An-Najah National University

Factually Engineering

Department of Electrical and Computer Engineering

A Najah Virtual Museum of Palestinian Heritage

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DEDICATION

As the result of our communications engineering studies at An-Najah National University, we dedicate this project to everyone who has encouraged, helped, and believed in us.

To our families, who have supported us at every turn with their unending love, sacrifices, and encouragement. This accomplishment would not have been possible without your steadfast support, which has been the cornerstone of our journey.

To our academic home, An-Najah National University, which has given us the skills, tools, and direction we need to accomplish this goal. We appreciate the chance to develop in such a supportive setting.

To our friends, who have supported, encouraged, and confided in us. Together, we have conquered every obstacle, and your friendship and support have made this journey unforgettable.

This initiative, a virtual exploration of Palestinian history, embodies our dedication to conserving and disseminating our culture. We intend to honor our history and motivate future generations by bringing our heritage to life through the immersive potential of virtual reality.

With sincere appreciation, Rahaf Harb-Farah Abu Nimah.

ACKNOWLEDGEMENT

To start, we would like to sincerely thank God Almighty for His innumerable gifts and direction, which have enabled and strengthened us as we have worked to finish this project.

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NOMENCLATURE

VR	**Virtual Reality**
AR	**Augmented Reality**
3d	**Three Dimensional**
XR	**Extended Reality**
MR	**Mixed Reality**
HTC	**High Tech Computer Corporation**
2d	**Two Dimensional**
CAD	**Computer-Aided Design**
AI	**Artificial intelligence**
RT3D	**Real-Time Three Dimensional**
EON-XR	**EON Reality's Extended Reality platform**
DB	**stands for a regulation standard, used in technical or legal documentation**
GB/T	**National Standards of the People's Republic of China (GB) and the Recommended Standards (T)**
YD/T	**The technical standards for mobile communication and telecommunication systems in China**
ITU	**International Telecommunication Union**
SDG's	**Stands for Sustainable Development Goals**
UI	**User Interface**
DPI	**Digital Public Infrastructure**
PBP	**Payback Period**

ABSTRACT

The "Virtual Reality of the Palestine Museum" project aims to create a global digital platform for exploring Palestinian architectural heritage and interacting with Palestinian history. It provides global access to Palestinian heritage, protects it from damage, raises cultural and educational awareness, and allows interaction with impactful pieces, traditional costumes, and Palestinian arts. The project seeks to strengthen Palestinian identity and trace its historical evolution.

The use of virtual reality (VR) in Palestinian museums can address several challenges, including limited physical access, preservation of cultural heritage, education, and inclusivity. By allowing visitors to explore collections virtually, the museum offers a more interactive and immersive educational experience, enabling in-depth examination of artifacts. Moreover, VR can help museums extend exhibitions, lower maintenance costs, and attract a wider audience. By digitizing historical records and documentation, VR supports scientific research and provides greater flexibility for remote visitors. It also enhances the tourism experience, allowing individuals to explore the museum at their own pace and convenience.

On a global scale, this initiative can be expanded by partnering with international cultural institutions, educational platforms, and digital archives. Collaborations with museums, universities, and heritage organizations around the world can help host virtual exhibits, translate content into multiple languages, and integrate Palestinian history into global education curricula. Additionally, incorporating the museum into global VR platforms or app stores can ensure broader accessibility. Through such international efforts, the project can amplify awareness of Palestinian heritage, foster cross-cultural understanding, and preserve history for future generations in a globally connected format.

CONSTRAINTS

1. **Technical Limitations:**

There are some limitations regarding the Unity environment regarding hardware and software compatibility for the augmented reality technology used in this project. The museum experience is only available to customers with suitable devices, such as the Meta Headset Quest 2, as not all mobile devices fully support augmented reality. This is in contrast to the Spatial software, which allows access to the environment from web browsers, mobile devices, and virtual reality headsets, subject to differences in quality.

The project also requires precise alignment of virtual artifacts with the physical world. The accuracy of augmented reality tracking may be affected by changes in surface texture and lighting, making it difficult to ensure accurate placement of 3D models in the augmented reality environment.

2. **Limitations on Resources:**

High-quality 3D models of Palestinian antiquities are essential to the project, but producing or acquiring these models calls for either specialized 3D artists or access to sophisticated 3D scanning technology. A lesser or less comprehensive selection of objects may be displayed in the AR experience due to a lack of funding for expert scanning or modeling.

Furthermore, the breadth and authenticity of objects included in the virtual museum may be limited due to restrictions on access to real artifacts or their precise requirements for correct digital depiction.

3. **Budgetary Restrictions:**

Because augmented reality technology may require specific software or hardware. For example, publishing a project on the Spectral software requires a monthly or annual subscription (up to $80 per month), and there are also specific scanning software programs that require payments to obtain the best results for the piece, using and producing 3D models can be expensive.

4. **Time Restrictions:**

A substantial amount of time is needed for 3D modeling, testing, and debugging in order to create an AR-based museum experience with high-quality 3D models. Some features or improvements, including more interaction options or highly realistic 3D models, might have been simplified or left out due to the project's short completion timeline.

5. **Ethical and Cultural Restrictions:**

Accurate and respectful representation of each object is crucial, especially considering the cultural value of Palestinian artifacts. In order to respect Palestinian heritage and prevent any misrepresentation or cultural insensitivity, this initiative had to carefully choose and showcase objects.

Making sure the information included with each artifact is accurate is another aspect of ethical considerations. The depth of information accessible in the AR experience might have been impacted by limited access to expert consultation and verified historical data.

Chapter 1: Introduction

1.1 Overview:

The Metaverse is the post-reality universe, a perpetual and persistent multiuser environment merging physical reality with digital virtuality. It is based on the convergence of technologies that enable multisensory interactions with virtual environments, digital objects, and people such as virtual reality (VR) and augmented reality (AR). Hence, the Metaverse is an interconnected web of social, networked immersive environments in persistent multiuser platforms. It enables seamless embodied user communication in real-time and dynamic interactions with digital artifacts. Its first iteration was a web of virtual worlds where avatars were able to teleport among them. The contemporary iteration of the Metaverse features social, immersive VR platforms compatible with massively multiplayer online video games, open game worlds, and AR collaborative spaces.[1]

Computer science innovations significantly impact daily life because they improve and transform social interactions, communication, and interaction. Three significant waves of technological innovation have been identified from the perspective of end users, and they are centered on the advent of personal computers, the Internet, and mobile devices, respectively. At the moment, spatial, immersive technologies like virtual reality (VR) and augmented reality (AR) are at the center of the fourth wave of computing innovation [1]. This wave is anticipated to create the next paradigm for ubiquitous computing, which could revolutionize business, education, remote work, and entertainment. The Metaverse is this new paradigm. The Greek prefix "meta," which means "post, after, or beyond," and "universe," make up the closed compound word "metaverse."

The Metaverse is a perpetual and persistent multiuser environment that combines digital virtuality and physical reality, or, to put it another way, a post-reality universe. Metaverse has the potential to address the core drawbacks of web-based 2D e-learning resources in the context of online distance learning. Despite many technological advancements, the fundamental implementation techniques in the vital sector of education-which revolve around textbooks, classrooms, and content transmission-remain constant [2]. There is currently fierce competition to build the standards, protocols, and infrastructure that will control the Metaverse. In an effort to draw users and establish themselves as the de facto Metaverse destination, big businesses are working to build their own closed, proprietary hardware and software ecosystems. Divergent strategies and various systemic approaches clash over ideas like privacy and openness.

1.2 Extended, Virtual, Augmented and Mixed Reality

The phrase "extended reality," sometimes known as "cross reality" (XR), refers to a broad category of immersive technologies, such as electronic, and digital environments that project and represent data. Virtual reality (VR), augmented reality (AR), and mixed reality (MR) are all included in XR. In each of the aforementioned XR aspects, people witness and engage with a technologically created, entirely or partially synthetic digital environment. Virtual reality (VR) is a different, entirely distinct, artificial, digitally generated environment. In virtual reality (VR), users have a sense of immersion, are situated in a separate universe, and behave similarly to how they would in the real world. With the use of specialized multimodal devices like omnidirectional treadmills, VR headsets, and immersion helmets, The senses of sight, hearing, touch, movement, and organic engagement with virtual objects all enhance this experience.

AR (Augmented Reality) embeds digital inputs and virtual elements into physical spaces, merging the physical with the virtual world. It can be implemented in VR headsets with pass-through mode capability. MR (Middle-Range Virtual Reality) is a combination of AR and VR, with intermediate variations such as augmented reality. AR and VR remain the two fundamental technologies, with MR their combination. To visualize how these immersive technologies interact with the environment, Milgram and Kishino's one-dimensional reality-virtuality continuum is used. AR is near the left end of the spectrum, while VR occupies the right extremum. MR is a superset of both.

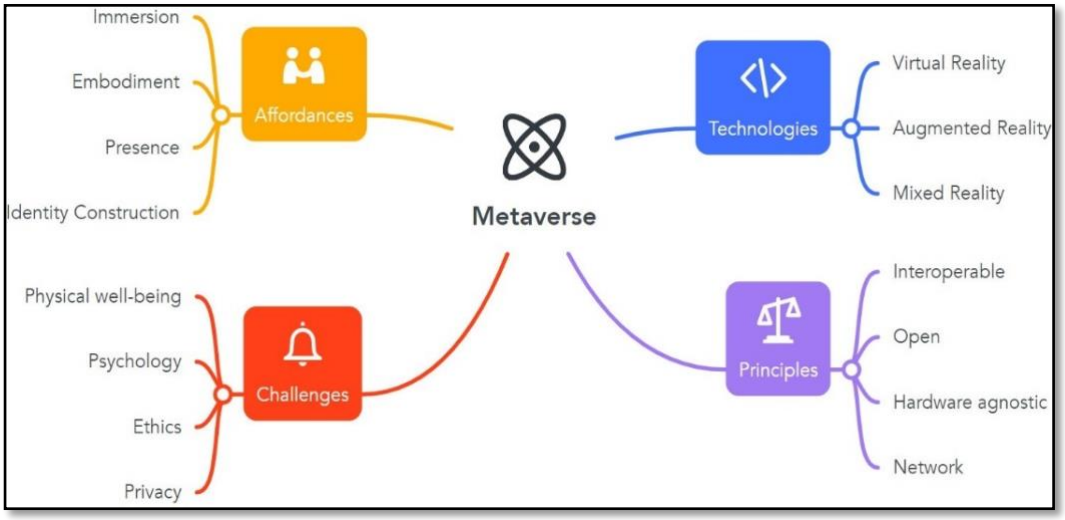

Figure 1: Metaverse technologies, principles, affordances, and challenges

Figure 2: Augmented Reality (AR), Virtual Reality (VR) & Mixed Reality MR

Table 1: The differences between virtual reality, augmented reality, mixed reality, and extended reality.

Aspect	Virtual Reality	Augmented Reality	Mixed Reality (MR)	Extended Reality
Definition	completely immersive virtual world that takes the place of the physical world.	an object or piece of information superimposed digitally on the physical world.	a combination of virtual and real-world settings that permits communication.	a catch-all phrase for VR, AR, and MR technologies.
Environment	completely virtual and cut off from reality.	Digital components are added to the real world.	interactively blends the real and virtual worlds.	varies according to the particular XR tech (VR, AR, MR)
Equipment	VR headset (such as the HTC Vivi or Oculus).	AR glasses (such as HoloLens or ARKit apps) or a smartphone or tablet.	MR headgear, such as the Magic Leap or Microsoft HoloLens.	Variables: MR headsets, AR glasses, and VR headsets can all be used.
Examples	virtual meetings, training simulations, and VR games.	AR navigation, AR apps (like Pokémon Go), and Snapchat filters.	Interactive learning, remote help, and industrial training.	Any VR, AR, or MR application can be referred to as XR.

1.3 Problem Statement:

Preserving and displaying cultural heritage digitally is challenging due to the lack of a reference for artifacts, and traditional platforms often underrepresent history, especially when artifacts are scattered across the globe. Cultural history is constantly at risk of inequitable preservation, inaccessibility, and misinformation, as well as threats from climate change and natural disasters such as earthquakes and wars.

This is where preserving digital copies of artifacts comes in. Although the immersive potential of virtual reality (VR) has yet to be fully realized through current technologies, the thriving world of cities holds revolutionary promise.

