Exploring the significance of augmented reality technology to the experience of museum visitors: A cluster analysis

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Abstract

This study aimed to analyze the existing literature from 2015 to 2023 on museum tourism, augmented reality (AR) technology, and virtual reality (VR) technology applications. It also examined the current state of museum tourism, the use of AR technology in museums, and the impact of AR technology application on tourists' experiences. To accomplish this, the Web of Science search system was utilized to search for and analyze domestic literature and research related to museum tourism experience and VR technology. The results found that the application of AR technology in museums can provide a more immersive experience, allowing visitors to gain a deeper understanding of the exhibition's contents. AR technology can create realistic scenes, allowing the audience to feel as if they are actually present. Moreover, AR technology can provide more interaction for the audience.

Keyword

augmented reality， virtual reality， museum tourism

Introduction

At the same time, augmented reality technology can provide more interaction. As a new type of immersive experience, VR is also widely used in the museum field. The museum are an important place to protect and inherit the cultural heritage of mankind. How to use virtual reality technology to provide more immersive travel experience for tourists has become a hot topic and important topic of current research. This study takes tourism experience as the research object, aiming to explore the impact of AR technology application in museums on college students' tourism experience.

Overview of the literature quantity.

The research on museum tourism experience abroad mainly focuses on the past 20 years. Influenced by virtual reality, augmented reality and other technologies, museum tourism experience has become a hot topic in the tourism academic circle. For understanding the present situation and progress of domestic tourism experience research as a whole, the author made a statistical study of foreign tourism experience research literature in recent five years.

Overview of Literature quantity

In order to grasp the key words of "research on museum tourism experience", "AR technology in museum"

and “virtual reality in museum” as a whole, the core journals at home and abroad were accurately searched. After preliminary ranking, the search results expressed by the number of documents are obtained, as shown in Figure 1.

Figure 1: Distribution of foreign literature retrieval results in different years.

According to the above preliminary results, from the literature point of view, after 2017, the research on museum tourism experience in domestic and foreign academic circles showed a sustained, rapid and relatively stable trend. Especially in 2023, there was a certain breakthrough in the number of relevant research results. Therefore, the application of AR and VR technology in museums is an academic hotspot in the field of tourism at present, and it is on the rise year by year.

Overview of Literature research content

Museum tourism

Maria Eugenia Andreyes Garcia, etc. pointed out that museum tourism refers to the activity of visiting and exploring museums and exhibition centers. It provides an opportunity to understand and appreciate human cultural heritage, and promotes education, cultural exchange and social integration.1. José Magano and others pointed out that museum tourism refers to the tourist activities of visiting museums or related cultural sites. This form of tourism aims to convey knowledge and educational information to visitors through exhibits on history, culture and art2.Philip Fei fan Xie believes that museum tourism refers to the use of museums as tourist attractions to display and inherit cultural heritage, attract tourists to visit and learn, and thus promote the development of tourism3.JunShao et al. believe that museum tourism are an important way to showcase a city’s unique culture and history 4.Duda-Seifert and Katarzyna Kajdanek think museum tourism refers to tourists visiting a museum and experience of cultural and heritage5.Jinwei Wang et al. believe that museum tourism refers to a kind of tourism in which tourists learn about cultural heritage, artworks and historical exhibitions by visiting museums, so as to enhance knowledge, experience and enjoyment6.

Sabine Khalilet al. believe that museum tourism refers to a way to enhance the museum experience by adopting augmented reality (AR) technology7.Mariapina Trunfio and Salvatore Campanapoints out that the museum tourism is refers to the tourists to visit the museum and through various technical means such as virtual reality, augmented reality and mix it) to enhance their experience and participation8.These technologies can provide personalized information, interactivity, entertainment, education and sociability, thereby enabling visitors to better understand and appreciate museum exhibits and cultural heritage.Xinran Yang and Liaoniao Zhangthink museum tourism refers to the digital technology into the cultural heritage exhibition, Tours, online storage, display or transmission, etc., in the form of digital, interactive and can be Shared to provide services, in order to promote further research of intelligent museum9.Yongcai Huet al. believe that museum tourism refers to the use of three-dimensional virtual simulation technology to enhance the audience’s experience in museums10. Through virtual reality technology, people can interact and communicate with real objects in a virtual environment, and get vivid visual, auditory and tactile feelings, thus generating immersive feelings and experiences.

