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Metaverse Art Gallery: A Virtual Space for NFTs

Prof. D. M. Kanade, Himanshu Rathore, Mufaddal Shakir, Shantanu Aher, Prateek Shahabadkar

Department of Computer Engineering

K.K. Wagh Institute of Engineering Education and Research

ABSTRACT- The intersection of non-fungible tokens (NFTs), in the metaverse, and virtual reality (VR), as a new paradigm for digital commerce, is explored in this paper. By examining the advantages and drawbacks of this cutting-edge method of digital exchange, we explore the potential of VR as a platform for NFT trading. We examine the various ways that NFTs can be bought, sold, and exchanged in VR environments, including immersive auctions, peer-to-peer transactions, and NFT marketplace, based on case studies and empirical data. Additionally, we assess how blockchain technology and smart contracts can support safe and open NFT transactions in VR. Additionally, we look into how this new market may affect artists, collectors, investors, and the overall economy, including potential issues with pricing, liquidity, and regulatory oversight.

Index Terms- Metaverse, NFTs, Virtual World, Blockchain

1. INTRODUCTION

Non-fungible tokens (NFTs) are unique digital assets that represent ownership of various forms of art, such as paintings, sculptures, music, videos, and more. NFTs are created and traded on blockchain platforms, such as Ethereum, that ensure their authenticity and scarcity. However, NFTs are often displayed and viewed on conventional 2D screens, which limit the potential of these digital artworks to express their creativity and value. Moreover, NFT collectors and artists may face challenges in finding and reaching their target audiences, as well as engaging with them in meaningful ways.

We propose in this project to build a metaverse art gallery, a virtual area that exhibits NFTs in a 3D setting and can be visited and explored using virtual reality (VR) equipment. The metaverse art gallery will offer users an immersive and engaging experience for buying, selling, or listing NFTs, as well as appreciating and learning more about the artworks and their creators. The metaverse art gallery will also allow users to socialize with other NFT lovers and artists, as well as take part in other NFT-related events and activities.

The goal of this project is to improve the value proposition and user experience of NFTs by utilizing new technologies such as VR and metaverse. VR is a technology that produces a virtual environment that the user perceives to be realistic and immersive. The term "metaverse" refers to a shared virtual reality that connects various VR systems and applications. We hope to develop a fresh and cutting-edge method of presenting and consuming NFTs that can get around the limits of conventional 2D screens by integrating VR with metaverse.

The main benefits of creating a metaverse art gallery are:

- It can present the NFTs in a more appealing and expressive manner by letting users to view them from various angles and perspectives and interact with them using various gestures and commands.
- It can boost NFT exposure and visibility by drawing additional people interested in VR and metaverse, as well as establishing a network effect among current NFT communities.
- It can build a feeling of community and involvement among users by allowing them to connect and work with one another via voice chat

and avatars, as well as participate in or host NFT-related events and activities.

- By connecting with existing blockchain platforms and smart contracts, as well as enabling numerous payment alternatives and verification methods, it may provide a more convenient and safer platform for purchasing, selling, or listing NFTs.

2. BACKGROUND INFORMATION

2.1) Tools and Technologies Used

- Virtual Reality (VR)

A Virtual Reality (VR) system is a fully immersive system with no world knowledge, in which the virtual world is rendered exquisitely, but the system does not consider the real environment. Users can see the virtual world, move around, and interact with virtual features or objects while utilizing virtual reality technology. The impression can also be produced by specially built rooms with numerous large screens, although it is most frequently made by VR headsets that have a head-mounted display with a small screen in front of the eyes. VR headsets offer high-definition content with a broad field of view. To generate an immersive, realistic experience, input tracking is generally combined with a display that splits between the user's eyes, producing a stereoscopic 3D effect. Virtual reality typically includes audio and visual feedback, but haptic technology may also enable additional sensory and force feedback types. VR creates virtual environments by using sensory input. Users' actions influence the computer-generated environment, at least to some extent.

