

3D Virtual Reality System for Digital Tourism Visualization in Smart Cities

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Abstract. As a high-tech emerging in the field of graphics and images in recent years, three-dimensional virtual reality systems mainly rely on computer simulation to create a three-dimensional virtual world. However, through the simulation of visual, jerk, and tactile organs, users can feel incredibly realistic. This high-tech has started to be applied in various fields in recent years, so this article aims to study whether the digital tourism industry in the context of smart cities is suitable for using this technology. At the end of this article, the passenger flow of a certain scenic spot before and after loading the 3D virtual reality system is statistically analyzed. The average passenger flow before loading is about 3314 people, and the average passenger flow after loading is about 4536 people. It can be seen that with the support of this technology, the passenger flow has been significantly improved.

Keywords: Smart City, Digital Tourism, 3D Virtual Reality System, Urban Planning, 3D Modeling

1 Introduction

Due to the various limitations of traditional tourism, this article aims to identify a method that can improve the current situation of the tourism industry. Coinciding with the widespread construction of smart cities and the application of 3D virtual reality systems in various fields, this article hopes to solve this problem through digitization of the tourism industry.

The current tourism industry is affected by the dual effects of the epidemic and the economy, and there is an urgent need for some ways to improve it. Akhtar N proposed that digitization of the tourism industry is a feasible solution to save the tourism industry in the context of the epidemic [1]. Cheung M L believed that user generated content is one of the important concepts that affect tourist decision-making [2]. Pasca M G believed that the gamification of tourism and hotels in the digital platform era is beneficial for local tourism business [3]. Kitsios F believed that the use of big data can help hotel managers understand consumers' expectations [4]. It can be seen that the form of digital tourism is deeply rooted in people's hearts, and the construction of digital tourism is definitely inseparable from the construction of smart cities that are also digital and intelligent. Ghazal T M believed that smart cities aim to make cities more efficient, technologically advanced, environmentally friendly, and inclusive [5].

Sharifi A believed that in the context of the epidemic, smart cities can promote resilience by enhancing planning, absorption, recovery, and adaptation capabilities [6]. Bhattacharya S believed that advances in information and communication technology would make the concept of smart cities a reality [7]. Veselov G proposed that artificial intelligence automation would greatly contribute to the construction of smart cities [8]. Digital tourism cannot do without the background of smart cities.

An important manifestation of tourism digitization is that many tourist attractions nowadays have advanced technology, such as various experience halls, among which VR (virtual reality) experience halls are very popular. Its powerful functionality has also made it popular in other fields, and Arichi T proposed that virtual reality systems can be used internally in magnetic resonance imaging systems [9]. Azarby S believed that the way virtual reality systems shape human experiences would affect design results [10]. It can be seen that the way to change the human experience is novel and can naturally arouse the interest of tourists. However, many tourists may experience discomfort such as dizziness when using VR. Hussain R believed that adding spatial blur to three-dimensional 3D stimuli can reduce the dizziness that users experience when using virtual reality systems [11].

