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A framework to design and implement cross-platform WebVR walkthrough for a Chettinad heritage building

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Abstract

Immersive walkthroughs are increasingly used to document, interpret, and communicate heritage sites to remote audiences. This study presents a framework for designing and implementing a cross-platform WebVR walkthrough of Athangudi Palace, a significant Chettinad mansion in Tamil Nadu, India. The project addresses limited physical access due to conservation sensitivity and geographic distance by developing a browser-based experience accessible on Head-Mounted Displays (HMDs), desktop computers, tablets, and mobile phones. It has a systematic workflow that involves on-site documentation, 360-degree image capture, spatial-audio recording, post-processing, WebVR development in A-Frame, refinement, and deployment. The walkthrough features panoramic shots, guided tours, hotspots, and contextual commentary, to convey the spatial nature and sustainability elements of the palace, such as passive cooling, material selections, and climate-adaptive planning. The paper contributes a reproducible workflow for documenting and interpreting domestic heritage architecture through a lightweight WebVR system. It demonstrates how browser-based immersive media can support remote heritage access, conservation awareness, and sustainability-oriented interpretation without increasing physical pressure on a sensitive site.

Keywords: Athangudi palace, Chettinad heritage, immersive media, virtual reality, virtual walkthrough.

1. Introduction

1.1. Heritage buildings and sustainability

Heritage buildings are examples of sustainable architecture built on traditional local knowledge and experience. These buildings are specifically designed to withstand the local climate using passive strategies such as thick walls, high ceilings, courtyards, shaded spaces, and natural ventilation, which play an essential role in the building's thermal performance. These buildings are mainly built using locally sourced materials, including imported materials, as they were constructed during the economic prosperity period. This influences the building's architectural style, which contributes to environmental sustainability by reducing construction impacts and extending building life. Preserving these heritage buildings supports sustainability in many ways. Virtual Walkthroughs and Virtual Reality experiences provide a sustainable way to document and share these buildings.

1.2. Virtual reality for cultural heritage

In modern times, Virtual reality (VR) is used to document and present cultural heritage buildings (Cecotti, 2022). Virtual reality is an innovative tool that can be used to create immersive content and educational resources. In this way, users can explore and learn more about heritage sites from anywhere in the world, at any time. This tool is effective because, due to preservation concerns, most heritage sites are not open to the public or are only partially open. VR also supports narrative

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engagement, which plays a crucial role in fostering a deeper understanding of spatial and environmental designs.

This study presents a design-and-implementation framework for a browser-based WebVR walkthrough of Athangudi Palace. Its contribution lies not in proposing a new immersive technology, but in demonstrating how a lightweight, open-source, cross-platform workflow can be applied to a less-represented domestic heritage context in South India while making architectural sustainability legible to remote audiences.

1.3. Aim and research questions

This study aims to develop a virtual walkthrough and VR experience application for the Athangudi palace. The primary research questions include:

1. How can VR be used to document and represent the architectural features of a heritage building?

2. In what ways does a VR walkthrough improve access and understanding of heritage sites?

2. Literature Review and Background

Immersive technologies have significantly expanded the ways in which cultural heritage can be documented, interpreted, and communicated. Previous digital heritage projects tended to focus on visual reconstruction and archival representation, but more recent ones are starting to explore immersive media as a medium for access, participation, and interpretation. Bekele et al. (2018) describe this broader shift by showing how virtual, augmented, and mixed reality have evolved into mature systems capable of supporting both heritage documentation and public engagement. This transition is important because it places heritage VR not only within the domain of digital preservation, but also within educational and interpretive practice.

The later review papers affirm that the field has evolved to become more diverse in both usage and intent. Chong et al. (2022) demonstrate that cultural heritage virtual reality has adopted reviews, case studies, system design, and evaluation research, indicating that the field has moved beyond spectacular representation to learning, interpretation, and user participation. Similarly, Rodríguez-García et al. (2024) underline the importance of clear workflows for data acquisition, modelling, and user interaction, indicating that the value of immersive heritage systems does not necessarily lie in their visual realism but in how well their documentation and design logic are explained. These reviews, combined, indicate that successful heritage VR must unite three dimensions in a consistent manner: technical documentation, content, and user experience.

At the implementation level, many heritage VR projects still rely on detailed 3D reconstruction workflows, institution-specific systems, or museum-based installations. In contrast, lighter alternatives, such as browser-based and panoramic WebVR, can be more suitable for conservation-sensitive, resource-constrained heritage settings. Although earlier projects have demonstrated the value of immersive heritage environments for access and interpretation, fewer studies have emphasised open-source, cross-platform workflows that can operate across HMDs, desktops, tablets, and mobile devices without requiring dedicated software installation. The present study is positioned within this smaller but important design space, where the aim is not to produce a highly complex reconstruction, but to develop a reproducible WebVR framework for architectural interpretation, remote accessibility, and sustainability-oriented heritage communication.

There is a parallel literature associating digital heritage technologies with long-term conservation and sustainability. According to Mendoza et al. (2023), virtual reality, 3D documentation, and sensor-based systems are increasingly used tools for communicating with the public and for conservation planning, monitoring, and risk awareness. Rambach et al. (2020) also note the greater environmental and educational opportunities offered by immersive media. In this framing, heritage VR is not only worthwhile because it enhances access to remote locations, but also because it conveys the environmental acumen of traditional architecture, such as climate-sensitive design, material performance, and low-energy spatial reasoning. This view is particularly pertinent when historic buildings are interpreted to align with modern discourse on sustainability.