No one can be left behind thanks to its potential to protect cultural assets, promote inclusive travel, and offer authentic and engaging heritage experiences. It enables everyone, regardless of location, physical ability, or economic circumstances, to access places, artifacts, and benefit from information. Digital public infrastructure within the world of cities can significantly contribute to addressing these global issues and opening the door to a more resilient and equitable future.

The virtual museum addresses the issue of long-term advance bookings often required months in advance by offering immediate and flexible access to the same educational and cultural experiences without the need to physically visit the location.

1.4 Strategic Foundations for Developing a Global Virtual Museum Experience:

1. Scalable:

The project guarantees outstanding scalability and long-term sustainability by leveraging flexible technologies including cloud services, APIs, dynamic updates, precision engineering, cross-platform and modular architecture, and scalable virtual reality design. The user experience is improved while maintaining authenticity thanks to these characteristics, which enable the constant addition of new digital assets like interactive virtual guides and customized digital identities.

Importantly, the project's primary goal of preserving and promoting Palestinian cultural legacy is directly supported by this technological foundation. It makes it possible for audiences throughout the world to investigate and interact with the depth of Palestine's history and identity through engaging and easily available digital experiences. Furthermore, the initiative facilitates wider access and interaction on a worldwide scale by integrating with public digital infrastructure, forming strategic alliances, including international digital payment methods, and being compatible with a variety of devices.

Although deeply anchored in Palestine's cultural history, the project's scalable architecture, made possible by services like Google Cloud and Microsoft Azure, allows it to grow in the future to incorporate other nations and civilizations, aiding in the broader digital preservation of world heritage

2. Accessible:

This platform can accommodate everyone, including those with limited resources or disabilities, by offering free experiences, low-cost devices (mobile, web, & Headset), real objects, online tours, multilingual support, and 24/7 accessibility to educational materials, cultural assets and tourism sites so no one left behind.

3. Sustainable:

The project promotes social sustainability by removing geographical barriers, providing inclusive experiences, and fostering cultural understanding. It also preserves cultural heritage and engages local communities whether in gathering information, participating in design, or telling their stories which fosters a sense of belonging and responsibility. The project addresses the long-standing issue of unequal representation in the preservation and narration of cultural heritage, where historically, dominant groups or institutions have often controlled whose stories are told and how. By involving underrepresented communities and giving them an active role in shaping their cultural narratives, the project challenges this imbalance and promotes more equitable, authentic storytelling.

4. Applicable

Our team has developed a platform that aims to preserve cultural heritage and provide interactive experiences for users, The platform is designed to cater to diverse groups of users, offering multiple language options and an easy-to-use interface. It also emphasizes educational and cultural value, partnering with our university to offer virtual, Pilot programs are provided to schools and cultural organizations to gather feedback and edit content.

The platform also adheres to international accessibility standards. The project involves identifying artifacts and tourist sites, obtaining permits, 3D scanning, and creating digital twins. A dedicated application is created to access the virtual environment via mobile phones or Meta Vision. Content is published on platforms like Metastore, SideQuest, the Apple Store, and Google Play, highlighting artifacts and linking them to original stories and texts.

1.5 Objectives and SDG's

Through an immersive virtual experience, the Palestinian Museum Virtual Reality Project seeks to improve access to Palestinian cultural assets, increase engagement, and promote a thorough understanding of Palestinian history. The project aims to use virtual reality technology to break down geographical boundaries and introduce Palestinian culture to a worldwide audience. The following are the project's main.

Objectives

The goal of this project is to create an immersive Virtual Reality (VR) experience that allows users all over the world to investigate Palestinian history and cultural heritage using interactive, high-quality 3D representations of items. This project intends to overcome geographic constraints by utilizing virtual reality (VR), enabling Palestinians and the international world to interact with historical relics and cultural tales in an approachable, captivating manner. In order to improve cultural awareness and education, this virtual museum will provide rich context for each relic, including its provenance, cultural relevance, and historical history.

Stands for Sustainable Development Goals

These are 17 global goals adopted by the United Nations in 2015 as part of the 2030 Agenda, aiming to eradicate poverty, protect the planet, and ensure peace and prosperity for all, So the SDGs that fit our project here are 4, 7, 9, 10, 11, and 13, and each one of them will be detailed below.

- **The virtual museum is a project that aims to enhance the quality of education, support clean energy and efficiency, promote innovation and digital infrastructure, reduce inequalities, preserve cultural identity, and promote sustainable cities. It serves as an interactive teaching tool, enabling lifelong learners, teachers, and students to investigate cultural narratives in immersive ways that are often unavailable in typical classroom settings. This aligns with Target 4.7, which emphasizes teaching students to be global citizens and appreciate cultural variety.**

- **The virtual museum also supports Clean Energy Goal 7 by providing an affordable and clean energy option, promoting environmentally friendly energy use. By hosting the museum on servers powered by renewable energy, the project aligns with green standards and opens the door for clean, tech-driven cultural access.**

- **The project's contribution to achieving SDG 9 is to foster innovation and build a robust digital infrastructure. By integrating VR technology into cultural heritage preservation, it ensures cultural artifacts and historical sites remain accessible, protected, and appreciated for future generations.**

- **The project's contribution to achieving SDG 10 is to reduce inequalities by providing virtual, worldwide access to the museum, empowering marginalized communities and democratizing access to heritage.**

- **The project's contribution to achieving SDG 11 is to make cities and human settlements inclusive, safe, resilient, and sustainable. By integrating VR technology, it helps preserve endangered heritage sites, promote sustainable tourism, enhance public awareness and education, build resilient communities, and improve accessibility and inclusivity.**

Lastly, the virtual museum contributes to reducing carbon emissions related to tourism and logistics by reducing the need for travel to visit real museums. It also brings attention to cultural heritage that is endangered due to displacement or destruction brought on by climate change.

1.6 Project significant:

A virtual reality (VR) project could significantly impact the Palestine Museum, preserving Palestinian heritage, promoting educational outreach, democratizing global accessibility, documenting historical narratives, fostering cross-cultural dialogue, supporting Palestinian artists and historians, and enhancing the visitor experience. VR could digitally preserve Palestinian artifacts, art, historical sites, and cultural practices, allowing them to be shared globally. It could also provide a platform for Palestinian artists, historians, and educators to collaborate and share their work. The project could also enhance the visitor experience with unique features like 3D reconstructions, virtual tours, and interactive exhibits, making it more engaging and memorable for younger generations.

1.7 Platforms used in environmental design

1.7.1 The first platform: Unity

Introduction:

Creating interactive 2D and 3D applications, such as games, simulations, and AR/VR experiences, is the specialty of Unity, a top real-time 3D (RT3D) development platform. It is extensively utilized in architecture, teaching, and gaming.

Benefits:

Cross-Platform Support: Create apps for a variety of platforms, such as PCs, smartphones, gaming consoles, and AR/VR gadgets.

Huge Community: A helpful user base and copious documentation.

Customization: For more complex changes, C# scripting is supported.

Disadvantages:

Learning Curve for Advanced functions: Although easy for beginners, it takes time to become proficient with advanced functions.

Costs of Licensing: For large-scale projects, commercial use may be expensive.

Uses:

Making video games. applications for AR and VR.

Visualization of architecture.

tools for education.

Preferred for:

Novices, cross-platform developers, and mobile developers.

Figure 3: Unity platform interface.

Your library of resources that you can use for your project is shown in the Project Window. This is where the assets show up when you import them into your project. The Scene View allows you to visually navigate and edit your scene. The scene view can show a 3D or 2D perspective, depending on the type of project you are working on. Each object in the scene is represented by a hierarchical text representation in the Hierarchy Window.

The two windows are naturally connected because every object in the scene has an entry in the hierarchy. The hierarchy shows the order in which things are connected to each other. You can view and modify all of the properties of the object that is currently selected in the Inspector Window. The inspector window's layout and contents will change depending on the type of object you are looking at. The Toolbar offers essential functional features such as scene view modification tools, controls for play, pause, and step, Unity Cloud Services and Account access, layer visibility menu, and editor layout menu for custom layouts

1.7.2 Second platform: Spatial

Introduction to Spatial:

Spatial is a virtual platform for collaboration that enables users to design and share immersive environments. It emphasizes real-time cooperation and is frequently utilized for online events, meetings, and art exhibits.

Advantages:

Teams with no technical experience can easily utilize user-centric collaboration.

Cross-Device Compatibility: Available on desktop computers, mobile devices, and VR headsets.

Users can develop virtual places in a no-code environment without knowing any programming.

Disadvantages:

Limited Customization: The platform can be too limiting for experienced developers.

online dependence: necessitates a steady online connection.

Feature Scope: More emphasis is placed on teamwork than on intricate design or game creation.

Uses:

Virtual meetings and events.
Collaborative design spaces.
Digital art galleries and presentations.

Preferred For:

Teams or individuals need a simple, immersive collaboration platform.

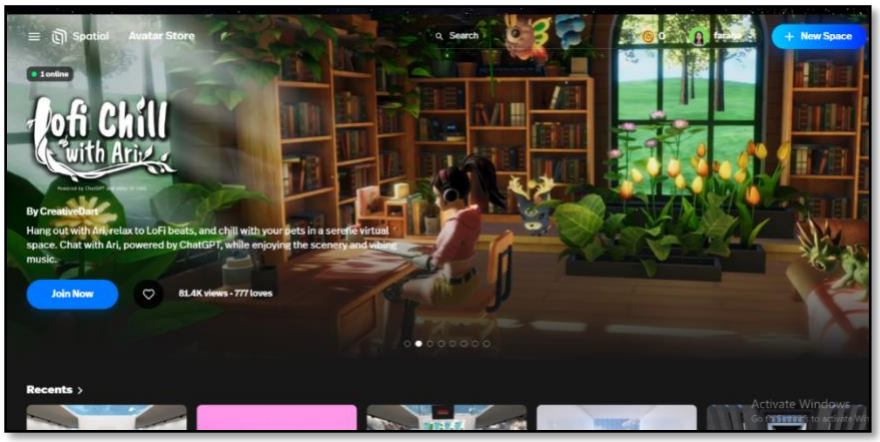

Figure 4: Spatial platform interface

You can personalize your avatar, which you use in virtual environments, at the Avatar Store. The "New Space" button enables you to establish a brand-new online space for events or collaboration. The space that is highlighted ("LoFi Chill with Ari"):
Theme: A comfortable virtual environment where users can enjoy calming LoFi music, converse with an AI companion, and take in beautiful surroundings. Interaction: Users can "Join Now" to chat with Ari (using ChatGPT or other AI-powered apps) and experience the space in VR or 3D.

Statistics on Engagement: Metrics like "views" and "loves" show how well-liked the space is among the spatial community.

1.8 The United Nations Citiverse Challenge

This project responds to the United Nations Citiverse Challenge and offers an immersive virtual digital platform for Android, iOS, the web, and virtual reality headsets. This global platform aims to showcase the rich and diverse cultural heritage of the world to a global audience and to preserve cultural assets digitally for future generations. Its most important features include access to content and secure digital tracking methods. We have a prototype of the project, but in the long term, the project aims to integrate with the principles and components of public digital infrastructure to enhance access, security, and operation, thus achieving a broader and more sustainable impact.

This project presents an immersive virtual museum environment created on the Spatial platform, an open-source platform for 3D environments. We have placed a variety of 3D models within it, including historical monuments, artifacts, tourist attractions, and heritage tools, all of cultural significance. Given that cultural heritage faces the risk of misrepresentation and inaccessibility, this project aims to make our rich and diverse heritage accessible to a global audience. It seeks to preserve these cultural assets, support sustainable and inclusive digital tourism, and engage local communities and cultural institutions to benefit from this project.

1.9 Programs used to create Digital twins:

- **Meshy AI**

is a generative 3D AI platform that simplifies 3D content creation for artists, game developers, and architects. The platform transforms text and image requests into complex 3D models, supports various art styles, and generates clear, proportional models using textures and shapes. Models can be integrated with Unity and spatial software and exported in various formats.

Advantages:

Efficiency: Much less effort is required to manually create and texture 3D models.

Accessibility: It facilitates rapid prototyping and experimentation, making it suitable for users with limited or no 3D design experience.

Flexibility: It provides options to modify styles, change the number of polygons, and optimize requests.

Various Use Cases: Ideal for education, architectural visualization, game creation, and film pre-production.

