Design of Intangible Cultural Heritage Virtual Roaming System Based on Veb VAR Stereoscopic Panoramic Technology

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Abstract. The application of panoramic roaming in the dissemination of intangible cultural heritage has the advantages of low development cost and excellent experiential effects. This article elaborates on the architecture and development process of an intangible cultural heritage panoramic roaming system. Through practical applications of panoramic roaming at intangible cultural heritage sites such as the "Canal's Ten Scenic Spots" and the Suzhou Zhoushan Core Sculpture Art Museum, it confirms the favorable results of panoramic roaming in the dissemination of intangible cultural heritage.

Keywords: Virtual Roaming; Intangible Cultural Heritage Dissemination; Panoramic Technology; Veb VAR

1 Introduction

In today's digital era, the protection and inheritance of intangible cultural heritage faces new challenges. Intangible cultural heritage includes traditional skills, verbal traditions, and performing arts, which is an important part of a national cultural treasure house. However, factors such as globalization, modernization, and urbanization have led to the gradual loss and change of traditional culture. Therefore, finding innovative ways to save and inherit the intangible cultural heritage becomes vital [1].

Virtual reality and panoramic technologies have been widely used in many areas, providing people with immersive immersive experiences. The application of this technology provides new opportunities for the protection and inheritance of intangible cultural heritage. By combining the virtual roaming system with non -heritage elements, it can create a new way of cultural inheritance, so that people can experience and learn traditional skills and cultural practice in person, thereby promoting the inheritance and spread of intangible cultural heritage [2].

Therefore, this study aims to design and develop a non -heritage virtual roaming system to provide a novel and effective inheritance method of intangible cultural heritage. Through this system, people can experience intangible cultural heritage in the virtual environment to better understand and cherish their cultural traditions. In addition, this study will also explore the potential applications of panoramic technology in the field of cultural protection, providing valuable experience and reference for the development of similar projects in the future.

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2 Current Application Status of Panoramic Virtual Roaming in the Dissemination of Intangible Cultural Heritage

The significant function of intangible cultural heritage projects is in line with the actual needs of the national public cultural service demonstration areas. Panoramic roaming technology can provide users with a good experience of appreciating intangible cultural heritage at a relatively low cost [3]. It integrates various information technology methods such as digital image capture, graphic image processing, network technology, and virtual interactive technology, offering an interactive experience with a sense of realism and immersion [4].

In China, there have been early applications of virtual roaming technology in the dissemination of intangible cultural heritage. For instance, the Beijing Palace Museum employs virtual roaming to showcase the full view of royal palaces from the Ming and Qing dynasties [5]. The Dunhuang Mogao Grottoes use virtual roaming to display the artistic charm of Buddhist sculptures and paintings. During epidemic prevention and control, to better meet the spiritual and cultural needs of the people, the Xianyang Intangible Cultural Heritage Exhibition Hall launched a "360° panoramic online exhibition hall," featuring various unique intangible cultural heritage projects such as Guanzhong clay sculptures and Xunyi paper cutting [6].

In recent years, many regions have successfully established online intangible cultural heritage exhibition halls, heritage villages, and heritage scenic areas. Through virtual panoramic roaming technology, users can freely browse and interact in 720 degrees, providing a new way of disseminating intangible cultural heritage exhibitions.

3 Related Concepts

WebVR three -dimensional roaming system is divided into roaming production system and roaming browsing system. For two different users, the service process is shown in Figure 1.

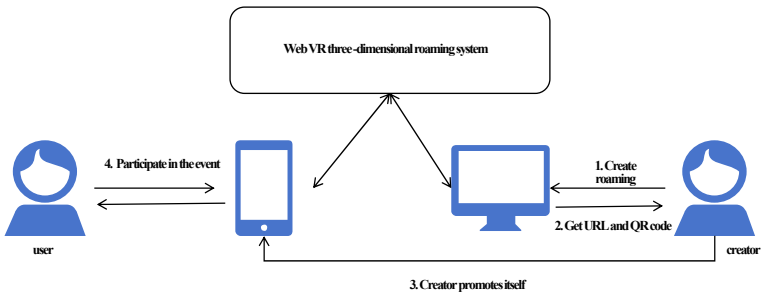

Fig. 1. Webvr service flowchart

(1) Panorama: Panorama refers to a panoramic project that is generated from a single panoramic image and can be viewed on a web page.

(2) Roaming: Roaming refers to a panoramic virtual tour created through the WebVR platform. It can be a specific URL or a packaged file. A panoramic virtual tour typically includes

multiple shooting locations for panoramic images and allows switching between these locations.

(3) Platform: In this context, a platform refers to a system that provides users with services for creating panoramic virtual tours.

(4) Creator: The user of the virtual tour creation system who can log in to the platform, upload panoramic images, and create virtual tours. Creators have the platform permissions to create and manage virtual tours.