The case-based studies also reveal how immersive systems can transcend documentation to become interpretative environments. Cantatore et al. (2020) reveal how VR could unite architectural documentation, material data, and maintenance expertise in a teamwork heritage context. Similar examples of using immersive environments to increase access to conservation-sensitive sites and to help experts communicate with broader audiences are presented by Comes et al. (2020) and Banfi et al. (2023). These works are significant because they demonstrate that the most effective digital heritage systems are those in which documentation is incorporated into a well-organised visitor experience rather than displayed as isolated visual products.

The quality of the virtual visit itself is another issue that is replicated in the literature. Studies of virtual tours and museum experiences indicate that user engagement is highly influenced by navigability, interface clarity, authenticity, and whether the spatial content is legible. According to Resta et al. (2021), perceived architectural space, clearly represented artefacts, and navigability are the main factors influencing visitor engagement in virtual environments. Ren and Chen (2021) also found that positive reactions to the 360-degree heritage tour were strongly associated with authenticity, ease, and technical reliability. This knowledge is particularly applicable to domestic heritage contexts, where the visitor needs to know not just what they are looking at, but also how spatial layout, daily activities, and environmental design contribute to the building's cultural sense. These concerns are also consistent with broader findings from immersive learning research, which emphasise the need for clearer links between design choices, user engagement, and educational outcomes (Radianti et al., 2020).

Even with the rapid development of the field, significant gaps remain. To begin with, much of the literature remains devoted to museums, archaeological sites, monuments, or mass reconstructions, whereas domestic heritage architecture is still relatively underrepresented in immersive studies. Second, numerous published projects rely on resource-intensive modelling processes, custom installations, or institution-specific solutions, and place less emphasis on lightweight, browser-based, and cross-platform solutions that can be viable when working on a limited budget to document heritage and make it accessible to a broader audience. Third, sustainability is frequently viewed as an aspect of the context rather than as content actively communicated through the immersive experience, per se. These constraints indicate the necessity of structurings which are technically viable, situationally based and specifically directed at architectural comprehension.

Such gaps are particularly apparent in Chettinad architecture. Chettinad mansions in South India are notable examples of domestic heritage not only for their historical and social importance, but also for their design that responds to the climate, the use of materials, artisans, and a sophisticated spatial hierarchy. However, even immersive reenactments of such buildings remain minimal compared to museum-based or archaeological heritage applications. Digital structures that can reflect Chettinad architecture not merely as visual heritage but as a form of environmental and cultural knowledge decipherable by distant viewers are required in this regard.

The current research addresses this requirement by creating a WebVR virtual tour of Athangudi Palace. Unlike more reconstruction-oriented pipelines, the project uses a lightweight workflow, built on panoramic documentation, spatial audio, guided navigation, and hotspot-based interpretation, in an open-source A-Frame environment. The value of the study is thus less in its proposal of wholly new technology than in showing how a repeatable and cross-platform workflow can be utilised in a less-represented domestic heritage environment and the familiarisation and comprehension of sustainable architectural knowledge. In this regard, the project is placed as a design-and-implementation structure that integrates documentation, accessibility, and interpretive communication.

The argument also concurs with broader issues in heritage education and sustainable development. Cultural heritage conservation is also related to SDG 11, particularly the conservation of cultural assets in sustainable cities and communities, and the transmission of traditional building knowledge falls under the educational objectives connected with SDG 4. Through its presentation of Athangudi Palace as a heritage site and a reservoir of climate-responsive design information, the walkthrough is not only intended as a remote-access tool but also to convey the ever-relevant nature of vernacular architectural intelligence.

3. Case Context: Athangudi Palace & Its Sustainable Features

3.1. Historical and Cultural Context

Sri Letchmi Vilas popularly known as 'The Athangudi palace', is located in the district of Sivaganga, in Tamil Nadu. This mansion reflects the cultural and social values of the Chettinad region. The palace was built around 1929-32 by Shri N.AR. Nachiappa Chettiar. The construction was aided by the foreign connections of the Chettiar community through trade. The mansion used both local and imported materials, preserving the region's sustainability and cultural significance. The builders tried to keep the traditional architectural features and amenities fit to the climatic conditions with proper plan and vision (Rajivkumar & Kesavaperumal, 2018).

3.2. Architectural and Sustainable Features

This construction blends the features of both Western and traditional architecture. Notable features include open spaces for airflow and light, extensive wood carving on doors and pillars, rainwater harvesting outlets, and temperature regulation using homemade tiles called 'Athangudi tiles'. One major achievement is that this was created at a time when machinery and sophisticated tools were not available. The credit goes to the manual efforts of hundreds of craftsmen from regions like Tirunelveli and Nagercoil. This method of using sustainable features in heritage buildings can be made feasible by careful design and material use (Krishan et al., 2001; Kasiviswanathan et al., 2024).

3.3. Rationale for a VR Walkthrough

Athangudi Palace is a major heritage site in Chettinad and a climate-sensitive domestic building. The building, in addition to its historical and cultural significance, demonstrates the principles of sustainable design through spatial planning, material selection, and passive environmental design. Consequently, it can be of great interpretive benefit to students, architects, researchers, and broader audiences (Table 1). Nevertheless, the accessible areas are restricted due to geographical separation, transportation constraints, ownership, and conservation sensitivity.

A virtual walkthrough is a feasible solution to these constraints. The site allows a broader audience to experience it by enabling remote exploration through immersive visual and auditory representations, without causing additional wear and tear on the physical structure. Virtual reality, in this manner, can aid in heritage conservation and public education by making the building more accessible while maintaining its integrity.

