Online Virtual Tourism Platform Based on VR Technology

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Abstract. The COVID-19 pandemic and the development of emerging technologies have brought new challenges and opportunities to tourism. The tourism sector must rethink its relationship with consumers and leverage emerging technologies for business expansion and transformation. Under this circumstance, providing travelers with an immersive virtual environment to meet their travel needs through virtual reality (VR) technology is considered to be a sustainable way to develop tourism1. In this paper, an online virtual art museum travel platform is built based on VR technology, which allows users to roam in the virtual scene and interact with the objects in the scene from the first-person view. VR tourism that provides a highly realistic environment and user-driven interactive functions is regarded as a potential alternative for real-life tourism2, achieving the immersive roaming in the virtual environment. VR tourism alleviates the contradiction between constrained mobility and increased tourism willingness up against the COVID-19 pandemic, and has positive social significance.

Key words: Virtual reality, tour, roam, user-driven interactivity, immerse.

1. Introduction

With the world economic boom, countries all over the world have gradually increased their investment in the tertiary industry. However, the flow of people and field tourism are both affected by the severe COVID-19 pandemic. Therefore, the digitalization and intelligence of the cultural tourism industry are new opportunities and trends for its revitalization, and the tourism industry needs to find new ways to establish remote contact with customers. At present, augmented reality, virtual reality, and mixed reality can provide users with an immersive interactive experience, thus affecting travelers' choices3. Using these immersive reality technologies to assist the development of some intelligent tourism systems can ease the human-environment conflict, reduce tourism costs and facilitate the transformation of tourism. Promoting virtual tourism-related activities during the COVID-19 pandemic could undercut virus transmission, weaken the virus' blow to the tourism industry and improve the sustainability of tourism4.

At present, virtual tourism lacks a universal and widely accepted definition5. However, it can be described as simulating an existing place with a series of videos and images, which can provide a unique view to users with user-controlled interaction and input to achieve an immersive state6 7. On the other hand, the virtual tour can serve as a promotional tool for tourist attractions to expand their reach and meet the visitation needs of people who have no access to the scenic spots. Currently, VR head-mounted displays are used more often for virtual tourism experiences. With this device, users can see the simulated environment, interact with it through gyroscopes and tracking sensors, and move in the simulated location, thus achieving an immersive experience8. In addition, users can also interact with the simulated environment through computers and their input and output devices, so as to experience a virtual tour. Lo, J. H. et al used the panoramic image to build a VR navigation system for a temple, allowing users to visit the temple by controlling the camera angle. This system has stronger interactivity compared with traditional web pages which only display static descriptive information, but it suffers from stitching of spherical virtual images and visual distortion that leads to vertigo when users shift the viewpoints9. Guo, J. et al used hybrid augmented and visual reality technology to build a historical town tourism system that could recreate scenes of the area through drones and 3D scanning technology to generate a guided tour route, but fail to dynamically update the tour route according to changes in reality10. Binti Azizo et al designed a VR campus tour system using voice commands combined with head-mounted displays to help students and tourists adapt to

the school more quickly. However, the voice recognition function is vulnerable to unstable networks and noise, which will provoke poor interactivity of the system11. At this stage, virtual reality technology in tourism is mostly applied in the basic services to help travelers make decisions before departing, such as exploring a destination in advance, providing a reference for making travel plans, etc. When the hardware technology turns full-fledged, users will be able to truly travel online12.

This paper discusses the feasibility of experiencing virtual tourism through the interaction between a computer and a simulated environment. Besides, it puts forward an online virtual tourism platform based on Unity engine, a real-time 3D interactive platform for content creation and operation, which can restore the spatial layout of tourist attractions by 3D modeling and utilize Unity 3D engines to develop functions of roaming, interaction, and so on. This platform is packaged into WebGL files and published on the web page where users can directly roam and interact with virtual scenic spots after registering and logging in.