2 Construction of a 3D Virtual Reality System

2.1 Application of 3D Virtual Reality System in Urban Planning

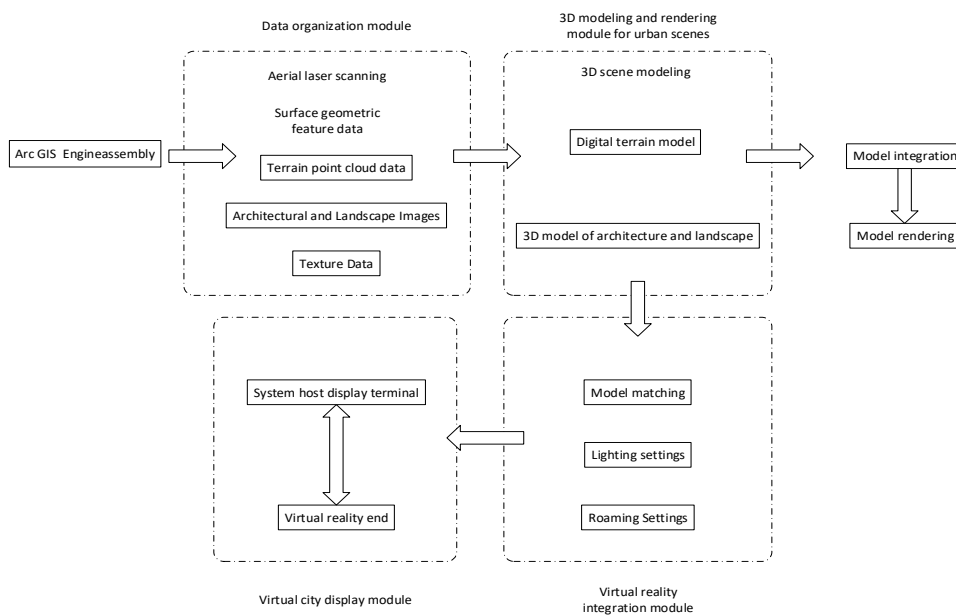


Fig. 1. Urban planning system based on 3D virtual reality technology

The three-dimensional virtual reality technology can model the scene of the target object in 3D and perform texture rendering, matching the built model with the coordinates of the virtual reality software, and ultimately obtaining an ideal visual display effect. It can be said that the application scope of this system is quite extensive. Liu Y L applied this technology to urban planning in his research and believed that urban planning systems need to consider various functions such as the rationality, economy, ecological function, and aesthetic art of urban architecture and landscape planning, which is very suitable for the application of this technology [12]. The system he built is shown in Figure 1.

From this system, it can be seen that it is mainly divided into four modules: data organization module, urban scene 3D modeling and rendering module, virtual reality integration module, and virtual city display module. Firstly, the Arc GIS Engine component is laid out towards the data organization module. The data organization module utilizes aerial laser scanning to extract surface geometric feature data, mainly including terrain point cloud data, architectural and landscape images, and texture data. After obtaining this information, the urban planning part can proceed with the development and design of the city. Then these information would be transferred to the 3D modeling and rendering module of the urban scene for 3D scene modeling, mainly the digital elevation model and the 3D model of architecture and landscape. Then the model would be integrated, and then the model would be rendered through the 3D graphics rendering engine. The obtained model is then placed into the virtual reality integration module through virtual reality components for model matching, lighting settings, and roaming settings. Finally, the image output is carried out through the virtual city display module, which consists of the system host display end and the virtual display end. They are connected to each other through interfaces. Nica E also proposed that IoT technology is an important technical support for urban planning [13].

2.2 Application of 3D Virtual Reality System in Tourism System

Li W X has also applied 3D virtual reality systems in tourism systems [14]. In his view, virtual reality technology is a computer simulation technology that can create and experience a virtual world. It uses computers to generate an interactive 3D dynamic scene, and the simulation system of physical behavior can immerse users in the environment. However, traditional tourism departments or scenic spots have problems with game systems such as weak immersion and insufficient interactivity. Therefore, he hopes to enhance the interactivity and entertainment in the game system by establishing a virtual reality system.

Figure 2 is the architecture diagram of the tourism VR (Virtual Reality) game system. When working in this system, it is mainly divided into two modules, namely the unified business server and the business display end. The unified business server is responsible for interactive data reception, interactive data processing, and statistical data exception reporting, while the business display end is responsible for displaying interactive data collection, interactive trigger action statistics, and VR content display.

