



Research on Spatial Vitality Design of Yingze Park in Taiyuan City Based on Augmented Reality Technology

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Abstract. Urban parks are an entertainment mecca for people's daily communication, and an important part of modern cities, which are important for civic life and urban development. Taking Yingze Park in Taiyuan City as an example, this study analyzes the pedestrian flow of the park by using the Baidu map heat map, and proposes a targeted design strategy for the vitality of the park space from the perspective of augmented reality technology from the design principles of ecology, culture, and friendliness. In order to increase the frequency of use of park space by the public.

Keywords: Augmented reality technology; Yingze Park; urban park; spatial vitality; smart city

1 Introduction

With the acceleration of digital technology and urbanization, urban parks can not only improve the ecology, but also play a role in activating the vitality of urban space and spreading local culture. As the "green lung" of Taiyuan city center, Yingze Park carries the city's deep emotional and cultural memory, but at the same time, it also faces problems such as insufficient spatial vitality and single display culture.

Based on this, this study aims to analyze the population density of the park based on the data provided by Baidu Heat Map, and put forward specific design principles by using augmented reality technology to improve the vitality of the unpopular space of the park, enhance the frequency of public use of the park, and provide a new practice model for the improvement of the spatial vitality of Yingze Park, in order to provide a useful reference for the renewal of similar urban parks.

2 Research Status and Theoretical Overview

2.1 Research Status

In recent years, the research literature and theories on the application of augmented reality technology in environmental space have become relatively mature. Figure 1

compares the number of international and domestic augmented reality technology published in various fields in the past 10 years, and the results show that the international has been growing significantly from 2015 to 2024, while the domestic peak reached in 2018, and then slowly declined, but increased again in 2024, which also shows the importance of augmented reality technology for real life. It is believed that its application in urban parks can further enhance the humanistic care and sustainable spatial vitality of parks.

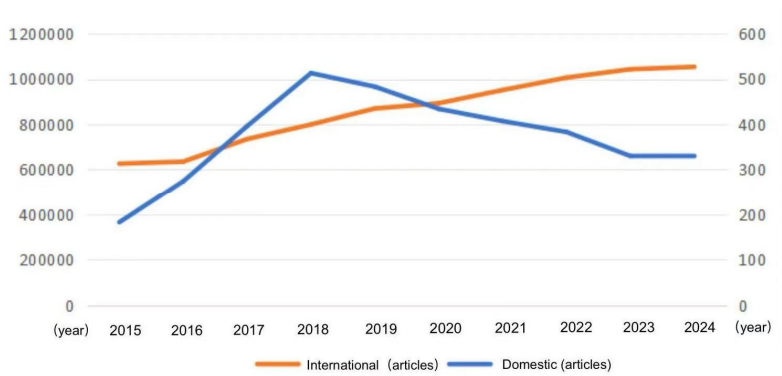


Fig. 1. AR technology in the subject at home and abroad in the last 10 years the number of publications (Image source: EI; CNKI)

Based on the existing literature, comparing the differences between domestic and foreign research perspectives, it is concluded that foreign research is more diversified and innovative, integrating various disciplines such as sociology or psychology to explore the relationship between behavior and spatial vitality. However, domestic research focuses more on the solution of local practical problems, focusing on local cultural inheritance and sustainable development. On the whole, most of the research is still designed from a single perspective, and the spatial vitality of urban parks has not yet formed a unified and systematic theory, especially the application of emerging technologies, which should be deeply discussed.

Taking Yingze Park in Taiyuan City, Shanxi Province as an example, this paper uses augmented reality technology to enhance the vitality of the park to meet the long-term requirements of contemporary urban development.

2.2 Augmented Reality Technology and the Vitality of Urban Park Spaces

Augmented Reality (AR) was first proposed in 1990, which refers to the display of the virtual world by users through mobile terminals such as electronic devices, and the superposition of virtual objects, scenes and other information generated by intelligent terminals into the real world,^[1]so as to realize the interaction between users in the virtual and real space.

Urban parks are public welfare outdoor spaces led by the government or public institutions, with natural or semi-natural landscapes such as green spaces, water bodies, and vegetation as the main body to provide residents with necessary activity venues, and they play a role in spreading urban spirit and culture.^[2] The term "vitality" is abstract, originally originated from a biological concept, There is no clear definition of vitality, and most scholars describe the term in terms of people and human activities.^[3] The spatial vitality of Yingze Park is considered in this paper to improve the vitality of unpopular spaces under AR technology.

3 Study Design

3.1 Scope of the Study

As a large-scale comprehensive park in Taiyuan City, Yingze Park has a total area of 65.54 hectares, of which the lake area is about 16.8 hectares. It is a large-scale comprehensive park with unique geographical advantages,^[4] The park is divided into three natural scenic spots: northern, central and southern, and the whole is in the form of a belt. The site is surrounded by landmarks such as residences, schools, and hospitals. The spatial layout functions are relatively clear, as shown in Figure 2, there are seven functional areas: quiet rest area, viewing and sightseeing area, children's activity area, cultural science popularization area, intelligent interaction area, sports and fitness area, and natural ecological area^[4]. Based on the current situation of the spatial vitality of Yingze Park, this paper puts forward the application principles for improving the spatial vitality.



Fig. 2. Yingze Park Landscape Planning Functional Zoning Map^[4] (redrawn by the author)

3.2 Research Methods

Early scholars mostly used fieldwork and questionnaires^[5,6],With the rapid development of emerging technologies, Baidu heat map is a kind of positioning data based on the user's mobile phone, which converts the distribution and aggregation of the crowd into a visual heat image through big data algorithms, so that the population density per unit area under different colors can be intuitively seen (for example, red and orange represent high-density people, blue and green represent low-density people), and these data sources are widely and real-time and dynamic.