Table 1 Contextual Overview of Athangudi Palace and the VR Walkthrough

Aspect	**Description**
Geographic Location	Athangudi village, Chettinad region, Tamil Nadu, India 10.1540° N, 78.7265° E
Cultural Affiliation	Nattukottai Chettiar mercantile community
Period of Construction	Late 19th to early 20th century (colonial-era economic boom)
Heritage Value	Domestic residence and social space for trade-based households

Aspect	Description
Geographic Location	Athangudi village, Chettinad region, Tamil Nadu, India 10.1540° N, 78.7265° E
Conservation Status	Privately owned heritage structure with restricted access
Key Sustainability Logic	Passive cooling, material efficiency, climate-responsive design
Educational Relevance	Demonstrates traditional sustainable practices and spatial intelligence
Role of VR	Enables access, interpretation, and preservation without physical impact
Target Users	Students, researchers, and the general public

4. System Design and Implementation

4.1. Content Creation Framework

A plan for creating a digital capture of the place was done with detailed steps. A team of researchers formed a group and planned the application's features and content process beforehand. The process starts with on-site documentation, followed by data capture. The team captured high-resolution images and 360° panoramic pictures of the palace. In the post-processing stage, the captured images are stitched, colour-corrected, and compressed for VR compatibility. The images are then formatted and optimised for web rendering. Spatial audio, in the form of a narration explaining the palace's structure, was integrated into the application. It is evident from existing studies that high-quality standards and a structured methodology must be followed in virtual reality applications (Wang et al., 2020). This is essential for better understanding and educational purpose.

The content creation diagram (Figure 1) illustrates the workflow of creating the VR scene. It describes the process from documentation to application deployment. User testing was also implemented before final deployment to identify flaws in the application. In summary, the workflow progressed through site documentation, media capture, post-processing, WebVR implementation, internal testing, and iterative refinement, with each phase informing subsequent design decisions.

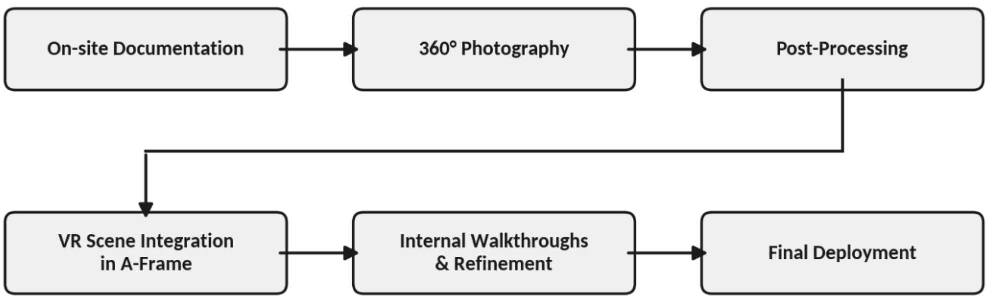

Figure 1 Content Creation Framework

4.2. Design and Implementation

4.2.1. Design-Oriented Research Workflow

The project followed a design-oriented development workflow in which documentation, content preparation, interaction design, testing, and refinement were iteratively integrated into the final WebVR environment (Yang et al., 2024; Innocente et al., 2023). Figure 2 shows the application development process, which begins with on-site documentation. This phase involved conducting multiple visits to the site, during which high-resolution photography, 360-degree panoramic photographs, and spatial sound recordings were captured.

