MUVE – Virtual Museum

Team 9

Final Report 50.052: Extended Reality

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1. Overview

The International Council of Museums (ICOM) defines a museum as a permanent, non-profit institution that serves society by preserving and presenting tangible and intangible heritage. Museums are designed to be accessible, inclusive, to preserve the history of human civilization and foster cultural exchange and learning[1].

However, accessibility remains a significant challenge for many individuals. Physical, financial, and geographical barriers prevent many individuals such as those with disabilities, in remote areas, or with limited finances, from accessing these invaluable resources. This raises the challenge of transforming museums into truly inclusive spaces that can transcend such limitations, ensuring equitable access for all.

1.1 Problem Statement

After identifying the issue, we propose a problem statement to serve as a guide for the development this project:

“By leveraging virtual reality (VR) technology, how shall we create an immersive museum experience that will make cultural heritage accessible to diverse audiences worldwide.”

1.2 Goal

The identified barriers to accessing museums emphasize the need for solutions that prioritize inclusivity and accessibility. To address these challenges effectively, we have outlined a series of targeted goals.

1.2.1 Enhancing Accessibility

We want to overcome the physical, financial and geographical barriers of visiting a museum and ensuring that no matter where or who are you are, you will be able to learn about the world.

1.2.2 Preserve Cultural Heritage

By digitalising the artefacts, their current state will be “frozen in time” and allow anybody in anytime in the future be able to interact with it in our virtual world.

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[1] https://icom.museum/en/resources/standards-guidelines/museum-definition/

1.2.3 Enhance Education and Museum Design

We want to increase interest in arts and cultural heritage but making learning it fun and interactive.

1.3 Reason for Virtual Reality

Having established the goals necessary to address the challenges faced by traditional museums, we now focus on the ideal platform for achieving these objectives. Virtual Reality (VR) offers unique capabilities that go beyond traditional digital displays, making it an optimal solution for our virtual museum.

1.3.1 Life Sized Scale

Although digitizing artifacts for websites and mobile applications is valuable, viewing them on a screen often fails to convey their true scale. Virtual reality offers a solution by accurately scaling artifacts to their actual size, allowing visitors to fully grasp their dimensions and context. This creates a more immersive experience, as exemplified in (Figure 1).

1.3.2 Global Inventory

With virtual reality, if an item is digitalised, it can be placed in the virtual museum, and it is a non-rivalrous good which meant that it can be interacted by any number of people without limits. This also meant that the virtual museum could hold any item from any museum without limit even if physically, they are more than hundred thousand kilometres apart. This mean that a virtual reality museum could potentially become the world's most comprehensive and realistic museum with every single item in the world.

1.3.3 Infinite Canvas

The space in VR is also infinitely extendable which meant that no matter how large the museum becomes, you will still be able to fit more things in and this is especially ideal for building a complete encyclopaedia of artefacts of humanity.

2. Approach

2.1 Addressing the problem

To tackle the challenge of creating an engaging virtual museum experience, our team focuses on three key aspects: user interaction, realistic artefact representation, and immersive audio description, all within a uniquely designed medieval themed environment.

This setting not only enhances the aesthetic appeal but also enriches the user experience through strategic mood lighting, creating an atmosphere that captivates users. By leveraging Extended Reality (XR) technologies, we aim to deliver a seamless experience where users can explore artefacts interactively as if they were wandering through a medieval hall.

2.2 Pipeline steps

2.2.1 Conceptualization and Design

In the initial phase of our project, we focused on defining the overall layout and user experience of the virtual museum. This involved collaborative brainstorming sessions where our team explored the medieval theme and identified the types of artefacts we wanted to include in the experience. We discussed how to best represent the historical context and aesthetics of the period.

To visualize the user journey, we created rough sketches and wireframes that outlined the navigation and interaction points within the themed environment. This planning stage was crucial for establishing a cohesive design that would guide users through the museum in an engaging and intuitive manner, ensuring that every element contributed to the immersive experience we aimed to achieve.

2.2.2 Sourcing for artefacts and 3D modelling game objects

In this phase, our objective was to develop realistic 3D models of the selected artefacts to enrich the virtual museum experience. Most artefacts were sourced from the public domain collections of Minneapolis Institute of Art and Cleveland Museum of Art, which generously provided high-resolution 3D scans of their collection. This access enabled us to create accurate representations, significantly enhancing the educational value of the museum. Additionally, we gathered detailed descriptions and dimensions of each artefact from the official websites to ensure that our models were precise and informative. Beyond the artefacts, we utilized Blender to import and design specific "game" objects necessary for user interaction, such as clipboards. This approach ensured that the virtual environment was not only visually appealing but also functional and engaging, allowing users to interact seamlessly with both the artefacts and the additional objects within the space.

2.2.3 Virtual Environment Development

The objective of this phase was to construct the immersive medieval-themed museum space where the artefacts would be displayed. To achieve this, we utilized the Unity game engine to build a detailed medieval layout, incorporating elements such as stone walls and wooden beams that reflect the architectural style of the period. We also implemented atmospheric lighting effects to enhance the environment, creating mood lighting techniques that not only added to the aesthetic appeal but also guided users through the space, making navigation intuitive. Additionally, we enriched the virtual scene by adding decorative pieces, such as tapestries, barrels, and torches, to create a sense of a “lived-in” space. This attention to detail contributed to a more immersive experience, allowing users to feel as though they were truly exploring a medieval museum filled with history and character.

