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VR VanMieu: The Interactively Virtual Temple of Literature

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Abstract. Historical heritage is representative stowage for our memories and provides us with a physical means to connect to past values. Recently, digital preservation of heritage has attracted many researchers. Virtual reality (VR) technology is the ability to simulate a complete and interactive virtual environment for audiences to get a more comprehensive and concrete presentation. In this paper, we propose a process of building a VR VanMieu application - a virtual heritage environment using VR technology to promote historical knowledge of the Temple of Literature.

Keywords: Virtual Reality · Virtual Reality application · The Temple of Literature

1 Introduction

A virtual world is a computer-simulated environment, and virtual reality (VR) can be defined as a simulated experience. It has helped users to solve many difficult issues that cannot be resolved in the physical world. It also enables individuals to grasp anything in the virtual world better and increases their interest in it. For instance, by simply clicking, users can visit several well-known locations like historically virtual museums. These product series are gaining popularity as a means of learning and experiencing new things. By creating such a product, users will have a new channel through which to acquire information. History plays an important part in our life. Virtual History Museum is an application that helps users discover models and pictures that partially reflect the stages that people have gone through.

Vietnam has a rich and diverse history and culture spanning more than 1000 years with thousands of historical relics. In particular, The Temple of Literature (Van Mieu in Vietnamese) is a complex on the list of special National Monuments of Vietnam, the pride of the Vietnamese people. With a rich culture and long history, the Temple of Literature relic has become an attractive destination in the tours and discovery of Hanoi tourism. The Temple of Literature is a long-standing, prominent, and diverse historical relic including many unique and detailed architectures built from the Ly Dynasty in Hanoi, Vietnam.

In this paper, we created a VR VanMieu application with the desire to promote the image of the Temple of Literature to people, both domestic and foreigners who have not had the opportunity to visit it directly or are looking to learn about tourist attractions when visiting Vietnam.

2 Background and Related Works

2.1 Virtual Reality

VR technology is described as a simulation technology of a realistic virtual environment that is created using interactive software and hardware and can be controlled by body movements [1]. A believable, interactive 3D computer-created world that the users can feel immersive as they really are there, both mentally and physically. The user's involvement in virtual environments is created by the immediacy provided by the VR hardware used, where no other medium is visible between the user and the visible virtual world, while multimodal interaction involving visual and tactile feedback ensures the feeling of immersion [2]. The simultaneous development of consumer-grade VR headsets, 3D game engines, and mobile devices, and the increase of computational power for processing multimedia content have allowed the emergence of consumer-grade VR technologies in various domains such as education and entertainment [3]. The literature combining works at the frontier between education, computer science, and engineering has significantly developed to propose a wide range of studies and applications related to immersive learning and cultural heritage [3, 4]. It is two-way interaction: as you respond to what you see, what you see responds to you: if you turn your head around, what you see or hear in VR changes to match your new perspective.

With VR technology, several virtual objects and their related material (multimedia data) were placed in a virtual environment in which users could explore their meaning. To evaluate a VR application's effectiveness, authors in [5] conducted an experiment comparing how respondents remember information presented in different forms of data: visual, audio, textual and kinaesthetic. They showed that the test score of the VR application experiment depends on the respondent's experience with VR. The more users use VR the higher score they get. The benefits of virtual reality go beyond just simulating the real world. For instance, through the use of virtual reality technology, we are able to recreate historic buildings that have been demolished and experience them under the dim light of oil lamps rather than more contemporary lighting sources.

There are some famous programs to create and make virtual worlds possible for users to experience, such as Unity 3D, Blender, Maya, Unreal, etc. Maya, Blender, and Unity are three great choices among them. Maya is comparable to Blender, however, it is more expensive. They have commonly been used in scene and model construction. Unity 3D is a game engine in which developers can design interactions. People can also create 3D models in Unity, then manipulate their movement, 360 rotation, check information, etc.

