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ORIGINAL RESEARCH ARTICLE

Survey on some key technologies of virtual tourism system based on Web3D

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ABSTRACT

Some key technologies on how to build large-scale virtual tourism systssems comprehensively on Web browsers and mobiles were analyzed and the current R&D status on Web3D virtual tourism was surveyed insightfully. Then, some methods were summarized, including 3D trees or plants modeling, 3D architectural modeling, 3D Virtual Human behavior modeling, virtual agents path planning, collision detection and progressive transmission strategy suitable for developing large scale Web3D tourism scenarios. Also, some bottleneck problems of Web3D virtual tourism system were investigated. At the same time, the lightweight 3D engine, the lightweight 3D modeling, the lightweight 3D streaming and P2P based progressive transmission of huge Web3D tourism contents would become much helpful to breakthrough those bottlenecks of Web3D tourism systems were pointed out. In addition, all kinds of Web3D engines in terms of lightweight, realism and efficiency that would be a good reference for developers to choose during various applications were compared comprehensively. Finally, the prospect of future investigation of Web3D tourism system is presented, which will be going on in terms of four characteristics lightweight, high-speed, realism, beauty.

Keywords: Web3D; virtual tourism; 3D engine; lightweight

1. Introduction

Virtual reality technology, multimedia technology, computer visualization technology and Internet technology provide a networked, virtualized and humanized 3D virtual tourism platform for tourists. Tourists can enjoy the flowing scenery of the world without leaving home, get the experience of being in their environment, and greatly reduce the tourism cost. Compared with foreign countries, which began to widely and deeply study the application of virtual reality technology in the field of virtual tourism in the 1990s, domestic research started late, but developed rapidly. Therefore, several key technologies of virtual tourism based on Web3D have become the current research hotspot. The current research mainly focuses on the application and implementation of virtual tourism, and there are few references to deeply explore some key technologies of building Web3D virtual tourism from the perspective of scientific and technological visualization. Therefore, from the new perspective

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of tourism environment network visualization, this paper will discuss the research status of some key technologies involved in Web3D virtual tourism, focusing on the lightweight modeling technology of 3D scene trees and buildings, virtual human modeling technology, virtual human roaming navigation technology, collision detection technology, fast downloading and scheduling mechanism technology of large-scale virtual scenes, compare and analyze Web3D virtual reality engine technology. It points out the lightweight direction for some key technologies of Web3D virtual tourism. The work of this paper is of great significance to promote the development of virtual tourism technology, promote the application of this technology in the field of virtual tourism, and create greater economic and social benefits.

2. Current situation of virtual tourism technology based on Web3D

Virtual tourism system based on Web 3D refers to integrating many emerging technologies such as Web GIS technology, multimedia technology, 3D modeling technology, virtual reality technology, computer network technology and computer visualization technology. Based on the existing landscape or existing tourism landscape, it constructs a three-dimensional virtual tourism environment with the Internet as the carrier by simulating or constructing surreal 3D landscape, so that tourists can browse and operate the objects in the virtual scene from any angle without leaving home, and even carry out role-playing and virtual community dating activities, so as to produce an immersive experience.

2.1. Application status of virtual tourism technology based on Web3D

With the development of information technology, virtual tourism has developed rapidly at home and abroad. Online virtual tourism has become the first choice for Internet users to prepare for travel or revisit after travel. At present, many key technologies are applied to the development of virtual tourism system, which has produced huge tourism economic benefits. In 2003, linden laboratory in the United States launched second life[1], the Web3D virtual tourism platform uses three-dimensional graphics technology to build a large-scale, multi-person online role-playing and interactive 3D virtual world. After visitors loged in, they enable virtual agents for automatic tour guides. In 2005, Google Earth launched 3D Virtual Ancient Rome, integrating archaeology, architecture, art and other disciplines, built many 3D architectural models, and reproduced the ancient Rome in its heyday online. In 2009, the Palace Museum and IBM jointly developed the Virtual Forbidden City[2] using SOA technology in 2008, and used 3D modeling technology to build a large number of high-resolution and fine palace buildings, cultural relics and character models, virtually reproducing the Royal grand occasion of that year. In 2011, flying carpet company realized the smart Lijiang 3D tourism platform[3] by using self-developed 3D virtual tourism engine, which enables tourists to roam online immersively and provides reference and guidance for offline field travel. In terms of technical means, these systems use exquisite modeling, detailed mapping and wonderful light and shadow technology to build 3D scenes, and use 3D engine for scene management, resource management, character and bone animation management, dynamic loading and unloading resources, visual cutting technology and other technologies.

