical blueprint for the next stage of design, where the interactions would be translated into Unity and connected with AR functions.



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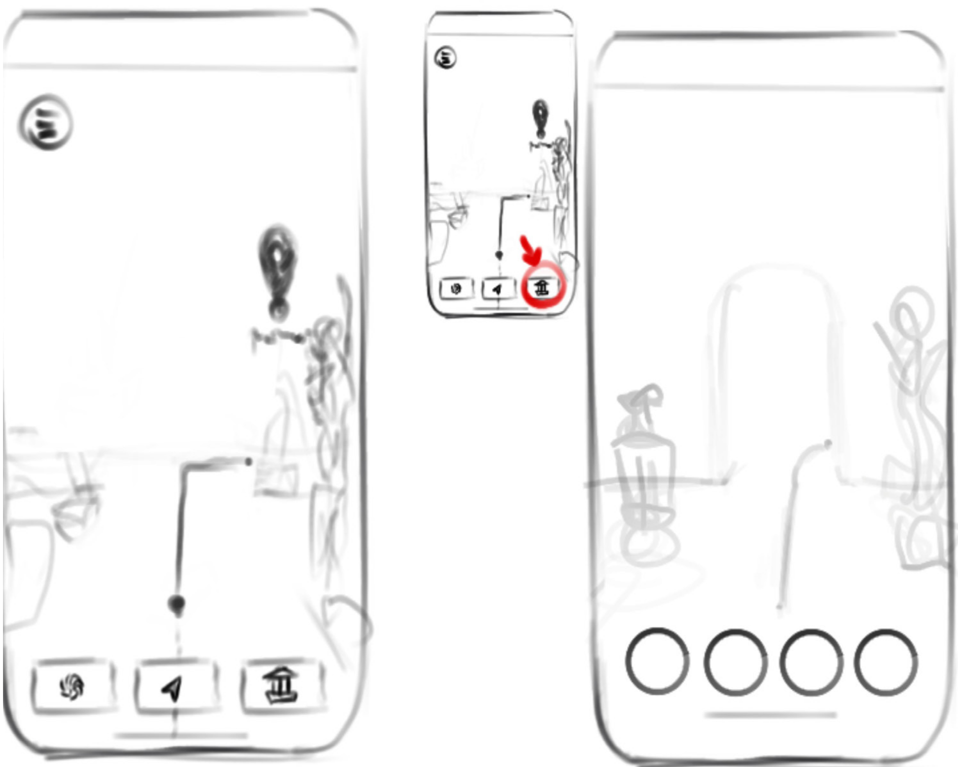
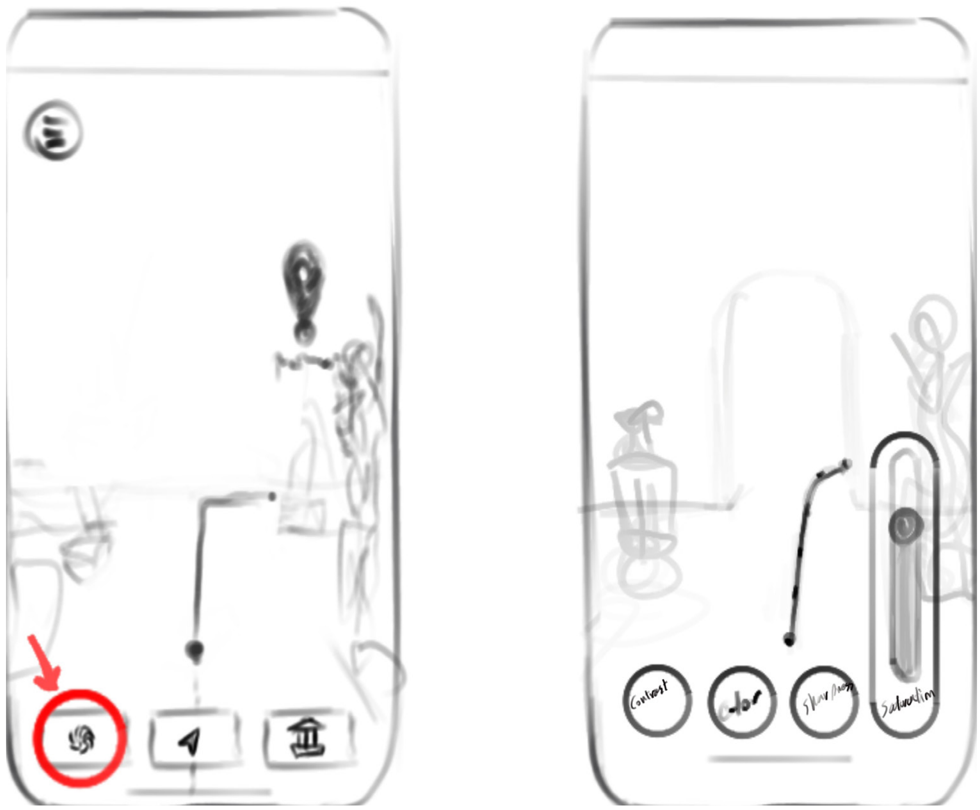


2

Possible ways of trasition between home page and AR adjustments panel

04.
Concept Development



Possible ways of trasition between home page and Image adjustments panel

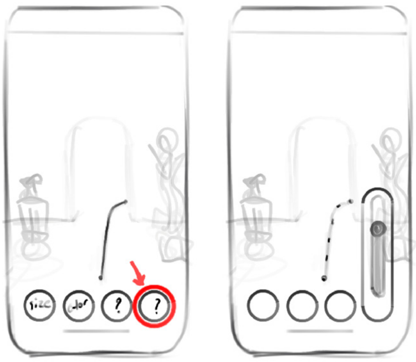
Opening of Options Side Menue. which contains other crucial page buttons such as finding and selecting available museums, Settings, Profile.

04.
Concept Development

CHAPTER 05

Prototype Development

05.
Prototype Development



5. Prototype Development

The prototype development phase translates conceptual designs and scenario-based use cases into a working AR navigation system. This stage focuses on practical implementation, integrating interface elements, navigation logic, and multimodal feedback to create a functional and testable application. The goal is to provide a tangible system that demonstrates how tunnel vision users, such as Marta Rinaldi, can navigate museums independently and confidently.

The chapter is organized to describe the main components of the prototype: the AR navigation interface, audio and haptic feedback integration, and interaction design considerations. Each section explains the development approach, technical decisions, and alignment with user needs identified in previous stages of the project.

5.1 AR Navigation System – In app Phone Camera View

The AR navigation system was designed to overlay directional cues and contextual information directly onto the user's camera view, creating a seamless integration of digital guidance with the physical museum environment. When Marta launches the app and begins her visit, the camera serves as the primary interface, displaying the museum layout with intuitive arrows, markers, and waypoints that guide her from one point of interest to another.

To minimize visual clutter, AR elements are kept simple, with high-contrast colors and large icons that remain within Marta's central field of view. This approach addresses the perceptual limitations of tunnel vision, ensuring that guidance cues are easily noticed and interpreted without causing distraction. Visual cues are supplemented with subtle animations to draw attention to key points, such as upcoming turns or exhibit entrances, without overwhelming the user.

