

REVIEW ARTICLE

A review of foreign research on the application of virtual reality technology in tourism

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ABSTRACT

As an emerging technology in recent years, virtual reality technology has penetrated people's fields of material production and life. Nowadays, with the development of technology, the impact of virtual reality technology on the tourism industry is becoming more and more obvious. This paper sorts out and studies the literature of virtual reality and virtual tourism in the past 50 years, discusses the definition of virtual reality and the development of virtual reality technology, sorts out the virtual tourism literature in chronological order, and summarizes the four development stages of virtual tourism. Finally, the existing developments and shortcomings are summarized, and some suggestions for future development are proposed.

Keywords: virtual reality; virtual tourism; real tourism; tourism market

1. Introduction

Virtual reality technology, originated in the 1980s, is an emerging technology that takes computer technology as the core and combines related science and technology to generate a highly realistic virtual environment with a certain range of environments such as sight, hearing and touch^[1]. Virtual reality technology is used in many fields with the advantage of reproducing real environments, and tourism is one of them. The application of virtual reality in the tourism industry is becoming more and more extensive, and this field has attracted the attention of many scholars, led to a large number of academic researches, formed a situation of "a hundred schools of thought", and many scholars have

formed different angles and divisions of research views. These theories and studies have objectively promoted the development of the field of virtual reality and promoted the application of virtual reality technology in tourism industry. This article examines the relevant foreign literature in the past 50 years, refines relevant academic views, summarizes the development context of the virtual tourism industry and makes suggestions for its future development.

2. Definition of virtual reality

Since the introduction of virtual reality technology, people's understanding of virtual reality has gone through a stage of development from exploration to initial understanding. At first, people's un-

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derstanding of virtual reality did not rely on computer technology, believing that any virtual environment that could make people feel immersive was called virtual reality, such as theme parks, etc. Later, with the development of computer technology, virtual reality technology added more computer technology components.

In the 1980s, Lanier, founder of the American VPL company, proposed the concept of virtual reality (VR). In the 1990s, the American scholar Steuer compared various “virtual media”, from books to television to virtual reality glasses, arguing that books to television to virtual reality glasses are all different degrees of virtual reality, and defined virtual reality from the perspective of telepresence^[2]. Ryan then defined virtual reality in a narrow sense, arguing that devices that provide an “immersive” sense can be classified as a form of virtual reality^[3]. Helsel and Roth’s explanation for virtual reality is also given that “virtual reality is a specific event in a specific scene, not real”, emphasizing the “realism” in a specific scene^[4]. A common feature of these understandings of virtual reality is that they are not limited to computer technology, but any technology

that can provide a sense of immersion is called virtual reality. In the 20th century, with the development of computer technology, the definition of virtual reality added more elements of computer technology, and Williams, Bryson, and Cotton all believed that VR was a three-dimensional object that used computer technology and human-machine interface technology to create a very realistic three-dimensional scene, giving people a strong sense of presence^[5-7]. These understandings of virtual reality technology are based on computers, the development of technology is changing with each passing day, people’s understanding of virtual reality is deepening, and the understanding of virtual reality is also constantly developing and improving.

3. Development of virtual reality technology

Virtual reality technology, as a new thing that appeared only in recent years, has developed rapidly, and the research in the industry appears to be ahead of the academia^[8]. **Table 1** lists the representative research results in the development of virtual reality.

Table 1. Representative research results in the development of virtual reality

Age	Key results	Key functions
1965	Sensorama’s motorcycle emulator	The simulation is one of the earliest immersive virtual simulation systems, which can present rich 3D animations, 3D sounds effects, and simulate the tilt of the body during motorcycle driving, which is the beginning of the computer simulation system.
1968	A helmet-mounted display driven by computer graphics	This helmet-mounted display can only display 2D images, without immersion, and is an important milestone in the field of computer virtual reality.
1990	Simnet emulator	It is the first large-scale interactive simulation system successfully applied to the military, which can achieve complex team training and task retelling, which is a major advance in the history of computer simulation applications.
2003	Second life	It is an online virtual world with more than 1.3 million active users, and users can communicate with others, participate in events and trade on the platform.
2013	Virtual reality glasses	Developed by Oculus Rift, it is an augmented reality wearable device that can present computer images in a three-dimensional way, giving the person an immersive feeling.