The excellence of the above 3D virtual tourism system in functional design is that it has the function of role-playing and virtual community. Users can dress up “themselves”, use the systemetic “self-help tour” function, follow the preset route of the system, listen to the “guide” to introduce scenic spots and character stories, and share them with friends on the social platform. This system has a strong sense of immersion, interactivity and imagination, but the scene modeling is complex and time-consuming, so it is not suitable for the construction of large-scale scenic spots.

2.2. Main key technologies of virtual tourism based on Web3D

The construction of Web3D virtual tourism platform needs the support of multiple key technologies. It includes lightweight modeling technology of trees and buildings in 3D scene, virtual human modeling technology, virtual human roaming navigation technology, collision detection technology, fast downloading and transmission mechanism of large-scale virtual scene, lightweight 3D engine technology, efficient Web3D system support architecture technology and high efficiency, high scalability and high adaptability software engineering method.

The content arrangement from Chapter 2 to Chapter 5 in the subsequent chapters of this paper will focus on in-depth analysis of these key technologies from a new perspective of tourism environment network visualization, along with the clue of building Web3D based virtual tourism, that is, 3D scene tree modeling → building modeling → virtual human modeling → virtual human roaming and navigation → scene collision detection → rapid download and scheduling mechanism of large-scale virtual scenes → Web3D virtual reality engine technology. It also points out the technical bottleneck in the development of virtual tourism, and points out the lightweight direction for some key technologies of Web3D virtual tourism.

3. Virtual tourism scene 3D tree and building modeling technology

A large number of 3D plant and tree models, 3D building models and 3D virtual avatar models are arranged in the model-based virtual tourism scene, and 3D modeling generally occupies 50–80% of the total project cost, and its development time also accounts for more than half of the whole project development cycle. In order to make the model lightweight and operate on the web with limited bandwidth, many scholars have done a lot of researches and exploration on various modeling technologies. This paper only summarizes the following modeling technologies, and extracts the tree lightweight 3D modeling framework from many modeling technologies according to the requirements of virtual tourism.

3.1. 3D tree or plant community landscape modeling technology

In the virtual landscape of Web virtual tourism system, 3D tree or plant group landscape model occupies an important position and proportion. Researchers at home and abroad have used different methods to build realistic 3D tree models. At present, the mainstream 3D tree modeling methods mainly include sketch based tree modeling[4,5], image-based tree modeling[6–8] and rule-based tree modeling[9]. The 3D tree/plant community landscape constructed by sketch based and image-based modeling methods has strong realism and a wide range of tree species, but the volume is too large to be uploaded on the Internet. The rule-based modeling method is suitable for generating virtual trees in virtual tourism scenes. At present, more mature modeling systems include Xfrog, L-Studio and GreenLab. In addition, by means of manual modeling, modelers often use 3ds max, Maya, milkshape and other software to construct the scene with the combination of geometric modeling, billboard or cross map for complex trees[10], which has strong practicability, but the tree model made by this method is rigid and lacks natural vitality in the virtual scene.

In terms of lightweight 3D tree modeling, Kim et al.[11] combined the hierarchical recursive hierarchical structure and rules of trees to build a virtual ecosystem, which embodies a certain idea of lightweight modeling[12], Cheng et al.[13] adopted the similarity and repeatability of lobes branch and leaf structure to eliminate a large amount of useless information for lightweight storage and packaging, and proposed a rapid 3D tree modeling method based on lobes, but the modeled tree species are not lightweight enough to be effectively analyzed by the current Web3D and webvr browsers or engines.

In order to solve the problems of lightweight

3D tree construction and Web3D application, Jia's team[14,15] carried out lightweight Web3D tree modeling based on images and rules. For one or a group of pictures or videos of the same tree input by the user, the 3D reconstruction theory of human vision and the reuse idea of branches and trunk substructures are used to restore the three-dimensional morphological characteristics of the tree, and then intelligently reconstruct the parameter L-system rules to describe the tree. Finally, the tree L-system description file is parsed into a lightweight VRML/X3D file. This technology makes the tree or plant community landscape model lighter and further improves the scale and rendering efficiency of tree and plant community landscape modeling. The modeling process is shown in **Figure 1.** Because the reconstructed L-system model is highly regular and parameterized, it makes the model lightweight enough to facilitate the real-time transmission of 3D models on the Internet, thus breaking through the "transmission bottleneck" of heavy virtual scene models, and can be applied to large-scale virtual interaction scenes in the network environment, leading the direction of lightweight 3D tree modeling.