The navigation system is powered by indoor positioning technologies, such as BLE beacons and Wi-Fi triangulation, which provide real-time location updates. Waypoints are dynamically adjusted based on Marta's movements, allowing the system to respond accurately to turns, stops, or detours. For example, if Marta approaches a corridor or encounters an obstacle, directional arrows are recalculated and displayed to maintain a smooth path to the next exhibit.

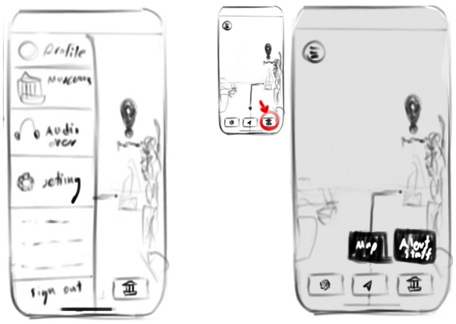
The camera view also supports contextual information delivery. Tapping or focusing on an exhibit marker triggers audio narration and brief textual descriptions, allowing Marta to receive exhibit information without needing to rely solely on peripheral vision. Additionally, the interface was designed to accommodate different user preferences, including adjustable font sizes, icon scales, and contrast levels, providing flexibility for varying levels of visual acuity.

By combining real-time navigation with contextual content, the AR camera interface not only guides movement but also enhances the overall museum experience, making it immersive, informative, and accessible. This system demonstrates how technology can be harnessed to provide precise, independent, and user-centered guidance for tunnel vision visitors, ensuring both safety and engagement throughout the visit.

5.2 Audio & Haptic Feedback Integration

To complement the visual AR navigation system, audio and haptic feedback mechanisms were integrated, providing tunnel vision users with multimodal guidance that does not rely solely on sight. These feedback channels are designed to communicate directional cues, proximity alerts, and points of interest, ensuring that users like Marta Rinaldi can navigate independently and confidently.

Audio cues are delivered through the smartphone's built-in speakers or connected headphones. Simple verbal instructions indicate turns, approach to exhibits, or obstacles, while spatialized sound helps Marta understand the direction of movement relative to her position. For



example, when approaching a right turn, a brief instruction is played with audio positioned to the right, reinforcing the directional cue visually represented in the AR camera view.

Haptic feedback uses the phone's vibration motor to provide non-visual guidance. Different vibration patterns correspond to distinct signals: intensity variations indicate proximity to an exhibit or waypoint, short pulses suggest minor course corrections, and longer pulses alert to potential obstacles or hazards. By encoding information in tactile patterns, the system ensures continuous orientation even when audio cannot be attended to, such as in noisy environments.

The integration of audio and haptic feedback was guided by scenario-based design principles. For each scenario, the timing, intensity, and sequence of feedback signals were planned to avoid confusion or overlap, creating a clear and consistent language of guidance. The combination of visual, audio, and tactile channels ensures redundancy, enhancing reliability and usability for tunnel vision users.

Through this multimodal approach, the prototype demonstrates how complementary feedback systems can provide nuanced guidance, reduce cognitive load, and foster independence. By addressing perceptual challenges from multiple angles, the AR navigation system becomes not only a tool for orientation but also a supportive companion throughout the museum experience.

5.3 Interaction Design for Tunnel Vision Users

The interaction design of the App focuses on the specific needs and perceptual limitations of tunnel vision users. All interface elements, feedback mechanisms, and user flows were carefully designed to reduce visual clutter, support clear orientation, and enhance overall usability for visitors like Marta Rinaldi.

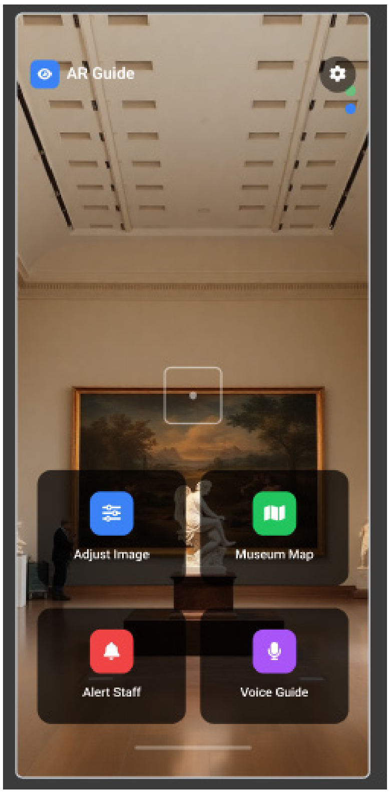
Central to the design is the principle of minimalism and clarity. On-screen elements are limited to essential cues, displayed in high-contrast colors and large sizes. Icons, arrows, and waypoints remain within the central field of view, avoiding reliance on peripheral vision. Interactive elements, such as buttons or exhibit markers, are sized and spaced to accommodate potential tremors or imprecise touches, ensuring that actions can be performed comfortably and accurately.

Navigation interactions are supported by redundant multimodal feedback. Visual cues in the AR camera view are paired with audio instructions and haptic signals, allowing users to rely on multiple senses to confirm directions and receive information. This redundancy helps maintain orientation in crowded or visually complex museum environments.

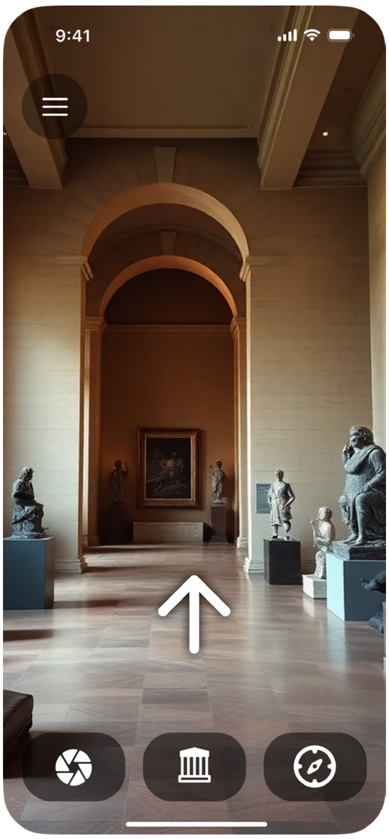
The app also allows for customization of feedback intensity and type, enabling users to adjust vibration strength, audio volume, and visual contrast according to personal preference or environmental conditions. This flexibility was incorporated to ensure that the system is adaptable, recognizing that tunnel vision varies in severity and perception across different users.

Scenario-based testing of interaction flows ensured that guidance signals occur at appropriate timing and spacing, preventing information overload while maintaining safety and orientation. For example, alerts are delivered slightly in advance of directional changes, giving users time to react comfortably, while contextual information about exhibits is provided incrementally to avoid distraction.