In this study, it can be used to observe the distribution of people in each space of Yingze Park, analyze the density of people in each space, so as to obtain the space with low density of people, and finally put forward the design principle of the space with low population density (Fig. 3) to improve the overall spatial vitality of the park.

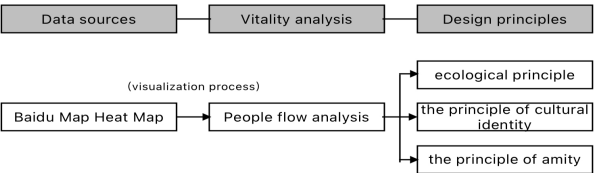


Fig. 3. Technical Roadmap (Author's Drawing)

3.3 Findings

According to the data in the Baidu map heat map in Figure 4, the distribution of the flow of people in the morning, noon and evening on weekdays on the left and the rest days on the right is obtained, and the data are taken at 8 a.m., 14 p.m. and 21 p.m. in the evening. On weekdays, the natural ecological area of the park is sparsely populated at noon, and in the evening, the smart interactive area is sparsely populated. The fluctuation of the park traffic on rest days is larger than that on weekdays, especially at noon and evening, the flow of people in the children's interaction area, cultural science area and natural ecological area is relatively sparse, while the flow of people in the morning on rest days is more uniform.

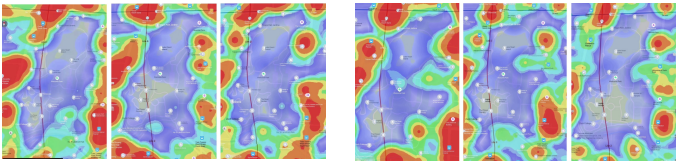


Fig. 4. Population heat map of Yingze Park

Overall, the vitality of the park space is closely related to the flow of people and the existing facilities of the park. There is a large amount of open area around the lakeside with less people that is not used; Although the architectural landscape has strong historical value, it seriously lacks dynamic narrative plots such as AR scene restoration

and interactive commentary, so the willingness of tourists to visit this place is low. Enhance the vitality of the space by using the open space around the southern part of the park to create indoor or nighttime outdoor AR displays.

4 The Design and Application of Augmented Reality Technology for the Vitality of Yingze Park

Yingze Park is the largest park in Taiyuan City,^[7]and it is also the core ecological green space of Taiyuan City. The design principles of ecology, culture and friendliness are applied to the park space, and through the combination of nature and humanity, it can not only create the vitality of the all-age friendly space, but also promote the sustainable development of the park.

4.1 Ecological Design Principles

Lakes, ancient buildings, plants, animals, and other ecosystems are the most important ecological resources in the park. Therefore, utilizing dynamic AR ecological information to enhance the vitality of park space is essential. Figure 5 shows specific interaction details. For example, an AR sign is set up near the ancient locust tree on the south side of the park; when scanned, visitors can see a 3D growth animation of it from a small sapling to a towering tree. The AR trigger point by the water system can simulate the comparative scenes of water purification and the ecological restoration of endangered species “past and present”.

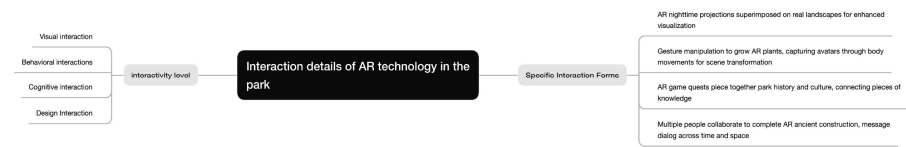


Fig. 5. The details of the interaction of AR in the park(Author's Drawing)

4.2 Cultural Design Principles

Relying on AR technology to excavate the Jin Shang culture in Yingze Park, a unique "memory map" is formed. The most important starting point of augmented reality application is to enhance the user's perception of the real world,^[8]Uses AR to truly restore the historical and cultural scenes of the local Jin merchants in the Ming and Qing dynasties indoors or in the evening, allowing citizens to personally transform into "shop-keepers" by the lake for trade transactions, coupled with background sound effects and 3D holographic projection technology, you can create an immersive cultural experience atmosphere and feel the great wisdom of Jin merchants.

4.3 Friendliness Design Principles

AR technology creates an age-friendly public space vitality on the basis of functional optimization and space flexibility.^[9]As shown in Figure 6 below, in terms of functional design, most of the functional areas on the south side of the park are natural ecological areas and viewing areas, so parent-child tourists can give priority to the AR children's activity area through the AR planning route; Fitness enthusiasts can get the fastest AR step count and fitness analysis of the smart track. For the needs of the barrier-free, hearing-impaired visitors can obtain information through real-time translation of AR subtitles, as well as necessary gesture instructions, so as to achieve unimpeded access to the park.



Fig. 6. Intention map of the park effect under AR technology

5 Conclusions

In view of the sparsely populated space around the South Lake of Yingze Park in Taiyuan City, this paper realizes the virtual and real interaction from the perspective of ecology, culture, and public friendliness, and from the perspective of AR technology, which can not only effectively enhance the attractiveness of the unpopular space of Yingze Park, but also use the way empowered by AR technology to create a fun and participatory interactive landscape,^[10]promote the sustainable and humanized development of the park, and provide a new path for the improvement of the spatial vitality of the park in Taiyuan City. In the future, it can further combine 5G and Internet of Things technologies to deepen the linkage between AR and park space vitality to create a smarter urban park.

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