To sum up, museum Tourism can help visitors understand and appreciate different cultural heritages, increase understanding and appreciation of historical events and works of art, and also provide entertainment and leisure experiences for visitors to enjoy a good time. With the increase of virtual reality technology, museums can provide interesting interactive experiences, and bring profound understanding and unforgettable travel experiences to tourists. Through the virtual reality system, visitors can naturally interact with the virtual environment through displays and motion sensors, overcome the limitations of time and space, and provide innovative tactile and emotional experiences. Applying virtual reality technology in museum tourism can not only enrich the style of tourism products, but also allow tourists to participate more deeply and improve the quality of tourism experience.So, it is very important to study the relationship between museum tourism and virtual reality technology for optimizing visitors' experience and promoting museum management.

(1)Concept of AR/VR technology

Tang Huaming pointed out that VR technology is defined as virtual reality technology, which is a late-model of computer science and technology11.Virtual reality technology generates a dynamic three-dimensional virtual space through electronic computer simulation, allowing users to perceive this virtual environment through visual, auditory, tactile and other sensory organs, and can interact with the computer in real time. Users have an immersive feeling in the virtual reality environment and can communicate and interact in real time. Chang Pan mentioned interactive three-dimensional dynamic landscape rendering technology for creating and experiencing 12 virtual worlds using computer simulation principle12.Yu Yao（2019）said that the definition of VR technology is virtual reality technology, which is a computer technology in a real virtual environment that combines vision, hearing and touch 13.Making three-dimensional models of simulated objects to obtain good visual effects, or making physical contact with the human body through physical devices such as handles, or making auditory impact through headphones.

Crofton, E. C. and others point out that Augmented Reality (AR) is the illusion that virtual objects and real objects coexist in the same space, and the information generated by computer coincides with the real world seen by human beings14.Jackey J.K. Chai et al pointed out that Augmented Reality (AR) technology embeds additional information or virtual objects in real scenes15.The user's understanding of the real world is improved by adding digital elements. Katrin E. Schein and Philipp A. Rauschnabel point out that the AR (augmented reality) is an innovative media format, the virtual information truly integrated into the user's field of vision16.A few companies hope to improve work efficiency by presenting virtual information related to work to users. Julie Carmignani and others (2011)thinks that augmented reality (AR) refers to directly or indirectly viewing the environment by adding virtually generated information to the real-time physical environment.17.Kaushik Parida etc. (2021) pointed out that augmented reality is a technology to extend and enhance user 'visual perception by superimposing virtual objects and information in the real environment 18. Augmented reality has increased interaction with virtual objects, enabling users to better identify and operate virtual objects. Iis P. Tussyadiah pointed out that in the tourism field, augmented reality is used to help tourists acquire and process information about surrounding scenic spots, strengthen their perception and cognitive process, and assisting in decision-making19. Augmented reality applications can also provide additional information superposition in indoor travel experiences through touch screen displays, smart phones and wearable devices, such as museums, art galleries and indoor theme parks.

Generally speaking, the difference between augmented reality (AR) and virtual reality (VR) is that AR adds virtual information to the real world, while VR completely immerses users in a virtual environment, with the aim of enhancing but not completely replacing the real environment. Generally speaking, Augmented Reality (AR) technology and Virtual Reality (VR) technology are different in their realization methods and purposes. AR technology provides users with a perceptual experience of mixed reality by superimposing virtual data on the real world. On the contrary, VR technology is to create an all-round virtual world in which users can immerse themselves from vision to hearing and even touch. AR technology is dedicated to enriching and expanding the real-world scene, rather than completely replacing it. The integration of this technology not only preserves the tactile and emotional connection of the real world, but also endows virtual information with unlimited possibilities, opening up new interactive modes and application scenarios. 7In this process, the boundary of user 'perception is widened, and the boundary between reality and virtuality is gradually blurred, presenting a brand-new dimension of experience. There are some research gaps in foreign countries about augmented reality technology and augmented reality technology. Foreign research on this technology is much earlier than domestic research, and the research scope is more extensive. At present, the domestic research mainly focuses on the application of augmented reality technology in the library field. The introduction of this technology not only changed the traditional way of book retrieval, but also increased the richness of interactive experience. As a temple of knowledge, the library is gradually transforming into a smart space integrating information acquisition, learning exchange and cultural experience through the integration of augmented reality technology. The integration of this cutting-edge technology provides readers with a more intuitive and vivid learning environment, and also brings the possibility of innovation for the service model of the library. Secondly, the application degree of self-developed programs in China is not high, and the cost is high in the early stage of application development, but the application degree in practice is not high. Therefore, China has a long way to go for the development of AR and VR technology.

(2) AR technology application status in museums

According to the above, the author finds that VR technology is devoted to creating a virtual three-dimensional world, while AR technology is devoted to the combination of virtual elements and real elements, which is beyond reality. The purpose of this study is to optimize the interactive experience of visitors when they visit museums, and then to deeply explore the practice and effect of augmented reality technology in cultural relics display.