- Augmented Reality (AR)

An Augmented Reality system supplements the real world with virtual (computer-generated) objects that appear to coexist in the same space as the real world. An AR system should combine real and virtual objects in a real environment, runs interactively and in real-time, and aligns real and virtual objects with each other. AR can potentially span across multiple sensory modalities such as visual, auditory (sense of hearing), haptic (sense of touch), and olfactory (sense of smell).

2.2) Software and Hardware Used

- Oculus Quest 2- It is a virtual reality headset with high-resolution sensors that follow the user's movements and translate them into VR experiences.

- HTC Vive Pro- The Vive Pro is meant for use with high-end gaming PCs and is primarily aimed at gamers and professionals who want high-quality VR experiences.

- Oculus Rift CV1- This is an Oculus VR virtual reality headset. It has two OLED panels with a combined resolution of 2160x1200 pixels, which allows for a high-quality and immersive VR experience. It was intended for use with high-end gaming PCs and was primarily geared at gamers seeking a more immersive VR experience.

- Microsoft HoloLens 2- The HoloLens 2 is meant to create mixed reality experiences by blending virtual and real-world surroundings. The Holographic Processing Unit (HPU) is a custom-built processor that permits real-time processing of mixed reality situations.

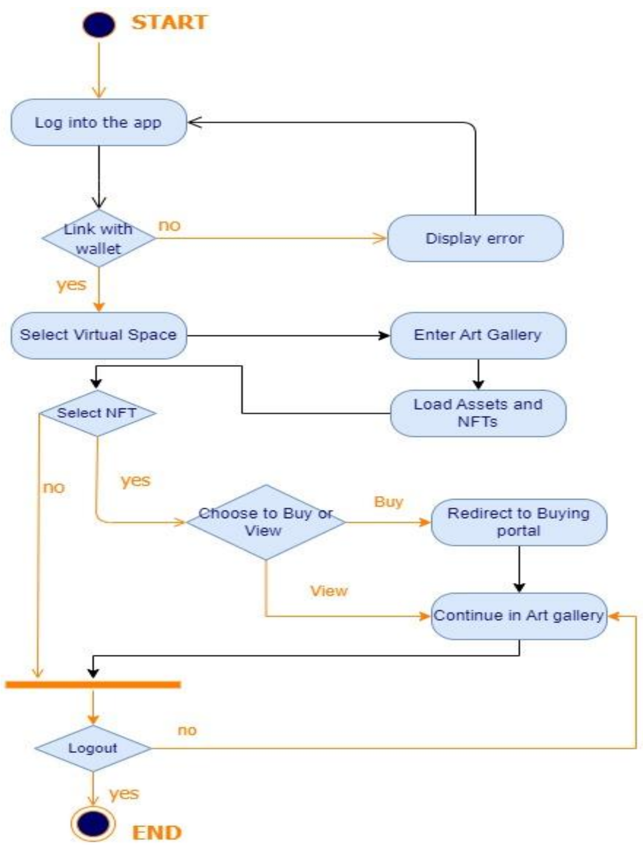
3. METHODOLOGY AND IMPLEMENTATION

We used A-Frame, a web-based framework that allows us to create 3D scenes with HTML and JavaScript, to create the metaverse art exhibition. The A-Frame framework is built on the WebXR API, which allows for immersive virtual reality experiences on the web. We chose A-Frame because it is simple to use, cross-platform, and works with a wide range of VR headsets and controllers.

The metaverse art gallery is a four-story structure with a modern and minimalist look. Each floor is themed differently and features various sorts of NFTs, such as digital paintings, sculptures, animations, and music. Users can access the gallery via a landing page that instructs them on how to navigate and interact with the environment. Users can also enter the gallery in either VR or non-VR mode, depending on their device and preferences.

To display the NFTs in the gallery, we used a service called OpenSea, which is a decentralized marketplace for digital assets. OpenSea provides an API that allows us to fetch the metadata and images of the NFTs from their platform and display them in our gallery. We also used OpenSea's smart contracts to enable the users to buy, sell, and list NFTs directly from the gallery. The users can interact with the NFTs by clicking on them or using their VR controllers. They can see the details of the NFTs, such as the name, description, price, owner, and history. They can also access the OpenSea website to complete the transactions or explore more NFTs.