2. Overview of Method

This paper designs a virtual art museum roaming system, which includes two main functional modules: user function and VR roaming, as shown in Figure 1. The user function module contains two sub-modules: registration and login; the VR roaming module consists of four sub-functional modules: basic scene display, first-person roaming, mini-map navigation, and interaction with objects in the scene. In the overall system construction, the functional process can be divided into the following steps: use Flask to develop the back-end technology stack, use Bootstrap to render the front end, import the open-source art museum 3D modeling scene to Unity, realize the first-person roaming by the role controller, make mini-maps, and interactive pages at the UI level, write scripts to achieve interactive functions, put WebGL files packaged and published by Unity for URL orientation through the back end, and finally test the expected effect.
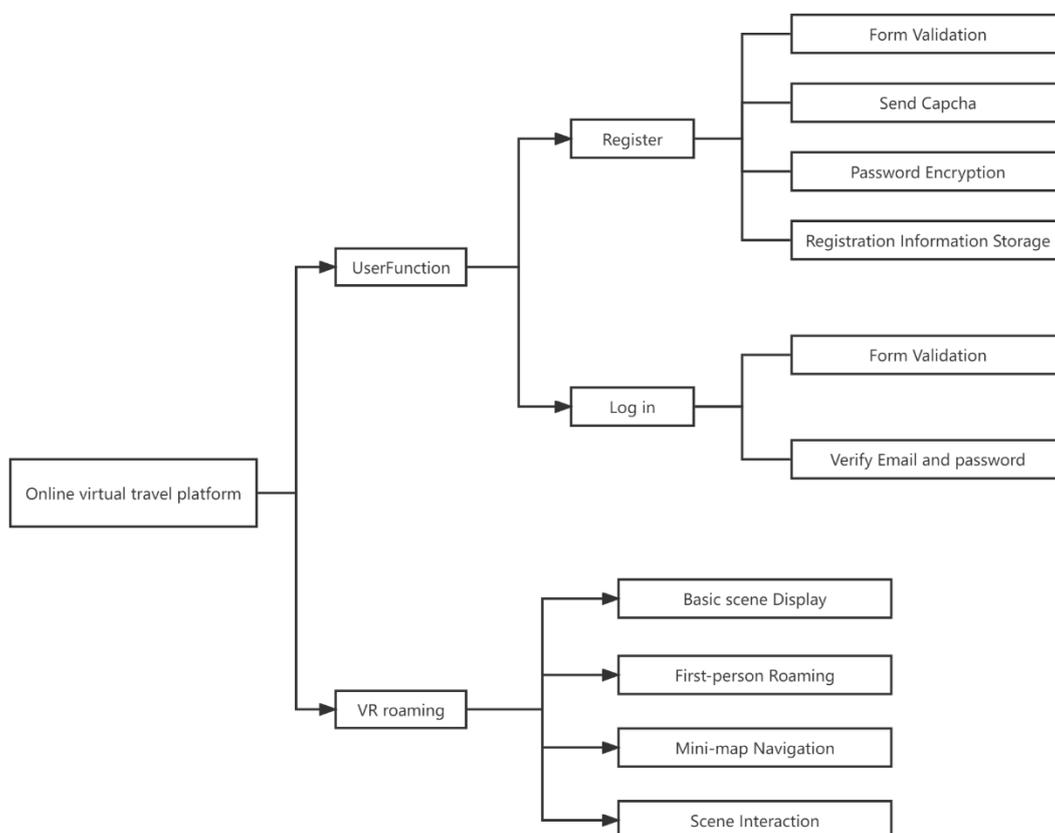