(5) User: The user of the virtual tour browsing system who cannot log in to the platform. Users are the viewers of VR panoramic virtual tours and the target audience for creators using virtual tours to showcase scenes.

(6) Location: Specifically, it refers to the position where a particular panoramic image is captured. A panoramic virtual tour typically includes multiple locations.

(7) Scene: In this text, the concept of "scene" has two different meanings. In general, a scene represents a connected space, such as a house or a venue, and typically involves creating virtual tours from multiple panoramic images captured within the same space. In Krpanoxml, a scene represents the rendering result of a single panoramic image, which corresponds to a shooting location.

(8) Equirectangular Image: This refers to a panoramic image.

4 system architecture

The Web VR Stereoscopic Panoramic Roaming System based on depth information is developed using PHP as the programming language. It utilizes a MySQL database to store relevant data objects and embeds the Krpano panoramic touring production tool to create the basic tours. Image rendering is performed using an HTML5 engine.

The system follows a layered development approach based on the MVC (Model-View-Controller) pattern, organizing the code by separating data, business logic, and frontend interface display. The MVC architectural model of the system is illustrated in Figure 2.

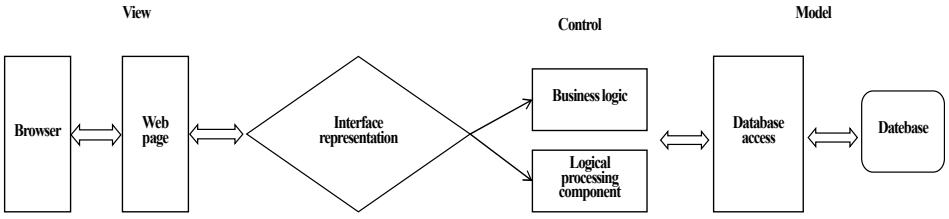

Fig. 2. System MVC mode architecture diagram

Among them, the view layer is composed of the front -end page and the JavaScript script. It is responsible for obtaining the user input and submitting the request to the control layer, displaying the data requested by the user, rendering the background roaming returned to realize the interaction with the user.

Control layers mainly include business logic and business processing components, which are used to receive requests returned by the front -end page of the view layer. According to different requests, select different business processing logic, and call the corresponding logical processing component to respond. Business processing During the process, the corresponding database operation is performed according to the needs, and finally the return data generated by the model layer is sent to the view layer.

The model layer (Model) mainly contains data sets composed of data objects and related data processing methods to establish communication with the database and perform data operation. Receive the data operation instructions sent by the control layer, read

The content of the database is returned to the control layer -related processing component or the data transmitted by the control layer and performed persistent storage.

The WebVR three -dimensional panoramic roaming system based on deep information is divided into two subsystems, roaming production systems and roaming browsing systems, facing two different users, panoramic roaming creators, and viewers. The two subsystems share the same database. The entire system adopts a layered design, which is divided into three layers of UI layer, business processing layer, and storage layer from top to bottom. Figure 3 shows the system functional module architecture diagram.

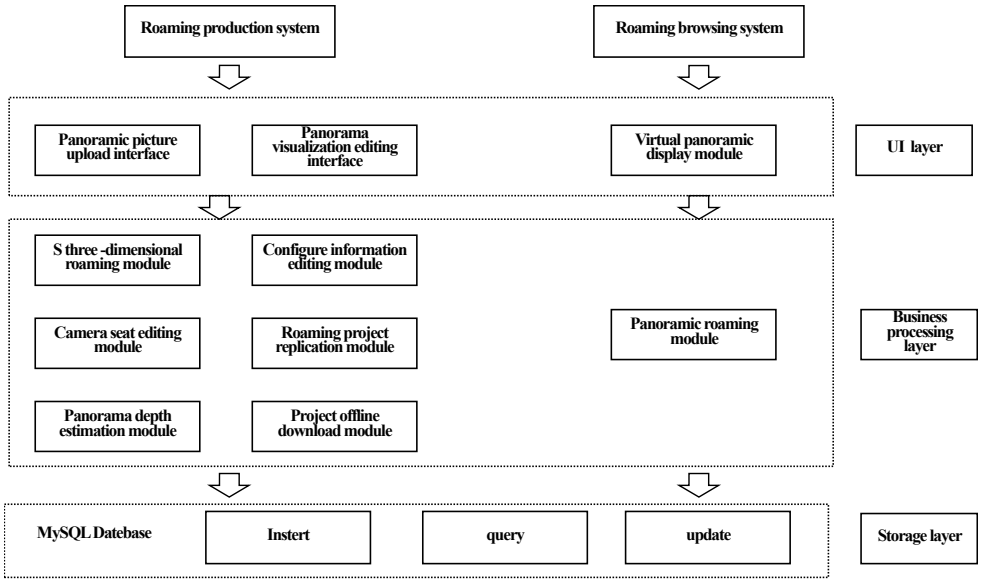

Fig. 3. System function module architecture diagram

(1) UI Layer

The UI layer corresponds to the view layer in the MVC pattern. It mainly utilizes technologies such as TPL, HTML, JavaScript, etc., to create the user-to-system interaction interface. It converts user operation information into HTTP requests submitted to the business processing layer and displays the corresponding responses. The UI layer provides two entry points for the panoramic tour creation system: the panoramic image upload interface, the panoramic visual

editing interface, and the virtual panoramic display interface for the panoramic tour browsing system.