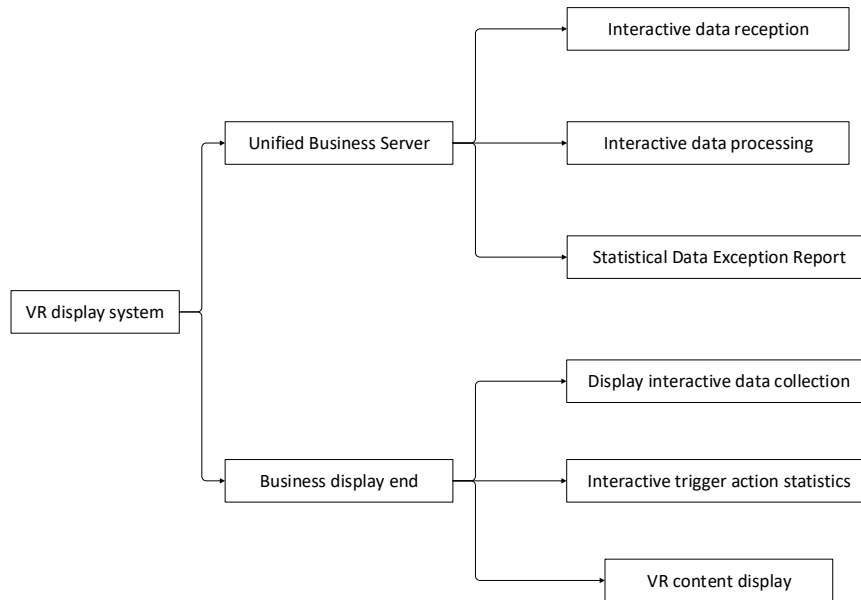


Fig. 2. Architecture of tourism VR game system

3 Function and Role of Smart Cities

With the increasing expansion of the city, its internal residential areas, the number of residents, industrial departments and administrative departments have become more complex and difficult to manage, so the concept of smart city has been proposed. Jiang M H believed that a smart city is a highly digitized, networked, precise, and intelligent information collection that integrates self-innovation, spatiotemporal compression, automatic recognition, and intelligent management functions [15]. Through smart cities, city managers can more easily and stereoscopically manage the city, and residents living in smart cities can also enjoy convenient and comprehensive modern services at any time. Haque A K M B also believed that smart cities can bring more convenient life [16].

Table 1. Some Subsystems and Their Functions in Smart Cities

Location Services	Locating and querying surrounding information
Video monitoring system	Real time monitoring
Smart Parking System	Automatic vehicle recognition, convenient parking space search, and automatic fee deduction
Convenient charging	Charging electric vehicles, mobile phones, and laptops
Smart public transportation services	Obtain bus route information and location information
Smart Library	24/7 provision of book services and academic information resources

Table 1 shows some subsystems and their functions in smart cities. Through the location service function, users can use their own or nearby intelligent terminals to perform location queries and learn about nearby location information at any time. The video surveillance function can ensure real-time monitoring and ensure the safety of citizens' lives and property. The intelligent parking system can provide automatic vehicle recognition function, convenient parking space search function, and automatic fee deduction for car owners when parking. The convenient charging function can charge citizens' electric vehicles, mobile phones, and laptops at any time. Intelligent public transportation services can provide users with route and location information of public transportation at any time, so that users can choose their travel routes according to their needs. Bielinska-Dusza E believed that intelligent transportation, sustainable transportation, and the construction of smart cities are inseparable [17]. Finally, there is the Smart Library, which allows users to use the library services and academic information resource services provided by the Smart Library around the clock.

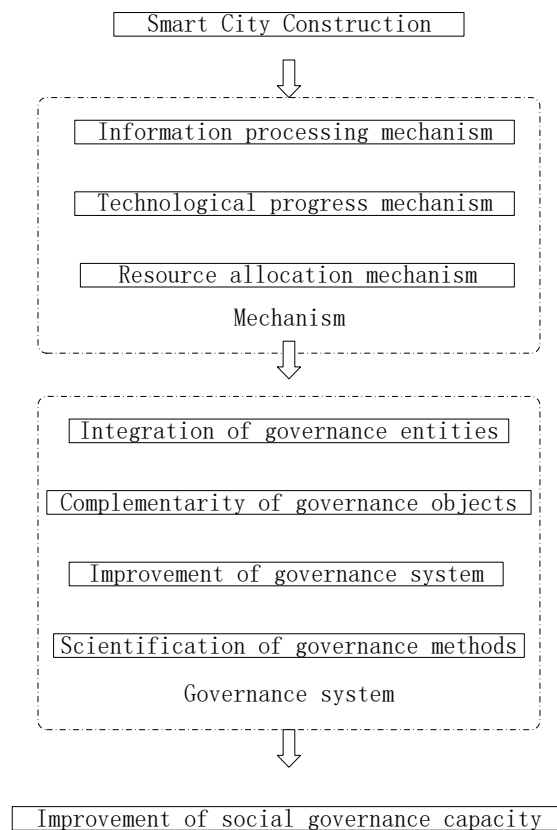


Fig. 3. Theoretical mechanism of improving social governance capacity through smart city construction

In addition to being convenient for the public, smart cities also mentioned earlier that they can assist managers in urban management, which Chu E M once agreed with. In his view, the construction of smart cities can enhance the social governance capacity of the city through information processing mechanisms, technological progress mechanisms, and resource allocation mechanisms [18].