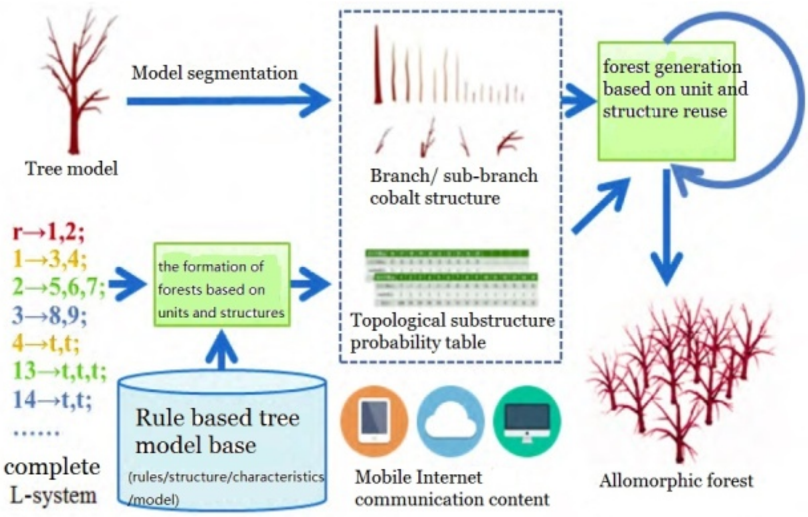


Figure 1. Lightweight modeling process of tree and plant community landscape based on branch/substructure reuse.

3.2. 3D modeling technology based on the concept of building structure likelihood

The tourism scene contains a large number of architectural elements. For complex or important landmark buildings, Multigen Creator and 3D Max are usually used for separate modeling to build fine structure and texture. For large area buildings, if they are still modeled separately in this way, the scene model will be very heavy and difficult to run in the web page. Therefore, the 3D model construction technology of large-scale building complex based on semantic ontology is gradually becoming an emerging technology.

Francesco et al.[16] proposed the ASA algorithm for 3D modeling of buildings in urban areas. Based on the concept of building structure likelihood and the visual cognitive law of tourists, the algorithm manually divides the whole city to be modeled into style areas (SAS: style area) through modeler. Set statistical probability values for buildings in each SAS, such as glass curtain wall skyscrapers, gypsum curtain wall buildings, mansions, villas, churches, etc., and create semantic ontology including wall texture, windows, porch, roof and other elements. Instantiate after setting attributes. When building a building model, use three building structure semantic rules to model the building in 3D. Such processing will not only improve the efficiency of modeling, but also reduce the amount of data, which is conducive to the display and roaming of 3D building scenes.

However, the algorithm reuses the building component elements and applies rules to reconstruct the building, which makes the appearance simple and consistent and lacks realism. In addition, it is time-consuming to collect and correct the sampled pictures. Therefore, it is necessary to explore a 3D building modeling algorithm that can achieve better results in terms of realism, model weight, development time and so on.

4. 3D virtual human modeling and roaming navigation technology in virtual tourism scene

4.1. 3D virtual human modeling technology based on five level model

Virtual tour guide refers to the virtual avatar that guides tourists to visit in the virtual tourism scene. Adding virtual tourists and virtual tour guides to the Web3D virtual tourism scene will increase the vividness and sense of nature of the scene. However, the construction of realistic and humanized virtual human is a complex process, which requires the integration of multi-disciplinary knowledge including computational geometry, dynamics, artificial intelligence, computer graphics and biomechanics. Funge et al.[17] proposed five hierarchical model layers in 1999: Geometric layer, kinematic layer, physical layer, behavioral layer and cognitive layer. The requirements of these five levels are gradually approaching the real characters, and the technical methods are becoming more and more complex. At present, most of the research on virtual human projects focus on the first three layers, namely geometry layer, motion layer and physical layer.