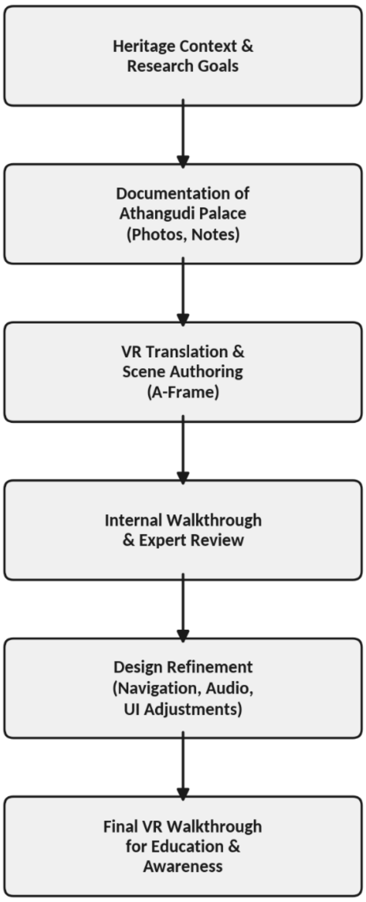

Figure 2 Design-Oriented Research Workflow

4.2.2. On-site Documentation

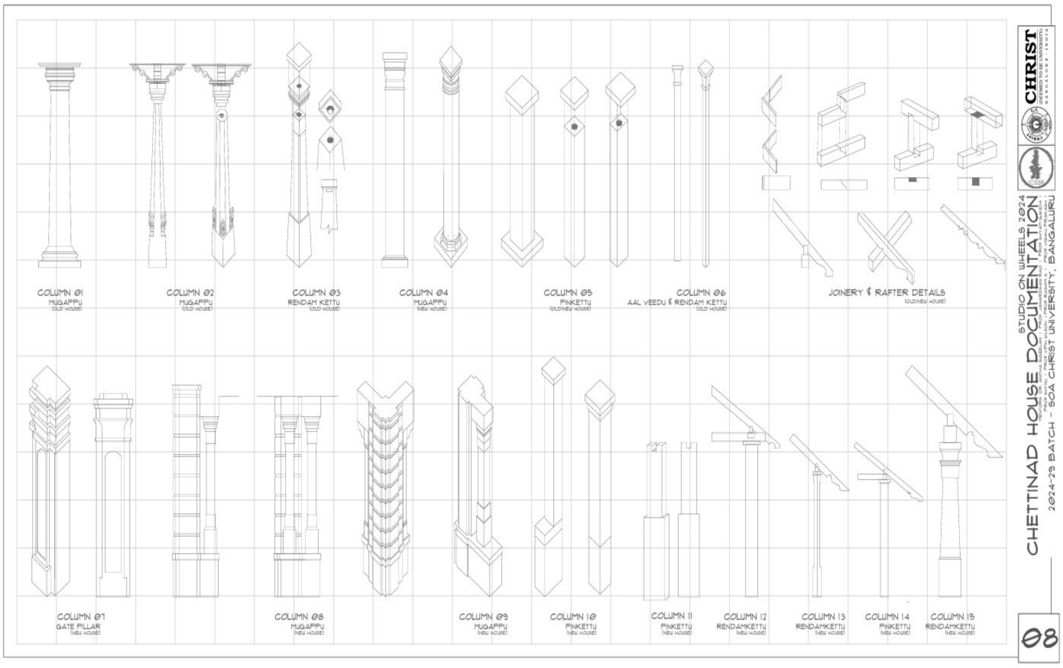

Figure 3 On-site documented pillar documentation (Source: Authors' Sketch)

Detailed written documentation was also prepared on the building's spatial features and other architectural components (Figure 3). These physical data played an important role in providing a basis for creating an accurate representation of the spatial environment's logic in the Athangudi palace, which allows subsequent replication of the experience and intangible aspects of the palace's heritage (Rodríguez-García et al., 2024).

After the on-site documentation, the next phase involved classifying and identifying the sustainable design features and attributes of the palace. This step was crucial in creating the accurate VR scenes and associated production process. For example, the panorama images were stitched together, 'optimisation' and 'colour correction' were conducted prior to usage for full immersion. The placement of navigation nodes and hotspots was designed to allow the user to have both a guided and exploratory experience of the palace.

4.2.3.Capturing 360° Photographs and Spatial Audio

After preparing the user journey script, the team captures high-resolution 360° images of the palace using a Ricoh Theta Z1 and records spatial audio using a Zoom H3-VR Handy Audio Recorder. Each photo was taken 5 feet apart to replicate a real walkthrough experience while covering the entire space. Audio was recorded along with the camera path using a Zoom H3-VR. These collected captures were later edited and optimised for creating the walkthrough and VR.

4.2.4.Creating WebVR Walkthrough

Technically, the Virtual Reality walkthrough of the Athangudi palace was developed as a web-based VR experience using the A-Frame framework, which is built on top of WebGL and WebXR (A-Frame, 2025; Mozilla, 2025). WebGL serves as the underlying graphics API that allows real-time rendering of 3D graphics directly in the web browser, while WebXR provides standardised support for both immersive and non-immersive VR/AR devices, ensuring cross-platform compatibility (Mozilla, 2025). This configuration has enabled the experience to be accessed across platforms, running on both standalone virtual reality headsets and web browsers on desktop and mobile devices, without requiring any special software installation.

The virtual environment is structured as a scene graph, comprising sky items, high-resolution equirectangular panorama images, and other 3D components for scene translation. The Scene translation facilitates users' journey throughout the environment. For this, 3D interactive navigation planes, raycaster-based inputs, gaze-based interactions and controller-based interfaces were used throughout the scenes. Another critical practice is maintaining assets throughout the application's runtime. Asset Management practices were implemented to ensure that the application's visual quality and performance were balanced, controlling image and audio configurations and thereby significantly reducing download time.

By attaching event listeners to hotspot interactions, spatial audio narration is triggered in a contextual way, allowing for greater immersion without requiring continuous background playback (which may increase cognitive load). The technical optimisations applied include limiting draw calls, reducing the number of real-time lighting calculations, and ensuring stable frame rates throughout VR use to enhance comfort during the VR experience. Through internal testing across various devices, we focused on evaluating latency, loading times, user responsiveness when interacting with objects and surroundings, and how to minimise symptoms of motion sickness and disorientation during VR use. When combined, the above-mentioned technical decisions provided users with an enhanced, lightweight, stable, and accessible experience while still offering an immersive educational experience and conveying the rich architectural and environmental complexity of Athangudi Palace.

4.3. VR platform and technical stack

With A-Frame (A-Frame, 2025) and support for the WebXR Device API (Mozilla, 2025), the VR application can be accessed on desktops, laptops, mobile devices, and standalone VR headsets without requiring additional software installation. The VR environment is created with tags. The assets are preloaded, so the scenes load faster. To create interactivity, the component provides precise control over the camera's movement, navigation nodes, audio triggers, and animation sequences.

For every VR prototype, performance optimisation remains a significant focus. The images are compressed to reduce download sizes while retaining clarity. Implementing Lazy Loading for models is essential to achieving an optimal frame rate (>60 FPS). The Asset Management Diagram (Figure 4) illustrates the hierarchical structure of the VR components.