Figure 1. Online Virtual Art Museum Travel Platform Functional Modules

3. Introduction of Specific Functions

3.1 The Registration and Login Module

The registration and login module is developed on a basis of simple Python Web micro-framework, Flask, and MySQL databases. The process is as follows. In the first step, create the application factory function. All application-related configurations, registrations, and other settings are done inside this function and then return to the application. The second step is to define and operate the database. First, an SQLAlchemy object needs to be obtained and registered in the application. In order to save a lot of time in writing SQL sentences, this paper uses the ORM of SQLAlchemy to operate the database. The third step is to create a blueprint that makes it easier to manage a set of related views and code. The steps are as follows: First, register the views and code in the blueprint, and then register the blueprint in the application in the factory function. There are two blueprints, one for registering the login function and the other for loading the roaming system. The fourth step is to write a template. Templates are files containing static and dynamic data placeholders that render HTML displayed in the user's browser. In this paper, bootstrap is used to assist the development of templates. There are four templates in this system: basic layout, registration, login, and homepage. Each page in the application has a different theme but the same basic layout, so other templates only need to inherit and extend the basic layout instead of rewriting the entire HTML structure.

3.2 Basic Scene Display

Generally, there are two ways to simulate the scene: 3D modeling and VR panorama. The former can accurately reflect the spatial layout of the scene, but its authenticity is insufficient, while the latter needs to shoot real-life materials to make a 360-degree panorama. Compared with VR panorama, 3D modeling is simpler to build the whole scene without high-precision shooting equipment and is less costly. With regard to the advantages of 3D modeling, the modeling scene in this paper uses open-source 3D art exhibition resources, including models of walls, exhibition stands, showcases, stone pillars, artworks images, sculptures, etc. The finally built virtual scene is shown in Figure 2.
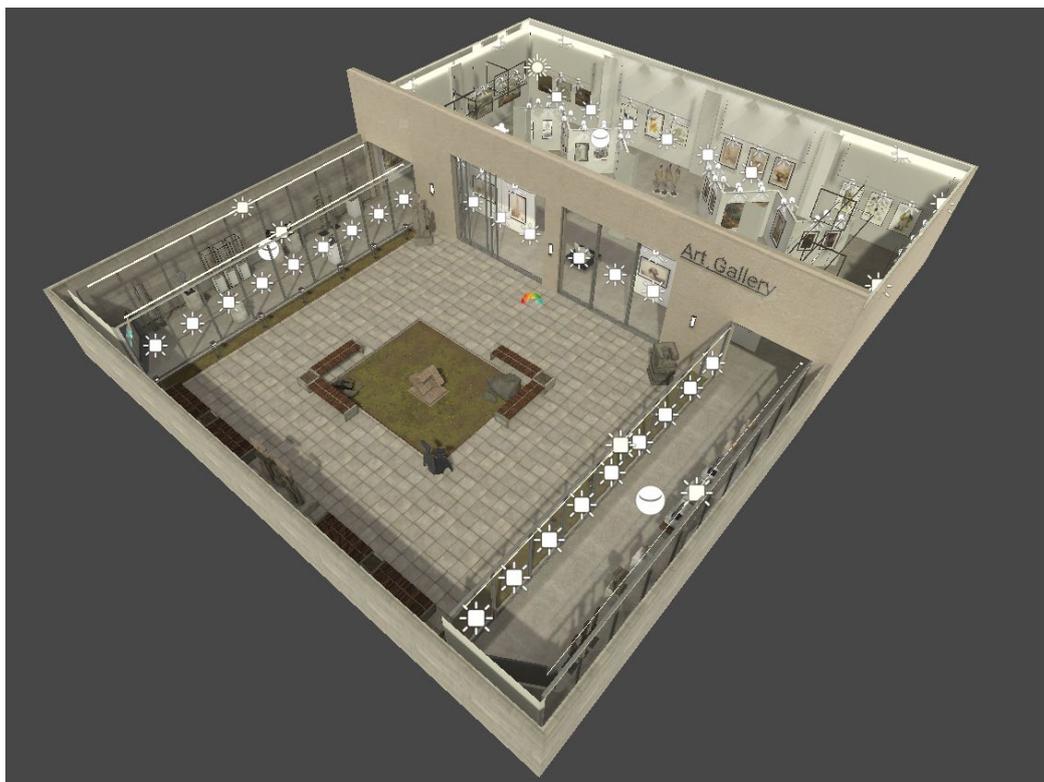