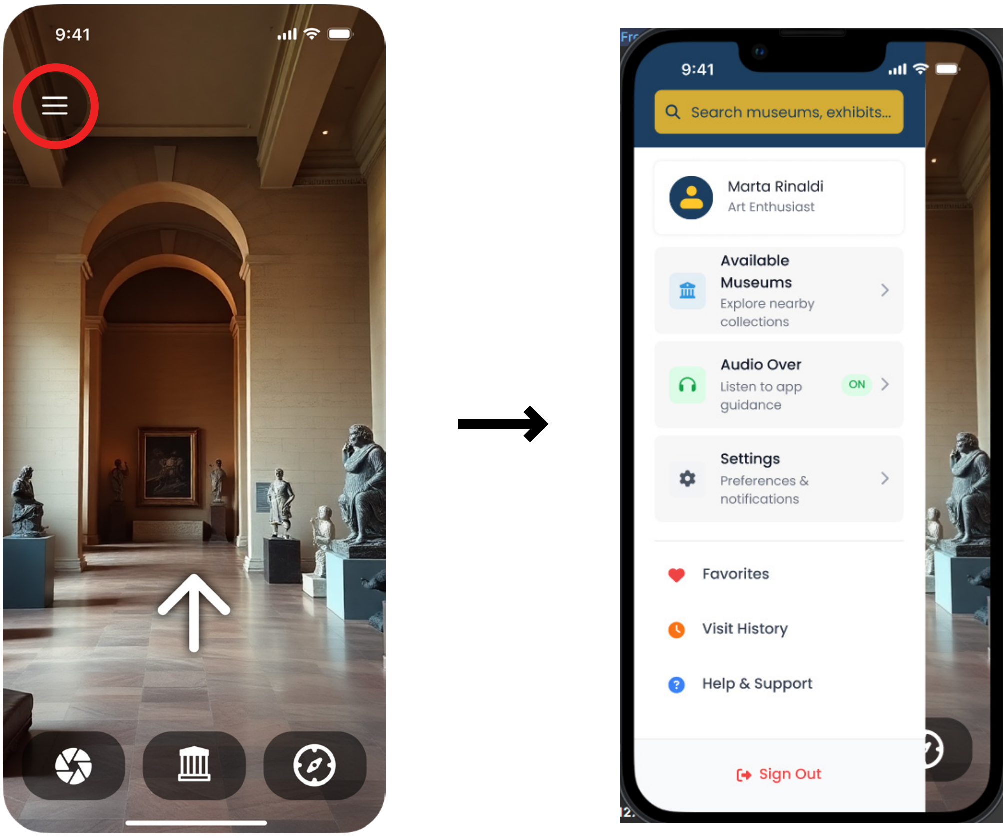
Through thoughtful interaction design, the prototype demonstrates how accessible, intuitive, and flexible interfaces can empower tunnel vision users to navigate museums independently, confidently, and safely, enhancing both mobility and engagement within the cultural environment.



