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ORIGINAL RESEARCH ARTICLE

Architecture design of Jinggangshan virtual tourism system based on WebVR

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ABSTRACT

In view of the current mainstream VR virtual tourism system, because of the heavy virtual scenes and limited network bandwidth, tourists can't browse the WEB pages directly, and they need to download plug-ins or client systems to browse. This paper studies the lightweight architecture of virtual tourism roaming system. Research technologies such as lightweight modeling of 3D scenes, 3D engine call and lightweight script design, build a cloud storage transmission platform, integrate key technologies such as tour guides, and construct the online Jinggangshan WebVR system. The system based on this architecture will enable visitors to browse Web pages directly, online and quickly in real time, and improve the sense of interaction and immersion of the system.

Keywords: WebVR; virtual tourism system; Web 3D; virtual scene; 3D engine; cloud storage

1. Introduction

Virtual tourism is based on the real tourism landscape, and a virtual tourism environment is built by simulating or surreal landscape, so that tourists can carry out virtual tourism activities as if they were in person[1]. Virtual Reality (VR) is the most important supporting technology of virtual tourism. At present, there are many VR-based virtual tourism systems. Using VR technology, Japan developed virtual Tokyo, and the United States developed Second Life and Rome Reborn system[2]. Virtual Tokyo, Second Life is a virtual tourism system that presents a large-scale and interactive Web virtual world based on Web3D, and Rome Reborn is a network roaming system that reproduces Trajan Square in ancient Rome based on Web3D technology. Virtual Forbidden City, digital Dunhuang and online Expo roaming system have been developed in China. The virtual Forbidden City is a 3D tourism system, the digital Dunhuang is a digital tourist center built by VRAR (Augmented Reality) and IR (Interaction Reality) technologies, and the online Expo is a network roaming system combining 2D panoramic technology and Web3D technology. Some of the above VR systems need to download heavy-duty client systems, but can't let visitors browse the Web pages directly, which affects the use of the system. Due to the heavy virtual scenes and limited network bandwidth, visitors can't browse the Web pages

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online in real time in virtual tourism platform system. At present, in China, the virtual reality roaming platform for red tourism has not yet been established, and the existing Jinggangshan scenic spot Web platform is limited to two-dimensional web pages, lacking immersion and interactivity, which restricts the spread and development of Jinggangshan as a 5A scenic spot. Therefore, it is very necessary to expand the influence of red tourism by using 3D scene lightweight processing technology, calling Web3D engine, building cloud storage transmission platform, integrating existing VR technology, researching and developing "online Jinggangshan" red tourism virtual reality roaming system based on WebVR, and displaying the red cultural landscape and green beauty of Jinggangshan with scientific and technological means, and also providing demonstration effect for online tourism systems of other scenic spots.

2. Functional design of tourism system

Jinggangshan virtual tourism system will become a 3D virtual tourism website with functions of virtual tourism experience, virtual online communication among tourists, tourism information inquiry and online booking service. With the help of navigation module and electronic tour guide system, tourists roam online along the preset routes of the system, or roam on their own routes, and deeply immerse themselves in the beautiful scenery of Jinggangshan in an all-round and interactive way. Show the 5A-level green beauty and red cultural landscape of Jinggangshan through 360-degree panorama combined with audio commentary and text introduction of scenic spots; Virtual role-playing in the virtual tourism community, extensive and open interactive communication with the help of words and sounds, and a deep understanding of human history such as red legends and red stories of Jinggangshan, so as to obtain a real tourism experience like the field. Through the inquiry system and e-commerce system, tourists can fully realize the travel needs of "food, accommodation, transportation, travel, shopping and entertainment" in Jinggangshan. The functional planning of the whole roaming system is shown in **Figure 1**, which is divided into two parts: foreground function display and background data management. The tourism system will become a virtual tour.