1. The User's view is centred about the camera rig.

2. The Navigation and Teleportation Nodes indicate what paths will be available for the user for movement.

3. The Hot Spot provides associated text labels, audio components, and visual highlights.

The modular design allows for the easy addition of more scenes or the potential development of more advanced features, such as interactive energy simulations for future integration.

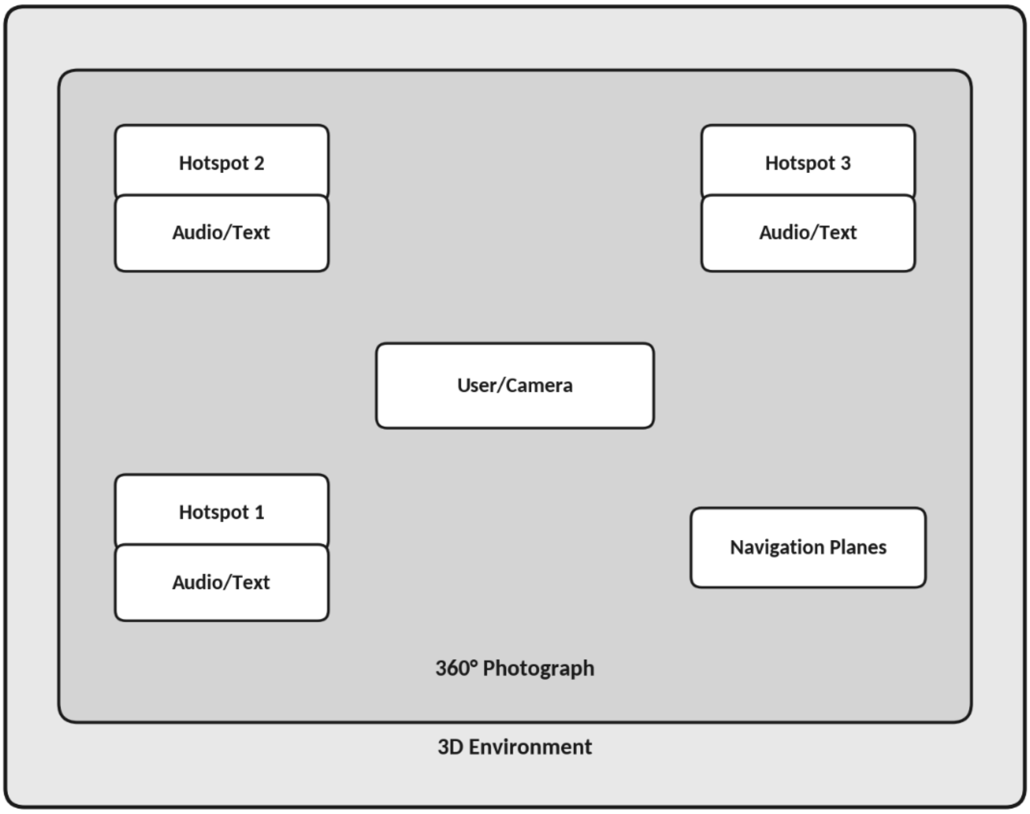

Figure 4 Interaction and Information Architecture

4.4. Overall concept and user journey

The application was divided into two parts: a walkthrough application that supports all devices (phones, laptops), and a VR application made specifically for Head-Mounted Displays (HMDs). Both divisions share the same resources, which aim to provide users with an immersive cultural learning experience while raising awareness of the conservation of heritage sites. The application guides the user throughout the palace, starting from the entrance, where they navigate through various scenes, including the central courtyard, Mugappu halls, veranda, thinnai, and many more. A structured user navigation flow diagram is given in Figure 5 A narrative flow was set in the application to visually and auditorially guide users throughout the palace, using audio cue buttons and navigation panels. The application was designed to mimic the real immersive experience of the palace; to this end, pre-recorded palace spatial sounds were added in the background, along with high-quality panorama images, to give the user a point-of-view (POV) perspective while highlighting specific points of interest.

The user journey flow diagram (Figure 5) shows the user journey in the application, starting at the entrance scene, progressing through the introductory interfaces, scene navigation, and scene hotspots, and concluding with an exit Scene. The application also allows users to revisit previous scenes and has a playback option for the same audio cues. The flexibility in terms of navigation aids users for a better understanding of the details, especially in virtual reality head-mounted displays.