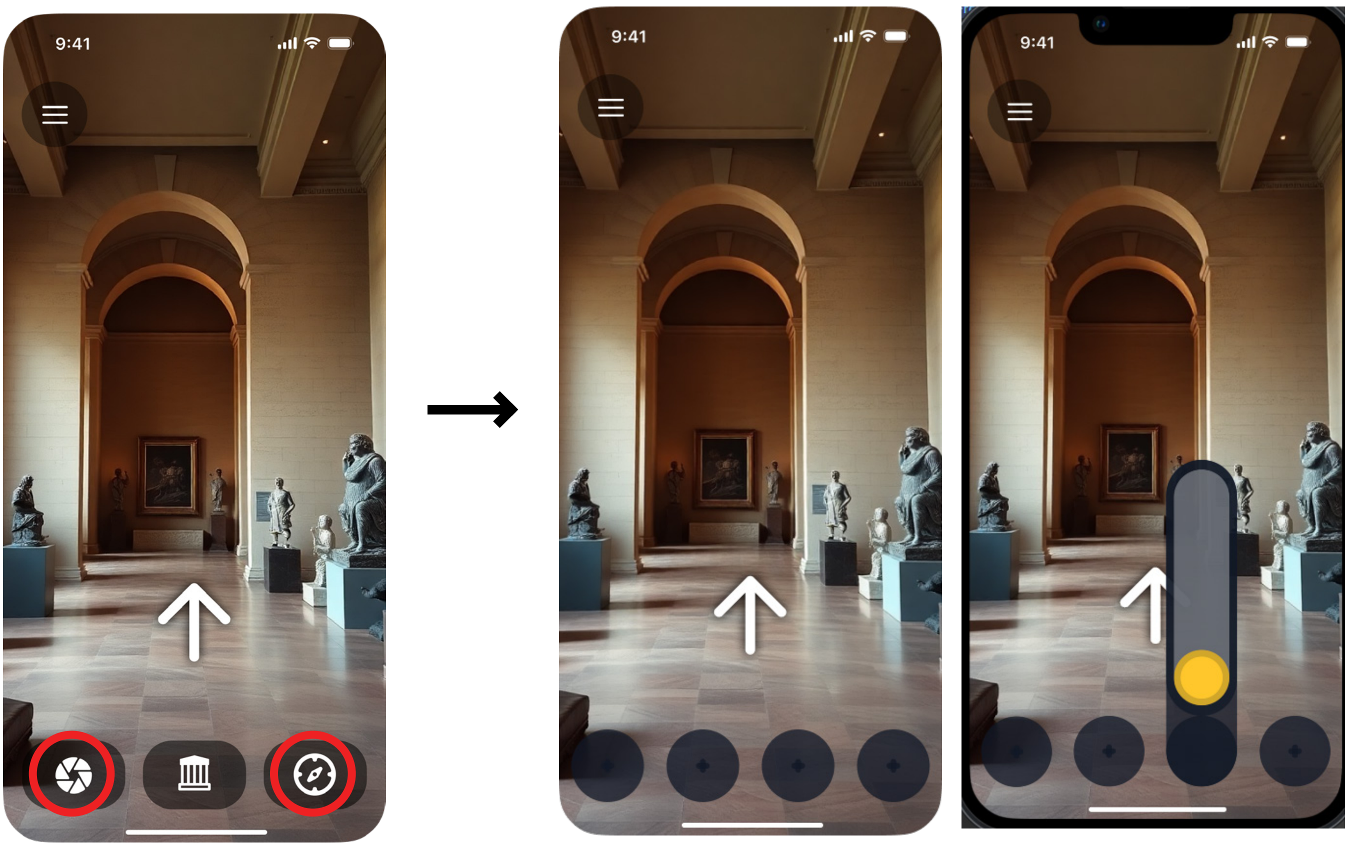
First Home-Page design



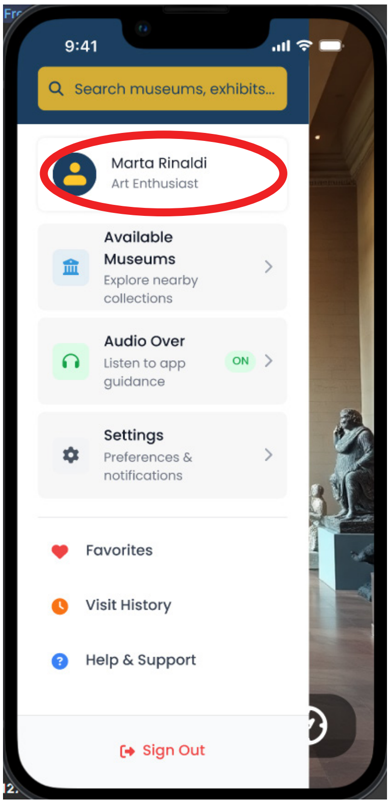
Final Home Page-Design

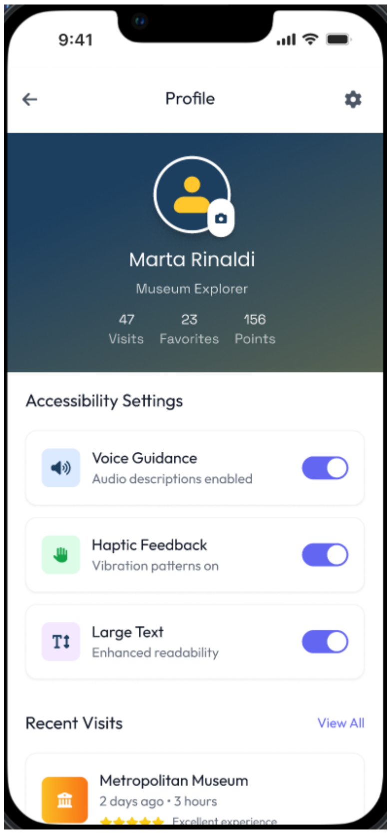


Side Menu for accessing Museums panel, Profile and Setting

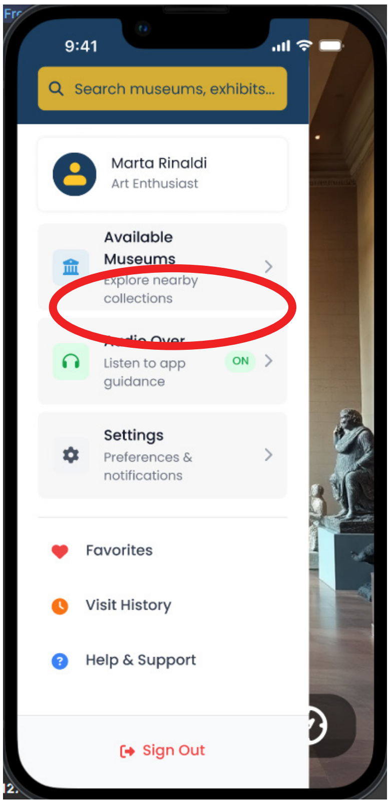


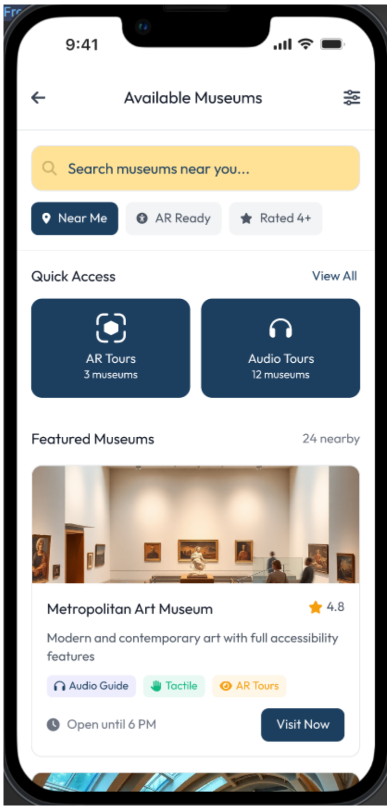
AR and Image adjustment panels which get open afer clicking on AR or Image Settings Buttons on the home page