2.2.4 Interaction Mechanics

In this phase, our objective was to enable users to interact seamlessly with the artefacts, allowing actions such as picking them up or triggering audio descriptions. To accomplish this, we programmed interaction scripts that recognized user inputs, particularly from controller buttons, which facilitated the picking up and manipulation of objects within the virtual environment. This programming was crucial for creating an intuitive and engaging user experience. Additionally, we developed a user-friendly interface that allowed users to easily access audio descriptions whenever they interacted with an artefact. This integration not only enhanced the educational aspect of the museum but also ensured that users could navigate the information effortlessly, enriching their overall exploration of the medieval-themed space.

2.2.5 Simulation of motion

The objective of this phase was to ensure smooth and realistic motion within the virtual environment. To achieve this, we implemented physics engines that simulated realistic movements and interactions, incorporating essential elements such as gravity and collision detection. This allowed objects to behave in a way that users would expect in the real world, enhancing the overall immersion of the experience. Additionally, we utilized animations for both user avatars and artefacts to further enhance realism, ensuring that movements felt fluid and responsive. By focusing on these aspects, we created a virtual environment that not only looked visually appealing but also provided a dynamic and engaging experience for users as they navigated through the medieval-themed museum.

2.2.6 Audio Integration

In this phase, our objective was to provide engaging audio descriptions for each artefact, as well as ambient sound effects, footsteps, and interaction sounds to enhance the immersive experience. We began by generating high-quality audio narration that offered historical context and interesting facts about each artefact, enriching the educational value for users. To ensure a seamless experience, we integrated audio triggers that were linked to user interactions, allowing descriptions to play at the appropriate moments when artefacts were examined or manipulated.

Additionally, we created an audio system that included ambient sounds, such as subtle background noises that evoke the feeling of a medieval environment, as well as the sounds of footsteps and the interactions of picking up and throwing artefacts. This attention to audio detail helped to mimic real-life experiences, further immersing users in the medieval-themed museum and enhancing their connection to the artefacts on display.

2.2.7 Minigame

The objective of this phase was to engage players by challenging them to find all the artefacts hidden within the virtual environment. To facilitate this, we designed a minigame that incorporates a checklist of clues, guiding players on their quest. As players navigate through the medieval-themed museum, they must use the clues provided to locate each artefact, adding an element of exploration and discovery to the experience. This interactive feature not only enhances user engagement but also encourages players to pay closer attention to their surroundings, making the exploration of the virtual environment both fun and educational. By integrating this minigame, we aimed to create a dynamic experience that motivates users to interact with the museum in a more meaningful way.

2.2.8 Testing and Iteration

In this final phase, our objective was to refine the virtual museum experience based on feedback from team members. We conducted testing sessions where team members explored the museum, focusing on various aspects such as navigation, interaction mechanics, the minigame, and the overall user experience. This hands-on evaluation was essential for identifying areas that required improvement or adjustment.

After gathering feedback, we carefully analysed the responses to understand user perceptions and experiences. This analysis informed our iterative process, allowing us to make targeted improvements that enhanced usability and engagement. By refining elements based on real user interactions, we ensured that the final product not only met our initial design goals but also provided a more intuitive and enjoyable experience for future users. This commitment to testing and iteration underscored the importance of user-centred design in creating an effective virtual museum.

By following this structured approach, we aim to create an immersive and educational virtual museum experience that captivates users and enhances their understanding of the artefacts on display, all within a uniquely themed medieval environment.

3. Implementation

For MUVE, it will be a complete standalone virtual reality application built for the Meta Quest 2.

3.1 Technological Stack

3.1.1 Development Environment: Unity3D

The virtual museum will be developed using the Unity Engine, a powerful gaming engine that is often used to build 3D environments and virtual reality applications.

3.1.2 Programming Language: C#

C# will be the primary programming language, as it is native for Unity and thus, we will be able to leverage its extensive libraries and tools for VR development.

3.2 Virtual Environment

To build up our virtual environment, we focused on three key elements, high quality 3D models and Assets, Realistic Audio and Realistic Lighting to build an immersive experience while having a unique artistic style that allows you to identify that you are in a fantastical world.

3.2.1 3D Models and In Game Assets

Artefacts

To bring our virtual museum to life, we sourced 3D models of artefacts from reputable public domain collections, primarily from the Minneapolis Institute of Art (MIA) and the Cleveland Museum of Art.

For this project, we carefully curated a selection of 20 artefacts from MIA and Cleveland Museum of Art. This curated set serves as a proof of concept, demonstrating the virtual museum’s ability to accommodate and showcase artefacts from diverse cultural and geographical origins.

After importing the 3D models into Unity, colliders were added to each artefact to enhance their functionality and realistic interactions for the users as seen from (Figure 2).

Building

For the museum building as well as tutorial room, we sourced open source and free models from online such as from Sketchfab. After trying out several 3D environments, we were able to narrow it down to a low-poly dungeon environment asset which we will use for the project and the below showcases our earliest iterations of the museum as seen in (Figure 3) and (Figure 4).

We were also able to find a separate set of assets that gave off a more modern feel for the tutorial room, seen in (Figure 5).

Customised 3D Assets

Apart from using online sources, we also handcrafted some assets by ourselves such as a clipboard that is used to display a custom mini map for the mini game after free exploration is completed. As seen in (Figure 6), we implemented the settings page and the task page onto the page of the clipboard.

In our virtual museum project, we plan to implement two pages on the clipboard to enhance functionality and realism. The first page will serve as the settings page in (Figure 8), while the second page will display a minimap of the museum for user navigation in (Figure 7). To make the interaction more lifelike, we will use Blender to create an animation where the first page flips over to reveal the second page. This animation will mimic the natural movement of a page turning, adding a layer of realism to the clipboard interaction.