4. Application of virtual reality technology in tourism

In the industry, virtual tourism refers to the use of computer technology to make a

three-dimensional real-life display of the real tourism scene, so that tourists can visit the virtual scene through the Internet and other media and obtain an immersive experience. In academia, virtual tourism, as a new thing, is still in the exploratory stage, and there is currently no unified concept. Initially, when

virtual tourism was proposed, Marshall pointed out that the virtual world is a completely new form, and no one can really understand it^[9]. Subsequently, Kim and Barwise argue that virtual tours are linear, text-based, and are primarily the whole process of providing web information for browsing and suggesting itineraries^[10]. At the same time, Frew also pointed out that virtual tourism can provide web information browsing and information retrieval functions^[11]. As virtual tourism expands into more aspects of tourism, the concept of virtual tourism deepens, with Senecal and Nantal stating that virtual tourism should integrate images and visual designs to provide a complete visitor experience^[12]. Virtual tourism is still in the development stage, and it is somewhat insufficient at both the technical level and the ideological level. However, in the industrial world, virtual reality with the rapid development of technology and the increasing application of tourism, we cannot deny the significance of virtual reality technology for tourism, and we cannot deny the value of its research. Nowadays, many scholars have entered this field of research, and researchers' studies on virtual tourism can be roughly divided into four stages according to the time range: The embryonic stage of 1960–1980, the preliminary exploration stage of 1980–1990, the initial development stage of 1990–2000, and the stage of wide application from 2,000 to the present. The author will discuss virtual tourism from these four parts as following.

4.1. Embryonic stage from 1960 to 1980

Before the 1980s, virtual reality technology was initially developed, and the development of this period was mainly concentrated in industry. In 1965, Sutherland envisioned a display technology that would allow people to immerse themselves directly in the virtual world, as in real life, and to interact with objects in the virtual world^[13]. In 1975, Boorstin argued that the early authentic tourism experience had been exhausted in mass society, and that people were more willing to pursue a travel experience that could be obtained anytime, anywhere, which showed that virtual tourism had

long been part of the tourism behavior at this time^[14]. This stage is the embryonic stage of virtual tourism, computer simulation has been proposed, people continue to explore this field, and constantly try to apply it to life, and it has also become the embryonic period of virtual tourism development in the future.

4.2. Preliminary exploration period from 1981 to 1990

After the 1980s, after a period of development, virtual reality technology has had a preliminary application in the industry and has also attracted the attention of some scholars. It was during this period that Lanier, founder of the American VPL Company, officially proposed the concept of “virtual reality”, and scholars also paid attention to the application of virtual reality technology in tourism. In 1981, the scholar Papon pointed out that before the emergence of theme parks, there had been virtual tourism based on destinations, such as the construction of a virtual tour based on a historical and cultural city, so that virtual tourism can meet the tourism needs of tourists^[14]. Then, in 1989, with the advent of e-commerce, scholars Palmer and Patrick discussed the impact of e-commerce on virtual tourism and the role of e-commerce companies in creating tourist destinations^[15]. During this period, there is rare academic research on virtual tourism, and the research on virtual tourism was still in the preliminary stage of exploration.