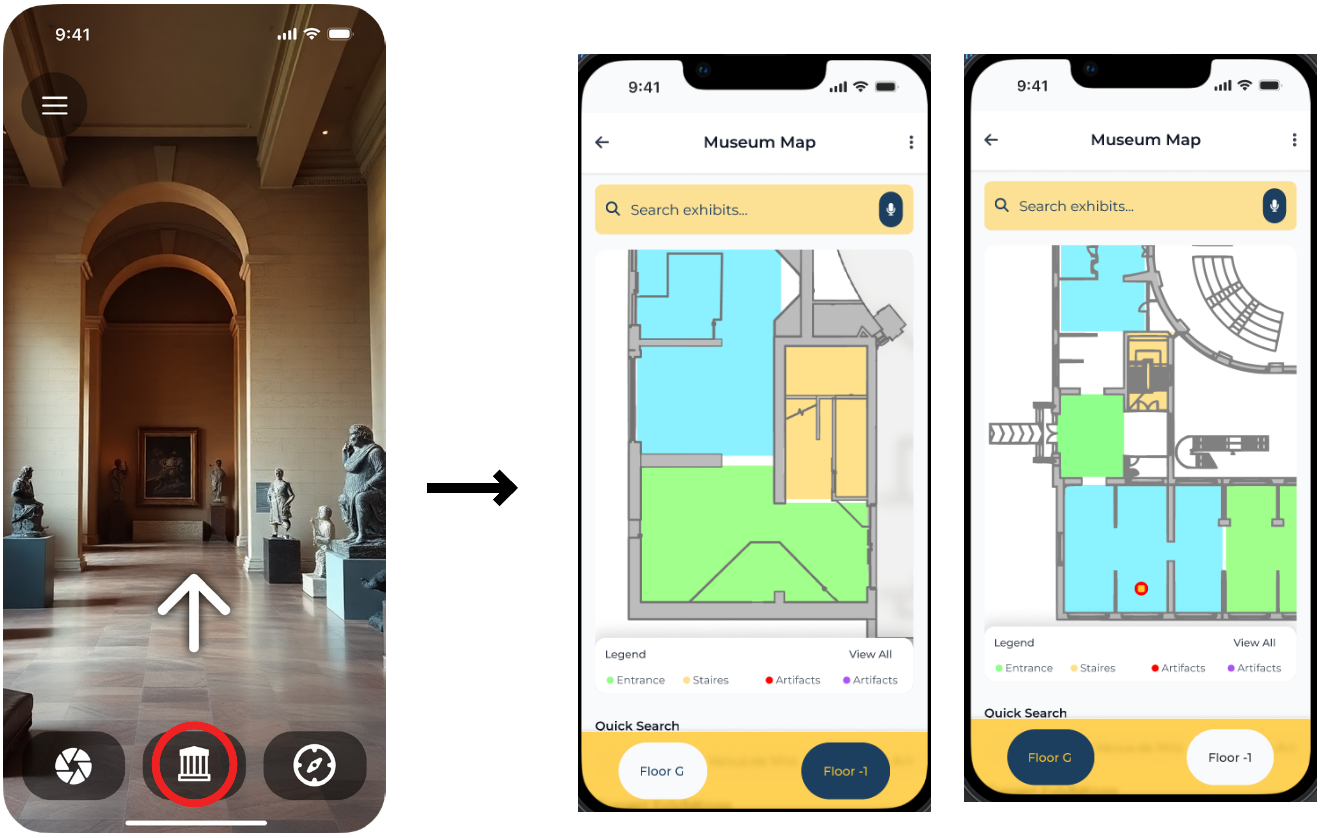


Side menu to Profile page

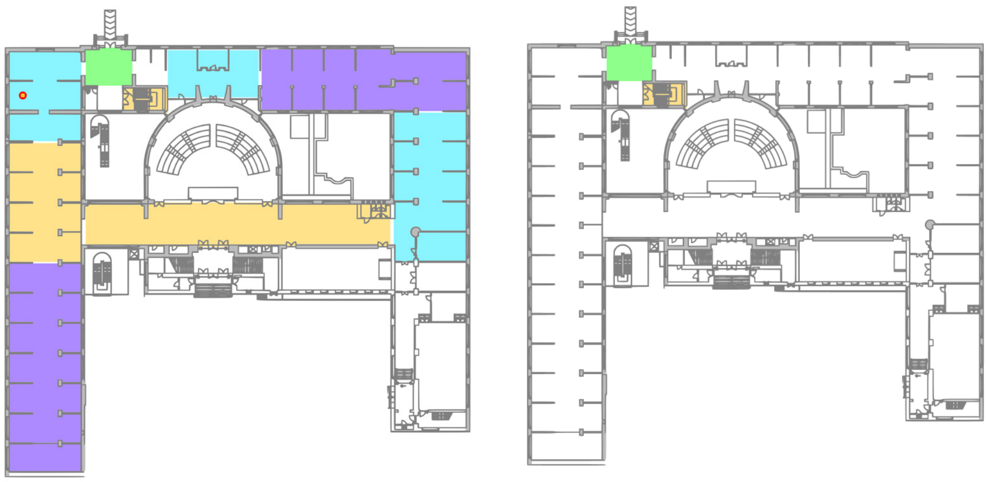




Side menu to Availble Museums page



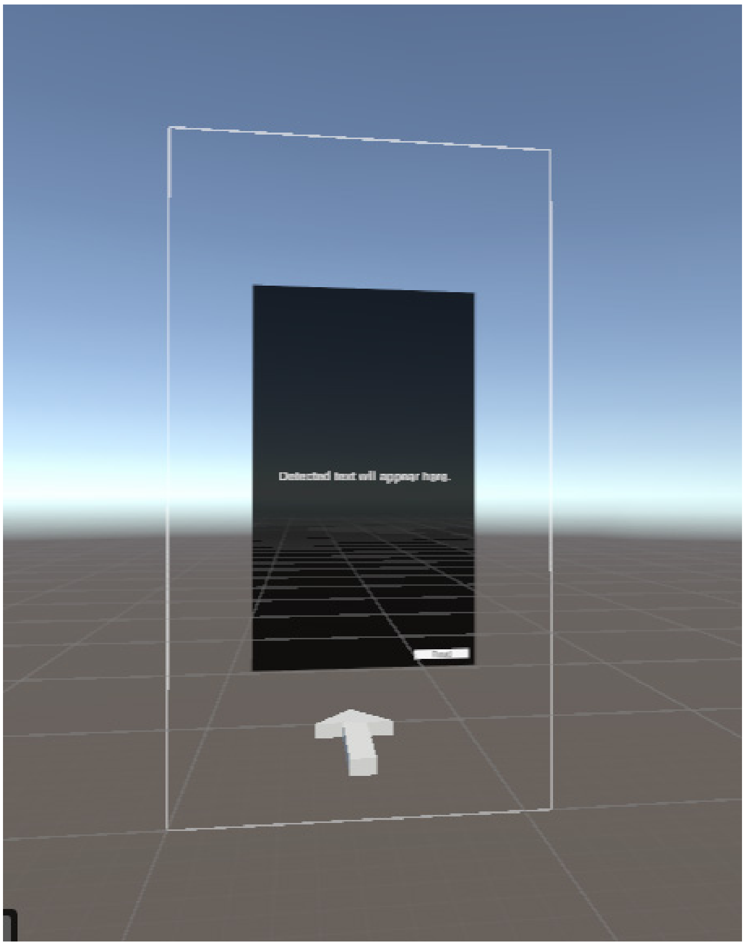
Home page to Museume Map Page



Ground floor

-1 floor

Museum Map layout prepaird for better understanding



AR Navigation Arrow in Unity

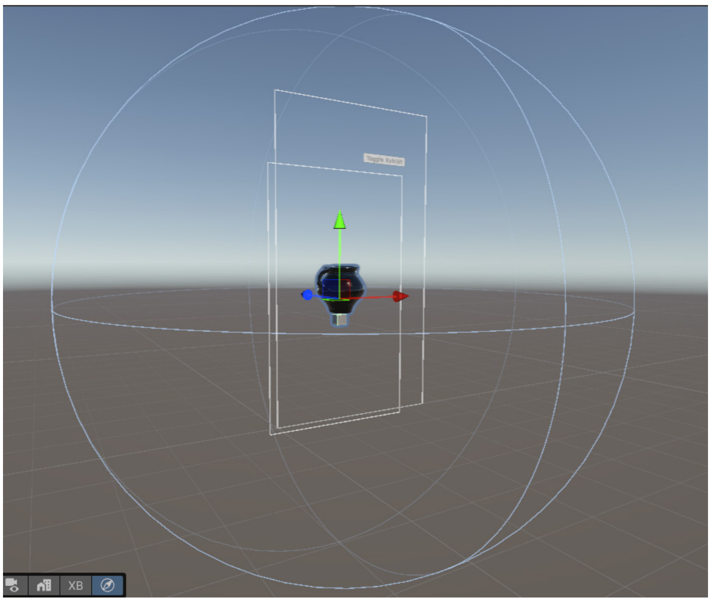
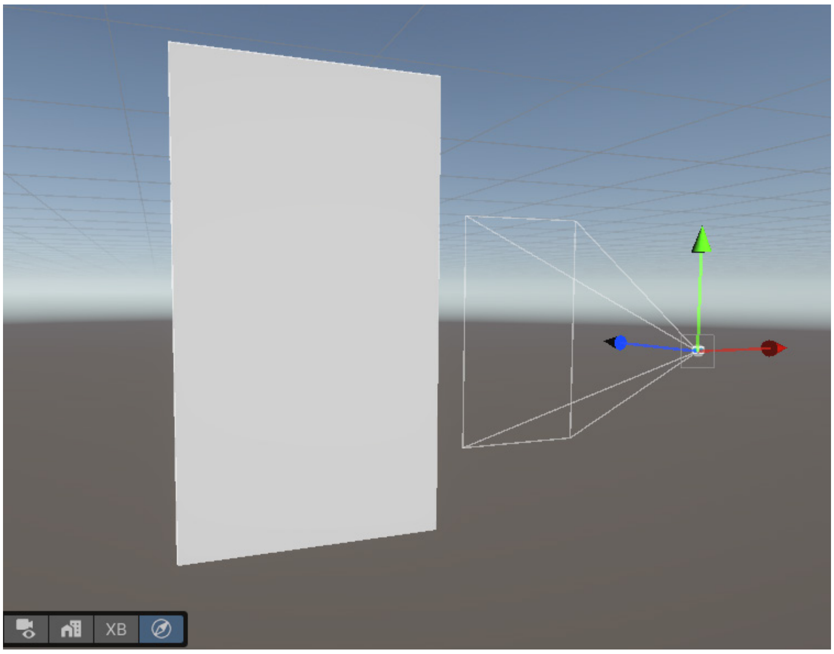


Exhibit 3D showcase in Unity



AR phone screen canvas in Unity

CHAPTER 06

Testing and Evaluation

06.
Testing and Evaluation

6. Testing and Evaluation

Evaluating the AR navigation system is essential to ensure that it meets the accessibility and usability needs of tunnel vision users. Testing focuses on the effectiveness of guidance, clarity of interface elements, and overall user experience. Although the system is still in the prototype stage, usability considerations were applied to anticipate potential challenges and inform future iterations.