Figure 2. Display of the virtual art gallery scene

3.3 First-Person Roaming

This roaming features the first-person view where users can switch views and move characters through WSAD buttons on the mouse and keyboard. In this paper, the lightweight resource bundle of Starter Assets－First Person Character Controller from the Unity Resource Store is used to implement this first-person roaming. Components from the MainCamera, PlayerCapsule, and PlayerFollowCamera in the resource bundle are imported into the scene and relocated. Since C# scripts that control camera view changes and character movements are already installed in these components, only the camera needs to be set up. Remove the original Camera from the scene and change the Follow property of the CinemachineVirtuaCamera component in PlayerFollowCamera to PlayerCameraRoot, so that the camera can follow the characters' movements. The final first-person view is shown in Figure 3.
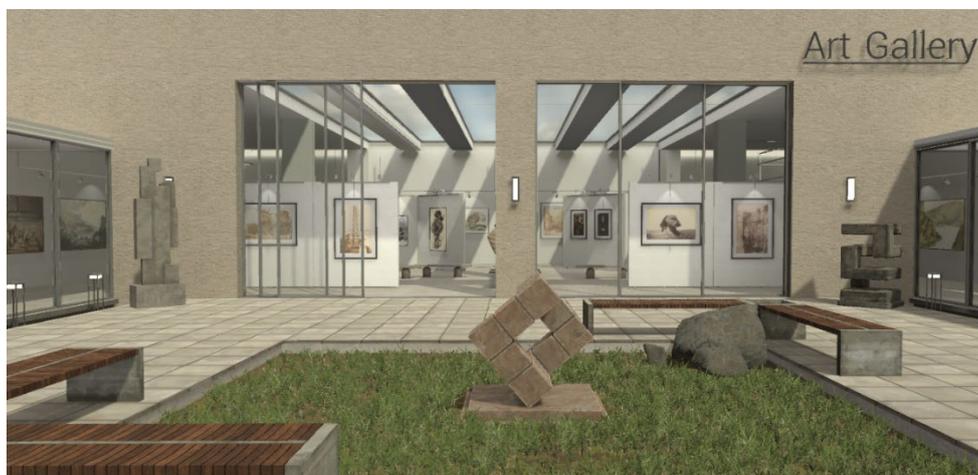

Figure 3. First-person view
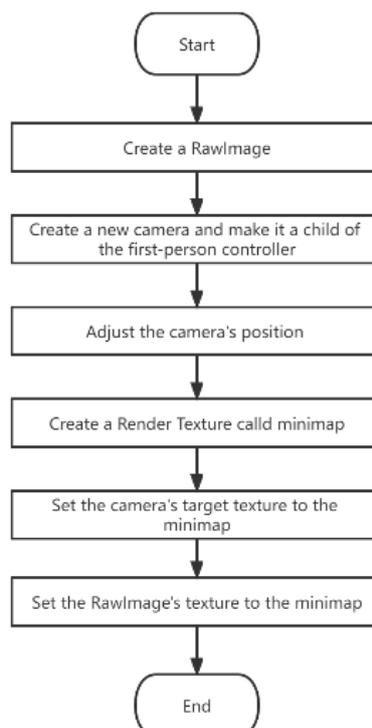
3.4 Mini Map Navigation

Figure 4. Flow chart of creating mini-map

The function of mini-map navigation module is to enable users to identify their position and direction relative to the whole scene when roaming and to determine their tour route. The design idea is shown in Figure 4. First, create a RawImage object in the UI layer of Unity and adjust its position and size appropriately. After that, create a new camera as a child object of the first person controller and adjust the position of the camera directly above the user character. Create a Render Texture, and set the rendering target of the new camera to this texture, so the camera will render the acquired image into the Render Texture. Finally, set the texture of RawImage to Render Texture, which will indirectly render the acquired image captured by the camera into a new UI object. In the end, a mini-map reflecting its position will be displayed at the upper right end of the system, as shown in Figure 5.