2.2 Unity

Unity, a power game engine, supports 2D and 3D graphics, and stands out for its ability to build games that run on multiple platforms. In Unity, the functions are written mainly

in CSharp language. Unity is widely used and has a large user community and has a lot of resources stored in the Asset Store. Asset Store contains resources for graphics, particle effects, sound, etc. Users can create packages themselves, and send them to the Asset Store, packages can be free or paid depending on the owner of the product. Products. Therefore, with a large user community, Asset Store is also becoming richer and richer. The Unity package helps users share and reuse Unity projects and content. Unity Assets on the Unity Asset Store are available in a package. Packages are collections of files and data from Unity projects or project components such as assets, shaders, textures, icons, scripts, plug-ins, and others. Users can open Package Manager to view and manage all their packages. Besides, users can add the package they want by adding the package from the Asset Store to the product, then downloading the package, and then importing the package into Unity. That's the reason why we have developed the VR VanMieu application based on the Unity platform.

3 A Process of Building VR VanMieu Application

Different phases of building a virtually interactive environment application were presented and discussed by Paulauskas, L et al. [5] for researchers and virtual application developers when they build a virtual heritage application. Based on the phases, we

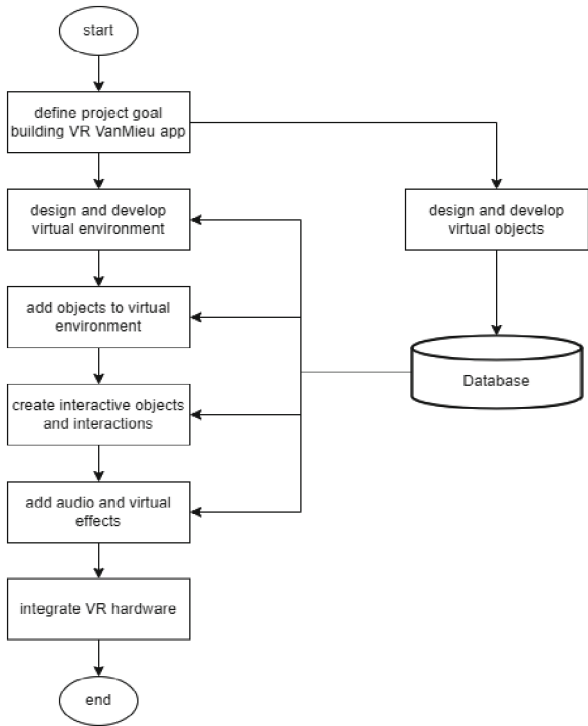


Fig. 1. A process of building the VR VanMieu application.

proposed a process of 7 phases (Fig. 1) in creating the VR VanMieu application and analyzing the experiment when the user uses the application.

The Temple of Literature is the pinnacle and symbol of Vietnamese Confucian education and is also one of the most famous temples in Vietnam. Vietnamese people are inherently studious and attach great importance to academics. Temple of Literature is the first university to train and organize a talent competition to serve the country. This is the place where many talented people have made great contributions to the country throughout history. There are also regular cultural events to promote learning. We built VR VanMieu to promote The Temple of Literature to more domestic and foreign audiences. The Temple of Literature (Fig. 2) is located in the heart of Hanoi capital, surrounded by four main streets of Dong Da district: Nguyen Thai Hoc, Ton Duc Thang, Van Mieu, and Quoc Tu Giam streets. The main gate of the Temple of Literature is located at 58, Van Mieu street.

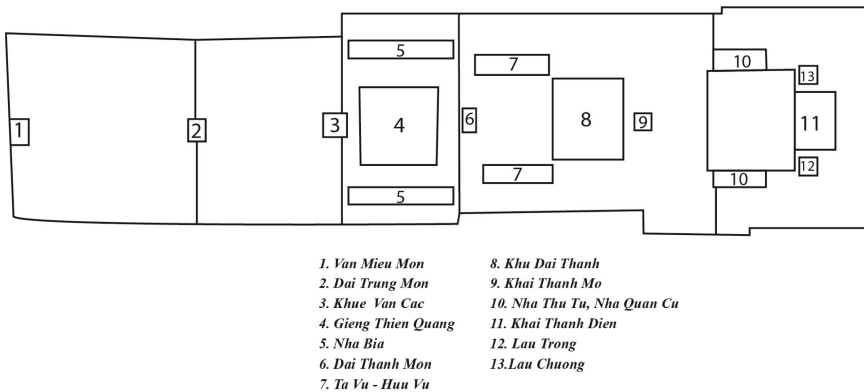


Fig. 2. The Temple of Literature map

With the desire for the application to be realistic, vivid, and easy to use. We use the kinds of data that make it possible for users to experience the most realistic and intuitive. Data types include images, 3D models, texts, and audio. Each data type has a different processing method.