6.1 Usability Considerations

Usability was assessed conceptually by simulating the experiences of tunnel vision users, with Marta Rinaldi serving as the representative persona. Key aspects considered included ease of navigation, clarity of feedback, and reduction of cognitive load. Each interaction flow, visual element, and feedback signal was examined to ensure that it could be interpreted quickly and accurately without causing confusion or disorientation.

The AR camera interface was evaluated for its visual simplicity, with attention to icon size, contrast, and placement. Directional cues were tested for visibility within a restricted field of view, while adjustments in color contrast and size were considered to accommodate variations in visual acuity. Audio and haptic signals were reviewed for timing, intensity, and clarity, ensuring that each feedback channel reinforced the others without creating overlap or distraction.

Interaction sequences were examined for efficiency and predictability. The flow from app launch, QR code scanning, and waypoint navigation was mapped to identify any potential bottlenecks or points of confusion. Emphasis was placed on minimizing steps and providing clear, incremental guidance to support independent movement through the museum environment.

These usability considerations establish a foundation for future user testing, where real tunnel vision visitors can interact with the prototype, providing empirical feedback. By anticipating challenges through careful evaluation of interface design and interaction flows, the system demonstrates a proactive approach to accessibility and inclusive design.

6.2 Expected Benefits and Limitations

The AR navigation system is designed to provide significant benefits for tunnel vision users, while acknowledging limitations inherent to both technology and user variability.

Expected benefits include improved independence and confidence during museum visits. By combining visual AR cues with audio and haptic feedback, the system supports continuous orientation, allowing users like Marta Rinaldi to explore exhibits without constant reliance on staff or companions. Multimodal guidance also enhances engagement with exhibits, as contextual information is delivered seamlessly alongside navigational cues, enriching the educational and cultural experience.

The system further promotes safety and accessibility. By providing clear alerts for turns, obstacles, or transitions between rooms, the prototype reduces the risk of disorientation or collisions. Adjustable feedback settings accommodate individual preferences, ensuring that the experience can be personalized for varying degrees of visual impairment.

Despite these advantages, several limitations must be acknowledged. The accuracy of the navigation system depends on the effectiveness of indoor positioning technologies, such as BLE beacons or Wi-Fi triangulation, which may be affected by physical layout, signal interference, or crowded environments. AR overlays rely on the central field of view, which may still challenge users with extremely restricted vision. Audio and haptic feedback, while helpful, require environmental awareness, and their effectiveness can vary depending on ambient

06.
Testing and Evaluation

noise or user sensitivity.

Additionally, the prototype's current form has not yet been tested with real tunnel vision users, meaning that practical usability insights remain theoretical. Future testing is essential to validate assumptions, identify unforeseen challenges, and refine the system for real-world application.

Overall, while acknowledging these limitations, the AR navigation prototype demonstrates strong potential to improve independence, safety, and engagement for tunnel vision visitors, providing a foundation for further development and evaluation.

6.3 Feedback and Iterations

Although full user testing has not yet been conducted, a framework for feedback collection and iterative improvement has been established. Feedback mechanisms are designed to capture insights from tunnel vision users, museum staff, and technical observations, enabling ongoing refinement of the AR navigation system.

Potential feedback points include the clarity of visual cues, the responsiveness of audio and haptic signals, and the intuitiveness of interaction flows. Each aspect of the prototype is structured to allow easy adjustments based on observed challenges or preferences. For example, vibration patterns can be recalibrated for strength and frequency, audio instructions can be rephrased or timed differently, and AR overlay placement can be adjusted to maximize visibility within the central field of view.

Iterations are planned according to a scenario-based testing approach, using simulated or real museum journeys to evaluate system performance. Each scenario highlights specific tasks, environmental conditions, and potential obstacles, allowing incremental improvements to be made. Adjustments are documented and tested in successive cycles, ensuring that each refinement enhances usability and accessibility for tunnel vision users.

This iterative process emphasizes a user-centered philosophy, where assumptions are continuously verified and design decisions are informed by actual user experiences. Even at the prototype stage, the approach demonstrates the value of systematically evaluating performance and incorporating feedback, establishing a strong foundation for a functional, reliable, and inclusive AR navigation system.

CHAPTER 07

Final Design Proposal

07. Final Design Proposal

7. Final Design Proposal

The final design proposal presents a consolidated view of the AR navigation system, integrating insights from research, concept development, scenario-based use cases, and prototype evaluation. This chapter outlines the system's key features, illustrates the user experience, and demonstrates how the application addresses the accessibility needs of tunnel vision visitors.

The final design emphasizes multimodal guidance, simplicity, and adaptability, combining AR overlays, audio instructions, and haptic feedback to provide an inclusive and intuitive museum experience. Each design decision reflects both technical feasibility and user-centered considerations, ensuring that the system supports independent navigation, safety, and engagement throughout the visit.

App Prototype link: https://www.figma.com/proto/i5q8bHpVnZ0gchf5VPmvs2/MusemAR-02?page-id=&node-id=155-11127&viewport=-18346%2C-3824%2C0.69&t=gMvJWofiwAWfEoak-1&scaling=scale-down&content-scaling=fixed&starting-point-node-id=155%3A11127&show-proto-sidebar=1

7.1 Key Features

The AR navigation system includes several core features designed specifically to accommodate the perceptual and navigational challenges faced by tunnel vision users:

1. AR Camera View with Directional Cues: The primary interface overlays arrows, markers, and waypoints directly onto the camera feed, guiding users through the museum with high-contrast, centrally-focused visual cues.
2. Audio Guidance: Contextual verbal instructions provide information on direction, proximity to exhibits, and potential obstacles. Spatialized audio reinforces directional cues, helping users interpret the environment accurately.
3. Haptic Feedback: Distinct vibration patterns communicate directional changes, proximity alerts, and hazard warnings, allowing users to receive guidance without relying solely on vision.
4. Customizable Settings: Users can adjust visual contrast, icon size, audio volume, and haptic intensity, ensuring that the system accommodates individual preferences and varying degrees of visual impairment.
5. Scenario-Based Guidance: Navigation sequences are informed by scenario-based design, anticipating environmental challenges such as crowded galleries, low lighting, and complex floor layouts.
6. Integrated Exhibit Information: Tapping or focusing on exhibit markers triggers audio descriptions and concise textual information, enhancing engagement and providing a rich cultural experience.

These features work together to create a cohesive, reliable, and accessible navigation system, supporting tunnel vision users in independently exploring museum spaces while remaining informed, safe, and engaged.