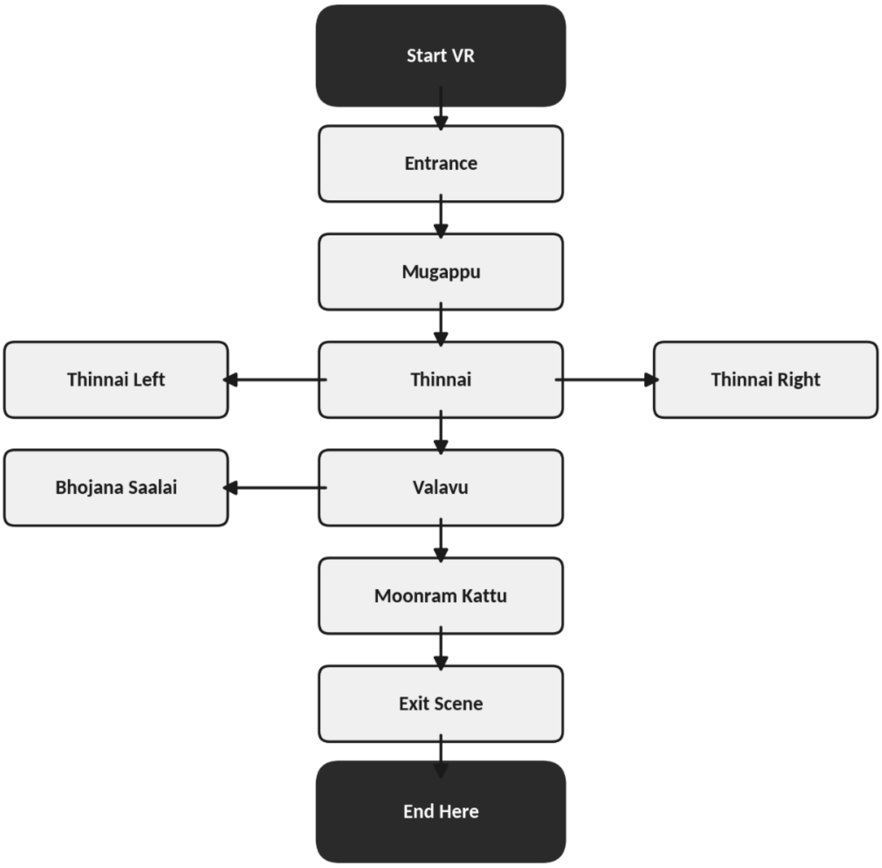

Figure 5 User Journey Flow Diagram

4.5. Interaction and information design

The interaction system aims to strike a balance between open-ended exploration and educational guidance. Users navigate by utilising both hotspots and teleport nodes located at significant architectural features. Hotspots have been created that provide users with:

- Audio narration that provides detailed explanations of different environmental strategies.
- Visual highlights that draw users' attention to specific design elements.

Users can navigate linearly through rooms or take non-linear routes for self-directed learning. This will allow users to develop a cognitive map that connects their understanding of spatial navigation with their knowledge of the building. The design of these interactions was created with accessibility in mind. The text overlays feature high contrast, making them easy to read. Motion paths and camera rotations are designed to minimise the effects of motion sickness. Audio or text descriptions can also be replayed for users who utilise different learning styles.

4.6. Audio and immersion design

Audio is a key component in creating a compelling and realistic experience of Virtual Reality (VR) and fosters greater immersion and understanding of how Athangudi Palace's architectural design functioned. Every scene features ambient sounds that replicate the palace's acoustic environment, including the natural reverberation from high ceilings in open hallways, the faint sound of wind in open courtyards, and the subtle sounds of footsteps and people throughout the surrounding space. Hotspots are supplemented with audio narration that provides information on sustainable building techniques, building material choices, and the building's historical background, so users can have multiple experiences or layers of information on top of what they see. Audio interactive sounds have been created to accompany user-triggered actions, such as scene transitions or hotspot activations, allowing users to receive immediate auditory feedback and providing a greater sense of place and presence when interacting with the space, and encouraging users to engage further. Audio placed in specific spatial locations enables users to experience the dynamic elements of an environmental system, such as airflow through an extension porch or cooling areas created by shaded locations in a courtyard, very physically, at the point where ambient sounds occur. Layering both ambient and instructional audio in a binaural format, which enables spatial audio listening through headphones, provides a more realistic atmosphere by identifying key factors within the user's view, thereby leading the user towards learning by retaining the essential components (Zoom Corporation, n.d.). Audio capture was conducted in two stages. In the first stage, the ambient bed was captured using the first-order ambisonics microphone Zoom H3- VR. The second stage involved recording narration in a soundproof studio. The 3D spatialisation and audio post-production were done using Reaper digital audio workstation (evaluation version), and Free (Proprietary) audio plugins such as dearVR PRO 2 and dearVR spatial connect (Figure 4). These plugins helped position the audio segments in the desired places so users would feel a realistic sense of the environment.

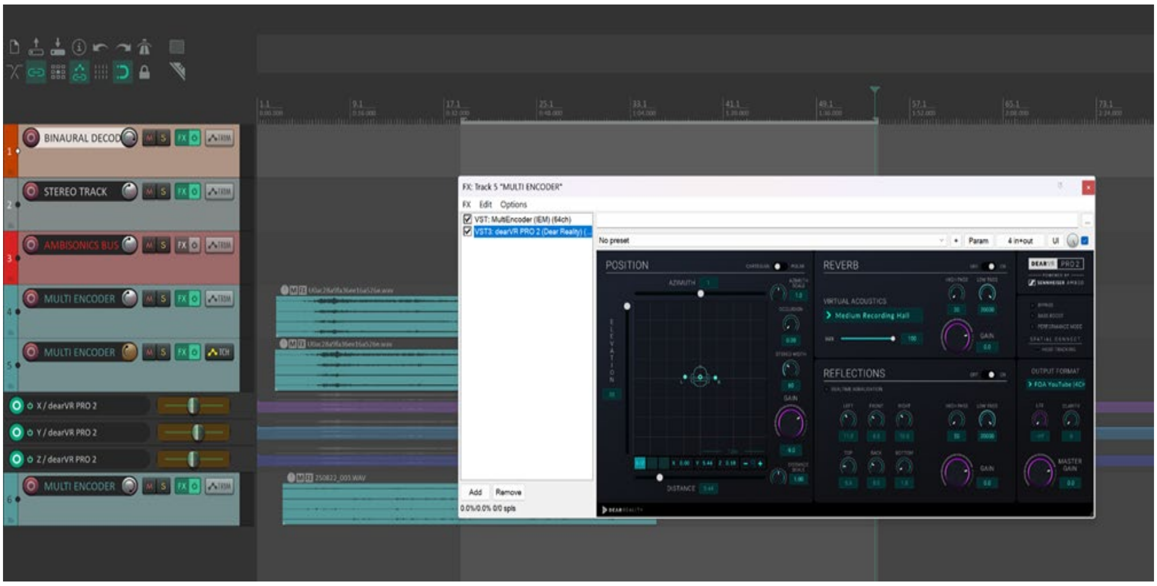

Figure 6 Spatial audio production in Reaper software (Source: Authors' screen capture)