The minimap on the second page is an exact scaled-down representation of the museum's layout. We meticulously designed the outline to ensure accuracy and consistency with the actual museum dimensions as seen in (Figure 9) and (Figure 10). To enhance usability, we also incorporated a user icon on the minimap, allowing users to easily identify their current location and navigate the museum with confidence.

3.2.2 Audio

We have a variety of audio pieces used for our projects from the artefact narration to the footsteps and UI interaction sounds.

Artefact Narration

For artefact narration, from the curated lists of artefacts, we took the description and made slight modifications and used that as the text that will be narrated whenever a visitor press on the narrate button next to the artefact label such as the one in (Figure 11). We used online AI text-to-speech from ttsmaker[2] to convert the description text to voice for the audio. We also generated subtitles when required using maestra.ai [3].

Background Music, Ambient Noise, UI Sound Effects and Footsteps

For the background music and ambient noise, UI sound effects, and footstep noises, we sourced it from the Unity Asset Store. The footstep noises are essential as it provides a more immersive experience when the visitor move around in our virtual museum. A museum will often provide you with a calming and tranquil experience and the addition of footsteps sound effect based on different tile materials aims to emulate this.

3.2.3 Lighting System

For the lighting, we made use of spotlights and reflection probes in addition to the lighting from the torch props. Since the light intensity from the torch props were not enough, we used spotlights to create an ambience of soft lighting. Reflection probes were used to ensure that materials that have reflective properties would be displayed correctly.

For performance, we baked the lighting.

3.2.4 User Interaction

Navigation

For this virtual museum, we decided to implement two versions of movement control. Firstly, it is movement via the handset joystick which allows the visitor to move like WASD on the keyboard as seen in (Figure 12). This is a learned experience, and most users should be familiar with joystick control and therefore, it is necessary for this to be implemented, or else the virtual museum might not work as the user expected which could break immersion immediately.

Another method for movement is teleportation as seen in (Figure 13). From class lectures and research, it is found that teleportation movement reduces motion sickness which is important for us as we are trying to create a calming environment and due to the multi-storey layout of our museum, travelling up and down can be nauseating and tedious, therefore, the secondary option of teleportation was also added.

As can be seen in the above image, we have also implemented ways to teleport between different storeys instead of step-by-step teleportation which improves usability.

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[2] https://ttsmaker.com/
[3] https://maestra.ai/tools/subtitle-generator

UI Interaction via custom UI toolkit

To reduce the amount of work needed to implement various user interface affordances, we developed a custom UI Toolkit that serves as a convenience layer between object states and affordances.

Object states can refer to Unity GUI element states (e.g. Hover, Select, Focus, Disabled) or XR Interaction Toolkit's Interactable states (e.g. Hover, Select, Focus, Activate, Disabled). Affordances refers to side effects that results from object interaction that makes the interaction more impactful. These side effects can refer to object transformations such as position, rotation, or scale offsets, or it can play audio, or change text values.

The controller component (Figure 14) serves as the abstraction layer between the affordance and the user interface element. It handles binding the object states to a common resulting state. This component can be extended for any other kinds of stateful components. A custom inspector layout was created to easily visualize all current attached effects on the host GameObject, as well as common functions like adding a new visual effect component.

The current list of effects is as shown:

1. General:
    a. Activate Visual Effect
    b. Animation Trigger Visual Effect
2. Colour:
    a. Material Colour Visual Effect
    b. Image Colour Visual Effect
    c. Sprite Colour Visual Effect
    d. Sprite/Image Colour Visual Effect
3. Transform:
    a. Position Visual Effect
    b. Rect Position Visual Effect
    c. Rotation Visual Effect
    d. Scale Visual Effect
4. UI:
    a. Text Visual Effect
    b. Image Swap Visual Effect
    c. Sprite Swap Visual Effect
    d. Sprite/Image Swap Visual Effect
5. Audio:

a. Audio Clip Visual Effect

These different effects are hosted under a Visual Effect component (Figure 15) on the GameObject, where the type of effect and its values are stored as an asset, to allow common effects to be shared across different UI elements. These effects have a “target” GameObject to allow them to apply effects on GameObjects other than the one they are attached on. Most effects can be interpolated via an animation curve if applicable.

Object Interaction

The XR Interaction toolkit provides a Grab Interactable component (Figure 16) that provide functionality to finely control object interaction behaviours such as single or multi-hand grabbing. This allows objects to be grabbed and moved via a ray or via a direct grab, and scaling with two hands.

3.2.5 User Interface

In-Game Interactive UI

With the user interface, we first ideated by drawing out on paper simple UI, did a mood board, such as the one in (Figure 17), and looked at existing VR applications to get a feel for how VR UI should function. We ideated that there should be a clipboard that displays key information such as the tasks that needs to be completed and other information like mini map should also be included in the UI.

From there, we went and did a prototype of it in Figma to get a better understanding of how it might eventually look as seen in (Figure 18). After discussion, we decided to take out some elements such as health bar and inventory as there was not much purpose in these UI being present as they will not be used.

Player Menus

We also started to develop and implement various hand menus in the actual virtual museum that can control things such as sound level as seen in (Figure 19). This was especially important for usability so that users will be able to control the application settings.

3.3 Optimisation

Here are the various techniques we used for optimizing our standalone application so it can run smoothly on the Quest 2, which uses a mobile chip.