Images are divided into two categories: images used to build the application and images used in the application. We went on a field trip and took pictures of the Temple of Literature. We focus on architecture and environments, these are two important things to create a virtual Temple of Literature. To create the most realistic environment, we captured all areas of the Temple of Literature in as much detail as possible. We use images of architectures and environments to create 3D models for visiting virtual reality environments. In addition, we cut patterns that are difficult or time-consuming to build to incorporate into the models.

We use images of architectures and environments to create 3D models for visiting virtual reality environments. Then, we cut patterns that are difficult or time-consuming to build to incorporate into the models. In addition, we use Unity's built-in environment packages such as plants, flowers, etc. to make the environment come to life.

Users can view information about the Temple of Literature through text. There are two types including page flipping and scrollable readers.

After we collect written information, we record that information into audio. This gives users more ways to access information. In addition, the background sound also helps the user’s experience become better when visiting the Temple of Literature.

We create the Temple of Literature environment following the real map (Fig. 2) by aligning 3D models to their real-world locations. For the outdoor models, we arrange the environment to become harmonious so that users can easily see the whole view of the Temple of Literature. Besides, we put some more supporting models for our functions such as the info panel, weather switch column, etc.

4 Architecture and Campus of the Temple of Literature

The VR VanMieu application consists of elements that mimic the real-world Temple of Literature. The 3D models are constructed from real objects with high details and include many architectures such as Phuong Dinh, Nha Dai Bai, Nha Bia, Khue Van Cac, Dai Trung Mon, Den Khai Thanh, Dai Thanh Mon, Van Mieu Mon, and so on (Fig. 3, 4). Besides that, other objects are built to make the environment more lively and realistic, such as a small lake, trees, separating walls, etc.

About the buildings of the Temple of Literature: We constructed the buildings from genuine schematics and then adjusted them to match the correct architectural proportions. The majority of buildings are made out of blocks that have been assembled and arranged. Other methods must be used to refine some other elements, such as arched doors. Then, we add materials to structures. We come to observe reality and develop fresh, high-quality materials that, in terms of textures, are most like the genuine thing. Ultimately, we assembled the buildings based on maps and actual observations. Most of the buildings in the Temple of Literature have been built since the very last decade with that period style, some are reconstructed after being destroyed by the war. Thus, the main materials

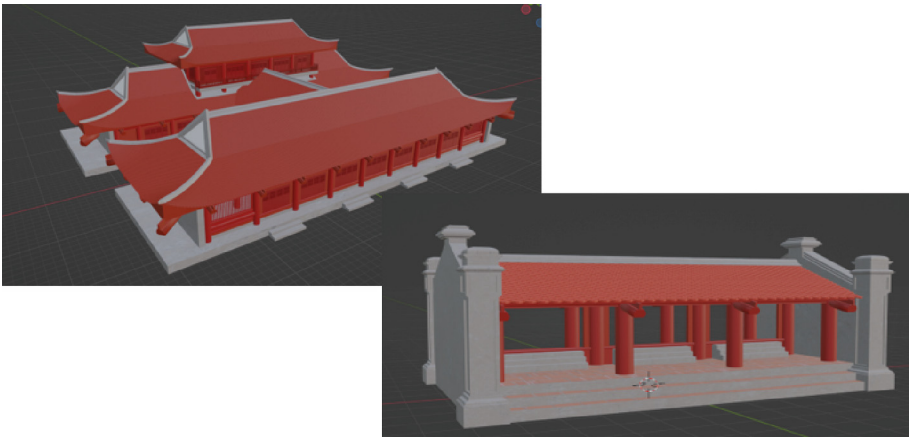


Fig. 3. Den Khai Thanh (left) Dai Thanh Mon (right)

for the buildings are old wood, red brick for the roof, and concrete color for the steps and walls.