Ana Martí-Testón et al. (2021) mentioned in their study that the British Museum was one of the first to apply virtual reality technology to educational projects by recreating a virtual scene using 3D-scanned Bronze Age artifacts. Then the Tate Modern in London used virtual reality to showcase Modigliani's studio23.The research of Bekele and others' research(2018) shows that the application of AR in museums mainly focuses on exhibition enhancement and reconstruction21. Exhibition enhancement refers to enhancing the visitor experience in a museum by overlaying virtual elements, such as descriptions, guided maps, or virtual characters, on the real world of the user's current vision.Hammady Ramy et al. (2020) found that AR technology is applied to museums with the main purpose of providing more attractive and interactive visiting experience22.According to Ioannis Paliokas' research in 2020, modern museums are creating a new experience dimension of interaction between visitors and exhibitions through augmented reality technology in mobile

devices23.Qianling Jiang et al. (2022) showed that AR (augmented reality) can provide tourists with rich interactive experience, in addition, AR can be used as a guide tool to provide tourists with guide and interpretation services, and help them better understand the exhibits and exhibition content24.Chong Wang and Ye Zhu revealed in their exploration in 2022 that in the field of museums, integrating virtual information with real scenes with augmented reality technology can greatly enhance the exhibition level and effectively respond to the audience's desire for fresh experience in the digital age25.Chen CA and Lai HI（2021）found that through augmented reality technology, museums can improve visitors' learning motivation and increase learning effect26.Augmented reality can superimpose digital information on the real environment, allowing visitors to experience the display content and historical trajectory more deeply. Many museums have already begun to adopt augmented reality to enhance the visitor experience, such as in exhibitions in Dublin, Deoksu Palace in South Korea and Manchester Art Gallery.Wu, Chih-Hung et al. (2023) showed that after AR technology was applied to museums, users' willingness to visit museums increased, and they believed that AR technology could provide more attractive, authentic and immersive experience and increase knowledge learning and teaching27.Carmen Bachiller et al. (2023) showed that AR technology can provide a novel and authentic learning experience that increases visitor engagement and satisfaction28. Especially for young tourists, AR technology is more attractive. Nechita Florin and Rezeanu Catalina-Ionela（2019）study found that AR technology has been applied in the museum's permanent exhibition, in order to enhance the experience of tourists and attract a younger audience29. AR technology can improve the communication between museums and young audiences by increasing interactivity and enriching content. Cheng, Anping etc. (2023) pointed out thaAR technology provides detailed information about museum exhibits, including historical facts, scientific principles and interesting stories related to the exhibits.30. Farzan Baradaran Rahimi et al. (2018) pointed out that in museums, AR technology can be used to overlay information and virtual objects in real environment to provide rich exposure experience.31.Wangming Hu and others (2023) discovered that AR technology was applied to digital museums, and the virtual reality environment 32, which realized real-time interaction and entertainment by using multimedia and 3D modeling, combined the exhibits of the virtual museum with real environment, and display them by intelligent devices. Khan Mudassar Ali et al. (2019) refer to the M5SAR system in their study, which is a mobile five-sense augmented reality system for museums33.The system enables an augmented reality experience of five human senses through a combination of a mobile phone app and a portable device. The goal of the system is to provide a more immersive visiting experience, enriching the user's sensory experience. Volkan, G**ö**nc and others(2023) pointed out that the most common application of augmented reality technology in museums is to add explanations to exhibits and exhibitions34. Augmented reality adds another dimension to the display by making object or scene lifelike. For example, the French National Museum of Natural History uses AR technology to allow visitors to see digital animals that are extinct in the real world.

To sum up, the research of scholars can be summarized as follows:

AR application based on sensory stimulation: In museums, AR can integrate cultural connotations and exhibits into the user's vision by displaying clear statements, attractive animations and visualized 3D models in the real environment, so as to meet more information cognitive needs. For example, AR can completely restore damaged artifacts, showing their original freshness and vividness. AR can also enhance the user's sensory stimulation through interactive graphics and other ways to stimulate their curiosity and attention.

AR application based on tour: AR can combine the user's behavior pattern, design the tour function, and guide the user to visit the museum. For example, AR guides can provide personalized exhibition recommendations and route planning according to user 'location and interests, so as to help users better understand the exhibition content.

Interactive AR application provides new forms of museum education, such as interactive explanation and excellent games. On the basis of physical immersion, it realizes deeper psychological immersion and shows deeper humanistic connotation. For example, AR can increase user interaction and engagement by designing cards in museums that allow users to view 3D artifacts and listen to audio commentary.