3.3.1 Baked Lighting

Baked lighting with mixed lights (Figure 20) is utilized along with keeping the scene static as much as possible. This allows us to have many lights in our indoor scenes while keeping rendering fast, as having many lights significantly slows down rendering.

3.3.2 Artefact LoDs

LODs refer to level of details meshes (Figure 21), and it is one of the most significant contributors in performance gains, besides baked lighting. The Quest 2 has a recommended triangles per frame metric to keep under (2 million) for stable performance, but since the artefact models are 3D scanned, they often have unoptimized geometry (up to 800k tris on a particular object!) and are very dense in tri-count. Most of the time, the details from the high-fidelity meshes are not visible due to the object being too far from the player's view and the screen simply does not have enough resolution to resolve all that detail.

Thus, using lower quality meshes depending on how much of the screen the model is occupying optimizes the computational power needed to only render the required level of detail per object.

Meshes of different polycounts are generated and are actively swapped on-the-fly during runtime with minimal disruption to allow the player to experience the high-quality artefacts up close, and a stable framerate when in a room full of artefacts.

3.3.3 Occlusion Culling

Like baked lighting, occlusion details can also be baked to allow objects hidden from view (e.g. behind a wall) to not be rendered (Figure 22). All objects outside the camera frustrum also have their renderers disabled.

4. Result

The project successfully delivered a proof-of-concept for a virtual museum, showcasing a virtual world that immerses users in a museum experience. This application includes life-sized exhibits, detailed 3D artefact models, and intuitive navigation features tailored for the Meta Quest 2.

4.1 Virtual Environment

4.1.1 Main Hall

In this project, we managed to build a multi-storied museum environment that visitors can freely explore, view and study life sized artefacts placed all around the building as seen in (Figure 23).

We also managed to place numerous artefacts such as the ones seen in (Figure 24) are placed around the museum and visitors are encouraged to freely explore the area to study and understand them.

Taking note of performance issues, we made sure to place our artefacts so that they will always be taking full advantage of occlusion culling as much as possible to reduce lag as the models are all highly detailed. To do this, we created dedicated sections, walls and rooms for artefacts and minimised the number that can be rendered and seen together.

In total, we created 2 exhibition rooms for the visitors to explore.

4.1.2 Main Menu

We also created a main menu room which is where the game will start from. As seen in (Figure 25) it emulates a very classical modern room that you expect to see in a museum. Spotlight also illuminates the wall and showcase famous paintings which gives subtle clue to the visitor that this will be a virtual museum virtual environment.

Here users will also be greeted by the main menu, as seen in (Figure 26), which will display all the exhibitions that will be available. In the current iteration of the application, we have implemented the ancient artefacts exhibition hall that was explained previously.

4.2 Stimulated Motion

As previously mentioned, users have the option to move using either joystick navigation or teleportation. Furthermore, objects within the environment can be grabbed from a distance and rotated for closer inspection.

4.3 Designed Interface

For the designed interface, we have created several UIs for the virtual museum.

User Settings UI

For the user setting UI, it essentially allows users to control the virtual museum settings which includes the volume of narration, resetting the scene, returning to home page and movement mode as can be seen in (Figure 27)

Clipboard UI

We 3D modelled the UI clipboard and drew out the mini map and clipboard layout. The design went through many iterations, firstly from hand-drawn, to mood boards and finally the Figma prototype. For the design, we took inspiration from existing VR applications. Throughout the iterations, we made changes to the design, such as removing the health bar which we felt was unnecessary after prototyping it out. (Figure 28)

Artefact’s Information Board (2 example)

For the artefact information board, it essentially conveys information about the artefact and have two interactable buttons, the play narration button which acts as both a start narration and stop narration button. It also features a restart narration button so that you can restart the narration if you miss certain parts. This board can be seen in (Figure 29)

Mini Game UI

For the mini game UI, on the secondary tab of the clipboard. The first page contains flavour text to inform the user what the mini game is about, what needs to be done, and why they are doing it. If the user clicks on “START QUIZ”, the hints for the quiz will pop up. As you progress in the game, more hints will pop up until you complete the entire quiz. There will be 11 hints in total, and the clipboard is a scrollable element for you to look through all of the hints. (Figure 30)

When the correct object is grabbed, there will be a strikethrough across the hint to show that it is completed. There will also be a vibration and auditory cue to tell you that the correct object was selected. Users can also end the game by clicking on “GIVE UP”. (Figure 30)

5. Discussion

5.1 Features

Our medieval-themed virtual museum offers several standout features designed to enhance the user experience. First and foremost, the immersive environment provides a visually captivating experience enriched by mood lighting that cultivates an engaging atmosphere for visitors. Users can also interact with artefacts, allowing them to pick up and explore each piece. This fosters a hands-on learning experience that closely mimics physical exploration.

Each artefact is complemented by high-quality audio descriptions which provide detailed narrations that enrich the educational aspect and offer essential historical context. Furthermore, the application boasts a user-friendly interface that enables easy navigation throughout the museum, allowing users to access information about the artefacts seamlessly. To assist users in becoming familiar with the application, there is also a dedicated tutorial room designed to help them learn how to navigate and interact with the virtual museum effectively.

The application features a minigame that challenges users to utilize clues provided to solve a checklist displayed on a clipboard. This interactive element encourages exploration and critical thinking as players search for hidden artefacts within the museum, making the overall experience both engaging and educational.