7.2 User Experience Walkthrough

The user experience of the AR navigation system is designed to be intuitive, continuous, and supportive, allowing tunnel vision visitors such as Marta Rinaldi to navigate museums independently while engaging with exhibits. The walkthrough follows the typical journey of a user, from entry to completion of the museum visit.

Upon launching the app, the user is greeted with a clean home screen featuring large, clearly labeled buttons. The interface prioritizes simplicity, ensuring that key actions—such as starting a guided tour or scanning a QR code—are immediately accessible.

Once the tour begins, the user is prompted to scan a QR code at the museum entrance, which activates the AR navigation system. In the AR camera view, directional cues and waypoints are displayed prominently, guiding the user through corridors, rooms, and galleries. Visual arrows are reinforced with audio instructions that announce upcoming turns and points of interest. Subtle vibration patterns provide tactile feedback, ensuring continuous orientation even in visually complex or crowded spaces.

As the user approaches an exhibit, markers within the AR interface indicate additional information. By focusing on or tapping a marker, audio descriptions and concise textual content are delivered, allowing the user to access contextual knowledge without being distracted from navigation. Adjustments to contrast, icon size, audio volume, and vibration intensity can be made at any time, accommodating individual preferences and environmental conditions.

The walkthrough continues until the user completes the tour. At each stage, scenario-based design considerations ensure that navigation remains smooth, consistent, and reliable. By combining AR, audio, and haptic feedback, the system provides a holistic experience where users feel guided, informed, and confident throughout their visit.

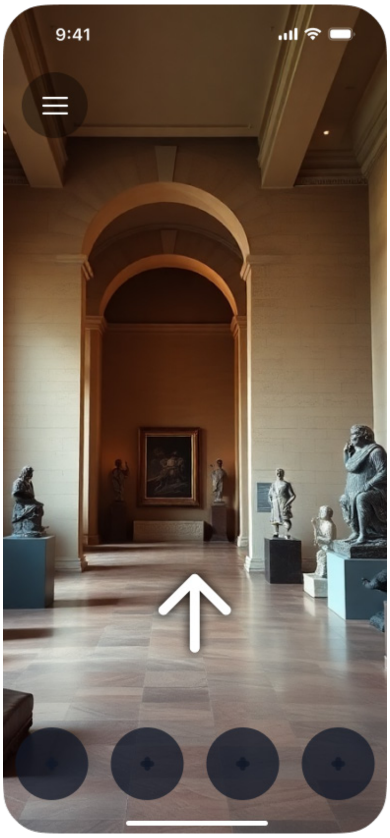
Through this journey, the design demonstrates the potential for AR technology to enhance accessibility and engagement for tunnel vision users, offering both independence and a richer cultural experience.

7.3 Visuals (Screenshots, Mockups, Diagrams)

Visual documentation plays a crucial role in illustrating the design and functionality of the AR navigation system. Although actual images cannot be embedded in this text version, the following descriptions provide a conceptual overview of key screens, mockups, and diagrams that support understanding of the system.

1. Home Screen Mockup: A minimal interface with large buttons for starting a tour, scanning QR codes, and accessing settings. High-contrast colors and clear typography ensure readability, while the layout emphasizes ease of use for tunnel vision users.
2. QR Code Scan Screen: Designed to guide users in connecting the physical museum environment to the digital app. The screen features a central scanning area and subtle on-screen prompts, allowing the user to align the code without relying on peripheral vision.
3. AR Navigation View: The core interface overlays arrows, markers, and waypoints onto the camera feed. Visual cues are centrally positioned and animated subtly to attract attention. Icons are large and high-contrast, while audio and haptic feedback reinforce directional guidance.
4. Exhibit Information Panel: Triggered by tapping or focusing on an AR marker, this panel provides concise textual information and plays audio descriptions of the exhibit. The design ensures that content is easily accessible without disrupting navigation.
5. Service Blueprint / Ecosystem Map Diagram: A visual representation of the user journey, touchpoints, and interaction with the AR system. This diagram maps the flow from app launch, museum navigation, and feedback collection, highlighting opportunities for multimodal guidance and points of user engagement.

These visuals collectively demonstrate how the design integrates accessibility, clarity, and usability into the AR navigation system. By combining interface mockups with process diagrams, the presentation conveys both the functional and experiential aspects of the system, ensuring that the design rationale is understandable and verifiable.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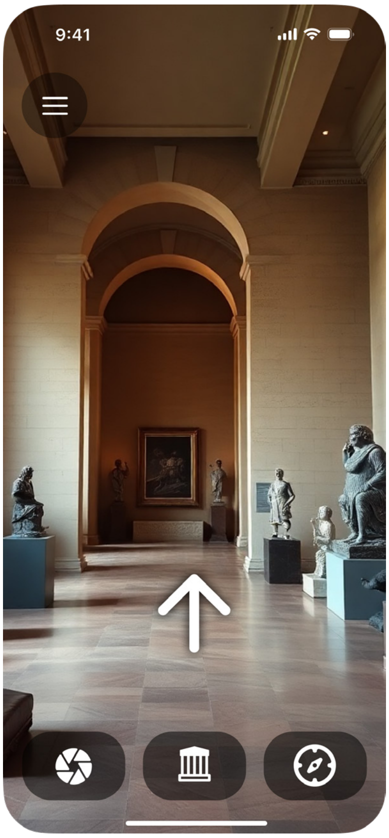
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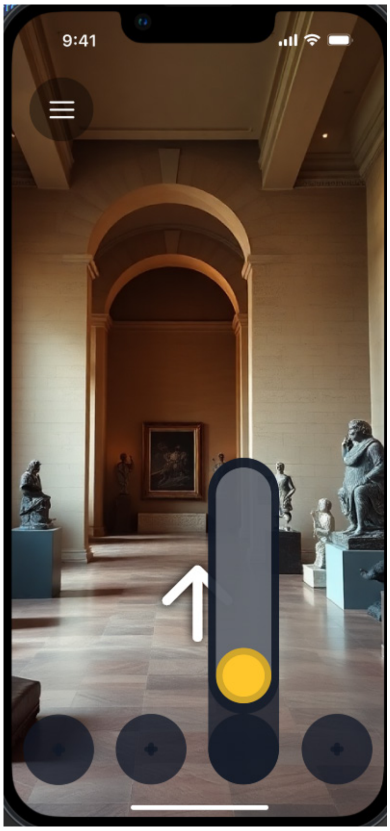
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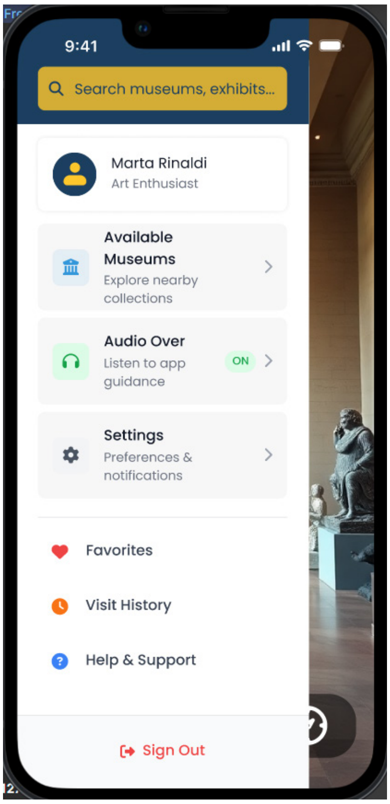
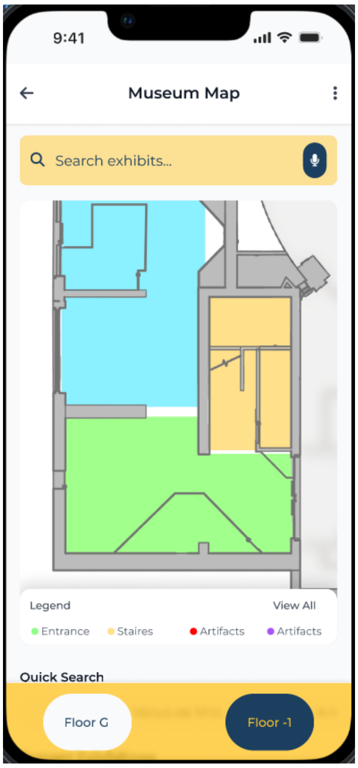
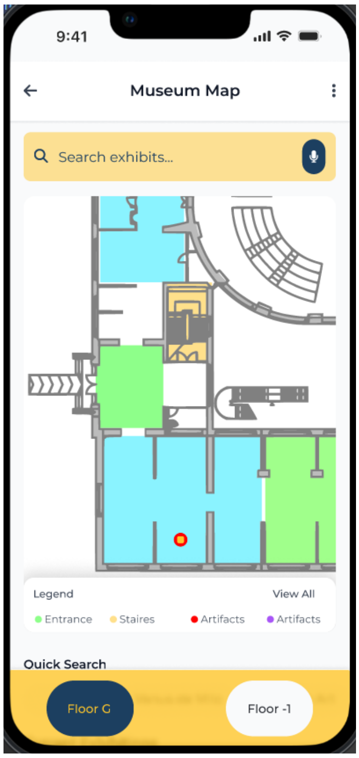