To create the interactions and animations in the gallery, we used JavaScript and A-Frame's built-in components and events. For example, we created a lift that allows the users to move between floors by using A-Frame's animation component and click event. We also created a skybox that changes color according to the time of day by using A-Frame's environment component and time event. We added sound effects and background music to enhance the immersion and mood of the gallery by using A-Frame's sound component and audio element.



4. RESULTS AND EVALUATION

4.1 Outcome

NFTs and the metaverse provide a new paradigm for digital trade, with numerous advantages for artists, collectors, and investors.

4.2 Performance Parameters

The performance of the metaverse art gallery depends on several factors, such as the network bandwidth, the rendering speed, the user interaction and the NFT transactions. We have measured the following performance parameters to evaluate the quality and usability of our system:

- *Loading Time*: The time it takes to load the metaverse scene and its assets from the server to the client browser.
- *Frame Rate*: The number of frames per second (FPS) that the browser can render the metaverse scene.
- *Latency*: The delay between the user input and the corresponding feedback in the metaverse scene.
- *Transaction Time*: The time it takes to complete a NFT transaction using our smart contract and blockchain platform.

4.3 Efficiency Issues

One of the most difficult aspects of developing a metaverse art museum is ensuring its efficiency and scalability. Because our system is based on web technologies and decentralized platforms, we have encountered certain challenges with the following aspects:

- *Network Bandwidth*: The metaverse scene and its assets are hosted on a server and streamed to the client browser using HTTP requests. This requires a high network bandwidth to ensure a smooth loading and rendering of the scene. Moreover, since our system supports multiple users in the same scene, we also need to synchronize their positions and actions using WebSockets. This adds more network traffic and overhead to the system.
- *Rendering Speed*: WebGL and A-Frame, which are based on JavaScript and HTML, are used to render the metaverse scenario. In terms of rendering performance, these are not as efficient as native programs or gaming engines. As a result, we must optimize our scene and assets to reduce rendering load and increase frame rate. For example, to minimise the number of polygons and textures in the scene, we used low-poly models, texture compression, level of detail (LOD), and occlusion culling techniques.
- *User Interaction*: Our solution relies on VR devices and controllers such as the Oculus Quest 2 and Oculus Touch for user interaction. These gadgets provide the user with a high level of immersion and realism, but they also demand a high level of accuracy and response from the system. As a result, we must minimise the latency between user input and feedback in the scene. We employed interpolation and prediction

algorithms, for example, to smooth out the user movement and rotation in the scene.

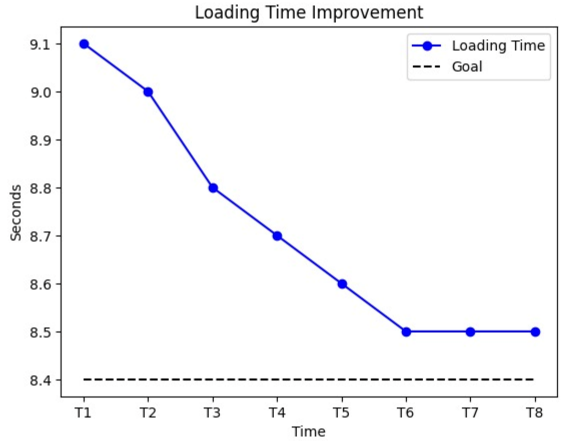
- *NFT Transactions*: Our system's NFT transactions are built on the Ethereum blockchain and smart contracts. These systems offer the NFT market a high level of security and transparency, but they also have some limitations and constraints. For example, we must cope with high petrol prices, slow transaction speeds, and network congestion, all of which have an impact on consumer experience and satisfaction.