Limitations:

Unreliable Results: Models may occasionally be produced with errors or extraneous information, but this is usually remedied by repeating instructions.

Complexity Issues: It struggles with highly complex designs, especially when working from highly detailed images.

Our VR project at the Palestinian Museum, Meshy AI, can enhance our project by:

Rapid Asset Generation: Using text or visual instructions to quickly create museum environments, props, or artifacts.

Customizable Textures: To represent Palestinian cultural history, use historically authentic or designed materials on models.

Interactive Development: To build immersive museum experiences, integrating elements into VR platforms like Unity and Spatial.

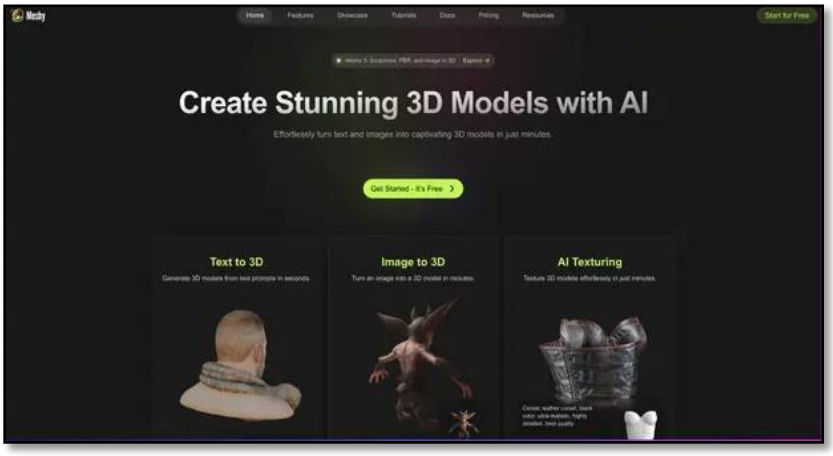

Figure 5: Meshy application interface.

- **Scaniverse**

Is an app that uses a smartphone or tablet's camera to take 3D scans of real-world objects and settings. To produce incredibly detailed 3D models that can be utilized for a variety of tasks, including virtual reality, 3D printing, game development, and design projects, the application makes use of sophisticated computer vision and photogrammetry techniques.

Scaniverse is a user-friendly app that uses a camera to scan objects or spaces, producing high-quality 3D models with textures. It offers export options in various file formats for use with game engines and 3D modeling tools.

Scaniverse also provides a real-time preview for users to monitor progress and adjust as needed. It is compatible with iOS and Android smartphones and devices with LiDAR sensors.

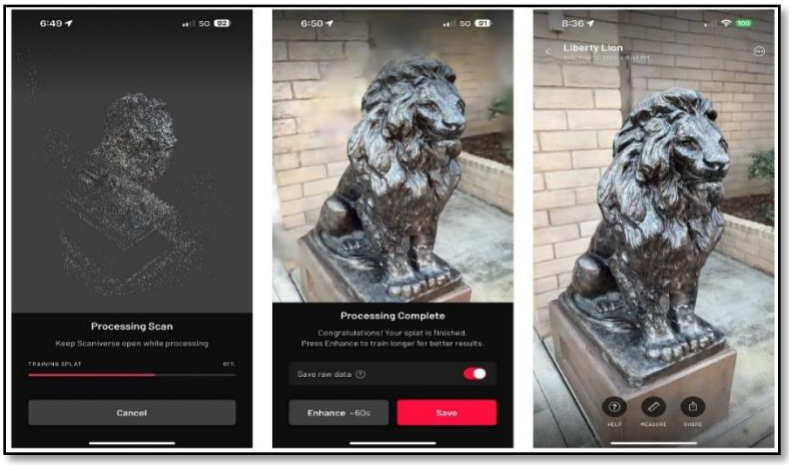

Figure 6: Scanning in Scaniverse

- **Polycam**

Is a user-friendly 3D scanning program that utilizes LiDAR technology and photogrammetry to create detailed 3D representations of real-world objects and environments, allowing users to edit, export, and collaborate on projects.

Applications:

Polycam is utilized in many different fields, such as teaching, gaming development, interior design, architecture, and cultural preservation.

It's especially popular for creating accurate 3D models for AR (augmented reality) or VR (virtual reality) environments, as well as for 3D printing and digital asset creation.

Figure 7: Results in Polycam

- **Sketchfab**

is an online platform for viewing, sharing, and downloading 3D models using WebGL technology. It supports various applications like gaming, virtual reality, augmented reality, and 3D printing. The platform offers free and paid downloads, with some models available with attribution licenses. Users can also purchase high-quality models from the Sketchfab Store.

1.10 Hardware Tools

The Meta Quest is a standalone VR headset developed by Meta, allowing users to experience an immersive virtual reality experience without a PC or external sensors. It features a lightweight, ergonomic design with adjustable straps and soft padding, and operates independently with an integrated processor.

The headset features high-resolution displays, adjustable IPD, inside-out tracking, and integrated spatial audio.

The Meta Quest controllers, also known as Touch controllers, are designed for interactivity and are lightweight and contoured for comfort. They feature analog thumb sticks, buttons, triggers, capacitive touch sensors, and haptic feedback. The controllers work seamlessly with the headset's cameras for accurate motion tracking.

The headset and controllers are powered by replaceable or rechargeable batteries, making it suitable for gaming, education, and professional applications.

Figure 5: Tools of the VR

1.11 Report Organization:

The work completed in this project is summarized in five chapters as follows:

Chapter 1: Introduction

An introduction to the Palestinian Museum Virtual Reality (VR) Project is given in this chapter, along with information on its goals, importance, and main issue.

Chapter 2: Standards and Challenges

This chapter covers user accessibility, digitizing cultural artifacts, and best practices and standards used in VR production. It also discusses the primary difficulties encountered during the project, including technical constraints, preserving the authenticity of digital artifact replication, and guaranteeing compatibility with various VR systems.

Chapter 3: Literature Review

This chapter examines previous research and projects on virtual museums, VR applications in cultural preservation, and related projects that digitize artifacts of cultural significance. It describes the gaps that this project aims to fill and highlights the technology and strategies employed in this research.

Chapter 4: Methodology

This chapter describes how the VR museum was designed, including how 3D models of Palestinian items were made, how interactive features were added, and how to make sure the museum was accessible from anywhere in the world. The choice of software and tools for VR development is also covered.

Chapter 5: Results and Analysis

The results of the VR museum project are shown in this chapter, along with the 3D models' success, user interaction levels, and the potency of immersive narrative in holding users' attention. A study of user feedback from testing rounds is also provided.

Chapter 6: Feasibility Study:

This chapter summarizes the feasibility of implementing the Palestinian VR museum project across four main areas:

1. **Technical Feasibility:**
   The project is supported by available tools (such as Unity) and can be accessed on various devices, including VR headsets and mobile phones.
2. **Financial Feasibility:**
   It includes estimated costs (design, development, hosting) and explores funding opportunities such as grants or sponsorships.
3. **Operational Feasibility:**
   A skilled team (designers, developers, historians) is required, with a clear implementation timeline.
4. **Market Feasibility:**
   There is growing interest in digital cultural preservation, and the project stands out from similar initiatives. It targets a broad audience, including students and researchers.

Chapter 7: Conclusions and Recommendations

This chapter provides an overview of the project's main conclusions, its effects on cultural preservation, and suggestions for future development and enhancement, including possible new features and collaborations for more content enrichment.

Chapter 2: Standards, Earlier Course Work, Challenges

2.1 Standard:

Examine the fundamental concepts of building digital museum standards and methodically develop current standards pertaining to digital museums in Palestine from the three perspectives of traditional museum construction, digital content presentation, and digital information technology application. It also looks at the new types of digital museums that are currently emerging. Digital museums ought to have a technical index system, content requirements, and basic functions.[2]

1) **Museum Dimension This text provides a comprehensive overview of current standards related to digital museums. It covers the collection registration of cultural relics, exhibition content design, form design and construction specifications, and functional design guidelines for exhibition venues. The collection registration process includes information on registration numbers, identification levels, sources, and intact condition. The exhibition content design specification outlines the principles and process of design, while the form design and construction specifications outline work procedures and technical requirements. The functional design guide for exhibition venues focuses on human flow, vehicle flow, and logistics systems.**

2) **Digital Information Technology Standard Dimension The "Technical Regulations for Three-Dimensional Information Acquisition of Cultural Relics Buildings" (DB11/T 1796-2020) outlines the technical requirements for three-dimensional information acquisition operations in cultural relics buildings. It covers technical preparation, control measurement, data acquisition and processing, results production, quality inspection, and archiving of results. The digital processing of content resources Part 6 (GB/T 38548.6-2020) specifies the application mode for long-term preservation and publication-oriented services. The Specification for Digitization Processing of Library Collection Resources Part 2 (GB/T 31219.2-2014) specifies the technical standards for digitizing library text resources, focusing on text as the main form of expression. The Specification for Digital Processing of Library Resources Part 3 (GB/T 31219.3-2014) provides processing standards and work specifications for digital resources of image collections. The Specification for Digitization and Processing of Library Resources Part 5 (GB/T 31219.5-2016) outlines the workflow of video digitization and processing, metadata standards for content marking, and naming rules for video digital objects. The Technical Regulations for Virtual Reality Imaging (DB22/T 3047-2019) and General Technical Requirements for Mobile Augmented Reality Business Capability (YD/T 3078-2016) provide technical requirements for business capabilities in mobile augmented reality systems.**

2.2 EARLIER COURSE WORK

During the last months, we have studied many courses that have added a lot of knowledge and skills. Some of these courses helped us with this project:

1. **Udemy course about VR basics development.**
2. **Metaverse Academy course (MA Q3001An-Najah), this course helped us is**
3. **I understand Metaverse very deeply.**
4. **The EON-XR starter course is regarded as the first step in this field.**
5. **VR Development Fundamentals with Meta Quest 2 And Unity**
6. **The Complete Unity C# Game Developer Bootcamp Part 1 of 2**
7. **Our participation in the ITU competition**

2.3 Challenges

1. **We faced problems in accessing the device needed to operate the Unity software located in scientific centers because it is not always available.**
2. **We encountered a problem with the scanning programs because they require the iPhone 12 Pro Max, 13 Pro Max, etc.**
3. **We had a problem accessing some of the pieces inside the cabinets to make scanning**
4. **The days available to visit the museum are limited and the time is short compared to the fact that scanning takes a long time.**
5. **The storage capacity of the environment and its contents of artifacts was small and did not suit the size of the museum required to be designed, so the most appropriate solution was to subscribe to increase the space.**

Chapter 3: Literature Review

3.1 History of Metaverse

The metaverse, a computer-generated world beyond the physical world, has been a topic of interest for researchers since its inception in the real world. It has evolved from a collection of separate virtual worlds to a vast network of linked virtual worlds, with the revenue opportunity estimated at $500 billion in 2020 and projected to grow to $800 billion by 2024. The metaverse is characterized by hardware, networking, computing, virtual platforms, interchange standards, payment, content services, and consumer and business behaviors.

The metaverse has been defined as a vastly scaled and interoperable network of real-time 3D virtual worlds, where users can experience synchronously and persistently with an infinite number of other users. It is also referred to as a community of inquiry (CoI) in the educational domain, where learners can find meaningful experiences at the intersection of online learning and networked virtual worlds.

Recent research has highlighted the importance of linking metaverse technologies with a CoI, such as Second Life, to provide meaningful learning experiences. Studies have also highlighted the significance of social and cognitive support in virtual reality environments, such as aviation virtual laboratories and organic chemistry labs. The CoI framework has been used as an educational model to examine students' knowledge and skill construction in the metaverse, focusing on teacher, social, and cognitive support/presence.

3.2 History of VR

The Sensorama by Morton Heilig is a famous virtual reality invention. The Sensorama by Morton Heilig is a famous virtual reality invention. It was created in the 1950s and included a mechanical [3]

prototype from 1962 that created an immersive experience by utilizing 3D visual, aural, tactile, olfactory, and even wind stimuli [1]. It is thought to be among the earliest instances of virtual reality. The Sensorama showed a video of a motorcyclist racing through Brooklyn while providing a lot of feedback to give the user the impression that he was there. But there was no communication with the films. The idea was abandoned because Heilig was unable to secure funding for production.

Figure 6: The Sensorama.