The theoretical mechanism for enhancing social governance capacity through the construction of smart cities is shown in Figure 3. It can be seen that the mechanism of action is the information processing mechanism, technological progress mechanism, and resource allocation mechanism mentioned earlier. These mechanisms would affect governance systems such as the integration of governance subjects, the complementarity of governance objects, the improvement of governance systems, and the scientificity of governance methods. With the joint improvement of these governance systems, social governance capabilities would ultimately be improved. Aurigi A also proposed that smart cities can provide rich technologies to make urban management more flexible [19].

4 Impact of Digital Tourism on the Tourism Industry

The digital revolution of many people would cause great economic and social changes, which has been reflected in many other fields. The tourism industry studied in this paper has also become one of them. Today's digital transformation of the tourism industry is actually changing the industry boundary and production mode of the tourism industry, and would also have a profound impact on the future development model. These changes and impacts are mainly reflected in the digitization and networking of the entire tourism activity process in digital tourism. The tourism industry itself's tourism marketing, service management, ecological protection, resource research, and planning and design work can basically rely on emerging digital technologies, and the computing power of computers is far beyond human comparison. Digital tourism not only improves the efficiency of tourism management and operation work, but also provides more information for tourists. For example, Ding J studied the structural characteristics of the tourism flow network of scenic spots around Chaohu Lake [20]. A portion of the data on tourist travel would be presented.

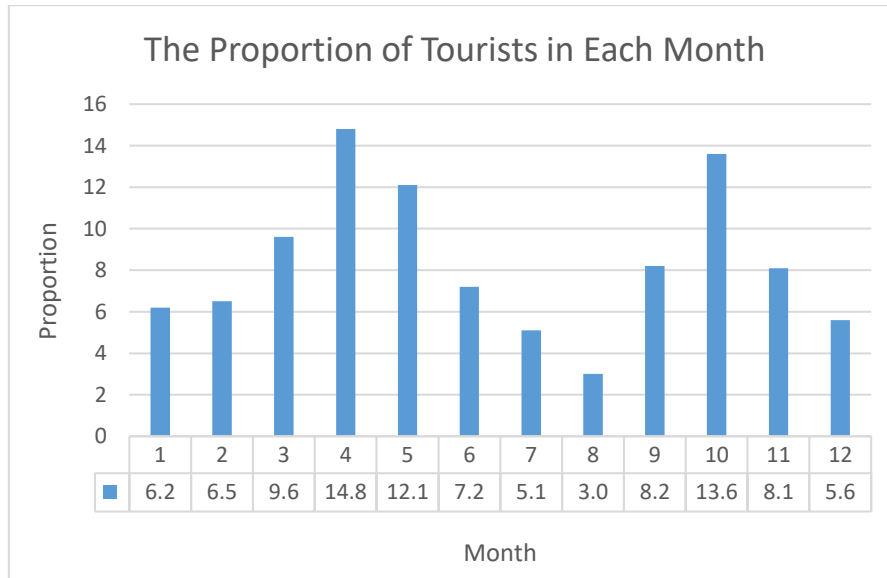


Fig. 4. The proportion of tourists to the scenic spots around Chaohu Lake in different months

The statistical results of the number of tourists to this scenic spot are shown in Figure 4. The digitization of the tourism industry can easily collect various data from a certain tourist attraction, and the number of tourists is only one of them. From this graph, it can be seen that the tourism peak is mainly concentrated in April, May, and October, with a probability of being caused by the May Day holiday and the National Day holiday.