4.3. Initial stage of development from 1991 to 2000

In the 1990s, with the maturity of technology, virtual reality technology has been initially developed, and virtual reality technology has gradually been applied to the tourism industry. In this initial stage of development, virtual reality technology is used in many aspects of tourism, and many scholars have joined in the research of this field. In 1995, scholars Cheong and Sussmann mentioned the role of virtual reality technology in planning, pointing out that “a VR model can allow decision

makers of scenic spots to view the scenic spots from multiple angles, rather than the previous simple 2D aspects of information, so that they can make better decisions”^[16]. Subsequently, in 1999, German scholars Lutz and Weintke conducted some researches on the Dunhuang Grottoes, and VR tourism can also meet the needs of tourists without visiting the grottoes^[17]. In addition to the application of scenic spots, virtual reality technology can also bring convenience to tourists and scenic spots from the perspective of information provision. Scholars Williams and Hobson point out that many travel products are confidence goods, and tourists do not have the means to do a certain test before purchasing, but only according to the simple descriptive information provided in the market^[18]. Based on this, in 1994, scholars Musil and Pigel also asked the same question, arguing that “Virtual tours” can reduce tourists’ vigilance about scenic spots and make tourists feel more relaxed^[19]. The application of virtual reality technology in the tourism industry has gradually become more extensive, which has triggered academic discussions on whether virtual reality technology will replace traditional tourism products. In 1995, scholar Cheong dismissed this view, arguing that “how can virtual reality technology accurately simulate the taste of seawater and the feeling of seawater hitting the face when surfing?” and denying of the substitution of virtual reality technology for traditional tourism. At the same time, he also discussed that virtual reality technology, as a marketing tool to enhance the image of destinations, may pose a threat to real travel companies.

4.4. Stage of widespread application from 2000 to the present

In the 21st century, virtual reality technology has developed rapidly, and its application in tourism has become very extensive. During this period, there have been many academic studies in academia, this field has become very active at this stage, and many scholars have formed different views. In view of the extensiveness of research in this industry,

according to the research status of researchers in this field, the author will make the following review from four aspects: tourists, tourism enterprises, tourism scenic spots and the entire tourism market:

Research on tourists

The application of virtual reality technology in the tourism industry has brought many conveniences to tourists^[20]. Many scholars have also done a lot of research on tourists. For example, in 2004, scholars Goodall and Pottinger argued that virtual tourism can help people with disabilities overcome transportation difficulties, psychological stress, and negative emotions, and can help them see the “outside” world^[21]. Virtual reality technology can present a realistic three-dimensional scene for tourists, so that tourists can experience a perfect scenic spot without leaving home^[22]. Scholars Huh and Singh point out that VR technology can benefit everyone, especially people with disabilities, who can visit an attraction and a shopping mall through virtual reality technology. The convenience of virtual tourism is fully reflected in Shakespeare’s house, where a virtual tour of the second floor is installed on the first floor, which brings convenience to people with disabilities. Scholars Law and Bai explored the customer’s virtual travel experience from the perspective of obtaining tourism information, and believed that the content of the scenic spots provided by the virtual tourism websites to tourists could facilitate tourists to visit the scenic spots^[21].

Research on tourism enterprises

The application of virtual reality technology in the tourism industry has made many tourism enterprises keep up with the pace of the times, introducing virtual reality technology, and scholars have also studied many tourism enterprises. In 2000, scholar Hamideh argued that the online tourism was a trend and that travel companies should remain competitive and introduce virtual elements into their enterprises^[23]. Scholars Pettia and Valentina explain the necessity of today’s virtual travel companies to take full advantage of information technology^[24]. With the development of virtual reality

technology, enterprises are also constantly absorbing elements of virtual reality, such as virtual tour guide services of some tourism companies, to bring convenience to tourists. It can be seen that with the development of technology, tourism enterprises should also continue to absorb new elements and apply virtual reality technology to enterprises, so that enterprises can keep up with the pace of the times and win in the fierce competition.

Research on tourist attractions

The application of virtual reality technology in scenic spots is also very extensive, and the research on virtual tourism in the academic community is mainly focused on the study of scenic spots, including the protection of heritage, the planning of scenic spots, and the destination marketing of scenic spots.