The Head sight, the first head-mounted display (HMD), was created by Philco in 1961. The head's location could be determined thanks to a tracking device and a cathode ray tube display on the helmet.
The "Sword of Damocles," created by Ivan Sutherland in 1968, is one of the most well-known HMDs, or better yet, BOOM (Binocular Omni Orientation Monitor). Because it was too large to head-mount (a feature of BOOMs), it had to be suspended from the ceiling.
The Greek tale of Damocles, in which a sword hung from a hair above the king's throne, is where it got its name.

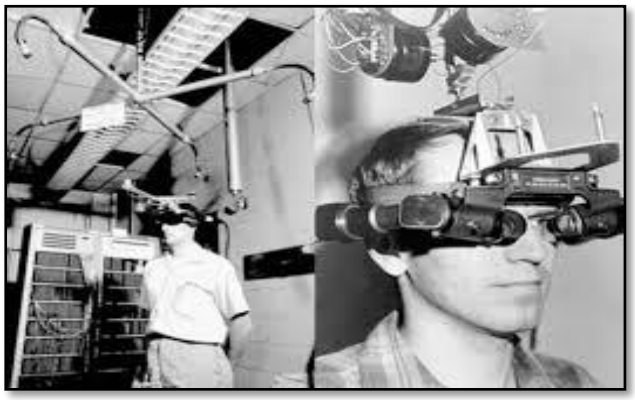

Figure 7: Ivan Sutherland and the Sword of

The Sword of Damocles had the ability to track the user's eyes and position, updating the stereoscopic view image based on the user's location.

The Wired Gloves are another popular gadget associated with virtual reality. The first was the Sayre glove, which was developed by fiber optics in 1977 by Tom DeFanti and Daniel J. Sandin. The Data glove, created by Thomas G. Zimmerman in the early 1980s, had a significant impact on other gadgets like the Power Glove.

It is seen as a commercial flop despite being reasonably priced and made by Mattel for the Nintendo Entertainment System.

Figure 8: The Power Glove.

Chapter 4: Methodology

4.1 Requirement Analysis

The Virtual Reality Palestinian Museum aims to showcase Palestinian antiquities in 3D, allowing visitors to explore them up close. The museum will feature themed rooms, user interaction, guided tours, immersive navigation, education features, collaboration among multiple users, localization and multilingual support, metadata management, high-resolution models, low latency, and privacy and security. The museum will also ensure cultural sensitivity, maintain a high-quality artifact database, and ensure low latency for a seamless VR experience. The museum's objectives and technological limitations may require modifications to meet specific functional requirements.

4.2 Scrum Methode

The Scrum technique is an agile approach to software development that involves daily standup meetings, breaking the process into sprints, and conducting a Sprint review and retrospective at the end of each iteration. This allows the product owner and stakeholders to adjust expectations and requirements for the next sprint. The Scrum team follows standard guidelines, with a Scrum master leading the team and resolving any obstacles faced by team members.

This allows for parallel operations, with each team member completing distinct tasks to improve brainstorming efficiency. The Scrum technique allows for better focus on end users and the end-users' benefits.

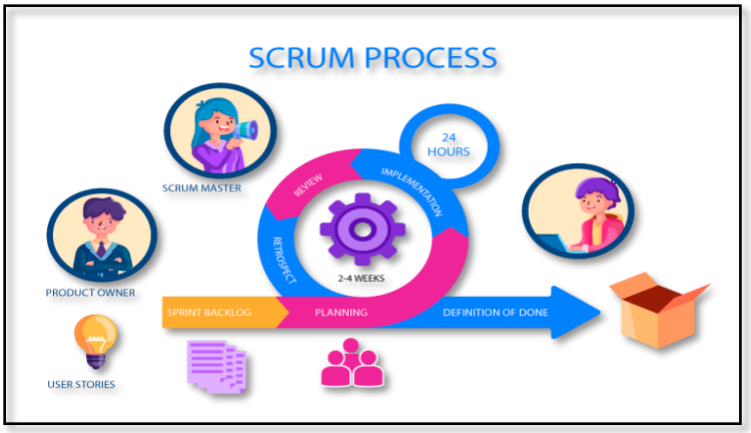

Figure 9: The process of the Scrum Method

4.3 Tools we used to make scanning

To work on the POLLYCAM and Scaniverse's, there was a need for sufficient lighting and an electronic piece that could hold the object rotate it in all directions, and take more than one picture while it was rotating. Taking pictures is done using specialized devices that enable us to do scanning or iPhone devices from the 12 Pro Max category and above, provided that it is a Pro Max. We used an iPhone 12 Pro Max to scan each object. As for working on Meshy.ai, it was enough to only take pictures of the pieces from more than one side and upload them to the program.

Figure 10: Tools, we use to do the scanning process

4.4 The practical side

At first, we visited the university museum and took the museum design plans to upload them to the 3D Max program so that we could upload them to Unity and work on them.

Figure 14: Pictures of the Museum in 360 forms

Figure 15: Pictures of Museum

4.4.1 Working on the program:

Then, in the following visits, we took pictures of a large number of artifacts, and for each piece, we took more than one picture & then uploaded them into the previously discussed program.

Depending on the nature of the piece we were scanning, we would choose the program we wanted to work on. For example, there were pieces that were full of

rust, heavy, and large, and the idea of taking pictures of them was very difficult, so the most appropriate solution was to use the Polycam program with the video feature and fix the piece inside the photography tent and take a video of it, unlike other cases, such as the Mancala game, where the easiest was to use the Scaniverus program. In other cases, if the process was difficult for both programs, we would resort to the Meshy.ai program.

Then we will show some objects how to work on them and how the scanning process was successful.

1) The Shahrukh

Figure 11a: Al Shahrukh in real environment

Figure 11b: Al Shahrukh by polycam in virtual environment

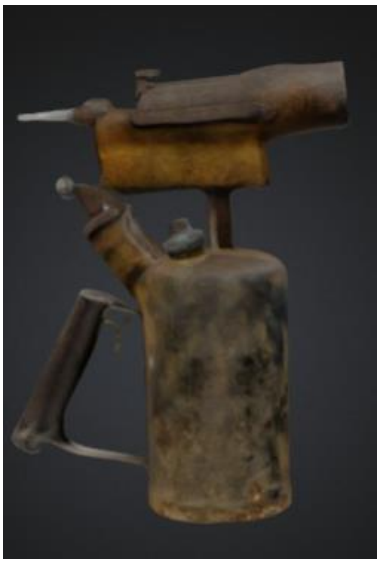

Figure 11c: Al Shahrukh by Scaniverse

The first piece we worked on was the Shahrukh. It was filmed on video using the Polycam program and we got a great result the first time. It was difficult to film it from all directions to put it on the Scaniverse program. We took the picture and put it on the Mishi program and the result was as shown in the picture above, not clear as the Polycam result. In the end, the best result was on the Polycam program.

2) The Crusher

Figure 12a: The Crusher in real environment

Figure 12 b: The failed trial Crusher by polycam in on iPhone XR

Figure 12 c: The failed trial on Scaniverse by using iPhone 12 Pro Max.

Figure 12 d: Bad result on Meshy.ai

Figure 12 e: The Crusher by polycam in virtual environment

We notice from all the previous images that the crusher was initially applied to the Polycam program using an iPhone XR, but the result was bad. There were gaps in addition to the appearance of a green base. We moved to work on the Scaniverus program using an iPhone 12 Pro Max, and the result was better than the previous result, but also unsatisfactory. We went to work on Mishi, and the result was bad. Some of its features disappeared. The last experiment was with the Polycam program using an iPhone 12 Pro Max, and the result was great, so we adopted it.

3) Iron pot

Figure 13 a: The iron pot in real environment

Figure13 b: The iron pot on polycam

Figure 13c: The iron pot on Meshy.ai

Now the other piece, which is the iron pot, we tried scanning it on the Polycam program and the result was very wonderful. We added the images on the Meshy program, but the best result was on Polycam. The details were more precise and clearer.

4) Mancala game

Figure 14a : The Mancala game in real environment

Figure 14 b: The Mancala game on Meshy.ai

Figure 14 c: The Mancala game on Scaniverse

Now the other piece, which is the Mancala game, was initially applied to the Meshy program, but the result was very bad and unacceptable. Then the Scaniverse program was used, and the result was very wonderful.

5) Al Daqaqa:

Figure 15a: Daqaqa in real environment

Figure 15b: Daqaqa in polycam

Figure 15 c: Daqaqa in Meshy.ai

Here the experiments were evaluated as successful as the result was very wonderful on both Polycam and Mechy

6) Madaqa:

Figure 16a: Madaqa in real environment

Figure 16b: Madaqa in Polycam

Figure 16c: Madaqa in Meshy.ai

This model was easy to work with as it turned out great on Polycam and acceptable on Meshy.

7) Babor

Figure 17a: Babor in Real environment

Figure 17b: Babor on scaniverse

Figure 17 c: Babor on Meshy

This model was full of fine details in its base and with rust and defects in the copper layer on it. It was tested on two programs, first on Scaniverse and then on Mechy. The result we got on Scaniverse was very bad because the wooden hall was what appeared and the base of the model itself was not visible, unlike the result that appeared on Mechy. It was more excellent and showed all the details as shown in the pictures above.

8) Lamb:

Figure 18a: Lamp on Real environment

Figure 18 b: Lamp on scaniverse

Figure 18c: Lamp on Meshy.ai

This lamp was tested on two programs, Scaniverse and Meshy. In Scaniverse, it did not recognize the glass and showed it as broken, but the material was excellent. The result on Meshy was excellent, showing all types of materials, from glass to rust. Mechy was better to deal with.

9) Jarra :

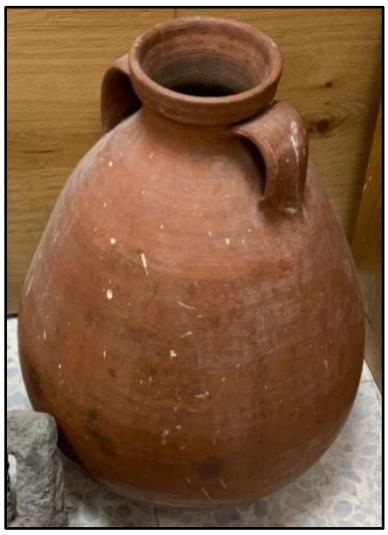

Figure19 a: Jarra in Real environment

Figure 19b: Jarra on polycam

Figure 19c: Jarra on scaniverse

The application was on the Polycam program as well as Mechy. The result we got from Polycam was excellent as it showed all the details of the jar and the result that appeared on Mechy was excellent but the result of the Polycam program was better.

10) Straw Basket

Figure 20a: Straw Basket in real environment

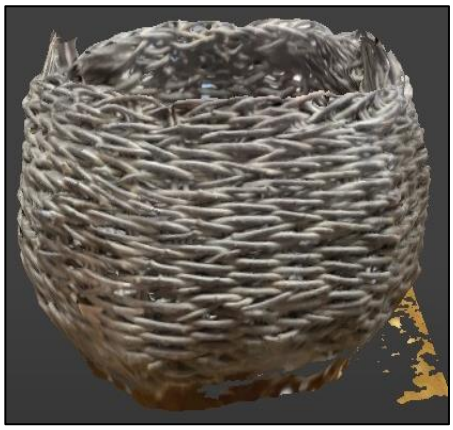

Figure 20b: Straw Basket on Scaniverse

Figure 20c: Straw basket on Meshy.ai

As for the straw basket, the scanning process was done on the Scaniveruse program, and due to the many details in it, it failed to convert it into a 3D model.

Then we uploaded the image to the Meshy program, and it showed the basket with all its details with a better result.

11) Old wooden door:

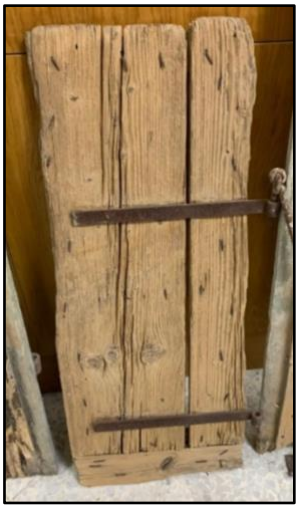

Figure 21a: Old Wooden door in real environment

Figure 21b: Old Wooden door in scaniverse

Figure 21 c: Old Wooden door in Meshy.ai

As for the design of the door, because it is large and heavy, it was difficult to deal with it in the scanning process on the Scaniveruse program. We resorted to Mishi, which gave better results.