4.7. Interface and usability considerations

A home page was designed (Figure 7). This page provides a brief description of the Athangudi palace. From here, users can choose between two options: a walkthrough feature accessible on any device (mobile or desktop), or a custom VR application designed for Head-Mounted Displays (HMDs). Both of these parts provide the same experience, though in HMD devices, the immersion will be comparatively higher. With these technologies, users can now experience the spatial and environmental characteristics of a palace without direct physical contact (Bekele et al., 2018; Cecotti, 2022). The home page also features an interactive header that rotates and displays random 360-degree images of the palace. The user interface design focuses on creating a comfortable, accessible, and educationally transparent experience for users with varying backgrounds and abilities, enabling them to interact within the virtual environment.

Therefore, all interactions are made as easy as possible to engage with via simple point-and-click or touchscreen controls (Jerald, 2015; Katona, 2021). The interface was designed to remain legible and approachable for users with limited prior VR experience. (Figure 8). Visual elements, such as overlays, captions, and labels, are created with high-contrast and clear typefaces for easy readability (Jerald, 2015). These visual elements provide users with information without interfering with their immersion in the immersive environment, using fade-ins, fade-outs, and transition techniques throughout the programme's configuration, as well as adjustable settings.

The user interface was designed to balance historical representation and the educational objectives. Virtual models have been simplified and enhanced to showcase the heritage's sustainable aspects while maintaining visual realism. The information is presented as hotspots, allowing the user to control how much information they take in at any one time while still maintaining focus on their desired level of learning. This allows the learner to build an immersive cognitive experience and create spatial relationships to the environmental context, thereby appreciating the sustainable principles behind the design of Chettinad architecture. At the end of the application, we have an exit page that provides a conclusion text and returns the user to the home page (Figure 9: Conclusion Page).

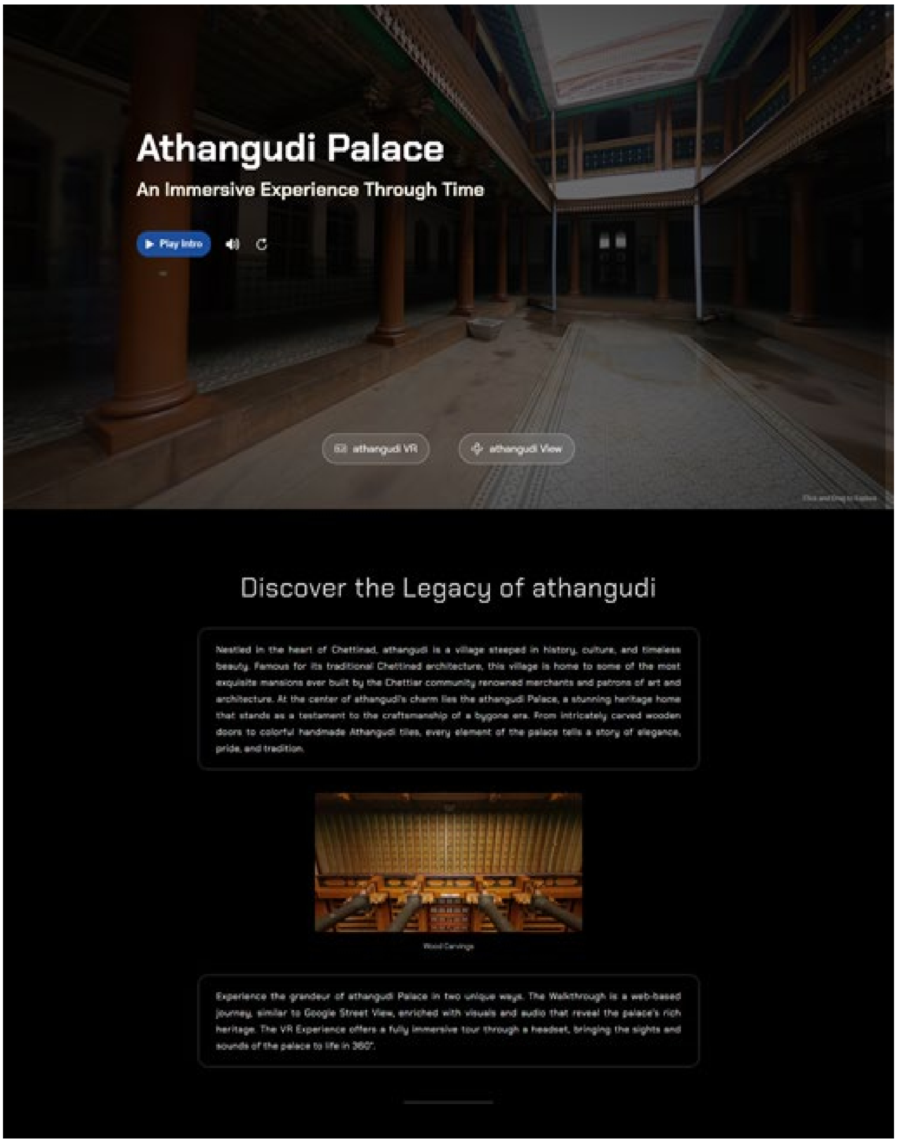

Figure 7 Home Screen (Source: Authors' Tool)