Genface is a relatively mature software in the world. It uses the face photographed by the camera to generate a three-dimensional human avatar, and can export VRML standard format. In the field of X3D/VRML, in order to be compatible with the interoperability and sharing between virtual humans created in different environments, a specification H-Anim[18] is formulated to describe the virtual human model, which can only deal with the low-level model level. In addition, the H-Anim specification does not explain how to define the behavior of virtual human and how to integrate different layers. As a result, developers have to convert from high-level behavior layer to low-level geometry layer and motion layer. Lucio et al.[19] proposed the VHA (virtual human architecture)architecture, considered the geometric model and appearance of the virtual human at the bottom, and processed the H-Anim virtual human into X3D/VRML format, so that developers mainly focus on the processing of behavior modeling at the top. Because the behavior of virtual human is triggered by environmental events, the behavior of virtual human based on sense decide act paradigm is realized. Domestic scholar Wang et al.[20–22] conducted in-depth research on the modeling of virtual human body, and applied it in human motion capture and virtual anthropomorphic modeling. Luo[23] studied the behavior model of virtual tour guide based on the characteristics of tour guide behavior, and proposed a virtual tour guide behavior model composed of perceptron, domain knowledge base and decision-making reasoning machine. At present, due to the limitation of computer performance and network bandwidth, it is not easy to realize a virtual tour guide with a certain intelligence level in the perception layer. It needs to integrate multiple disciplines.

4.2. Collision detection technology in Web3D scene

In the Web3D virtual tourism roaming scene, when virtual tourists or virtual tour guides move forward, backward or turn around, if collision detection is not carried out, it is easy to have penetration distortion such as virtual people entering the ground or passing through the wall. At present, the collision detection algorithms studied can be roughly divided into “spatial decomposition method” and “hierarchical bounding box method”[24] The space decomposition method divides the whole virtual space into small cells with equal volume, and uses k-d tree, octree, BSP tree, tetrahedral network and regular network to detect the collision detection between the avatar and the object in the cell. In terms of collision detection in virtual tourism roaming scene, unlike virtual assembly and simulation surgery, which pay more attention to accuracy, real-time and speed, it can approximate simulation collision detection. Therefore, a slightly larger bounding box with simple geometric characteristics is used to approximately describe the virtual human, and further intersection tests are carried out on the objects overlapped by the bounding box. Typical bounding boxes include AABB, bounding sphere, OBB, convex hull, etc.

Chang Ming et al.[25] used the surrounding ball to replace the virtual avatar, eliminated the closed cylinder space for three and a half times, and established the collision shape set, which can simplify the calculation of collision points, but only considering the linear motion of the virtual human, the curve motion may collide at any time. He et al.[26] considered the problem of collision perception between virtual human walking on slope and road surface, which has a sense of reality. Zhang et al.[27] divided the virtual scene space into regular grids from the perspective of virtual roaming, only detected the collision between the viewpoint and the objects in the current grid, and judged whether the viewpoint collided with the triangle through the orientation factor and the direction of the directed loop. The algorithm adopts vector cross product operation to speed up the detection speed. However, the algorithm only considers the static division of virtual space and the roaming of a single virtual person. If it is used to detect the collision detection between multiple virtual persons in dynamic scenes, the calculation is complex. Therefore, exploring efficient and lightweight algorithms is the research trend of collision detection in virtual tourism.

4.3. Virtual human navigation algorithm in virtual tourism scene

In the process of navigation, it is necessary to divide the collision between a virtual person and other avatars into the optimal state, so as to prevent the collision between a virtual person and other avatars. For the division of virtual scene space, there are cell method[28], corridor map method (CMM)[29], Voronoi diagram method[30], and mang diagram method (multi-agent navigation graph)[31]. The navigation of virtual human mostly adopts the extended social force model to guide the virtual tour guide or virtual avatar to move towards the destination.

Gayle et al.[32] proposed an online autonomous virtual agent virtual scene navigation system based on central server network topology, and the implemented navigation algorithm is applied to the virtual tourism scene of second life. In **Figure 2(a)**, there are multiple avatars, including RAS (real agents) and VAS (virtual agents), such as a_1, a_2 and a_3. The movement of real agents is controlled by user operation, while the movement of virtual agents is controlled by simulator.