Considering the above factors comprehensively, the application of AR in museums provides visitors with a more convenient, immersive and interesting experience. It can enhance the audience's understanding and participation in the exhibition by providing exhibit information, immersive virtual experiences, gamification design and additional exhibit information.

The impact of AR tour guide application in museum on tourism experience

Chih-Hung Wu et al. 's findings suggest that the quality of inspiration and perception after the application of AR in museums is critical to improving people's attitudes toward museum visits. The study suggests that AR developers should focus on practical and hedonic benefits to motivate users to visit museums27.Francesca emphasized that the use of AR technology in museums can release information between internal and external stakeholders and increase the participation and interest in museum experience.35.Ioannis Paliokas and others pointed out that AR technology can provide personalized and visual learning experiences, and museum visitors can learn and adjust their learning speed according to their own learning rhythm and needs. Visitors of all ages, cultures and knowledge backgrounds can freely choose the navigation route according to their own needs, and focus on the details that are most interested in the goods23.The research of Jung Timothy Hyungsoo and others shows that the use of AR technology in cultural heritage tourism can provide richer, more meaningful and better tourism experience39.AR technology can be used for digital restoration of cultural heritage, reproduction of historical events and prevention of degradation of cultural heritage sites. Many cultural heritage organizations in the world have developed and implemented mobile AR APP applications such as Dezhu Palace in Korea, Gyeongbokgung Palace, Ampost Museum in Ireland, LOVR Museum in France and British Museum in Britain. Xinlu Wen etc. found that the application of AR technology in cultural heritage tourism can influence the support behavior of tourists by providing AR experience value components such as visual attraction, entertainment, enjoyment and escape. In addition, content quality, personalized service and system quality also have influence on tourists' satisfaction and recommendation intention. These findings have important guiding significance for developing and improving the application of mobile AR heritage to improve the participation and satisfaction of tourists36. When studying underwater cultural heritage, Fabio Bruno and others pointed out that AR technology can provide virtual guides for divers, providing them with specific information about cultural relics, biological and geological features. Divers can know their geographical position in underwater relics and explore according to the planned route set by the Guide to Underwater Museums37. The application of AR technology can

make those who are not skilled or can't dive appreciate the original appearance and beauty of underwater cultural heritage, so AR technology has educational value in museums and can provide additional information about historical, biological and archaeological background. Caroline Scarles and others found that AR technology can strengthen the connection between tourists and artworks, so that tourists can have a deeper understanding and appreciation of artworks38. By providing multimedia content, AR technology enables tourists to trigger additional information such as photos, videos, audio and text through functions such as image recognition. This personalized experience enables visitors to explore the museum according to their own interests and rhythms, and enhances their interaction and participation with the artworks. Research by Timothy Jung (2019) shows that Augmented Reality (AR) has advantages in creating fascinating cultural heritage experiences and can create personalized experiences. The application of AR applications in cultural heritage tourism can provide historical and geological information related to the destination and enhance visitors' understanding of the destination39. Volkan Genc（2023）research shows that augmented reality (AR) technology plays an important role in the museum experience and can provide visitors with a unique experience. AR technology stimulates tourists' different senses, and factors such as visual attraction, entertainment, enjoyment and escape have a positive impact on the tourist experience34. Dag Kazim research shows that tourists can increase their satisfaction with museums by actively using AR technology. Technologies such as AR and virtual reality can make important contributions in the fields of accommodation, marketing, planning, management, entertainment, museums, catering, transportation, sustainable development, barrier-free environment and education, etc40.Jung, Timothy Hyungsoo and others found that AR technology can bring more fun, interaction and participation to the tourism experience, and increase tourists' interest in scenic spots or museums and their willingness to come back. At the same time, AR technology can also provide more economic value to attractions or museums, attracting more visitors and increasing revenue39. Chia-Yen found that through AR technology, visitors can interact with the exhibits, view virtual displays, and gain more information and knowledge. AR technology can also provide personalized tour services, and provide customized tour content and recommendations according to tourists' interests and needs41. Hatala M and Wakkary R pointed out that the application of AR technology in museums can provide a richer and more personalized travel experience. By using AR glasses or other AR devices, visitors can interact with the exhibits and get more information and story background42. AR technology can also enhance the immersion of the exhibition through audio and visual effects, so that visitors can be more involved and participate. In addition, AR technology can also provide personalized tours guides and recommendations according to tourists' interests and preferences, so that visitors can better explore and discover the collections of museums. Cristina Fenu and Fabio Pittarello studied the positive impact of AR technology on tourism experience. By combining AR technology with narrative, providing visitors with a more interactive and attractive experience43. AR applications can enrich visitors' sensory and emotional participation, exchange information by using vision and sound, and enjoy the museum. AR technology can also change the physical layout of a museum and provide a more coherent visiting experience. Generally speaking, AR technology brings a more attractive and emotional experience to the travel experience. Susan A. Yoon SusanA Yoon etc. found that AR technology can provide digital enhancement experiences in museums and other tourist places. Through the AR application, visitors can see virtual objects and interact with them in the real environment. This digital enhancement can increase visitor engagement and interest, providing more information and ways to interact. AR technology can also provide guided tour functions to help visitors better understand the exhibits and places. Therefore, AR technology can enhance the travel experience and enable tourists to enjoy and participate in tourism activities 44.