5.2 Limitations

While our medieval-themed virtual museum offers a rich and engaging experience, it also has several limitations that users should be aware of. One significant limitation is hardware dependency. The application requires specific hardware such as VR headsets to provide an optimal experience. This requirement may limit accessibility for some users who do not have access to the necessary equipment.

Additionally, there are performance constraints to consider. Despite our efforts to optimize the rendering of 3D models by strategically placing them far apart, the high-resolution artefacts can still lead to performance issues on lower-end devices. This could affect the overall fluidity of the experience for users with less powerful hardware.

Content limitations also present a challenge as some users may desire to see artefacts beyond those available from the Minneapolis Institute of Art and Cleveland Museum of Art. This restriction could limit the diversity of the collection and the overall educational experience.

Finally, user experience variability is an important factor; the effectiveness of the immersive experience can differ based on individual user preferences and their familiarity with Extended Reality (XR) technologies. This variability means that while some users may find the experience highly engaging, others may face challenges in navigating the environment or fully appreciating its features.

5.3 Future Improvements

In our design process, we identified several features that could enhance user experience. One of the standout additions is the implementation of generated subtitles for the artefact audio narration. This feature ensures that our content is accessible to a wider audience, including individuals who are hearing-impaired or those who prefer reading text over listening to audio. Moreover, it allows users to follow along with the narration even in noisy environments or situations where they cannot use audio.

Another significant enhancement is the introduction of a timer for the minigame, which limits the time users must complete the checklists. This addition forces a sense of challenge and engagement into the minigame, making it more exciting and motivating for users to improve their performance.

These features could broaden the accessibility of our application and enrich the overall user experience.

6. Conclusion

6.1 Summary

Overall, this game is designed for users who wish to explore museums that may otherwise be inaccessible to them, offering an immersive experience that closely mirrors being in a physical museum. By leveraging extended reality (XR) technologies, the game provides an interactive and engaging environment, transforming traditional museum visits into an enjoyable and dynamic learning experience. Through thoughtful design, the game aims to spark curiosity and foster a sense of joy in discovery, ensuring users remain captivated while exploring the museum virtually.

6.2 New Knowledge Gained

Throughout the course of this project, our team gained valuable insights into several key areas. We deepened our understanding of extended reality (XR) technologies, learning how to effectively implement them to create immersive and engaging environments. Our work with Blender and other 3D modelling tools allowed us to refine our skills in 3D modelling, while principles of user interaction design informed our approach to crafting intuitive and engaging virtual interactions.

The project also underscored the importance of teamwork and collaboration, as we navigated different roles, shared knowledge, and worked together to achieve our goals. Additionally, we learned to appreciate and integrate feedback, iteratively improving our application based on user experiences and suggestions.

Overall, this project not only enhanced our technical expertise but also enriched our understanding of how immersive environments can transform educational experiences.