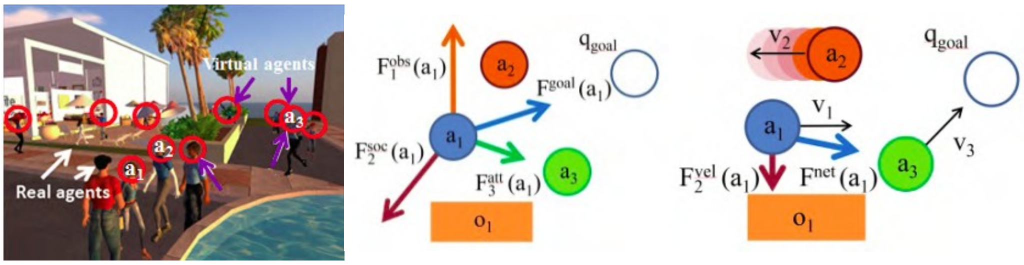
The driving of vas is completed by social force. Gayle refers to Helbing's social force model (SF)to build local navigation, as shown in **Figure 2(b)**. In order to reduce the impact of network delay, it is assumed that the vas moves in a straight line in a short time interval and increases the velocity bias force on the vas, as shown in **Figure 2(c)**. The final total driving force of F^{net} an agent (formula (1))is a_1 the resultant force obtained F_1^{obs} by a_2 vector calculation of F_2^{soc} five a_3 forces acting F_3^{att} on the agent, such F^{goal} as obstacle repulsion a_2 force, social repulsion F_2^{vel} force, attraction force, destination driving $\wp$ force, and speed offset force from.

$$F^{\text{net}}(a_1) = \wp(F_1^{obs}(a_1), F_2^{soc}(a_1), F_3^{att}(a_3), F^{goal}(a_1), F_2^{vel}(a_2)) \tag{1}$$

Since this article does not consider the safe distance between strangers, it lacks enough sense of real experience. In addition, the model may cause the virtual human to "tremble and linger" due to the attraction of the destination and the repulsion of others.

5. Progressive transmission mechanism of large-scale virtual tourism scene

With the deepening of the application of large-scale 3D virtual tourism scenes such as Google Earth, virtual earth, Bing Map 3D and second life on the Internet, the complexity of the scene is increasing day by day, and the scale (data volume) of the scene continues to grow. The rapid scheduling and real-time downloading of the sea volume data of large-scale online 3D Virtual tourism scenes have become the bottleneck problem perplexing Web3D, how to effectively reduce the number of model transmission patches and reduce model complexity is the key to realize the rapid transmission of virtual tourism complex scenes.



(a) Proxy in virtual scene; **(b)** Social force model; **(c)** Increase velocity offset force.

Figure 2. Social force model of virtual agent in Second Life virtual scene.

5.1. Simplification technology and reuse calculation of dev virtual scene model

In the distributed visual environment (DVE), in order to further reduce the amount of data download of 3D virtual scene, the dynamic LOD technology (the level of detail)[34] is adopted to establish multiple LOD models with different degrees of precision for 3D objects in advance. When the object is far away from the avatar's viewpoint, the model with low resolution is downloaded, and when it is close, the model with higher resolution is downloaded LOD technology can save time without reducing the fidelity of the scene by using the principle of human vision, and the rough large-size object model can consume a lot of bandwidth. In order to make up for the deficiency of discrete LOD, researchers have made a major breakthrough in the simplification and streaming coding technology of three-dimensional object model in recent years[35]. Progressive mesh PM (progressive mesh) is a famous stream coding technology[36]. It can represent any topological mesh as an efficient, lossless and continuous resolution stream coding. It simplifies the object model by "edge folding". In the process of simplification, it encodes the topological and geometric information of the object to form a stream, and its inverse process "point splitting" can restore the simplified model to the original model PM has some shortcomings, such as relatively slow coding. Lang[37] and Li[38] et al. developed CPM (compress PM) andslod (smooth LOD)technology on the basis of PM, and achieved good results.

Usually, it roams in real time in large-scale virtual scenes, and models such as trees and ordinary buildings usually do not receive special attention from users. Therefore, it is of little significance to present such particularly fine 3D models to the viewpoint. Based on this understanding, Wen[39] adopted the reuse degree calculation method of "one-time modeling and multiple reuse" for 3D models such as trees and ordinary buildings. Due to the high reusability of objects, the overhead caused by downloading a large number of such objects is saved.