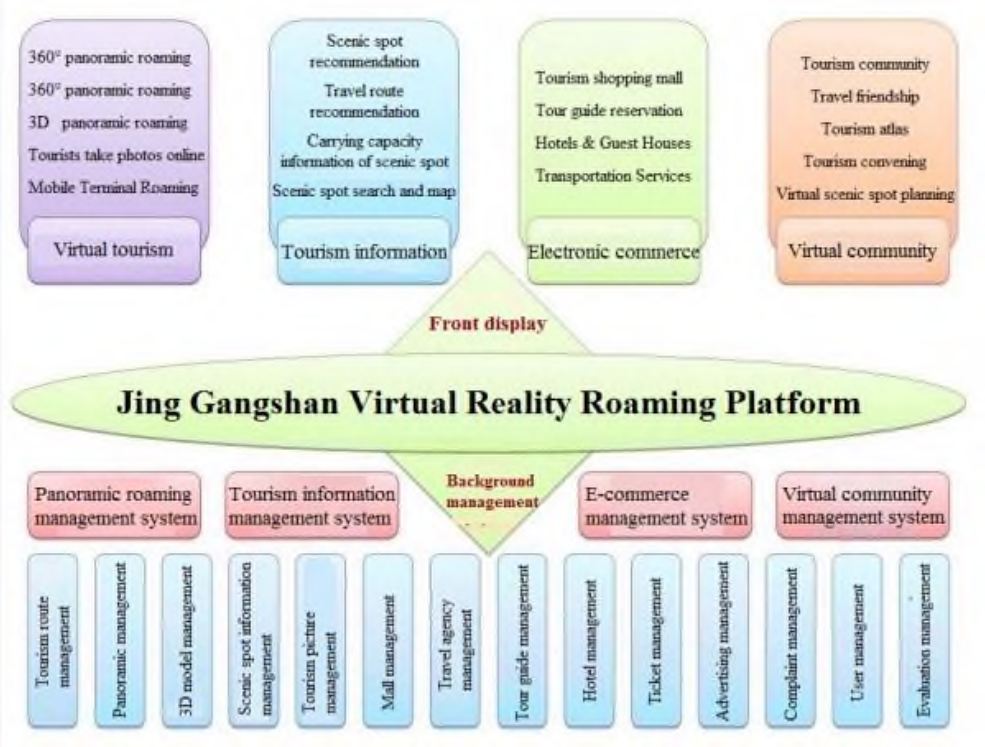

Figure 1. System functional module design.

2.1. Front desk display design of tourism system

1) Display of scenic bearing capacity. Using the research results of Jinggangshan Red Tourism Carrying Capacity, real-time information of scenic spots (such as the number of tourists, weather, traffic conditions, hotel occupancy rate, etc.) and early warning information are displayed.

2) Virtual visual navigation. Using the research results of Jinggangshan Red Tourism Standardized Guide System, we will implement standardized tourism information display and tourism explanation services in scenic spots. Using Web GIS technology[3], through the electronic map, query system and ecommerce system of Jinggangshan scenic spot, tourists can perceive the location, text, pictures, videos, user's evaluation and other information of interest points, and realize the navigation visualization of tourist routes.

3) Virtual roaming. With the help of navigation module and electronic tour guide system, tourists can use the location-based service of desktop or mobile terminal application system online to realize virtual roaming. Visitors can follow the preset route or optional route of the system and immerse themselves in the beautiful scenery of Jinggangshan in an all-round and interactive way. Through 360-degree panorama, stereoscopic panorama and 3D scene roaming, combined with audio commentary, text introduction and video of scenic spots, the 5A-level green natural beauty and red cultural landscape of Jinggangshan can be displayed online, and visitors can also take pictures online in beautiful scenic spots.

4) Virtual community[4]. Through the establishment of virtual tourism community, tourists can publish travel notes, tourism pictures, tourism evaluation, self-help travel, and make virtual planning for scenic spots, so that visitors can have extensive and open interactive communication and have a deep understanding of human history and natural scenery such as red legends and red stories of Jinggangshan 2. Tourism system background management design

2.2. Tourism system background management design

It provides many functions, such as the basic settings of the backstage website, scenic spot management, member management, order management, comment management, question and answer management, news management, help management, short messages in the station and so on. The heterogeneous resources involved in this platform are numerous and complex, and there are many data in the network storage server, such as videos, audio, pictures, texts, tourist routes, travel agencies, tour guides, hotels and so on, of 3D virtual landscapes, panoramic scenes, red legends and red stories. Therefore, the background pays attention to management functions and database planning and design, so that administrators and users can update and maintain all contents in the background, and visitors can also upload their own contents.

3. System support architecture

3.1. Web client architecture

At present, Web virtual tourism is mostly spread on the Internet in the form of website system, and how the webpage playing effect and response speed will affect the strong spread of virtual tourism websites. Therefore, using the combination of HTML5+JavaScript+CSS3 to develop the virtual tourism client makes the drag-and-drop operation, geographic location, video, audio, image, animation and other rendering and playing operations more beautifully and smoothly. Panorama roaming and 3D roaming in the platform are all played by flash, which realizes cross-platform plug-in free installation. Using Flex SDK and Flash Player API to realize Flash with 3D engine uses vector operation, which occupies less storage space, has fast download speed and brilliant effect. At present, 97% of web browsers all over the world have built-in Flash players, so the developed platform has a wide range of applications.