Appendix

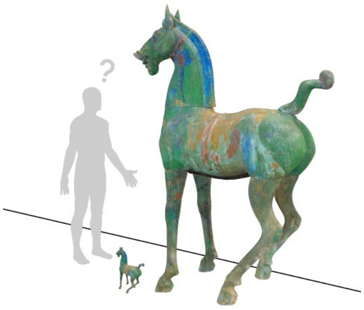

Figure 1Size comparison between mobile and XR

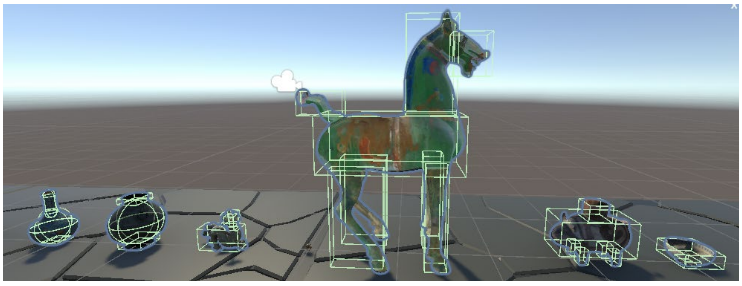

Figure 2 Colliders on MIA artefacts

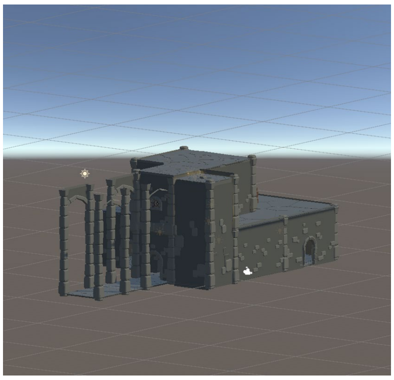

Figure 3 Exterior of Dungeon Asset

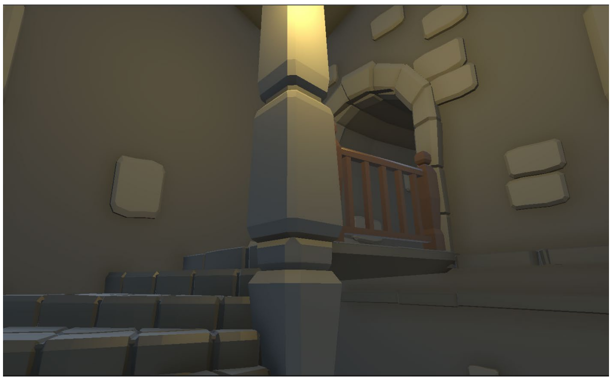

Figure 4 Interior of Dungeon Asset

Figure 5 Tutorial Room Asset

Figure 6 3D Clipboard with User Interface

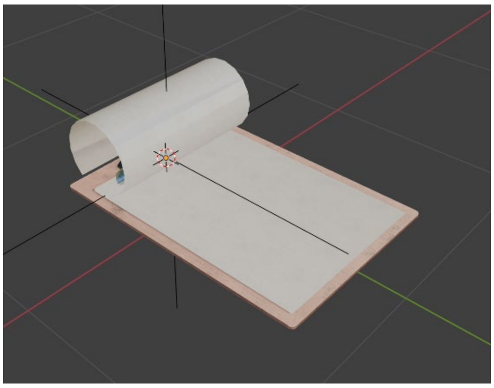

Figure 7 Flipped Clipboard

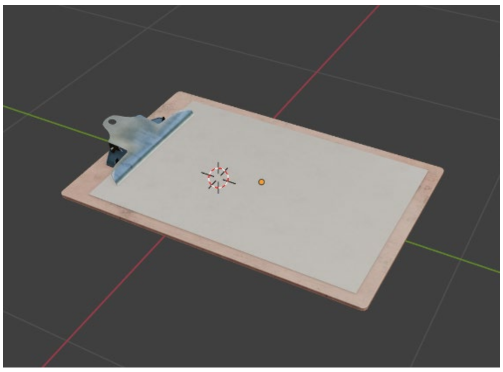

Figure 8 Un-Flipped Clipboard

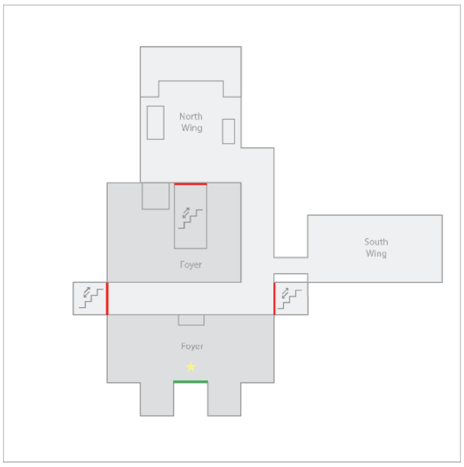

Figure 9 Outline of Museum with centre point

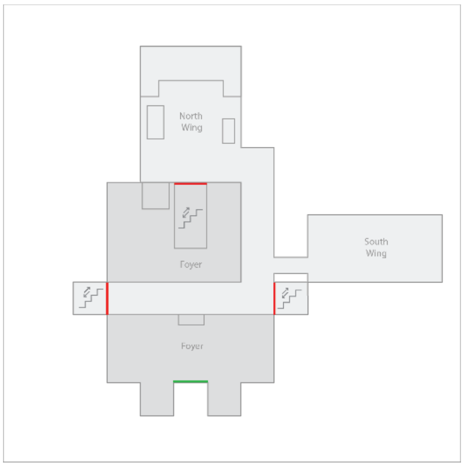

Figure 10 Outline of Museum

Figure 11 Audio Button next to Artefact Information

Figure 12 Joystick Movement