5.2. Pre download strategy

To quickly download large-scale Web3D virtual scenes within a few minutes, you need to download the scenes of interest to the client in advance. Chim et al.[40] used arithmetic average method and window method to predict the future position of the avatar, but this method did not consider the impact of historical translation at different times on the prediction. He improved this algorithm and adopted exponential weighted moving average (EWMA) to improve the download accuracy. Li et al.[41] proposed the MLM (most likelihoodmovement) pre download method that the translation trajectory of the avatar in the scene plan is determined by the translation trajectory on the desktop, which has high download accuracy, but also has the disadvantage of high computational complexity.Koltun et al.[42] proposed that the SNP (simple neighbor prefetch)method is based on the unit where the avatar resides and pre downloads the scenes in the surrounding 8 units. This method is relatively simple, but it also falls into the situation of "downloading scenes-local culling scenes" when the avatar moves back and forth.Cevikbas et al.[43] adopted a more flexible pre download strategy, taking the whole virtual scene as a horizontal plane, dividing it into several units and managing it in groups. The unit where the avatar is located and the unit with high future access probability are divided into the same group. If the avatar stays in a unit for a short time, the unit and its neighbor units are divided into the same group. The "simulated annealing" algorithm is used to iterate to determine the optimal prefetching sets PS (prefetching sets). As the viewpoint of the user's Avatar (virtual human) changes, gradually download the incremental IPVS (incremental potential visible scenes). When the cpvshas been downloaded and the viewpoint resides, pre load the fpvs (future potential visible scenes) by predicting the movement trend of the avatar and using the idle time of the system, so as to make the user browse more smoothly. This method provides a general idea of downloading, but it costs more time and computing resources.

5.3. Web3D engine technology

Web3D engine technology is the core technology of building virtual tourism system, which usually includes scene management, resource management, character animation, LOD terrain, UI, server scheduling and other modules. All modules work together to realize the dynamic scheduling of large scenes, with good low-end hardware compatibility, high compression ratio, multi-threaded download, support for high concurrent access, support for high-performance physical engine, support for script programming and other characteristics, which provides strong technical support and guarantee for virtual tourism based on Web3D. The existing mainstream commercial Web3D engine technologies include Virtools[44], unity3D[45], Quest3D[46], flash 3D, etc. In foreign countries, and VRP[47], conserve 3D[48] in China, which provides a platform for integrating 3D scenes, 2D web pages and heterogeneous databases for 3D virtual tourism system. However, due to the different performance of different 3D engines, the scale of virtual tourism platform suitable for development is also different. At present, the industry has not formed a unified measurement standard, and each engine in specific research and development lacks systematic and authoritative description documents, which brings confusion to researchers and technical developers in-depth research and further development. The author tries to analyze and compare the famous Web3D engines at home and abroad from the aspects of best application, development difficulty, image quality rendering effect, interaction ability, compression ratio, graphics engine technology, whether web browser plug-in is needed, whether mobile terminal is supported, etc., as shown in **Table 1.** It can be seen from **Table 1** that the flash 3D engine has the engine technology of plug-in free installation and lightweight script programming, which can be used for the development of small and medium-sized virtual tourism platforms. Unity 3D is a fully integrated professional game engine due to its highly perfect light and shadow rendering system, which is suitable for the development of medium and large-scale virtual tourism system.

Table 1. Comparison of functions and applications of 3D virtual reality engine

	Virtools	Unity3D	Quest3D	Flash 3D	Webmax	VRP	Converse 3D
Affiliated company	France	Denmark	Netherlands	USA	Shanghai chuangtu	Zhongshidian	ZhongtianHaojing
Best application	Multi product display, 3D online games	Multi product display, 3D online games	Stand alone display and roaming	3D web pages, virtual tourism	3D web pages, virtual tourism, 3D online games	3D Web Virtual tourism, 3D online games and	3D web pages, virtual tourism, 3D online games
Development difficulty	More difficult	Hard	Hard	Lower	Low	Low	Low
Image quality rendering effect	Preferably	Preferably	Preferably	Preferably	Preferably	Good	Preferably
Interaction ability	Good	Good	Preferably	Preferably	Commonly	Preferably	Preferably
Compression ratio	Commonly	High	Commonly	Higher	Higher	High	High
Graphics engine technology	Direct3D/opengl	Direct3D/opengl	Directx9.0	Directx/opengl	Directx9.0	Directx10.0	Directx10.0
Do you need a web browser plug-in	Yes	Yes	Yes	No	Yes	Yes	Yes
Does it support mobile terminals	No	Yes	No	Yes	No	No	No

6. Problems and development direction of key technologies of virtual tourism

6.1. Analysis of key technologies of virtual tourism

It is very challenging to use some existing key technologies to develop Web3D based virtual tourism platform, which mainly has several problems.