3.2. Web server architecture

The whole background adopts FluorineFx middleware and Entity framework, and adopts IIS Server and SQL Server database management system (server side shown in **Figure 2**), which effectively solves the problem of crowded concurrent visits by multiple tourists. FluorineFX is an open source library, which provides a remote procedure call to Flex, Flex data service and real-time data using technology under the. NET framework. Entity Framework is an object relational mapping solution developed by Microsoft based on ADO.NET. SQL Server is characterized by high security, ease of use, parallelism and good cost performance, which is suitable for the construction of this tourism system platform.

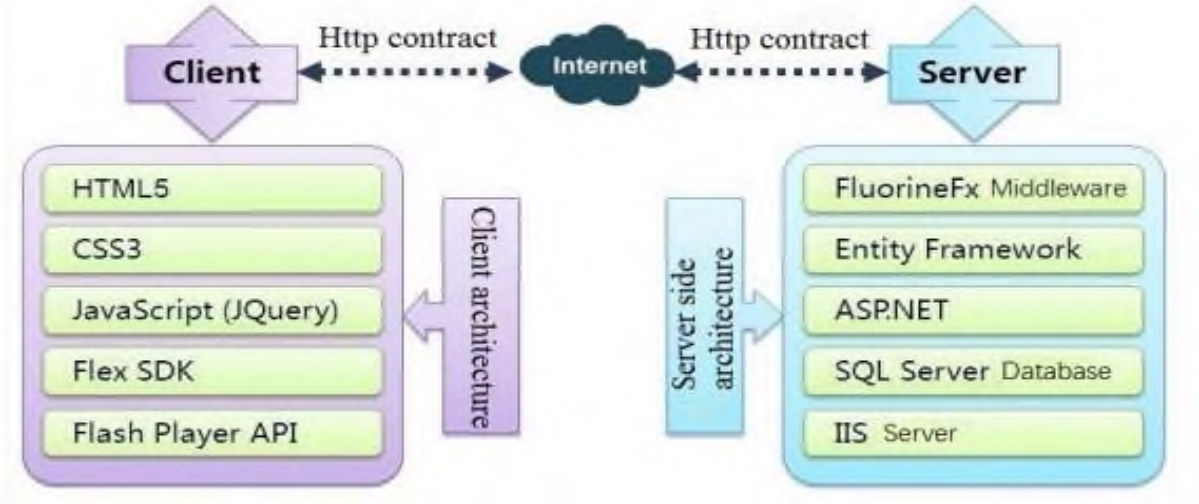

Figure 2. System framework.

4. Key technologies of tourism system based on WebVR

4.1. Route planning and design of Jinggangshan red tourist attractions

The route planning of virtual tourist attractions includes the generation of scenic spots routes and how to make the created virtual characters complete basic tour guide functions along the routes, that is, to guide tourists to visit and explain scenic spots, etc. The virtual tour guide scenic spot route is generated in the WebVR virtual environment, and the navigation route is optimized and screened by the heuristic search A* algorithm in artificial intelligence, so that the rover can quickly and accurately find the target or roam according to the ideal route even in an unfamiliar and complicated three-dimensional environment.

4.2. Design of virtual tour guides in scenic spots

Virtual tour guide refers to the virtual avatar that guides tourists to visit in the virtual tourism scene. In order to prevent tourists from feeling lonely in the WebVR scene, this project builds an intelligent virtual tour guide, and tourists can play roles, which makes the 3D virtual world of Jinggangshan Red Scenic Spot much lively. Using character modeling and animation technology to construct virtual tour guides, using the advanced technology of skeleton skin in the current 3D animation field to create the body of virtual characters and the lifelike virtual human body model obtained by skin processing, and establishing the virtual human body model library in line with international standards, and then realizing the creation of complex actions through animation mixing technology[5]. According to the simplification of key nodes of human body specified in H-Anim standard, key frames of virtual human body actions are set, and the actions of virtual characters that have been realized are managed and controlled by JavaScript. Using the navigation path generation algorithm in the virtual environment, the virtual characters can walk along the specified route

in the WebVR scene. The virtual human with humanized appearance, action and roaming function is transferred into the virtual scene that has been made, realizing the functions of virtual body double and virtual tour guide, and enhancing the interactivity of the virtual scene to a certain extent[6].

