

The VR Museum for Dunhuang Cultural Heritage Digitization Research¹

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Introduction

Dunhuang Mogao Caves are one of the most best-known Buddhist heritage sites in China, it's famous for the mural and sculpture of Buddhist art spanning a period of 1,000 years. Along with Longmen Grottoes, Yungang Grottoes and Dazu Rock Carvings, it is the remains of ancient Chinese Buddhist culture. (Jinshi, 2000)

For decades, at the initiative of the Dunhuang Research Academy, researchers, and scholars from all over the world have conducted a variety of practical research of digitization, exploration, and experimentation.

The *Theories and methods of digital protection of cultural heritage research project* was conducted with the National Basic Research Program of the People's Republic of China. It was an interdisciplinary research project for Dunhuang Mogao Caves. During the research process, the project team launched the digital modeling work based on SLAM technology, the mural color inversion research based on chemistry experiment, etc.

This VR museum is a practice of how to build a research project into a cultural consumer experience product for the general public. It brings together visual and auditory elements and shows murals from the Buddhist grottoes of Dunhuang from various perspectives.

Design goals

A museum is a place for humans to conserve collections, communicate information, encourage people thinking and educating each other. "Today, the museum in modern society has acquired a significantly broader public role than its early predecessors" (Awoniyi, 2001) However, for this Dunhuang VR Museum, there is no real-world museum corresponding to it. It's a virtual museum containing the digital copies of cultural heritage objects, recording and reproducing the process of scientific research of this resources in an interactive way, and expecting to spread and share these virtual exhibits more broadly though VR App stores on the internet.

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This Dunhuang VR Museum is a multimodal platform for the presentation of digitized cultural heritage. This presentation combines virtual reality and augmented reality, lives up even the most demanding artistic criteria, and offers both the general public and Dunhuang specialists an immersive experience that complies with both scientific and artistic standards.

The design goal of creating this platform is as follows:

1. Digitize the Caves: Recording the three-dimensional data and the physical space information before these actual caves are further damaged.
2. Visualize scientific research results: Provide professional audiences with specific detailed contents; also make it much easier for the general public to understand;
3. Achieve an experience: Create alternatives to the real caves, design an immersive experience for audiences who don't have a chance to enter the real one;
4. Extend the contents accessibility: Extending the material properties of cultural heritage, making its cultural communication behavior break through the limitations of space and time.

Design process and methodology

This VR Museum simulated a life-size museum in VR Head-Mounted Display. With the virtual reality interaction, audience can get an experience of walking in a real-size museum space. The interior space design uses natural form and color to build. The high precision 3D models are reconstructed by using photogrammetry and laser scanning technology. They are the main content which can be viewed, manipulated, adjusted, and can even change the look of different eras. Another benefit of virtual museum is that all the virtual devices can be set to automatic adjust into different style to cater to the audience.



Fig. 1. photo of Dunhuang 159 Cave (© Authors).



Fig. 2. Screenshot of Dunhuang VR Museum (159 Cave included) (© Authors).

For extending the right to access for different audience groups, the project is not only available in HMD, but also can be viewed on desktop and mobile devices. If using mobile devices that support the latest WebXR capabilities, the audience can also experience the augmented reality content of this museum.

The deep immersive application for HMD is developed in a game engine like Unity and Unreal Engine, and it is suitable to Oculus Rift and HTC Vive Head-Mounted Display. For better user experience, the design process follows four aspects of “Freedom of operation”, “Immersion”, “Comfort of play”, and “Picture quality” that are examined to clarify which type of virtual museum would be suitable for any specific user’s needs (Takeuchi et al., 2019).

Through the summary in Dunhuang Cultural Heritage Protection research, this practice gives out a low cost, easy to use and comfortable experience of mixed reality application development framework and developed a web-based virtual reality museums system.

The Way Forward

Contemporary museums are increasingly becoming digital. With access to digital technology, the role of museums as cultural heritage has been strengthened. They are nowadays considered as a high priority for communication and play a central role in making culture accessible to the mass audience.

Due to the novel interactive mode and immersive experience, the general public has a strong interest in augmented reality, virtual reality, and mixed reality. With the decrease of the cost both in technology and hardware, the demand for AR & VR applications increased rapidly. It can be expected that the demand for virtual reality museums will increase significantly.

Of course, the VR exhibition method does not have to be isolated. The inclusion with images, video, sound, and tangible interaction, will make the VR museum's communication strength stronger and increase the participation of the public.



Fig. 3. The audience is experiencing the virtual cave (© Authors).



Fig. 4. VR Integrated with Multimedia used on for Dunhuang Cultural Heritage Exhibition (© Authors).

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