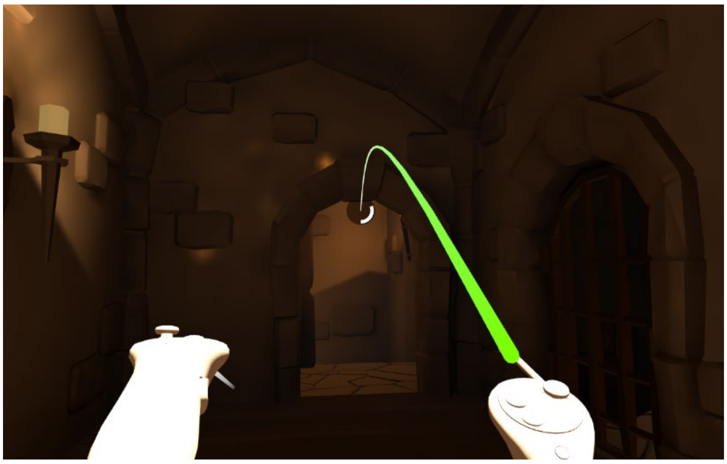

Figure 13 Teleportation Movement

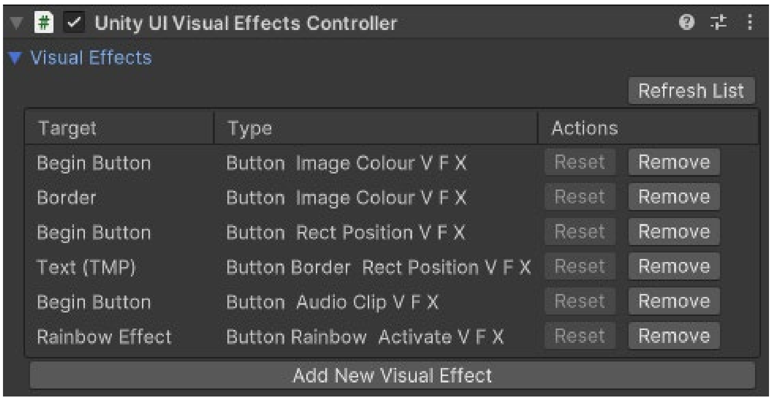

Figure 14. Controller component for a Unity UI button

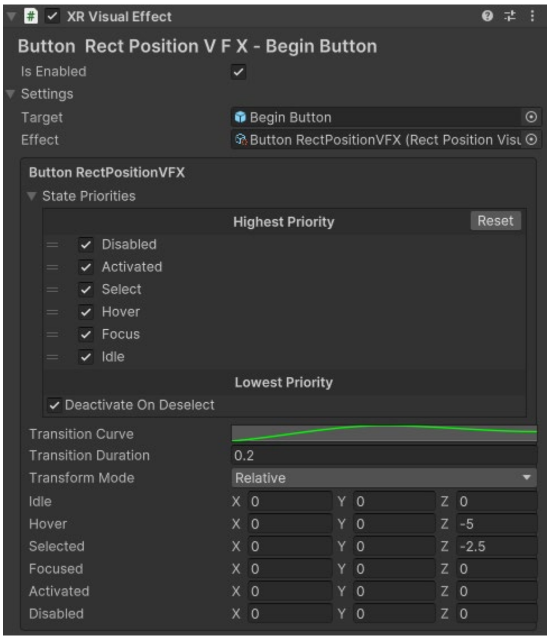

Figure 15. A RectTransform position offset visual effect

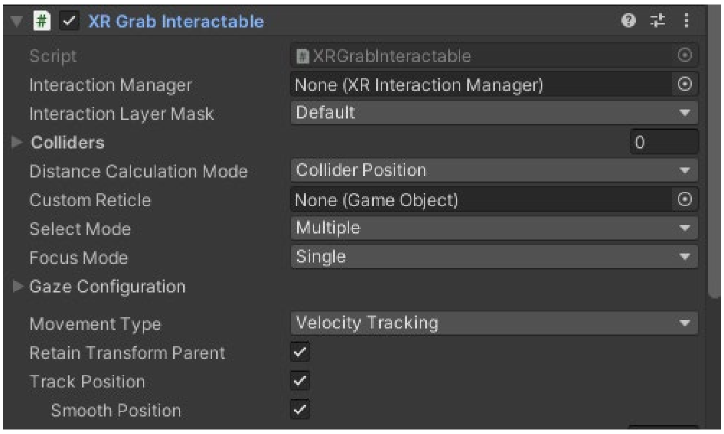

Figure 16. XR Grab Interactable

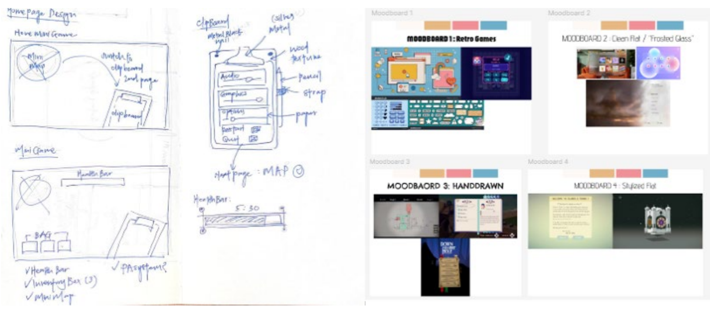

Figure 17 Sketch and Mood Board

Figure 18 (From left to right) Holding Clipboard; Selecting Elements; Storing Artefacts

Figure 19 Selection of Voice Volume

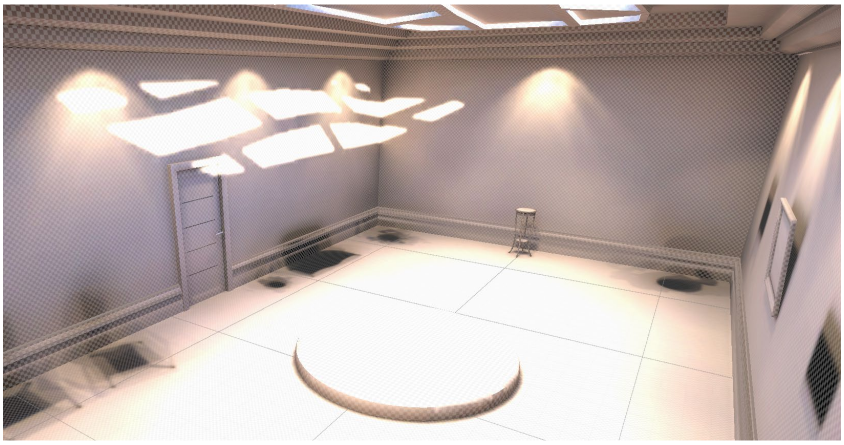

Figure 20. Lightmap visuals from baked lighting

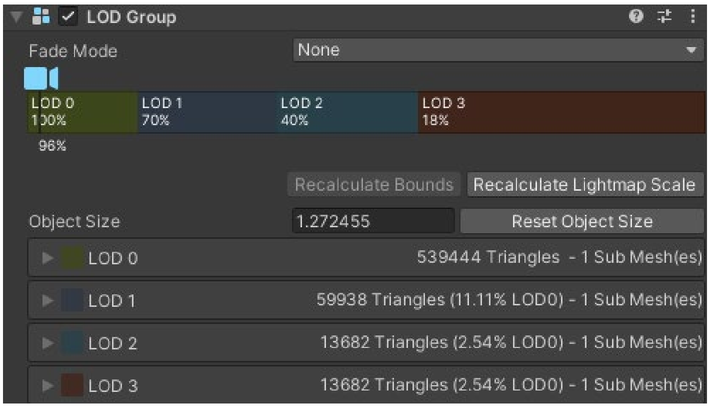

Figure 21. LoD Group component and different meshes with various levels of detail