Fig. 4. Khue Van Cac (left) Van Mieu Mon (right)

In addition to buildings, we have built Thien Quang well (Fig. 5), Sam drum (Fig. 6, Left), and Thai Hoc bell (Fig. 6, Right). Thien Quan well, i.e. “the well that illuminates the sky”, is also known as Van Tri. The name Thien Quang is given to the well with the implication that people want to obtain the quintessence of the universe, enlighten intellectuals, and improve the good human qualities of people. Thien Quang well and Khue Van Cac, one square and one round, collect all the quintessence of heaven and earth at this majestic educational and cultural center. Sam drum is one of the two biggest drums in Vietnam. The reason for this name is because when beating, the drum sounds loud like thunder, the sound is resounding and majestic. It is used to serve the 1000th anniversary of Thang Long Hanoi. The Thai Hoc bell is also created to celebrate the 1000th anniversary.



Fig. 5. Thien Quang well

The body of the bell is engraved with the history of the Temple of Literature and the nation’s studious spirit, and at the same time reminding generations of descendants to study, study more, study forever, study for the prosperity of the Fatherland, study for the happiness of the whole people. Unlike buildings which are largely composed of blocks, things require more techniques to create depending on the difficulty and details required.

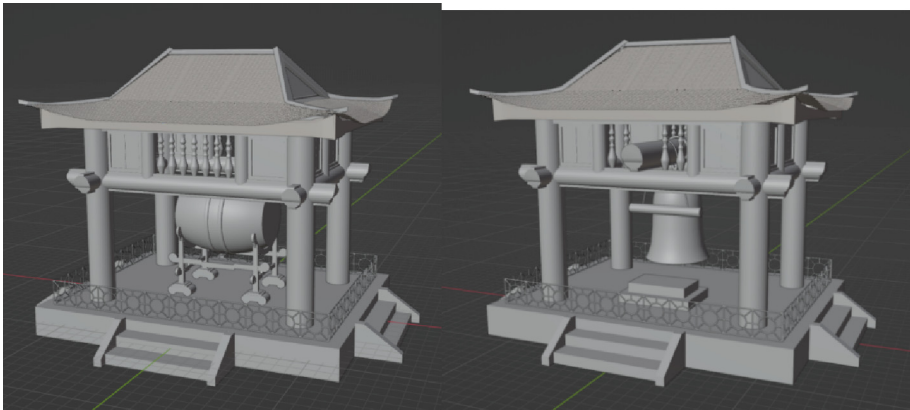


Fig. 6. Sam drum (left), Thai Hoc bell (right)



Fig. 7. VanMieu VR environment

After constructing the building and orther models, we embed these models into the built environment and have a VanMieu VR environment (Fig. 7).

5 Interactive Design

We designed a VR VanMieu application with 3 scenarios: The Temple of Literature tour, please calligraphy from the master and participate in the quiz game. Each scenario is contained in a box with the image and name of that scenario, this means each box represents each scene. Clicking on the box will switch to the corresponding scene. Those boxes include: Visiting the Temple of Literature tour is where players visit and experience the virtual reality environment of the Temple of Literature. For the VR VanMieu, we created a menu that includes visiting the Temple of Literature as the main scenario and two secondary scenarios are quiz games and please calligraphy.

The Temple of Literature tour is where players visit and experience the virtual reality environment of the Temple of Literature. In each scenario, the developed functions include moving, rotating 360°, changing the sky according to the weather and time of day, playing quiz games, viewing the user's location via the minimap in the right corner, reading information about Temple of Literature on bulletin boards or books, listening information about Temple of Literature, please calligraphy, the user's storage bag.

The second scenario is the quiz game (Fig. 8). Users can play quiz games to check the information they have received during the visit to the Temple of Literature. Besides, users can also exchange rewards with coins in the quiz game.

Finally, users can use coins that are achieved from quiz games to exchange the calligraphy of the master. Calligraphy paintings have many different designs such as Lotus and butterfly, Peach blossom and dragonfly, etc. Calligraphic letters also have many different characters such as Hoc, Phuc, Loc, Tho.



Fig. 8. Quiz game

Humans in VanMieu VR are divided into two types: play-character and non-play characters (NPCs).