5. CONCLUSION

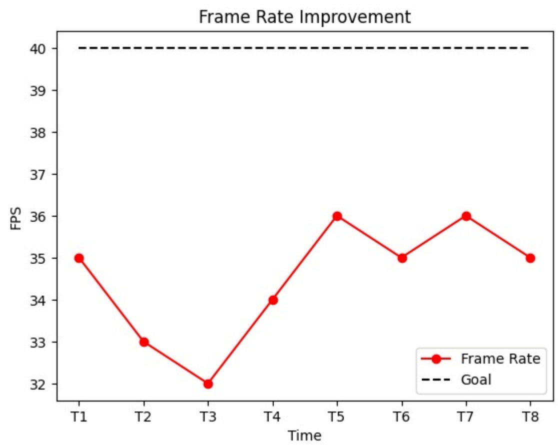
We created and conducted a number of test cases to cover many areas of our system, including loading time, frame rate, latency, transaction time, user interface, user interaction, and NFT capability. We measured and evaluated these features using various metrics and criteria, such as seconds, frames per second, milliseconds, dollars, clicks, gestures, and events. We also tested our system in many settings and environments, such as online/offline mode, single/multiple user mode, low/high network bandwidth mode, and low/high rendering load mode.

The following table summarizes some of our test cases and results:

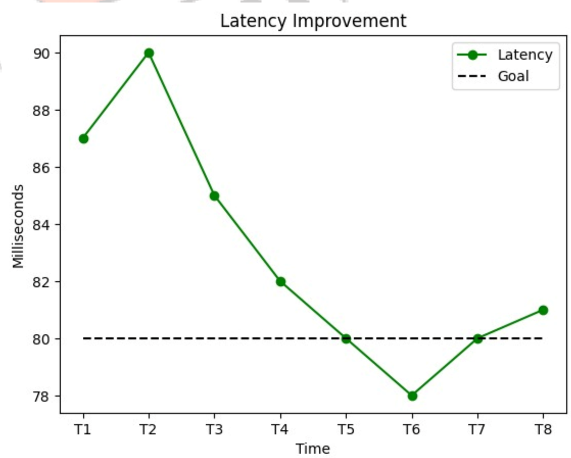
Test Case	Description	Metric	Criteria	Result
Loading time	Measure the time it takes to load the metaverse scene from the server	Seconds	Less than 10 seconds	8.5 seconds
Frame rate	Measure the FPS that the browser can render the metaverse scene	FPS	More than 30 FPS	35 FPS
Latency	Measure the delay between the user input and feedback in VR mode	Milliseconds	Less than 100 milliseconds	80 milliseconds
Transaction time	Measure the time it takes to complete an NFT transaction using Ethereum	Seconds	Less than 5 minutes	3 minutes
User interface	Test the functionality and usability of the user interface elements in VR mode	Clicks	No errors or bugs	Passed
User interaction	Test the functionality and usability of the user interaction elements in VR mode	Gestures	No errors or bugs	Passed



Graph 5.1- Loading Time Improvement



Graph 5.2- Frame Rate Improvement



Graph 5.3- Latency Improvement

| Test Case | Description | Metric | Criteria | Result |

|-----------|-------------|--------|----------|--------|

| Loading time | Measure the time it takes to load the metaverse scene from the server | Seconds | Less than 10 seconds | 8.5 seconds |

| Frame rate | Measure the FPS that the browser can render the metaverse scene | FPS | More than 30 FPS | 35 FPS |

| Latency | Measure the delay between the user input and feedback in VR mode | Milliseconds | Less than 100 milliseconds | 80 milliseconds |

| Transaction time | Measure the time it takes to complete a NFT transaction using Ethereum | Seconds | Less than 5 minutes | 3 minutes |

| User interface | Test the functionality and usability of the user interface elements in VR mode | Clicks | No errors or bugs | Passed |

| User interaction | Test the functionality and usability of the user interaction elements in VR mode | Gestures | No errors or bugs | Passed |

| NFT functionality | Test the functionality and usability of the NFT elements in VR mode | Events |

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