4.3. Web 3D roaming architecture design

The virtual real-life roaming platform of Jinggangshan red tourism based on WebVR technology will have the characteristics of real-time online, deep immersion and high interaction. Therefore, it is necessary to consider not only the fidelity of virtual landscape but also the fluency of downloading when generating scenes. When constructing online scenic spots in Jinggangshan, the background database will store many wide panoramic views, three-dimensional scene maps, 3D models, action scripts, texture materials, virtual avatars, audio, video and text data of red stories and red legends. When many tourists visit and browse online at the same time, it is easy to cause network congestion. To solve this problem, this project adopts the Web 3D virtual landscape roaming design architecture as shown in **Figure 3**.

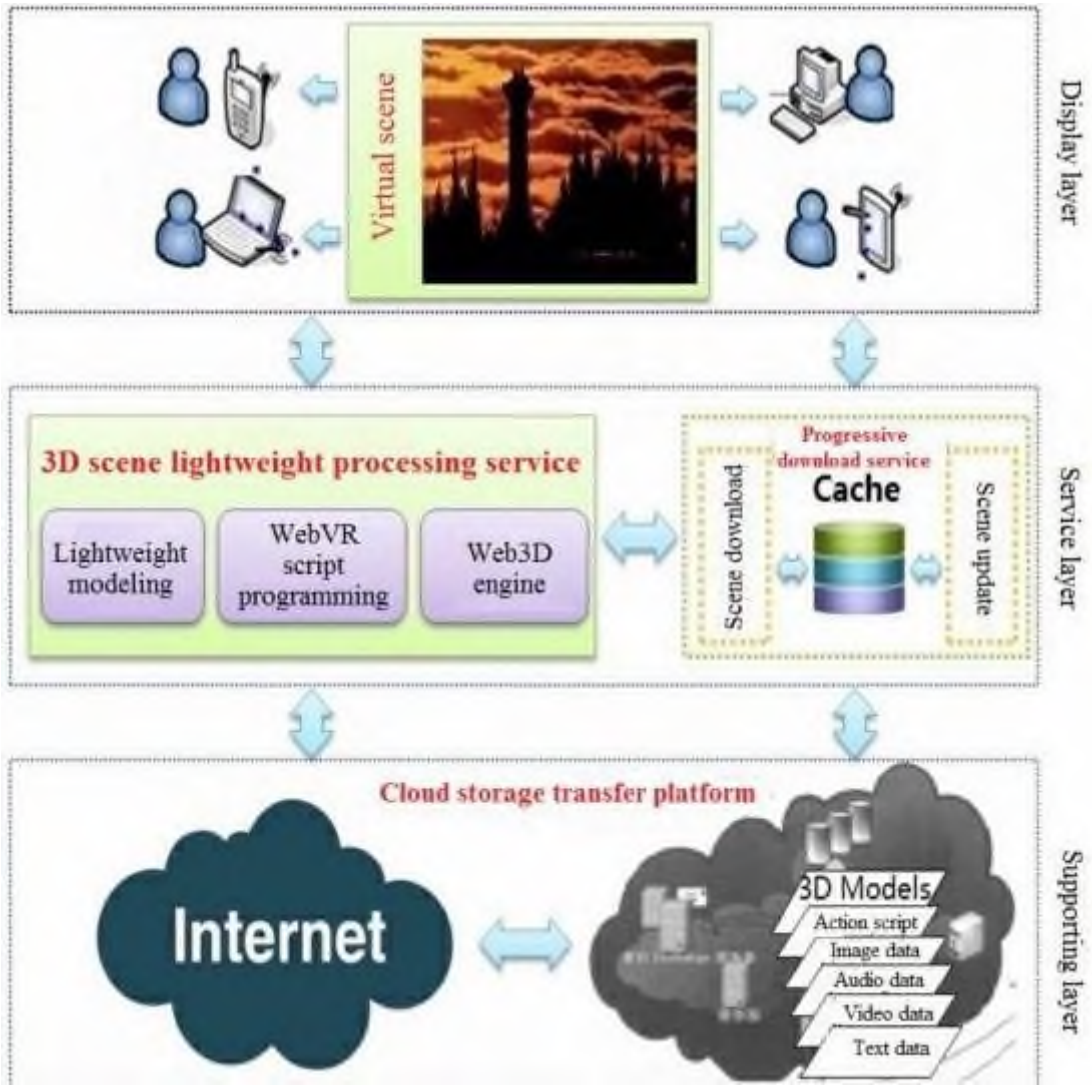

Figure 3. Framework of virtual landscape roaming design on Web3D.