(2) Business Processing Layer

The business processing layer undertakes the most critical tasks of the system and implements the main functions of stereoscopic panoramic tour creation. Positioned downstream from the UI layer, the business processing layer receives request information from the UI layer, parses it, and maps it to the respective service modules for specific business implementation. It then returns the implementation results to the upper layers. For the panoramic tour creation system, the stereoscopic tour generation module uses the pose estimation module and the panoramic depth estimation module to obtain depth maps for each panoramic image and relative positional information between panoramas, thereby achieving stereoscopic tour generation. The configuration information editing module renders panoramic tours on the page, adjusts hotspot positions and panoramic perspectives, and updates the adjusted configuration information in the database. The tour project duplication module creates copies of panoramic tour projects and copies resources. The offline project download module packages the dynamically loaded panoramic tour project source code into the vtour file package format, including XML files, HTML files, JS files, image files, and other plugins, etc. For the panoramic tour browsing system, the panoramic tour loading module renders panoramic tour projects in the browser based on the relevant project information in the database.

(3) Storage Layer

The storage layer establishes the connection between the business processing layer and the database, providing operations such as insertion, querying, and updating of the database. First, it designs the database table structure and relationships based on data and functional requirements. It creates panoramic tour entities through data insertion operations and records the storage paths of generated panoramic tour files, as well as the relative panoramic pose data calculated through camera pose estimation algorithms. It provides manual adjustment services for panoramic positions and rotation angles through configuration information data query and update operations.

4.1 Route Design

Conducting on-site visits to select iconic buildings is an essential preliminary task in the development of virtual tours for cultural heritage tourism. Based on the preliminary research, the shooting points and routes are planned to determine the locations and quantities for shooting. When designing the tour route, considerations should include the seamless connection and transition between consecutive shooting points and the rationality of the viewing route.

4.2 Image Capture

Photographers need to capture the shooting points in both horizontal and vertical dimensions to obtain 720-degree image information of the scene. To capture detailed information about the surroundings, dynamic exposure settings are used, addressing highlights, shadows, and mid-tones separately, resulting in three RAW format photos with different exposure values from the same location.

4.3 HDR Image Composition and Color Adjustment

HDR images have a broader dynamic range and greater detail, allowing for the realistic and aesthetically pleasing representation of the scene. The three RAW format images with different exposure values are imported into Adobe Lightroom software for HDR image composition. After completing the HDR image composition, parameters such as color temperature, tone, and exposure are adjusted to enhance image details and improve its visual appeal.

4.4 Image Stitching and Patching

Using PTGui software, the eight HDR images from a single shooting point undergo panoramic image stitching and patching through operations such as panorama editor, control point addition, optimizer, mask addition, and calibration. After stitching, the panoramic image is output with a width of 14,000 pixels, a height of 7,000 pixels, and JPEG format. Following image stitching, the Deval VR player is used to inspect the panoramic image for any stitching issues in detail, allowing for further modifications and enhancements.

4.5 Tour Creation

(1) Categorizing and Organizing Panoramic Images

For a cultural heritage site with multiple shooting points, the panoramic images are categorized, named, and uploaded to the panoramic tour backend material library.

(2) Perspective Setting and Adding Background Music

The maximum viewing range for a scene is 720 degrees, including a horizontal 360 degrees and a vertical 360 degrees, or it can be adjusted as needed, such as focusing on iconic architecture. When adding background music, it should be selected for all scenes. Narration audio should be applied to the corresponding scenes. The tour system allows for the embedding of explanatory videos, simulating a guided tour effect.

(3) Setting Tour Hotspots

Tour hotspot types include panoramic switching, hyperlinks, images, videos, text, audio, multimedia hotspots, and more. Tour hotspots allow users to interact with text, sound, videos, and the scene itself. When setting scene-switching hotspots, you can define an optimal tour route for users to navigate the entire site.

(4) Multi-Terminal Testing

After completing the tour system, testing should be conducted for both VR and panoramic viewing modes on mobile devices such as smartphones, iPads, and desktop computers.