Virtual reality technology can also play a role in digital tourism. Firstly, there are many scenic spots in the tourism industry for visitors to visit, and these ancient sites are generally fragile due to their age and require manual protection. Virtual reality technology can preserve the appearance of these ancient sites, and even repair the appearance of damaged ancient sites, allowing tourists to have a three-dimensional view of them. Virtual reality technology can also assist digital tourism in route planning, service customization, and cultural promotion for tourists. The main way is to build a virtual tourism system model, which allows tourists to choose tourism goals in person.

5 Statistics before and after Loading a 3D Virtual Reality System for a Certain Scenic Spot

In order to verify the impact of 3D virtual reality systems on the tourism industry, this article would compare the passenger flow of a tourist attraction before and after loading the 3D virtual reality system. In order to avoid the impact of the epidemic on the tourism industry, this article would select a certain scenic spot (hereinafter referred to as Z scenic spot) that was loaded with a 3D virtual reality system at the end of 2018 as

the research object, and then compare the data of the National Day holiday in 2018 and 2019.

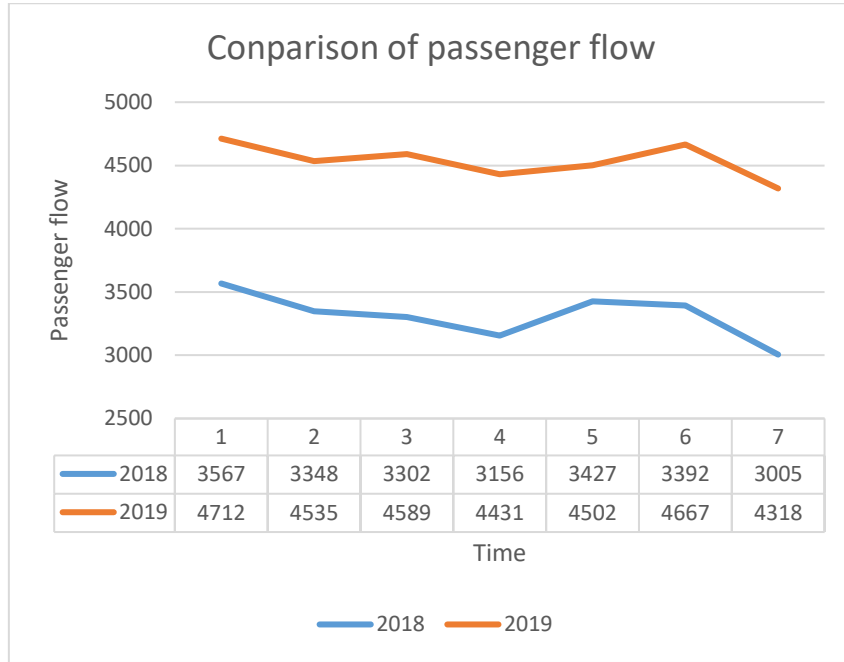


Fig. 5. Comparison of passenger flow data for z scenic spots in 2018 and 2019

From Figure 5, it can be seen that in 2019, after loading the 3D virtual reality system, the passenger flow data was significantly higher than in 2018. The average passenger flow in 2018 was about 3314 people, and the average passenger flow in 2019 was about 4536 people. This indicates that the scenic spot is indeed suitable for the support of 3D virtual reality systems, and 3D virtual reality systems can indeed bring competitiveness and attractiveness to the scenic spot, and can bring interest to tourists.

6 Conclusions

This article first demonstrates the feasibility of using 3D virtual reality systems in the fields of urban planning and coal mine visualization. Then, by explaining the role and necessity of smart cities in urban planning and management, it points out that digital tourism requires a highly digitized and intelligent smart city as the foundation. Finally, it points out that the digitalization of the tourism industry is compared to traditional tourism. Both tourists and related professionals are more popular, and a survey was designed to conclude that 3D virtual reality can indeed attract more tourists. However, the survey did not take into account other variables, such as the fact that even without

the impact of the epidemic in 2018 and 2019, there may be other multifaceted impacts that could affect the survey results.

Overall, digital tourism, supported by various emerging technologies, is bound to inject vitality into the tourism industry, especially in some relatively backward and remote areas that highly rely on tourism to drive their economy. These areas can achieve better development in the future.

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