9:41
Search museums, exhibits...
Marta Rinaldi
Art Enthusiast
Available Museums
Explore nearby collections
Audio Over
Listen to app guidance
ON
Settings
Preferences & notifications
Favorites
Visit History
Help & Support
Sign Out


9:41
Museum Map
Search exhibits...
Legend
View All
Entrance
Staires
Artifacts
Artifacts
Quick Search
Floor G
Floor -1


9:41
Museum Map
Search exhibits...
Legend
View All
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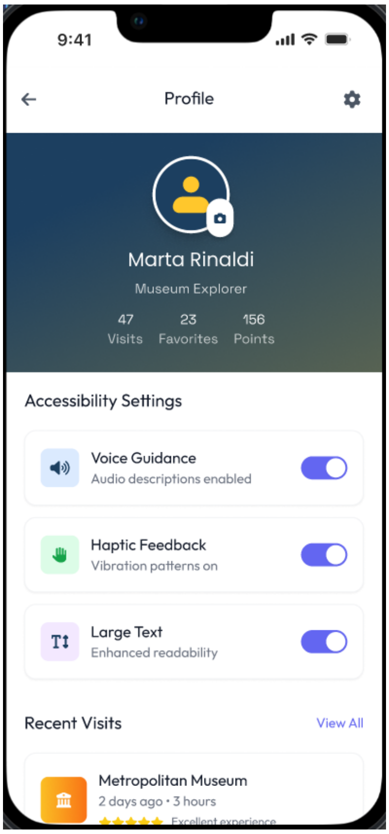
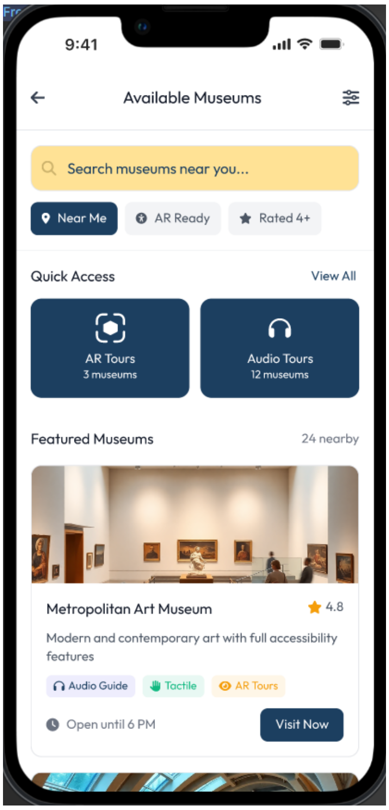
Floor -1


9:41
Profile
Marta Rinaldi
Museum Explorer
47
Visits
23
Favorites
156
Points
Accessibility Settings
Voice Guidance
Audio descriptions enabled
Haptic Feedback
Vibration patterns on
Large Text
Enhanced readability
Recent Visits
View All
Metropolitan Museum
2 days ago • 3 hours


9:41
Available Museums
Search museums near you...
Near Me
AR Ready
Rated 4+
Quick Access
View All
AR Tours
3 museums
Audio Tours
12 museums
Featured Museums
24 nearby
Metropolitan Art Museum
4.8
Modern and contemporary art with full accessibility features
Audio Guide
Tactile
AR Tours
Open until 6 PM
Visit Now

CHAPTER 08

Conclusion and Future Directions

08.
Conclusion and Future Directions

8. Conclusion and Future Directions

The AR navigation system developed in this project demonstrates the potential of technology to enhance accessibility, independence, and engagement for tunnel vision users in museum environments. By combining AR overlays, audio guidance, and haptic feedback, the design addresses both navigational and informational needs, creating a multimodal solution that supports users like Marta Rinaldi in exploring exhibits safely and confidently.

The design process highlighted the importance of scenario-based approaches, iterative prototyping, and user-centered considerations. Early wireframes, scenario testing, and prototype development provided opportunities to identify challenges, refine interactions, and ensure that guidance mechanisms are both intuitive and effective. Multimodal feedback and adjustable settings were key components in accommodating individual differences in visual perception, ensuring that the system is adaptable to a range of users with varying degrees of tunnel vision.

While the prototype demonstrates strong potential, future directions are necessary to achieve a fully functional system. Real-world user testing with tunnel vision visitors will be essential to validate usability assumptions, identify unforeseen challenges, and refine feedback mechanisms. Enhancements in indoor positioning accuracy, AR interface optimization, and personalized guidance could further improve navigation reliability and user satisfaction.

Additionally, expanding the system to include dynamic content updates, additional museum sites, and integration with museum databases could provide a richer, more interactive experience. Collaborative features, such as guided tours with optional staff support or social sharing of visited exhibits, may also be explored to enhance engagement and accessibility further.

In conclusion, this project establishes a comprehensive framework for AR-based museum navigation tailored to tunnel vision users. By combining technological innovation with thoughtful, user-centered design, the system demonstrates how accessibility and cultural engagement can be harmonized, providing a foundation for future research, development, and real-world implementation.

08.
Conclusion and Future Directions

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