Figure 5. Display of the mini-map

3.5 Interaction with Objects in the Scene

The function of this module is that when the user approaches the objects in the scene during the roaming process (as shown in Figure 6), the interaction function will be triggered to display the pre-designed UI interaction interface (as shown in Figure 7), which is mainly reflected in the system when the detailed introduction of the corresponding works of art will pop up. In order to achieve the effect of fade-in and fade-out, the display and hiding of the UI screen in this paper are realized by changing the transparency of the UI. The design idea is shown in Figure 8. The first step is to create an Image object by using the UI function and change the Render Mode of Canvas to Screen Space-Overlay, making the canvas tile the whole scene. Then create a sub-Image object under the Image object, import the external artwork image with its format as Texture2D, and take this image as the Source Image of the sub-image object to set the anchor point and adjust the size. Under this object, use the UI function to create a Text object and input the introduction text of the corresponding artwork. In the second step, add a capsule collider to the scene object, and turn on its trigger switch to adjust its size and position. Thirdly, compile a trigger script judging whether the user role enters the trigger area, and if so, calling a preset UI screen; After that, set the timer to automatically hide the UI screen after the specified time. The key code is as follows:

```
//Trigger Events
    private void OnTriggerEnter(Collider other)
    {
        m_Timer = 0;
        //If the trigger is colliding with a user object
        if(other.gameObject == player)
        {
            //Switch on
            m_isPlayerAt = true;
        }
    }
//Exit the UI
    void Exit()
    {
        //The timer grows with the refresh
        m_Timer += Time.deltaTime;
        //Gradually change transparency
        //alpha means transparency from 0 to 1
        TheBackGroud.alpha = m_Timer / fadeDuration;
        if (m_Timer>fadeDuration+displayImageDuration)
        {
            TheBackGroud.alpha = 0;
        }
    }
```