Figure 8 Walkthrough Screen (Source: Authors' Tool)

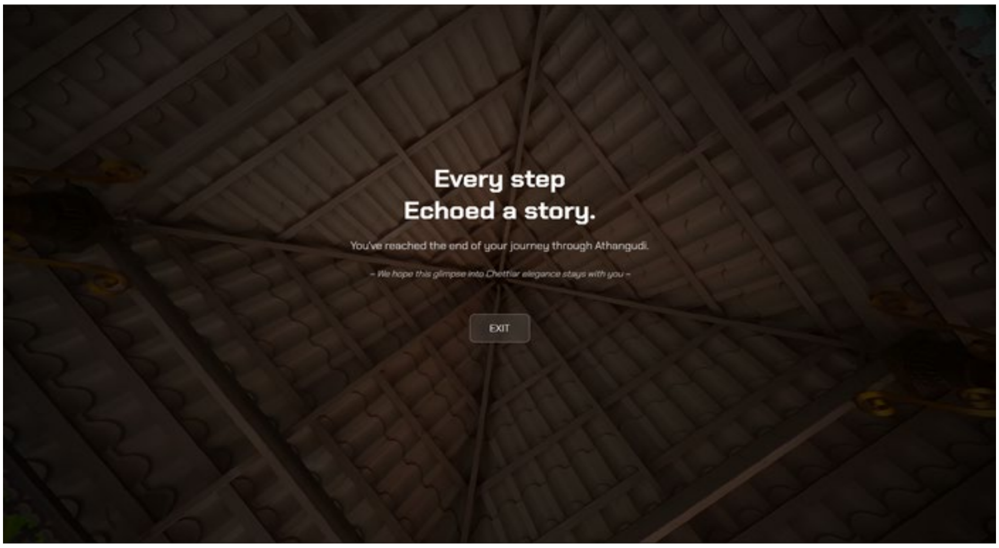

Figure 9 Exit Screen (Source: Authors' Tool)

5. Refinement & Testing

Refinement occurred through iterative internal testing during development (Figure 10). The project team reviewed the walkthrough across the intended access modes, including HMD and browser-based use, to identify issues with loading time, hotspot responsiveness, scene transitions, navigation clarity, audio triggering, and overall interaction comfort. Feedback from these checks informed asset compression, interface adjustments, and interaction refinements. In addition, consultations with heritage experts and design practitioners were used to improve the accuracy of architectural representation and the clarity of interpretive content. This phase should be understood as development-oriented in-house refinement rather than a formal usability or learning evaluation.

Figure 10 User Testing (Source: Authors' Test)

Use the following link to see the virtual walkthrough: https://zzz1750.github.io/Chettinad-Heritage-VR-Athangudi/

6. Discussion

The paper illustrates that a WebVR framework based on a browser can offer a feasible approach to documenting and interpreting a conservation-sensitive heritage building in a lightweight, accessible, and educative form. A-Frame and panoramic media can also enable a relatively low-cost, flexible workflow, which is particularly valuable in heritage settings where budgets, access, and technical infrastructure are constrained. The project also demonstrates that sustainable architectural knowledge can be integrated into the walkthrough through layered narration, navigational guidance, and hotspots with visual anchoring, rather than being viewed as background information. At the same time, the study has clear limitations. The current contribution is the design framework and the implementation logic, not a formal measure of user learning, usability, or behavioural impact. Subsequent development should then be based on this prototype, using systematic user testing, comparisons, usability improvements, and additional interpretive capabilities such as multilingual narration or environmental simulation. In this sense, the framework does more than provide visual access; it reorganises architectural knowledge into an interpretable sequence of spatial views, narrated cues, and interactive hotspots through which users can understand passive cooling, material logic, and spatial hierarchy as lived design principles rather than as static descriptive facts. Although developed for Athangudi Palace, the framework is also transferable to other vernacular, domestic, and conservation-sensitive heritage typologies that require low-cost, browser-based interpretation.

7. Conclusion

Athangudi Palace is a significant example of Chettinad heritage architecture with limited access. This study addressed that challenge by developing a cross-platform WebVR walkthrough that can be experienced on HMDs, desktops, tablets, and mobile devices. The study adds a systematic, repeatable process that includes documentation, media capture, asset preparation, browser-based implementation, and refinement. The panoramic representation, guided interaction, and spatial narration allow visitors to be more aware of the architectural and sustainability-related features of the palace without placing physical stress on the site, thereby enabling remote users to better understand the physical site. As a low-cost and adaptable model, the framework can inform future digital heritage projects involving vernacular and domestic architecture, while also providing a basis for subsequent user-based evaluation of learning, usability, and interpretive impact.

CRediT Authorship Contribution Statement

Antony Zharon: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Data curation, Conceptualization. Ajith Paul: Writing – review & editing, Writing – original draft, Methodology, Investigation, Analysis, Conceptualization, Data visualization. Balakrishnan C: Writing – review & editing, Methodology, Investigation, Analysis, Data curation, Conceptualization. Biju Kunnumpurath: Methodology, Investigation, Analysis, Data visualization. Anitha Suseelan: Methodology, Investigation, Analysis, Data curation.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data Availability

Data will be made available on request.

Ethics Committee Approval

Ethics committee permission is not required.

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Resume

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