12) Manfakh Al-Nar

Figure 22a: Manfakh Al -Nar in real environment

Figure 22 b: Manfakh AL-Nar in polycam

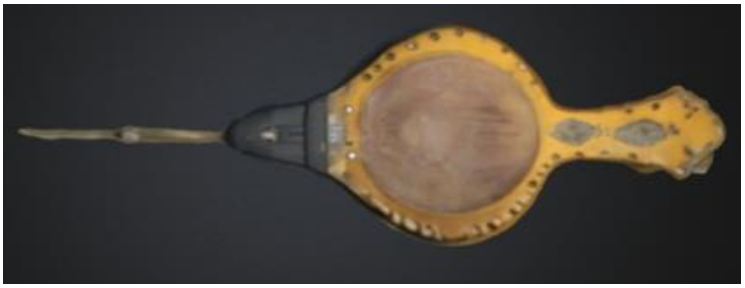

Figure 22c: Manfakh Al -Nar in Meshy.ai

We notice that the work on the Polycam program was good from the front, but not from the back, unlike the work on Mishi, which was better, although it hid some details of the piece from the front.

13) Musical Instruments:

Figure 23a: Musical Instruments in real environment

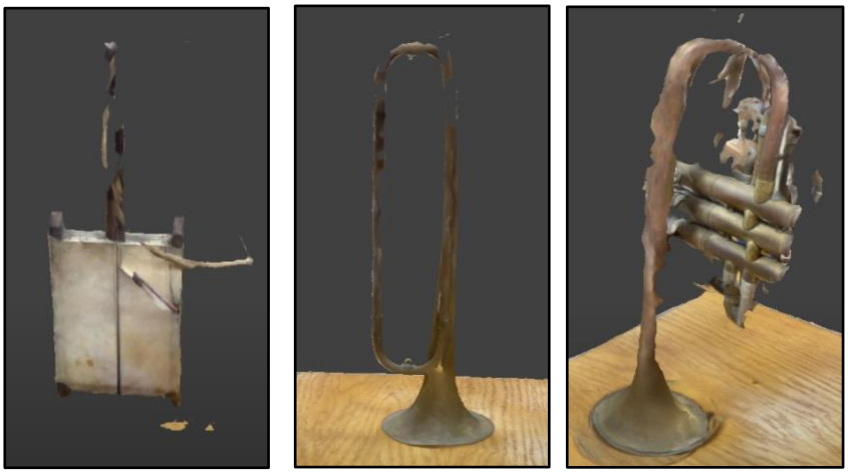

Figure 23b: Musical instruments in scaniverse

In these tools, when scanning each of these pieces separately using the Scaniverse program, the result is not satisfactory in terms of accuracy and quality, and the image is almost distorted. However, when using the Mishi program, the accuracy was high and the quality was excellent.

Figure 23 c: Musical instruments in Meshy.ai

We noticed that the pieces that had rust, large dents, burn marks, and were made of wood and metal, the best software for them was Polycam and Scaniverse.

As for the pieces made of glass or that were difficult to photograph from all sides, the best software for them was Meshy.ai Dot AI, because it was able to make a prediction for the other side.

4.4.2 Interaction with Objects: Grabbing and Holding

- **In this step, we added several components to the selected object, including:**

1. **Rigidbody, Box Collider& XR Grab Interactable**
2. **We set the Movement Type to Kinematic and the Interaction Layer Mask to Everything.**

- **Additionally, we enabled Smooth Position and Smooth Rotation to allow more natural object manipulation.**

The Result of Grabbing & Holding

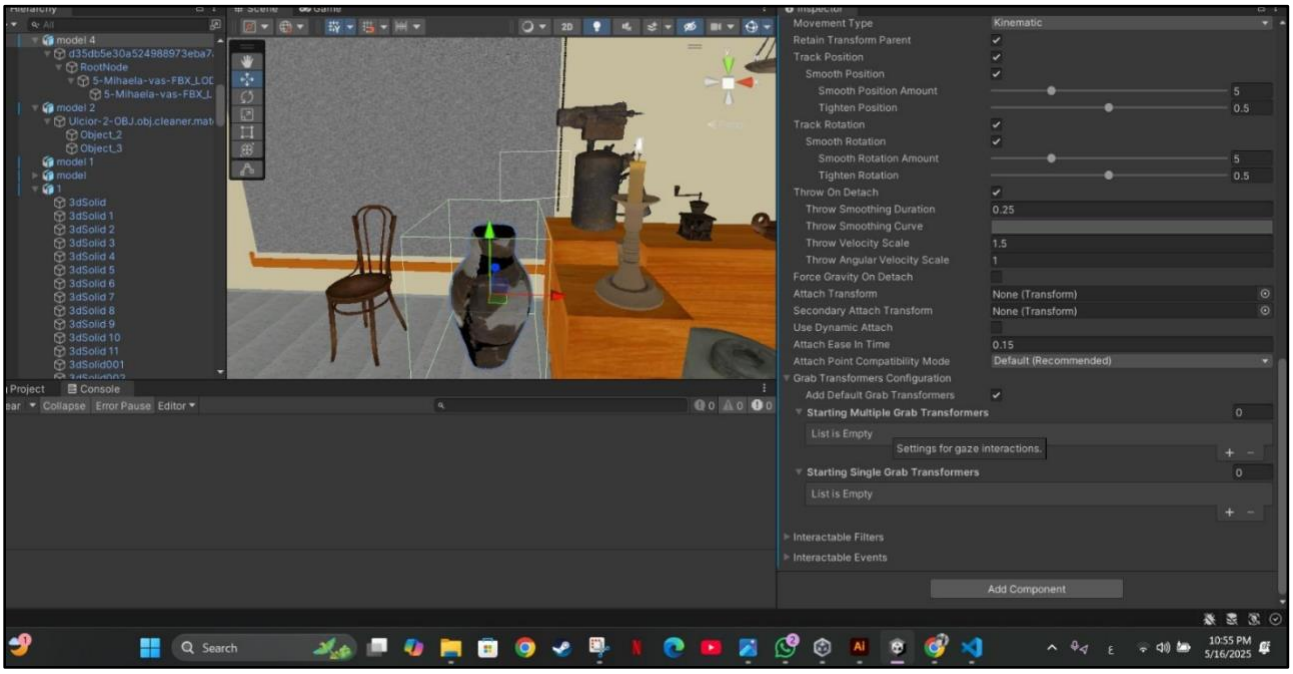

Figure 24:Setting of Grabbing in unity

Figure 25:Grabbing in unity

4.4.3 UI Configuration

- **At this step, we selected the desired object within the scene. After that, we right-clicked and navigated to the UI menu, where we added a Canvas to the scene.**
- **Next, we assigned the Tag of the object to ShowInfo.**
- **We proceeded to add several Components to the object, including:**
- **Rigidbody, Box Collider, XR Grab Interactable (We changed some configuration settings in the components).**
- **Additionally, we added both a Text element and a Panel to the object. The relevant information was then entered into the Text component.**

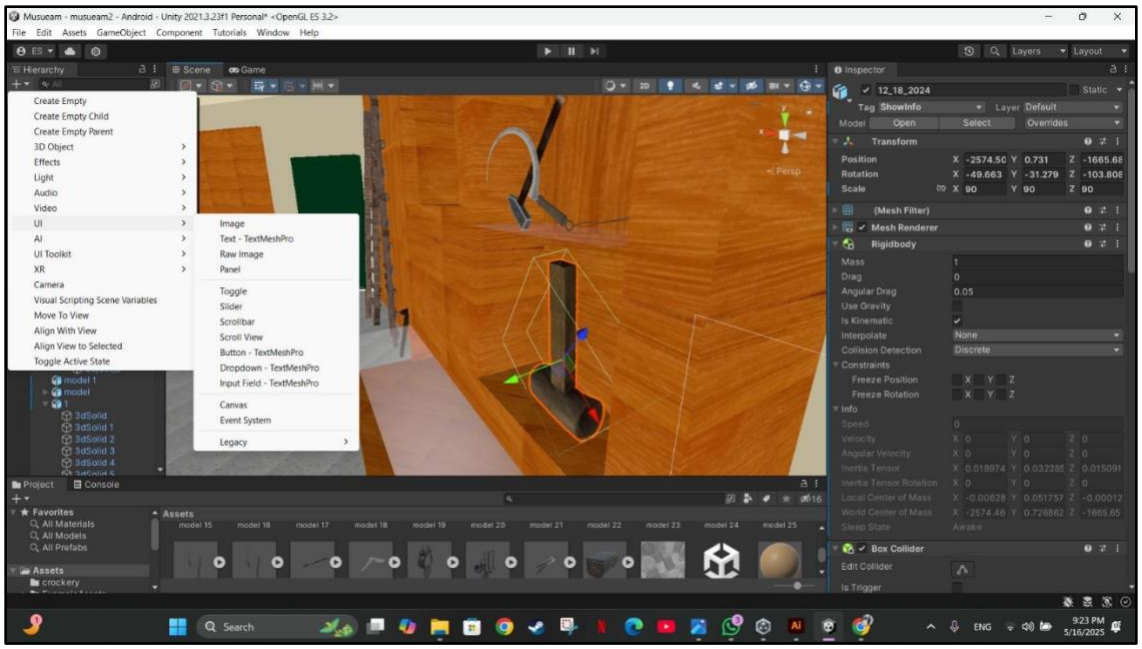

Figure 26: The process of UI

The code:

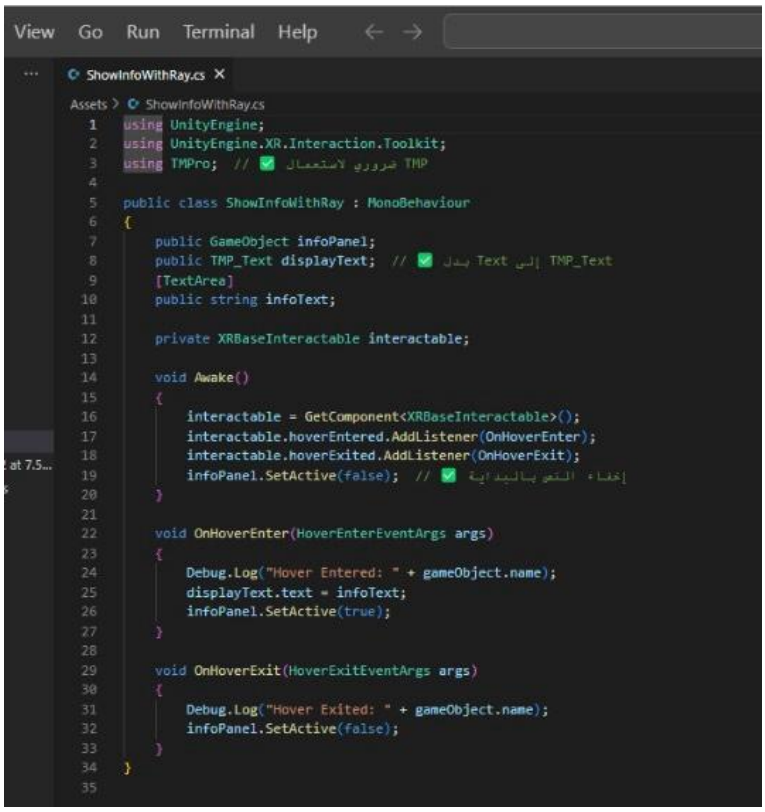

Figure 27: The code of UI

- **This script is used to display information when the user hovers over an object using XR Interaction Toolkit (with ray interaction).**
- **infoPanel: The UI panel that holds the information.**
- **displayText: The TMP_Text element that displays the actual info.**
- **infoText: The string containing the information to show**
- **In the Awake() method:**
  The script gets a reference to the XRBaseInteractable component.
- **Two event listeners are added:**
  hoverEntered → Triggered when the ray (pointer) enters the object.
  hoverExited → Triggered when the ray exits the object.
  The infoPanel is initially hidden (SetActive(false)).
- **On hoverEntered:**
  Logs the object name to the console, sets the text to infoText, and shows the info panel.

- **On hoverExited:**
  Logs exit to the console & Hide the info panel.