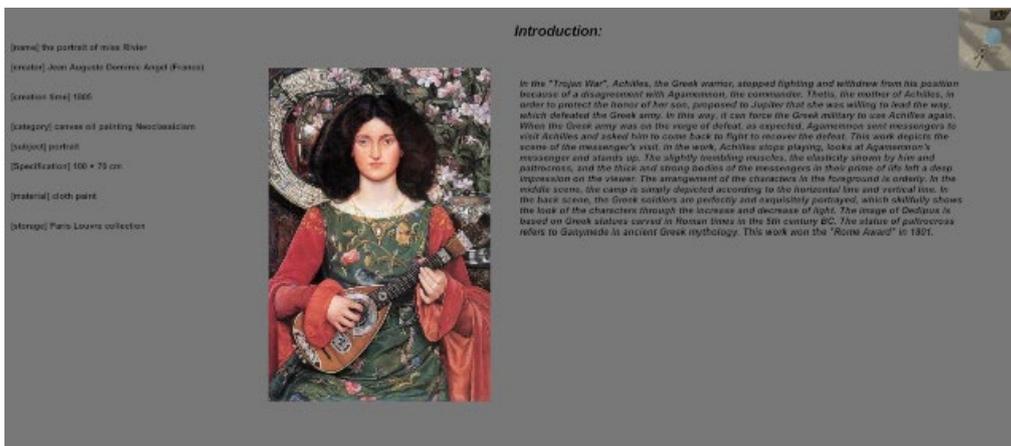

Figure 6. The object to be interacted with

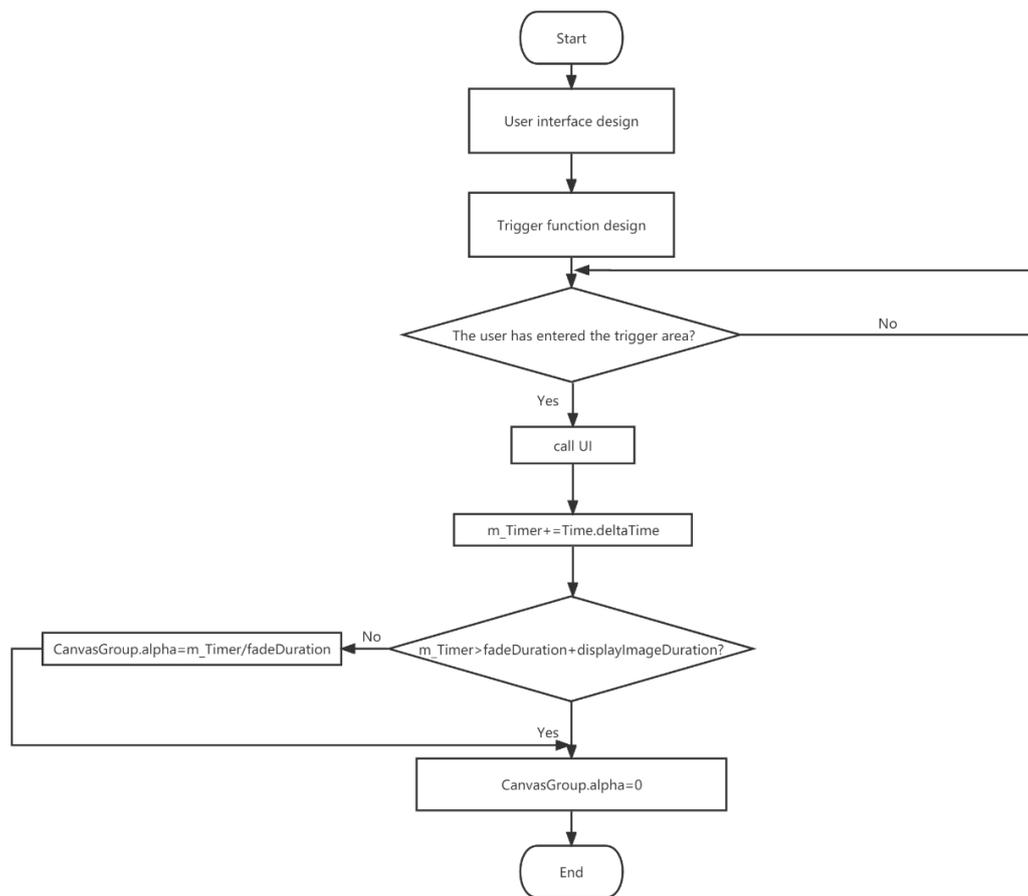**Figure 7.** Presentation of UI interaction interface

Figure 8. Flow chart of developing interactive functions

4. Deployment and Release

After the whole Unity project construction is completed, in order to create a build for WebGL, go to File > Build Settings from Unity's main menu. In the Platform list, select WebGL and then click Switch Platform and Build. Then we're going to get an HTML file, which is used as a template. Render this template to a web page. Then users can register and log in to roam the virtual scene.

5. Summary

This paper presents a series of processes of building an online virtual tourism platform with an art museum as the scene. Although it's possible to roam the virtual scene in the first-person view and interact with the objects in the scene under the guidance of the mini-map on the web page, there are still some shortcomings in function expansion, technical means, and practical application. For example, the automatic navigation function to reach an object can be added to the scene. In addition, the immersion brought by computer monitors is not intense enough. There is a positive correlation between VR immersion and user experience13, and immersion in the VR tourism largely depends on the vividness and interactivity of virtual tourism system14. Therefore, the system studied in this paper can replace the display device with VR head-mounted display to provide a better immersion experience. With the development of virtual reality technology, we have access to more novel and valuable virtual tourism experiences, such as reproducing historical buildings through virtual reality and augmented reality to share their appearance and characteristic information to the cloud, which launches a brand-new digital experience for cultural tourism15. The realization of this system provides a reference for the advertisement and transformation of tourism, demonstrating that VR technology will achieve better application and development in future tourism.

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