User plays the role of play-character. As a result, users will have a more authentic experience. The user has three main interactions: moving, rotating, and interacting with

objects. Users can navigate in the environment to left, right, up, and down, also, when the user turns the other way, users will rotate to see the other side. We provide the function of changing between first-person and third-person perspectives to suit the needs and preferences of users. Besides, when a user interacts with objects in the environment, each object will have a different form of interaction. We have handled collisions with external objects. Therefore, users can easily interact. NPCs play the role of inserting captivation and realism to the environment. Each NPC will have different behavior such as sightseeing, walking, answering the phone, etc. With text and images, we graft to the surface of the 3D object so that the user has a more intuitive image. With page-turning text, the text will be shaped like a book, the user will turn the page to read the information. Compared to the dashboard, users scroll down to see texts. As for the sound, when clicking on the sound box model, the user can turn it on and off conveniently. Besides, when users touch the gate, it will open.

The 3D models will act as transitions to other types of data such as text or images when the user clicks.

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The Temple of Literature is added with soothing sounds to help users enjoy the process of visiting the virtual environment and some animations such as the door opening when the user approaches or the water ripples.

6 Experiment and Evaluation

6.1 Experiment

For the virtual reality Temple of Literature, the user will first see the menu. Users can choose scenarios in which they want to experience.

Here users can move and see the whole view of the Temple of Literature. Besides, players can also listen to information about the architecture of the Temple of Literature, see the minimap and change the sky according to the time of day or the weather. In addition, during the virtual reality tour of the Temple of Literature, users will be provided with information about the Temple of Literature. After that, players can play QuizGame to consolidate, recall the information when visiting and receive rewards. With the please calligraphy scenario, users can exchange the teacher's text when exchanging rewards from QuizGame. Users can view and manage what they can exchange in the user bag.

Although it is possible to access any screen, first-time players should follow the flow below the image. When that flow is done right, users will experience the virtual reality Van Mieu Quoc Tu Giam with ease and know what to do as they go through each screen one by one.

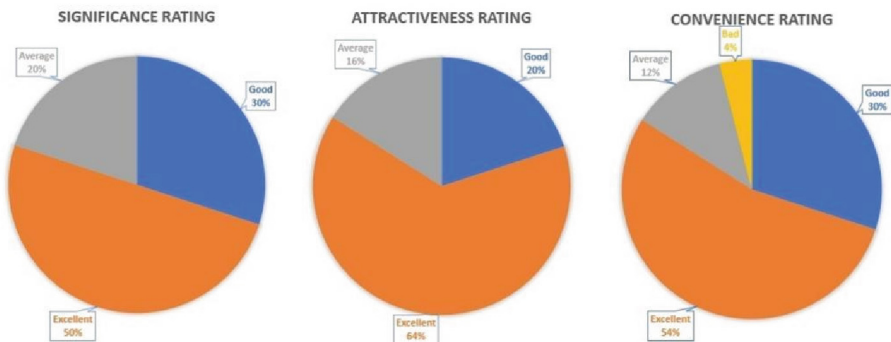
Questionnaire. We provide users with a survey (Table 1) for users to evaluate issues related to the application such as compatibility.

Table 1. Some questions in the survey about experience VanMieu VR

Question type	Question
Model	Which model do you think is the best?
	What aspects should we adjust to make the model more attractive?
Interaction	Please rate how you feel about the functions of the application
	Which function do you find the most attractive?
User experience	During your experience with the product, did you experience any symptoms?

6.2 Practical Experience

We surveyed the application with a scale of 50 people, who are students of the University of Technology. We examine 3 characteristics, which include significance, attractiveness, and convenience. With all three, we got pretty good results (Fig. 9). The app received reviews for its harmonious colors, pleasant sounds, concise information, and high historical significance. Most users in the process of experience find it quite convenient, but there are some people who are dizzy due to their location.

**Fig. 9.** Ratings

7 Conclusion

This paper presents an interactive virtual reality application about the Temple of Literature, a famous heritage of Vietnam. Here, we present the process and method of building the application, including the main function of visiting the virtual reality environment and some other functions such as quiz games, please calligraphy. Users have positive feedback after trying the product demo. This work has been supported by University of Engineering and Technology, project number CN.22.05 – “Exploring the architecture of Van Mieu Quoc Tu Giam with virtual reality glasses” (Khám phá kiến trúc quần thể Văn Miếu Quốc Tử Giám bằng kính thực tại ảo).

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