Research shows that AR tour guides plays an important role in travel experience. Through the application of augmented reality technology, AR tour guides can improve tourist 'satisfaction, increase their knowledge and understanding of tourist destinations and meet their individual needs. But there are still some problems in the current research, such as the technical maturity and user experience of AR tour guides. Therefore, future research should further explore the technical improvement of AR tour guides and the expansion of application scenarios to improve the quality of tourist experience and satisfaction.

To sum up, the existing literature research shows that AR tour guides have potential in tourism experience and have a positive effect on improving tourists' understanding and experience of destinations. However, the current research on the impact of AR tour guides on college students' travel experience is relatively limited, and more in-depth discussions are needed. In addition, further consideration should be given to the design and development of AR guide and the extensive use of AR technology in museums and tourism. Through these studies, we can provide additional practical and theoretical support for improving college students' tourism experience.

Recitation

The influence of museum AR tour guides on college students' travel experience has been widely studied, and researchers have explored it through different angles and methods. At present, the research mainly focuses on the following areas.

Application of virtual reality technology

Based on this research, using virtual reality in museums can make students experience more immersive experiences and better understand the exhibition contents. According to this research, using virtual reality in museums can make students experience more immersive experiences and better understand the exhibition contents. Virtual reality technology can create realistic scenes, so that the audience has a sense of immersion. At the same time, virtual reality technology can provide more interactivity, for example, interacting with exhibits through gesture recognition and head tracking technology.

Application of AR technology

It is found that the application of augmented reality technology in museums can provide richer information and interactive experiences. Students can get detailed information about the exhibits through the AR guide system, and they can interact with the exhibits through AR technology, such as touching the exhibits, rotating the exhibits, etc. The study also found that compared with the traditional guides, the guides using AR technology can provide a more interesting and attractive experience, and increase the interest and participation of college students in museum exhibitions.

Research on user experience

Some studies focus on the acceptance and satisfaction with AR guide systems among college students. Through questionnaire survey and on-the-spot observation, the researchers found that college students generally think that the AR tour guide system can provide a more convenient and interesting visit experience and improve their understanding and interest in museum exhibitions. In addition, there are some researches on the interface design and user interaction design of the AR tour guide system, so as to improve user experience.

In summary, through the summary and analysis of the existing studies, it can be concluded that the application of AR tour guide technology in museums can effectively improve the travel experience of college students. Future research can further explore the design and application of the AR tour guide system, and can also further understand the acceptance and satisfaction of college students with AR tour guide system.

Conclusion

To sum up, in the process of literature review, the author summarizes and comments on three aspects: research quantity, research methods and research content, and put forward prospects of related issues.

In terms of the number of studies, since the proposition of museum tourism experience was included in the field of tourism in 2002, the number of relevant literature has shown an increasing trend year by year, and in 2017, there was a quantum leap. However, compared with other branches of tourism research, it is still a research field that few people care about. In the era of experience economy, it will be a trend to study tourism experience.

In terms of research methods, the research methods of domestic tourism experience are mainly descriptive, and the methods of mathematical statistics, empirical analysis, model construction and case study have increased to a certain extent, but they still account for a small part. These research methods are the trend in future research.

In terms of research content, it is found that the application of virtual reality technology in museums can provide a more immersive experience, and let visitors have a deeper understanding of the exhibition. Virtual reality technology can create realistic scenes, so that the audience has an immersive feeling. At the same time, virtual reality technology can provide more interactivity, for example, interacting with exhibits through gesture recognition and head tracking technology. Some studies focus on the acceptance and satisfaction with AR tour guide systems among college students. Through questionnaire survey and on-the-spot observation, the researchers found that college students generally think that the AR tour guide system can provide a more convenient and interesting visit experience and enhance their understanding and interest in museum exhibitions. In addition, there are some researches on the interface design and user interaction design of the AR tour guide system, so as to improve user experience.

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