Cloud storage transmission platform architecture

Cloud service can provide a reliable and safe data center for the informatization of Jinggangshan scenic spot. The cloud storage transmission platform can provide high-performance and large-capacity

storage capacity by virtualizing large-scale computing resources, and can meet the demand of large-scale data storage and processing in scenic spots. In addition, the cloud storage transmission platform has high reliability, and measures such as data multi-copy fault tolerance, isomorphism and interchangeability of computing nodes are used to ensure the high reliability of services, and secure data backup and remote disaster tolerance[7]. Online Jinggangshan has high requirements for data security, so it is not possible to deliver all data to public cloud computing service providers. Some non-critical applications and non-confidential data (such as scenic spot publicity information, video data, picture files, etc.) and applications requiring peak computing power and short-term storage can be migrated to the public cloud system first. However, those classified spatial data and data with high security requirements remain in the private cloud system in the scenic firewall and are not shared with the scenic spots. The construction of the private cloud system will adopt the scalable pipelined processing infrastructure[8], which consists of three parts: the server network running 3D virtual applications, the graphics rendering server handling 3D image rendering and load balancing tasks, and the streaming media network used to encode multimedia frames into the standard of H.264/MPEG-4 protocol, which includes network memory for storing large-scale scene data and streaming media server cluster.

Progressive download design of virtual scene

In distributed virtual environment (DVE), the contradiction between the demand of large-scale scenes and the storage space of users is more obvious in mobile terminals with small storage space, such as iPad, and smart phone. In order to alleviate the above contradiction, a P2P-to-peer-based progressive download mechanism is adopted for real-time roaming in Web 3D virtual space, which greatly reduces the server load during roaming[9]. Use the Prefetching and Caching technologies of WebVR scene transmission based on SMLAOI to preprocess the transmission of massive WebVR virtual scenes[10]. The progressive transmission strategy based on the Area of Interest (AOI) is adopted for the scene space. With the limitation of the maximum visual distance of the viewpoint, users only need to download and render the current visual scenes that fall into the avatar AOI gradually with the translation of the viewpoint in the real-time walking and roaming of the virtual space, thus reducing the data amount of each scene requested by users and greatly reducing the demand for local storage space. For the progressive transmission of the model in the scene, firstly, multi-resolution modeling is carried out on the model, and then according to the distance between the object and the viewpoint, the deviation angle between the object and the line of sight and other factors, the model data with different resolutions can be downloaded as needed without reducing the roaming visual effect, so as to reduce the network delay of scene downloading. In the design, the transmission mechanism of parallel multi-channel progressive massive WebVR scenes is adopted at the same time to reduce the pressure of data stream transmission on the network.

Lightweight processing technology

Due to the limitation of Internet speed and bandwidth, the real-time download of online (super) large-scale WebVR virtual scenes has always been a bottleneck problem. If four classic red scenic spots in Jinggangshan, such as “Ciping Revolutionary Site Group, Dajing Revolutionary Site Group, Longjiang Academy, Mao Ping Bajiao Building, the former residence of Comrade Mao Zedong”, are made into 3D scenes and played smoothly on the Web page, the number of patches and textures of the scenes must be reduced, and the scene model should be made by reusing mechanism. According to lightweight modeling→WebVR script programming → background management and support architecture → lightweight engine scheduling technology, the 3D roaming of Jinggangshan red classic scene is realized. The lightweight Web 3D modeling of this project adopts the efficient lightweight WebVR interactive script library API and the cross-platform, efficient and plug-in-free Web 3D/WebVR engine technology based on Flash/ HTML5 to solve the real-time interactive roaming problem of large-scale

online virtual tourism environment. Using lightweight Web 3D interactive script program design, the code amount of the program can be about 1/5 of the original, and at the same time, the execution and calculation efficiency of the code can be improved. In addition, the plug-in-free WebVR engine technology based on Flash 3D can efficiently schedule millions of patches of scenes, making the virtual roaming experience of users on the Internet smoother.

5. Conclusions

At present, Suzhou, Nanjing, Fujian, Huangshan and other places are constantly carrying out the construction of "smart tourism" projects in different degrees, integrating 3S (RS, GIS, GPS) technology, distributed computing technology, 3D visualization technology, virtual reality technology, database technology, data mining and data fusion technology, broadband network technology, communication technology (such as 3G), cloud computing technology, SOA (service oriented framework) and other supporting technologies[11]. Jinggangshan virtual tourism system is supported by the 12th Five-Year National Science and Technology Support Program. This paper puts forward a practical virtual tourism system architecture, which integrates the existing key technologies. The system has the functions of tourism service, tourism management, tourism marketing, etc., and provides navigation, tour guide, tour guide and shopping guide services for tourists, thus improving the competitiveness of the virtual tourism system.

Conflict of interest

The authors declare no conflict of interest.

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