In terms of the protection of scenic spots by virtual reality technology, many scholars have done research, such as scholars Paquet and Viktor, who have proposed that virtual reality technology can not only provide a good alternative for tourists, but also allow tourists to contact brittle tourist attractions that are usually not accessible^[25]. American scholar Arnold, also proposed that virtual tourists can also protect cultural heritage, rather than paying hard work and sweat to visit real scenic spots, causing some harm to scenic spots^[26]. For example, the Dunhuang Grottoes are the most extant Buddhist mural shrine, and the visit of a large number of tourists will have a corrosive impact on the murals. The construction of the virtual Dunhuang allows tourists to enjoy the scenery of the scenic spot without reaching the scenic spot, so it is also a kind of protection for cultural heritage.

In addition to the applications mentioned above, virtual tourism can also achieve the purpose of protecting cultural heritage by recording the accurate original information of cultural relics models^[27]. For example, the Bamiyan Buddha in Afghanistan was once destroyed in war, and the German scholar Toubekis made a certain degree of virtual restoration of the scenic spot to protect the

precious heritage^[28]. Another example is the virtual reconstruction of the statues of David and The Virgins by Marco and Bernardini et al. respectively^[29]. In addition to the above, there are many examples of the recording and preservation of fragile cultural heritage, such as the more than 150 sculptures of the Parthenon in Egypt^[30] the simple and varied temples in Cambodia^[31], the Byzantine cellars in Italy^[32], the 19th-century address of a Canadian indigenous chief and a small auditorium in Ottawa^[33]. These small and fragile cultural heritages may be damaged due to the lack of policy protection, so virtual reality technology can preserve this cultural heritage through modeling to achieve the purpose of heritage protection.

The benefits of virtual reality technology brought for scenic spots are also the focus of scholars' attention in terms of scenic planning. Scholars Sussmann and Vanhegan proposed in 2000 that the help of virtual reality technology in scenic spot planning is also reflected in the measurement of scenic bearing capacity^[34]. Virtual modeling technology can intuitively provide a complete scenic model for scenic planners, rather than the previous text or simple 2D pictures, which can better serve the planning of scenic spots.

In terms of destination marketing of scenic spots, Belgian scholars investigated the perception of virtual scenic spots, and through analysis, the genus of virtual scenic spots will affect the attitude of virtual tourists to scenic spots and affect tourists' visits to real scenic spots^[35]. Virtual tourism can provide users with complete and intuitive scenic spot information, thereby enhancing the image of the destination and increasing the interest of tourists in visiting scenic spots.

Research on the entire tourism market

After virtual reality technology is widely applied to the tourism field, the study of the travel market is also the focus of researchers. Australian scholar Erik champion conducted two case studies of virtual Mexico and virtual Tower of Babel, and gave his advice through the conclusion. In 2011,

Taiwanese scholars analyzed the behavior orientation of users in the virtual market and proposed a conceptual research framework for the impact of virtual reality in the tourism market.

With the development of virtual tourism, many scholars have also paid attention to the question of whether virtual tourism will replace original tourism. Scholars Sussman and Vanhegan surveyed and studied 50 visitors to the UK, who agreed that virtual tourism was no substitute for traditional tourism, but can be a complement to the original tour. Although virtual reality technology is constantly evolving, the former also has concerns about whether virtual tourism will replace original tourism, but with the deepening of research, scholars seem to have a common conclusion that virtual tourism cannot completely replace real tourism.

5. Conclusions

In summary, since the rise of virtual reality technology in the 1950s, it has had a lot of impact on the tourism industry and attracted the attention of many scholars. Numerous academic views have been formed, and these views collide with each other and make a great contribution to the development of virtual tourism. However, since the introduction of virtual tourism, the rapid development of technology, people's understanding of virtual tourism has been deepening, and the acceptance of virtual tourism has been continuously improved, some of which have lagged behind, and many studies may have different results today. Technological developments are changing rapidly, and in the travel industry, we would like to see more updated research on the application of virtual reality-based technologies in tourism. With the advent of high-end devices such as Google Glass, and caused a sensation in virtual reality, research based on equipment and content-based research will keep pace with the times. With the update of technology, enrichment of content, virtual tourism will also become more perfect in the aspects of content and technology

Conflict of interest

The authors declare no conflict of interest.

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