- **This allows the user to interact with 3D objects and receive contextual information through a clean and intuitive UI.**

The final result of UI

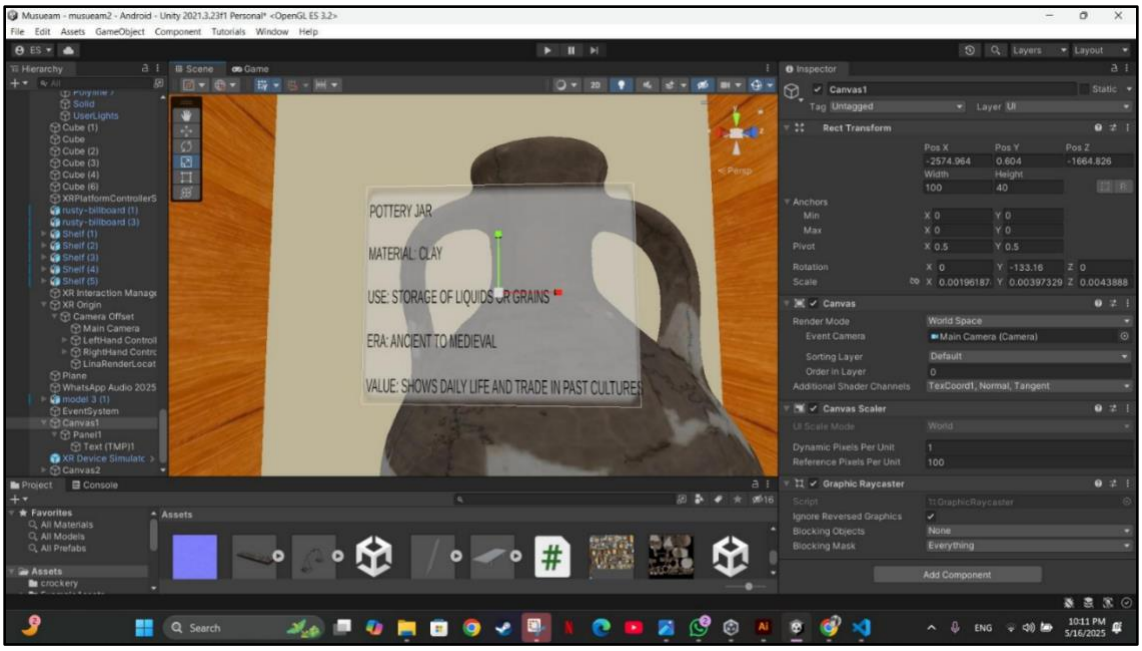

Figure 28: Setting of UI on Jarra

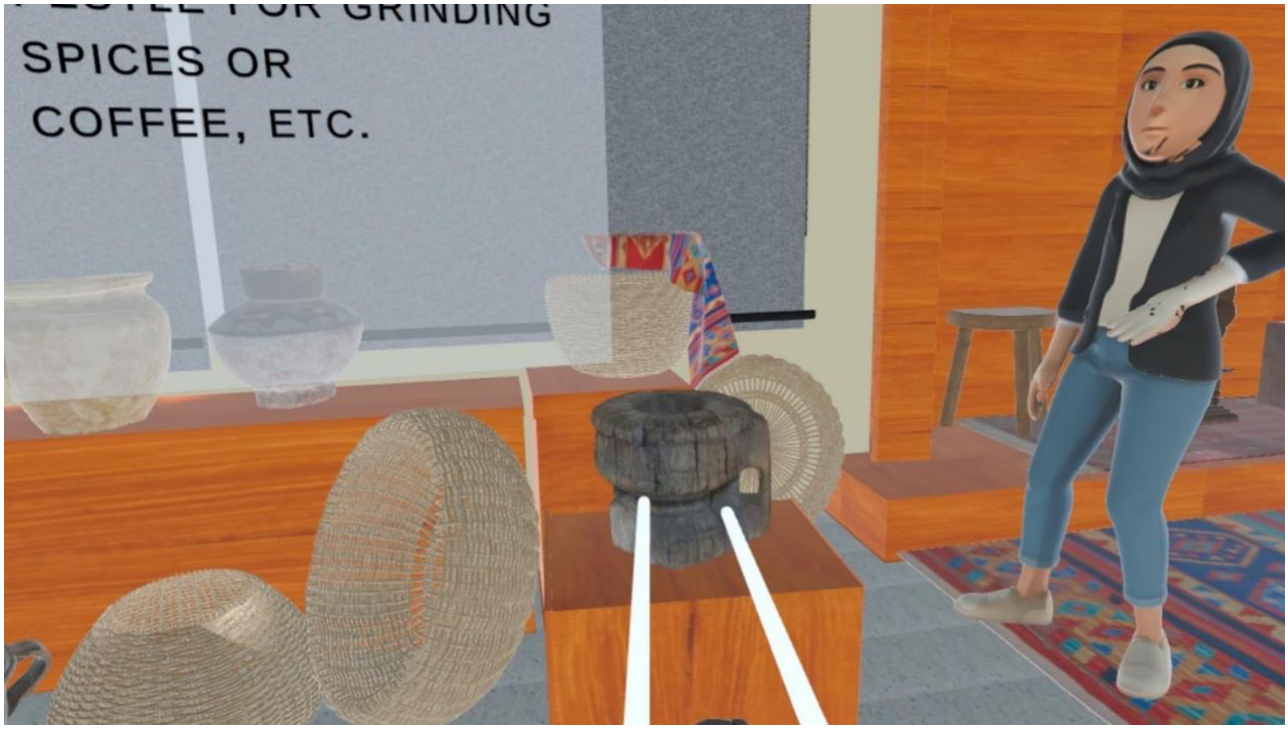

Figure 29: Results of UI

4.4.4 The Tour Guide

1. **First, we took a complete picture of the team members and converted it into a 3D object so that we could add it to the environment.**
2. **Then the new models were added to the MIXMO site so that we could add movements to the model so that it could interact with users in the environment.**
3. **After this step, some settings were applied within the Unity program until the avatar was activated.**

Setting on unity:

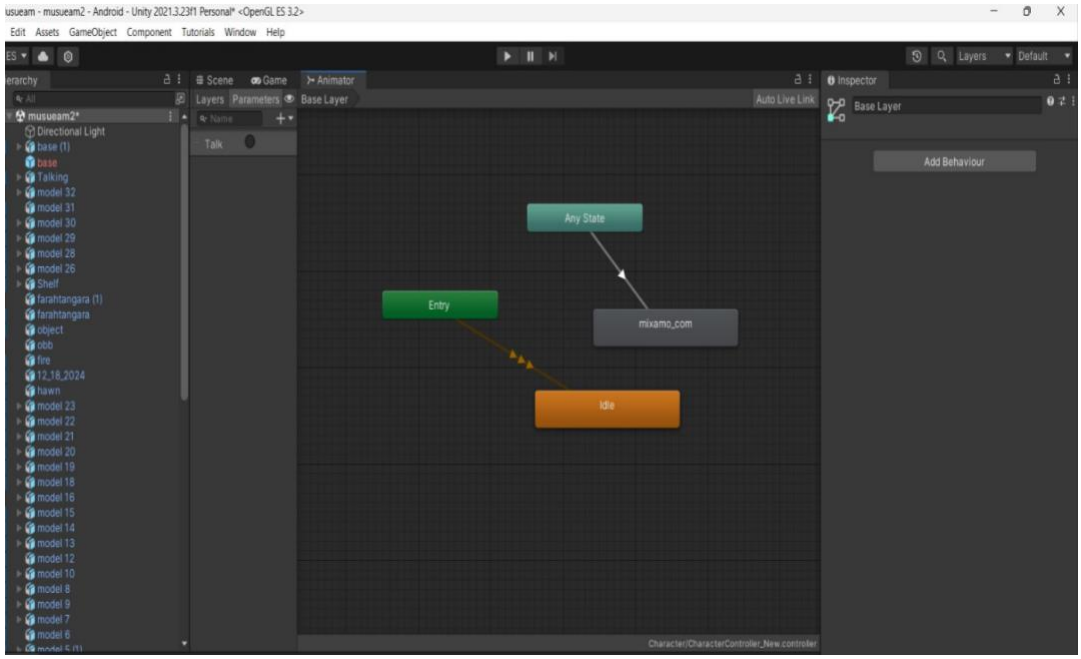

Figure 30: Setting of Avatars

This Unity screenshot shows the Animator Window, which controls the animations of a character (avatar). It uses an Animator Controller to define animation states and transitions between them.
Entry is the starting point of the animation flow.
Idle is the default animation state when the character is not moving.
mixamo_com isan animation imported from Mixamo.
Any State allows transitions to another state from any current animation.

4. **Then we were able to add code to allow the first avatar to perform hand gestures while explaining the objects.**

Explanation of avatar code

ArtifactTrigger Script Summary

This script triggers an interaction when the MainCamera enters a trigger zone near a museum object:

On Enter:

Plays a "Talk" animation.

Displays info text.

Plays audio (if available).

Prevents repeat triggers until the player exits.

On Exit:

Hides the info text.

Allows the trigger to activate again next time.

Useful for making interactive museum exhibits in Unity.

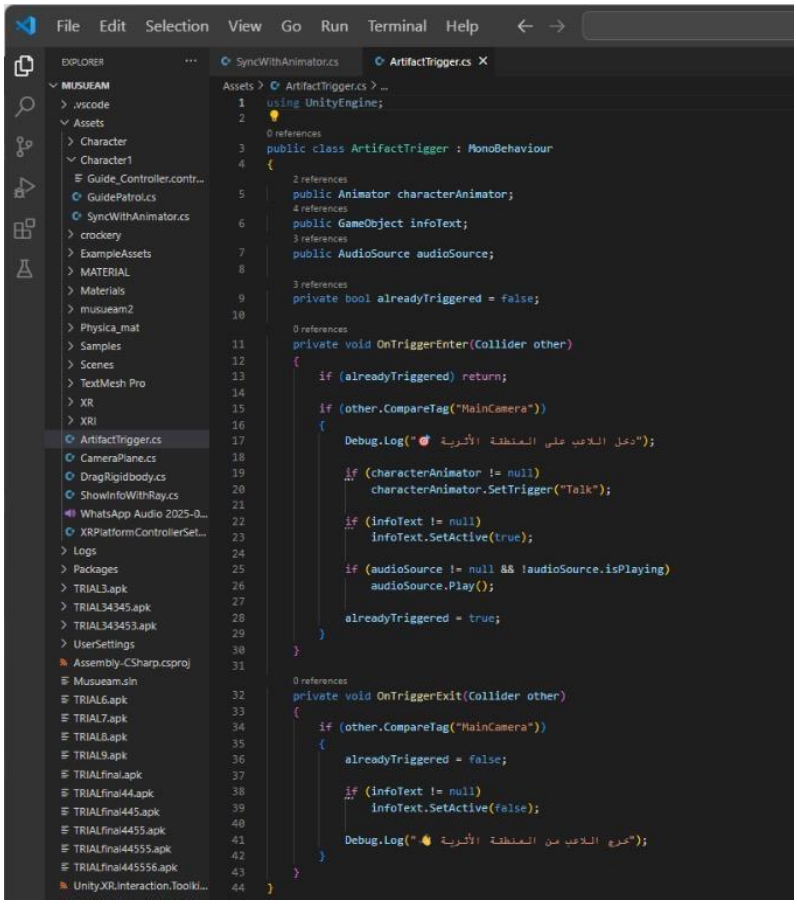

Figure 31: Avatars code (1)

5. **Then we added the second avatar with a slight difference from the first, as it will be free to move around the museum.**

Explanation of avatar code

C: > Users > dell > Downloads > GuidePatrol.cs

```
using UnityEngine;
using UnityEngine.AI;
[RequireComponent(typeof(NavMeshAgent), typeof(Animator))]
public class GuidePatrol : MonoBehaviour
{
    [Header("Patrol Waypoints (بالترتيب حددها)")]
    public Transform[] waypoints;
    [Header("المسافة بالمتر قبل أن ينتقل إلى النقطة التالية")]
    [Tooltip("استعمل 0.5 - 0.2 للمشي البطيء")]
    public float arrivalDistance = 0.3f;
    [Header("عتبة التحويل إلى Idle")]
    [Tooltip("إذا كانت السرعة أقل من هذا الرقم يتوقف Speed = 0")]
    public float idleThreshold = 0.05f;
    int index = 0;
    NavMeshAgent agent;
    Animator animator;
    void Start()
    {
        agent    = GetComponent<NavMeshAgent>();
        animator = GetComponent<Animator>();
        if (waypoints == null || waypoints.Length == 0)
        { Debug.LogError($"[{name}] لا توجد أي Waypoints مخصصة!");
            enabled = false;
            return;
        }
        agent.SetDestination(waypoints[index].position);
    }
    void Update()
    {
        float currentSpeed = agent.velocity.magnitude;
        animator.SetFloat("Speed", currentSpeed < idleThreshold ? 0f : currentSpeed);
        if (!agent.pathPending && agent.remainingDistance < arrivalDistance)
        { index = (index + 1) % waypoints.Length;
            agent.SetDestination(waypoints[index].position);
        }
    }
```

Figure 32: Avatars code 2

Script Name: Guide Patrol
This script makes a non-player character (NPC) walk between a list of waypoints (points in the scene you set up for patrolling). It also updates the "Speed" parameter in the Animator to play the walking or idle animation automatically.
Key Features:

1. **Waypoints Movement**
   The NPC walks from one waypoint to the next in order. When it gets close enough to one (based on arrivalDistance), it switches to the next.
2. **Smooth Animation Control**
   It checks how fast the NPC is moving using its NavMeshAgent.velocity.magnitude.