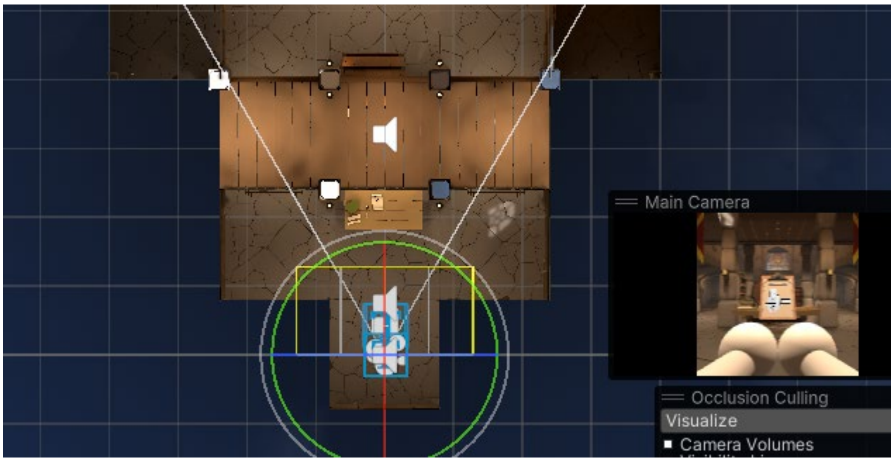

Figure 22. Occlusion culling visualised

Figure 23 View of the Museum's Interior

Figure 24 Artefacts Around the Museum

Figure 25 Main Menu Room

Figure 26 Main Menu Interface

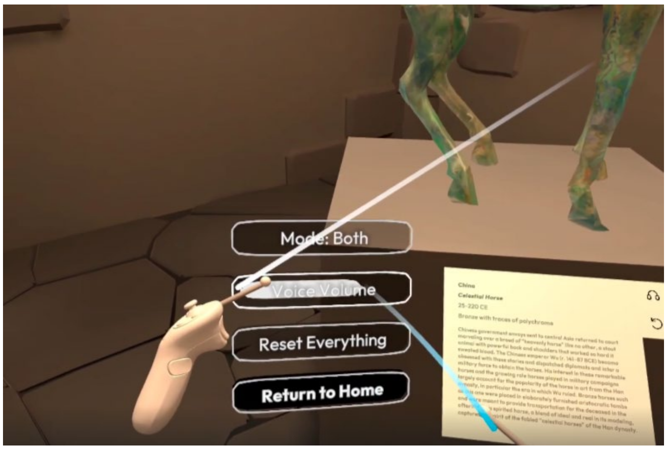

Figure 27 Hand Menu

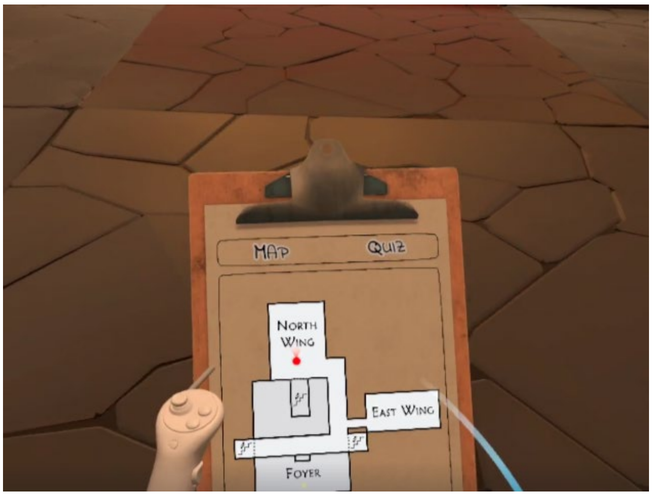

Figure 28 Clipboard Menu

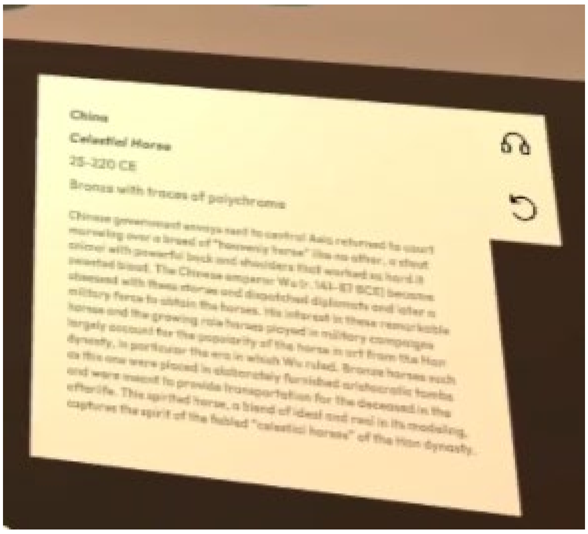

Figure 29 Artefact Board

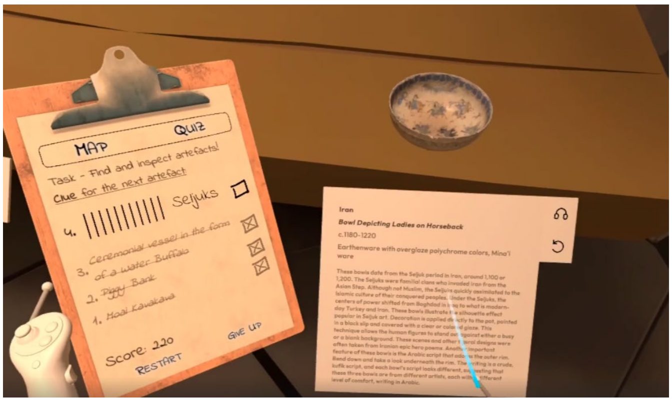

Figure 30 Mini Game UI