(1) In the new era of mobile Internet, virtual tourism is developing towards the realization of Web level Web3D on mobile devices. Due to the limited computing performance of web pages and mobile platforms, there are many heavy 3D landscape models in virtual tourism platforms. Heavy 3D models not only expand their storage space, but also directly affect their transmission and download in the network. Therefore, how to quickly and lightweight build various 3D scene models is one of the technical problems existing in Web3D virtual tourism technology.

(2) Due to the limitation of Internet speed and bandwidth, the real-time download of online (super) large-scale Web3D virtual tourism scene has become an insurmountable “bottleneck problem”. The existing virtual tourism platform lacks efficient, plug-in free, lightweight Web3D engine technology, weak Web3D script computing performance, dynamic transmission technology of large-scale virtual tourism scene and remote dynamic rendering technology. Therefore, how to break through the bottleneck and improve these technologies is another key of Web3D based virtual tourism technology.

(3) There are some problems in the existing virtual tourism platform of the system, such as the lack of authenticity of the roaming navigation algorithm of the virtual tour guide and the cumbersome collision detection technology of objects in the virtual scene. Coupled with the poor computing performance of the system, it is difficult to achieve a better computational balance between the realism of the virtual scene and frame rendering, and the natural fidelity of the scene can not be guaranteed.

6.2. Development direction of key technologies of virtual tourism

Our team has studied and explored the relevant technologies needed in the construction of Web3D based virtual tourism system and achieved certain results[14,15,49–51]. These technologies include lightweight Web3D modeling technology, fast download mechanism of large-scale Web3D virtual scene, lightweight Web3D engine technology and lightweight Web3D script program. With the accumulation of these achievements, we can grasp the development direction of key technologies of virtual tourism based on Web3D.

(1) Efficient, low-cost and lightweight 3D modeling.

A large number of 3D plant and tree models, 3D building models and 3D virtual avatar models are arranged in the model-based virtual tourism scene, while 3D modeling is mainly manual modeling, with relatively high labor cost and long manual modeling cycle. In order to make the model lightweight and run on the web with limited bandwidth, an efficient and low-cost intelligent lightweight 3D modeling solution is needed.

(2) High efficiency, low power consumption and lightweight Web3D engine.

It is a very challenging research direction to develop a Web3D virtual tourism engine to make it “light, fast, true and beautiful”. “Light” means that the Web3D engine is lightweight, requiring the engine to have a perfect progressive transmission mechanism to minimize the amount of scene data that needs to be preloaded, transmitted and cached during each roaming step. Navigate smoothly through virtual scenes. It can be expected that the current Web3D is developing towards a cross-platform, plug-in-free installation, and a lightweight 3D engine for Web pages and mobile applications. “Fast” is reflected in the fast running of the interactive script driver, enabling visitors to successfully download the scene of interest within tens of seconds. Therefore, exploring how to design efficient, low-power, lightweight script interaction algorithms is also a new research direction. “Truth and beauty” is reflected in the fact that the Web3D engine has realistic rendering methods to make various materials, light and shadow, particles, and animation effects natural fidelity and beauty of light and shadow, which is also one of the goals pursued by the key technologies of the Web3D virtual tourism engine.

7. Conclusions

This paper deeply analyzes some key technologies of building Web3D based virtual tourism platform, and analyzes several bottleneck problems restricting its development, such as a large number of heavy-duty 3D scene models, lack of efficient, plug-in free and lightweight Web3D engine technology, weak Web3D script calculation performance, slow dynamic transmission technology of large-scale virtual tourism scene and remote dynamic rendering technology. It points out the development trend of key technologies of Web3D based virtual tourism, including efficient, low-cost and lightweight 3D virtual scene modeling, lightweight Web3D interactive script programming technology, large-scale virtual scene fast download mechanism, and efficient, low-power and lightweight Web3D engine. In today’s new era of mobile Internet, virtual tourism based on Web3D is booming in the direction of web page and mobile devices. It is hoped that this article will enable readers to have a further understanding and understanding of the key technologies of virtual tourism based on Web3D.

Conflict of interest

The authors declare no conflict of interest.

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