- **If the speed is below a certain value (idleThreshold), it sets the Animator's Speed to 0 (Idle).**
- **Otherwise, it sets the Animator's Speed to the NPC's actual speed (to play walk/run animation).**

3. **Components Required**
   The script automatically requires two Unity components:
   - **NavMeshAgent: for pathfinding and movement.**
   - **Animator: to control animations.**

How It Works in Steps:

- **In Start(), the NPC starts moving to the first waypoint.**
- **In Update():**
  - **It updates the animation speed.**
  - **It checks if the NPC has reached the current waypoint, then moves to the next one.**

Results of Avatars

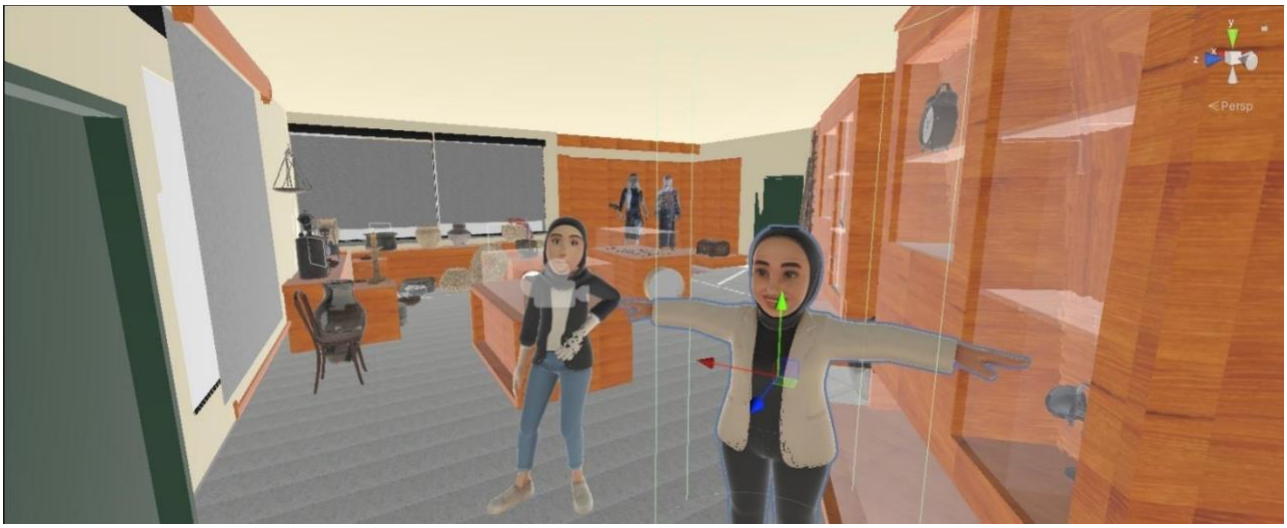

Figure 33: Avatars on unity

4.5 The environments layout:

On Unity:

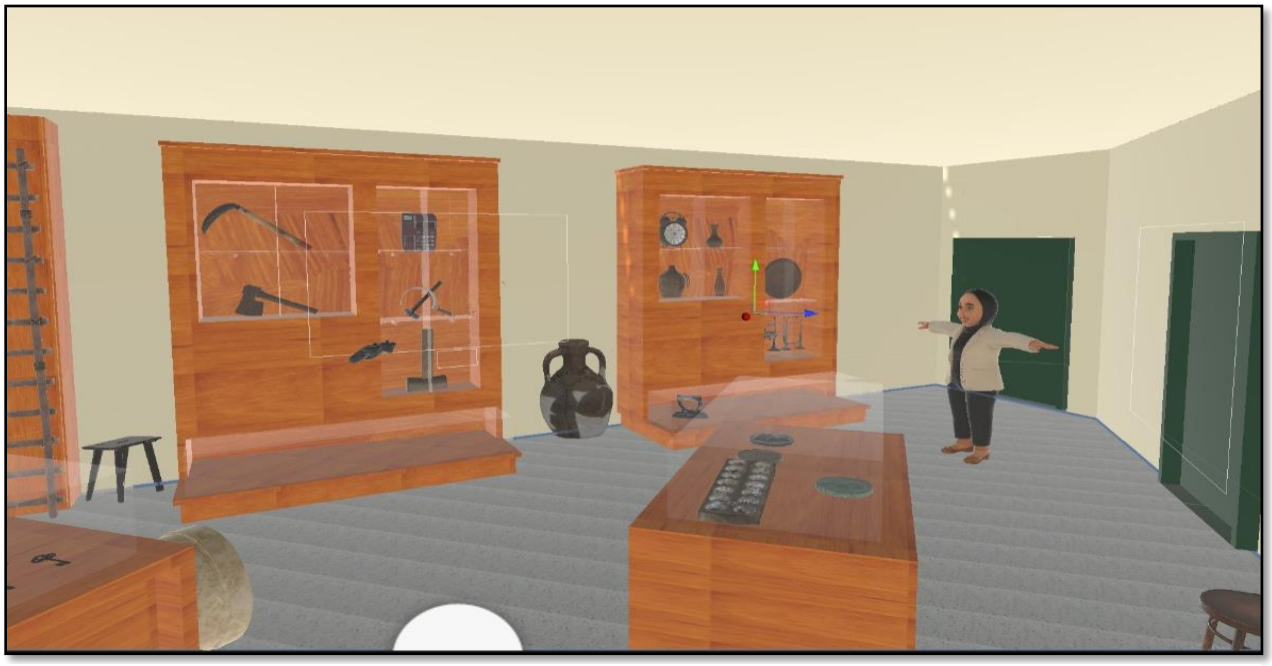

Figure 34:The environment layout in unity

In Spatial:

Figure 35The environment layout i Spatial

These Digital twins in the environments:

Figure 36:Digital twins in the unity environment

Figure 37:Digital twins in the Spatial environment

4.6 Pinch marking "A Comparison Between Local and Global Museum Displays"

The British Museum is one of the most well-known museums in the world, and it is well known for its expertly displayed rare items from ancient Egypt, Rome, and Greece. With thoughtfully placed lighting that accentuates their fine features, the items are set up in safe glass cases. With each artifact accompanied by a thorough explanation outlining its history and relevance, the museum complies with international standards for preservation and organization. A comprehensive visual and informative experience is provided to visitors by the tastefully designed and organized setting, which reflects the enormous importance of these historical artifacts. A monument of world culture and civilization, the British Museum is more than just a place for exhibitions.

Figure 38 The British Museum

This museum, which features a collection of local historical items like ceramics, traditional lanterns, antique scales, and handwoven baskets, stands out for being both instructive and participatory. The museum's straightforward layout, which mimics an interactive project area or classroom, makes it easy to explore and creates a feeling of intimacy with the items. Visitors are given a sense of freedom and direct engagement with the exhibits since they are arranged on hardwood tables without glass cases or boundaries. This kind of museum is perfect for educational or cultural events that want to showcase heritage in an easy-to-understand way.

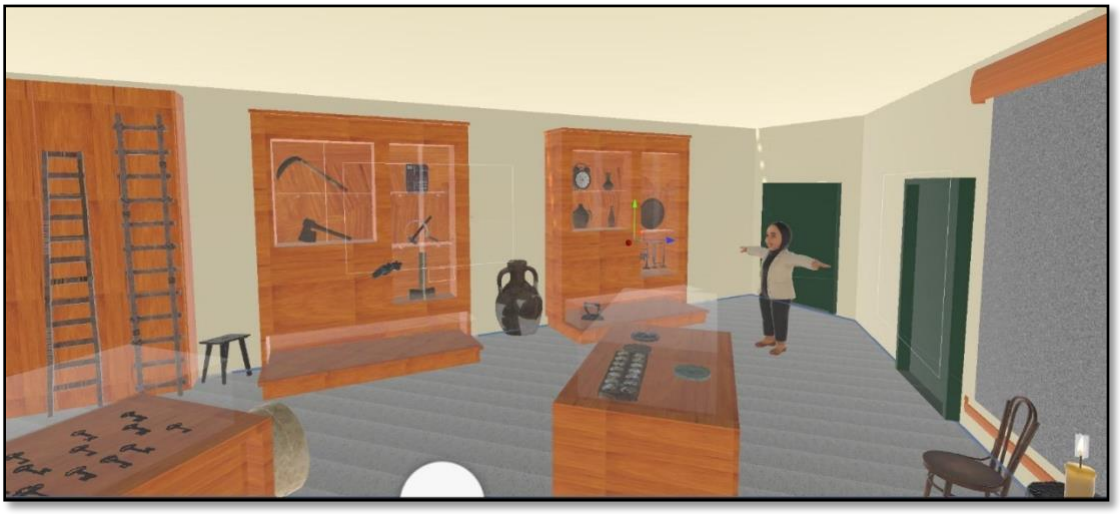

Figure 39: The Palestinian Museum

Chapter 5: Results, Impacts, and Analysis

5.1 Results

- **Polycam and Scaniverse are 3D modeling tools for scanning small to medium-sized artifacts, with Polycam being efficient in good lighting and Scaniverse having lower detail and device LiDAR capabilities, while Meshy.ai offers enhanced models.**

5.1.1 How to access the spatial program to view the results

- **This platform can accommodate everyone, including those with limited resources or disabilities, by offering free experiences, low-cost devices (mobile, web, & Headset), real objects, online tours, multilingual support, and 24/7 accessibility to educational materials, cultural assets and tourism sites so no one left behind.**
- **After completing the environment design and submitting (publishing) it to the Spatial platform, users can explore the project through the following steps:**
  a. **Accessing the Spatial website Visit the official website: https://www.spatial.io.**

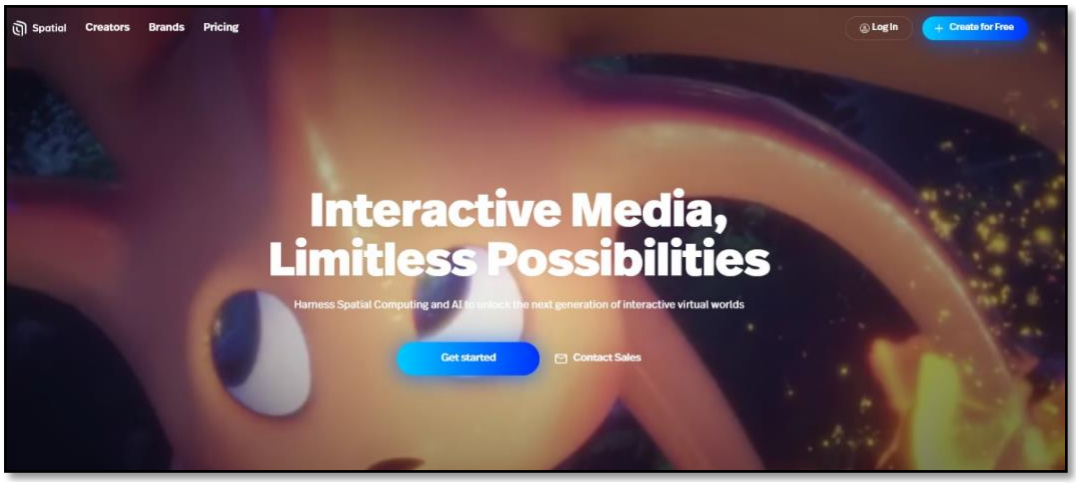

Figure 40: Spatial Website

b. **Sign in or create an account If you don't have an account, you can create a free one using your email or by linking your Google or Apple account.**

c. **Search for the project name After logging in, use the search bar on the homepage to search for the project name as published (Heritage Memory). Or you can access this link directly: https://www.spatial.io/s/Heritage-Memory-673b77ab0402ccd29e36703c?share=6110330421233066588 Accessing the environment Once the project appears in the search results, click on it to disable the virtual space.**

d. **Access options You can access it directly through a browser without the need to download any available software. Or you can use the Spatial app on your device (Windows, iOS, Android, or a meta headset) for a more interactive experience. Interacting within the Environment Once you log in, you can navigate the environment using**