5 Panoramic Tour Application in the Dissemination of Intangible Cultural Heritage

5.1 Panoramic Tour of Zhoushan Nuclear Sculpture Art Museum

The virtual panoramic tour project of the Zhoushan Nuclear Sculpture Art Museum is a collaborative project between Suzhou Vocational University and Xiangshan Street, Wuzhong District, Suzhou. Its goal is to explore productive ways to preserve intangible cultural heritage and promote the marketization, industrialization, and branding of traditional cultural craft products. Based on the management and application requirements provided by the Zhoushan Nuclear Sculpture Art Museum, field surveys were conducted, viewpoints were determined, and system functionality analysis was performed to design and develop the virtual panoramic tour system, as shown in Figure 2. In this virtual tour system, interactive media resources such as collections of nuclear sculptures, promotional videos, and micro-documentaries are used to engage with the audience. Users can immerse themselves in the Nuclear Sculpture Art Museum from the comfort of their own homes using their smartphones, VR headsets, or computer terminals. They can learn about the development history of nuclear sculpture, the sculpture production process, and masterpieces of nuclear sculpture.

5.2 Panoramic Tour of "Ten Scenic Spots along the Grand Canal" in Suzhou

Suzhou's "Ten Scenic Spots along the Grand Canal" include Wu Gate Watching Pavilion, Baodai Bridge, Husu Pass, Anchorage at Maple Bridge at Night, Pingjiang Ancient Lane, Tiger Hill Pagoda, Water and Land Panmen Gate, Hengtang Post Station, Stone Lake's Five Embankments, and Ping Wang - the Confluence of Four Rivers. Through literature research and field investigations, it was found that the scenic spots along the Grand Canal currently lack online virtual tour systems and dedicated websites. Leveraging the Jiangsu Province Innovation Training Program and utilizing the "Student Practice Innovation Incubation Center," in-depth exploration of intangible cultural heritage elements was conducted. This led to the design and development of the Suzhou "Ten Scenic Spots along the Grand Canal" panoramic tour system and dedicated website. For example, in the historical and cultural area of Pingjiang, scenes such as ancient lanes, Niu's Family Alley Pan's Residence, Wenhui Bookstore, and Quanjin Guild Hall were presented to showcase Suzhou's historical figures and cultural elements. Through virtual touring and internet technology support, digitization of intangible cultural heritage was achieved, enriching the promotional methods of Grand Canal scenic spots and allowing the stories of the Grand Canal to be better told.

5.3 Panoramic Tour of Suzhou National Musical Instrument Museum

The traditional craftsmanship of Suzhou's national musical instruments has been listed as a national-level intangible cultural heritage. The museum houses a collection of over a hundred precious national musical instruments, including erhus, pipas, guzhengs, konghous, and bianzhongs, comprehensively and systematically displaying the achievements of China's national musical instrument manufacturing. Through preliminary demand research, the Suzhou National Musical Instrument Museum's panoramic tour system was designed and developed. Team members used cameras, recording equipment, lighting, and other devices to capture the craft processes of artisans making musical instruments and instrument

performances. They created micro-documentaries in the form of short videos to promote traditional craftsmanship. These short videos were uploaded to the virtual panoramic tour exhibition system, allowing users to enjoy these precious national musical instruments from the comfort of their homes.

6 Conclusion

Non -heritage condenses the wisdom passed down from generation to generation, and is the confidence of cultural self -confidence. Combined with virtual reality technology, innovate the form of non -genetic communication, so that non -genetic communication is personalized, precise, interactive, and intelligent, thereby expanding the breadth and depth of non -genetic communication and protection. Panoramic roaming has yielded significant advantages in disseminating intangible cultural heritage. Firstly, it enhances the sense of presence. Within the panoramic roaming system, users can immerse themselves in the actual scenes of intangible cultural heritage. Qualitative surveys indicate that the vast majority of users feel as though they are truly on-site, resulting in a heightened immersive experience that deepens their understanding and appreciation of cultural heritage. Secondly, it elevates cultural engagement. The panoramic roaming system sparks users' interest and involvement in cultural activities. Many participants express a noticeable increase in their interest in intangible cultural heritage after using the system, demonstrating a willingness to engage in further learning and related activities. Thirdly, it amplifies the dissemination effectiveness. Following the utilization of the panoramic roaming system, there is a clear improvement in the dissemination effectiveness of intangible cultural heritage. Viewer rates and participation levels increase, leading to a substantial enhancement in the recognition and influence of cultural heritage. These assessment results unambiguously demonstrate that the intangible cultural heritage virtual roaming system, based on Veb VAR panoramic technology, has produced positive outcomes in the dissemination of intangible cultural heritage. It captivates users' interest, elevates the prominence of cultural heritage, and fosters cultural preservation and appreciation. These findings provide robust evidence and references for the future development of similar projects.

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