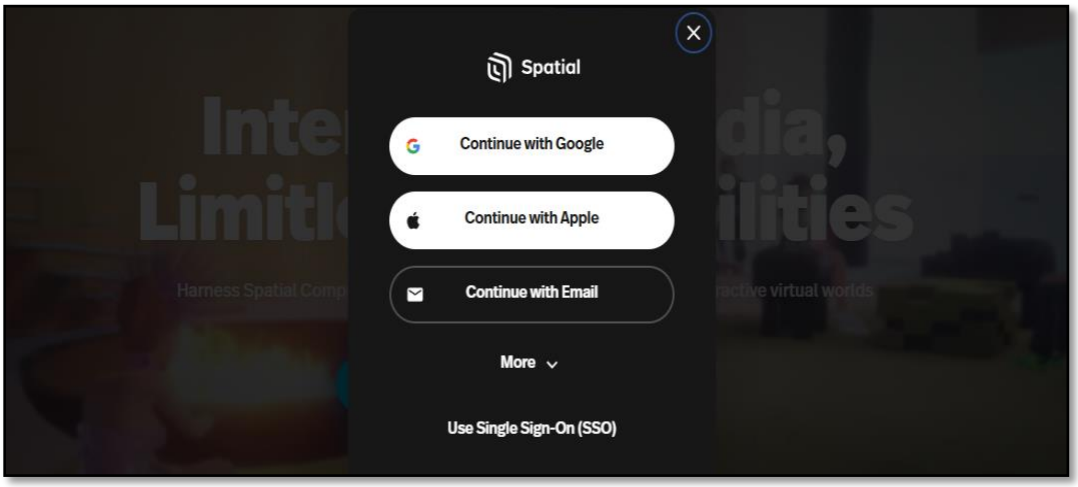

Figure 41: login Spatial

your mouse and keyboard, or interact with various elements. Note: Ensure you have a good internet connection to enjoy the e-library experience.

- **Here is a link to a video showing us the environment and the parts on the Unity program:**

  https://drive.google.com/file/d/1POXbahAljnlzGnVhYEHYUQbCnbeKieDn/view?usp=drive_link

- **Here is a link to a video showing us the environment and the parts on the Spatial program: https://drive.google.com/file/d/1MvnX4__SCRu54Rb6Q6yJI5gHu4sGgajD/view?usp=drive_link**

5.2 Analysis

5.2.1 Comparative Strengths

Table 2:Comparison between polycam,scaniverse & meshy.ai

Feature	Polycam	Scaniverse	Meshy.ai
Ease of Use	High	Very High	Moderate
Scan Detail	Excellent	Good	Enhanced
Optimization	Requires manual	Requires manual	Automatic
VR Integration	Medium	Medium	High

Table 3: Comparison between Unity & Spatial

Feature	Unity	Spatial
Ease of Use	Medium to difficult requires technical/programming skills	Easy built for non-technical users with a visual interface
Simultaneous Users	Can't support large numbers of user	Supports around 50–100 users per session
Programming Language Support	C#, (JavaScript in older versions)	No coding required basic scripting optionally supported
Text Support	Not supported natively (requires external libraries/workarounds)	Fully supports Arabic text out of the box
Supported Devices	Windows, Mac, VR/AR	Android, iOS, Web (browser), VR (e.g., Meta Quest)
Ease of Learning	Medium to hard requires learning curve	Very easy intuitive and user-friendly
Ease of Publishing	Medium to hard supports publishing to stores, apps, web	Very easy publish instantly via link or room code

3D World Building	**Requires designing the environment and models from scratch by the developer.**	**Easy drag and drop 3D asset Easily drag and drop 3D assets and environment design can be a ready-made design.**
Target Users	**Developers, programmers, game/tech companies**	**Teachers, artists, designers, students, presenters**

5.1 Impact of the Project

The project's true impact lies in preserving and archiving the cultural heritage and transmitting it across generations using an innovative, immersive technology that allows for virtual interaction via avatars and discussion of everything related to the artifacts.

A project like this can provide users with an appreciation of the country's foreign tourism and introduce local residents to their culture in a seamless and immersive manner.

Create new tourism opportunities in the fields of tourism and technology, which enhances the wheel of sustainable economic development and the creation of a new economic market that integrates several disciplines, including:

- **Tourism and antiquities**
- **Technology and programming**
- **3D design**
- **Marketing**

Societal Impacts

The potential impact includes several desperate areas, the most important of which is

1. **Increasing and providing democratic access to cultural heritage, allowing individuals around the world to experience the diverse virtual environment around Palestinian cultural heritage that they may not have a chance to see otherwise.**
2. **Digital preservation and long-term sustainability of cultural assets by creating high-resolution digital records of cultural heritage, which preserves them in the event that the original cat is destroyed by disasters or conflicts.**

3. **Educational opportunities and innovation by providing valuable resources for teachers and learners and offers attractive and interactive ways to teach and teach history and culture, for example, teachers can integrate the virtual museum into their courses to make it easier for students to explore artifacts in a dynamic and memorable way**
4. **Contribute to the public digital infrastructure system by exploring the public digital infrastructure such as digital identity and access standards**
5. **Promote global understanding and dialogue such as showcasing diverse cultural narratives and enhancing interaction between users from different backgrounds**
6. **Organizing future digital heritage events and initiatives, where the project can be a model and inspiration for institutions and individuals looking to benefit from advanced technology and digital infrastructure to preserve and disseminate cultural heritage**

Environment Impact

By eliminating the need for physical travel and reducing carbon emissions, the project offers a sustainable alternative to traditional tourism. It minimizes the environmental impact typically associated with heritage tourism and promotes eco-friendly practices by enabling users to virtually explore cultural landmarks.

Chapter 6: Feasibility Study

6.1 Project Overview

A ready-to-sell digital museum built using Unity, featuring around 10 high-quality 3D scanned cultural or artistic objects (via Polycam), with an interactive design and potential for expansion.

6.2 Initial Setup Costs

Table 4: Table od cost

Item	Cost (ILS)	Notes
Meta Quest 2 VR Headset	₪1,500	For VR experience testing
High-performance PC	₪3,600	RTX 3060, Core i7, 32GB RAM, 512GB + 1TB

Polycam Pro (60$/mo × 12)	**₪2,640**	**Required for 3D scanning**
Business Registration (lawyer)	**₪510**	**~100 Jordanian Dinars**
Office Rent (12 months)	**₪18,000**	**₪1,500/month – Nablus-based office**
Marketing & Ads	**₪4,000**	**Sponsored campaigns**
Total Estimated Cost	**₪30,250 ≈ $8,000**	

6.3 Product description

- **full interactive digital museum experience (Unity-based)**
- **10 high-resolution 3D scanned objects**
- **High-quality UX/UI**
- **Fully customizable by the buyer**

6.4 Sales & Revenue Assumptions

Table 5: Sales & Revenue values

Metric	Value
Selling Price per Project	**$3,000**
Expected Annual Sales	**4 Projects**
Total Annual Revenue	**$12,000**
Estimated Annual Operating Costs	**$5,000**
Net Annual Profit	**$7,000**

6.5 Calculations

6.5.1 Payback Period (PBP)

$$\text{PBP} = \frac{\textit{Initial Investment}}{\textit{Annual Net Profit}} = \frac{8000}{7000} = \approx 1.14 \textit{years}$$

The initial investment is recovered in about 1 year and 2 months – an excellent result for a startup.

6.5.2 Internal Rate of Return (IRR)

Table 6: Net cash flow

Year	Cash Flow (Net Profit)
0	-$8,000 (Initial Investment)
1	+$7,000
2	+$7,500
3	+$8,000
4	+$8,000
5	+$8,000

Using IRR estimation methods or financial tools, we find:

Estimated IRR ≈ 42%

This means the project offers a very strong return compared to typical investment benchmarks (10–15%)

6.6 Conclusion

Payback Period (PBP): ~1.14 years

Internal Rate of Return (IRR): ~42%

The project is highly profitable, offers fast capital recovery, and presents low risk with the right marketing and targeting strategy

Chapter 7: Conclusion and Recommendation

7.1 Conclusion

Virtual reality (VR) is a state-of-the-art technology that produces computer-generated, fully immersive environments for interaction in real-time. There are uses for it in a number of sectors, such as business, education, healthcare, and entertainment. VR has drawbacks like high hardware and software costs, technical difficulties, and user discomfort, but

it also has advantages like improved learning, teamwork, and creativity. Nonetheless, improvements in functionality, affordability, and accessibility are anticipated as a result of hardware and software developments. VR is a vital tool for innovation, and its uses are predicted to grow as it is integrated with other technologies like AI and AR.

We launched an interactive digital museum using the Spatial platform to showcase Palestinian and global cultural heritage. Featuring over 100 curated 3D models, the museum aims to democratize access to cultural artifacts and historical sites for a global audience. This initiative aligns with the principles of the Global Digital Compact, emphasizing the integration of Digital Public Infrastructure (DPI) to ensure accessibility, inclusion, and sustainability.

Beyond mere digitization, the museum is designed to foster cultural understanding, promote sustainable digital tourism, and support the long-term preservation of shared human heritage. The project is driven by cutting-edge technologies and a user-centric design philosophy, with a strong commitment to iterative development, community feedback, and strategic collaborations.

While Spatial was chosen for its ease of use, accessibility, and support for Arabic content, Unity remains a powerful option for future development phases that may require advanced customization, complex interactivity, or broader cross-platform deployment. Together, both platforms complement the vision of creating meaningful, immersive digital cultural experiences that are both inclusive and impactful.

7.2 Recommendation

1) Expand Accessibility and Affordability: Create reasonably priced virtual reality hardware and software to enable a larger audience to use the technology. Governments, academic institutions, and tech companies should collaborate to subsidize virtual reality (VR) solutions.

2) Handle Technical Difficulties: To increase the immersive experience, spend money on research and development to increase processing power, resolution, and reduce latency problems. To lessen motion sickness and user discomfort during extended use, concentrate on developing ergonomic designs.

3)Expand industry-specific applications in education, healthcare, and business by developing virtual learning modules, simulations, and promoting virtual collaboration platforms for remote work and product design.

4)Encourage Awareness and Training: Use workshops, online materials, and demonstration programs to inform people and organizations about the possible advantages of virtual reality. To optimize VR's impact, teach users how to use it efficiently in their respective fields.

5)Improved Integration with Emerging Technologies: To create smarter, more adaptable environments, combine virtual reality (VR) with artificial intelligence (AI). To increase applications and enhance user experiences, combine VR with AR (Augmented Reality) and IoT (Internet of Things).

6) Promote Sustainable and Ethical Use: Create rules for the moral application of virtual reality, emphasizing inclusivity, data security, and privacy. Encourage environmentally friendly production and deployment methods to reduce the negative effects of VR hardware on the environment.

7) Promote Innovation and Collaboration: To find new use cases and exchange best practices, promote cross-industry collaboration. Encourage entrepreneurs and trailblazers to investigate innovative uses of virtual reality to address pressing issues.

- **Unity is a versatile platform for creating interactive virtual reality environments, particularly in AR/VR and gaming. It supports 3D asset integration, allowing for intricate reproductions of museum spaces and incorporating 3D models of Palestinian items, Unity's cross-platform compatibility allows for a large audience to view the virtual museum on PCs, VR headsets, and mobile devices.**
- **Spatial allows users to participate in guided virtual tours or live museum events, promoting social or educational interaction. It also allows for easy access on web browsers and VR devices.**

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