Research Article
The Use of Visual Sensing Technology and Digital Image Technology in Public Art Design

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The intent of this research article is the analysis of application of digital image technology and visual sensing technology in public art design. The specific forms of public art design are studied. A series of studies on the public art form of live performance is carried out combined with the principles of advanced computer technology such as digital imaging, artificial intelligence, and visual sensing technology. An analysis method based on attention-satisfaction for the Return to the Three Gorges is put forward and some research results are obtained. The results show that the combination of live tourism performance and digital image technology creates endless possibilities for live tourism performance through technical means and artistic charm, but there are also some disadvantages. The survey results about the Return to the Three Gorges show that the proportion of tourists who choose "greatly different from expectations" and "fail to meet expectations" has reached 41.9%. And 45.3% of tourists choose the "very unwilling" and "unwilling" options in terms of willingness to revisit. It reveals that although the integration of science and technology and art has great charm, there is still much room for improvement, especially the homogenization of content and form, which needs further research.

1. Introduction

Public art includes sculpture, installation, or any other art form. As long as the condition of public existence is met, it can be additionally defined as public art, which is an artistic creation in a public open space [1–3]. As advanced computer technologies, digital image technology and visual sensing technology used in public art design can enrich the types of art design and optimize its visual expression effect [4–6]. The combination of digital image art and visual sensing technology can present a new way of communication and interaction, break through the limitations of traditional art, and bring rich visual experience to the audience. It inherits the characteristics of traditional art and endows traditional art with new aesthetic laws and artistic characteristics through new technology and innovation of new thinking [7]. With the progress of people’s living standards and the strong support of the state for the cultural industry and tourism industry, tourism performance, a comprehensive artistic expression form integrating modern science and technology, artistic communication, cultural elements and tourism publicity, is born with the trend and presents unprecedented prosperity [8–10]. Digital image and visual sensing technology have become indispensable elements in real-life tourism performance, accounting for a more critical proportion [11]. Systematically analysing the concept, development, social impact, and value evolution of urban public art and its landscape structures and understanding the design and creation process of public art and landscape structures in urban landscape is conducive to improving public art’s overall visual communication effect.

At present, an increasing number of experts and scholars have invested in the research of the combination of public art and advanced computer technology and made a lot of forward-looking research results. With the progress of modern ceramic art and public art, environmental ceramic art, as a new public art form, appears in multiple fields of public space [12–14]. Environmental ceramic art also has a close interactive relationship with urban culture, which is the value embodiment of
urban culture [15]. Zhang (2021) [16] pointed out the composition and interaction of environmental ceramic artworks facing the public art category. The research shows that environmental ceramic art has added dazzling highlights to public art with its special artistic language and performance connotation. Therefore, when public art becomes the symbol of modern civilization, environmental ceramics based on modern ceramic art murals and ceramic sculptures are applied to the environmental space of modern buildings, which brings a unique artistic sense to contemporary public art. With the rapid progress of the city and the continuous improvement of infrastructure, shaping the city’s unique culture has become a new challenge, which has attracted the great interest of many urban developers in the past few years. Among multiple strategies for developing real urban culture, using public art is a promising method. Cheng and Worrall [17] analysed the development of public art under the background of metropolitan cities in Beijing and Shanghai, trying to determine the development trend of urban public art in China. The development of public art in Chinese mainland cities was analysed and explored. The findings suggest some potential ways to encourage the implementation of public art policies in China. It can promote the development and prosperity of public art to maintain China’s cultural diversity.

Caffio and Unali (2021) [18] proposed a study on how colour shaped the perception of contemporary urban space to study the public art’s colour and space. The complex relationship among citizens, cities, and specific buildings of Pescara was investigated. Over the years, Abruzzo’s city has been the background for a series of interesting public works of art, whether short-lived or long-lasting. Among them, colour plays a vital role in establishing the path of urban transformation, and it is also a synaesthesia behaviour and communication mode on different scales. In the urban space between architecture and design, the process of art and socialization can release new aesthetic and participatory significance. Given the above analysis, there are multiple studies on public art design, but few studies combined with advanced computer technology. This thesis can fill this gap.

The literature research and model verification methods are adopted to study the specific forms of public art and the principles of digital image and visual sensing technology. The innovation is to take the public art of live performance as the research object to analyse its application status in detail combined with cases. Moreover, an analysis method based on attention-satisfaction for the Return to the Three Gorges is put forward, which provides a reference for future public art development. The paper is arranged as follows. Section 1 proposes the introduction and literature review. In Section 2 the methodology of the research is described by discussing methods and materials. In Section 3, a deep analysis of results and comparison has been carried out. Lastly, the conclusion of the paper is given in Section 4.

2. Materials and Methods

This section mainly discusses the methodology of research by talking about materials and methods. On the basis of digital image and AI, this paper proposes the public art design. Further, an application of digital image and visual sensing technology has been presented in the real performance. The promotion analysis of live performance strategy has been also carried out on the basis of attention-satisfaction analysis.

2.1. Public Art Design Based on Digital Image and Artificial Intelligence (AI)

The concept of public art originates from Britain. From sociology, its emergence is inseparable from the development of the industrial revolution, productivity improvement, and even the emergence of the middle class [19]. It is a comprehensive art that takes the public service as the core and combines various knowledge, such as graphic design, interior design, landscape design, painting, sculpture, mural, and printmaking. It can also be understood as a large-scale cultural activity. The opening ceremony of the Beijing Olympic Games, the National Day military parade, and the Qinhuai temple fair are all means to achieve public art design as an artistic technique. In particular, large-scale live tourism interpretation projects will combine AI, digital images, and other advanced computer technologies to present the information to the audience more accurately and effectively in a visual way. The purpose is to highlight the key content, weaken the interference information, and help the audience lock the visual focus on the information they want to transmit, which will make the presentation content more efficiently transferred to the audience, but this new combination form still has some disadvantages.

Live performance can creatively integrate the natural landscape and regional cultural characteristics, which is loved by major scenic spots and tourists. However, some designers blindly pursue the grandeur of the design scene and imitate each other, and it is difficult to highlight the characteristics [20–22]. As an extension of traditional images, digital images no longer rely on film recording but use the physical recording. For example, the electronic photosensitive element of digital equipment turns the image into a digital file for storage. The obtained image has higher resolution and sensitivity, and the acquisition method is more convenient. The combination of digital image and live performance has greatly changed image transmission mode. Digital transmission and 5G digital communication networks have gradually become the main ways of digital image transmission. The working process of digital image technology is inseparable from the photosensitive original, that is, the help of the image sensor. The image sensor converts the image projected by the lens onto its photosensitive surface into an electrical signal. Figure 1 shows the specific working principle.

The rise of new technologies such as AI, virtual reality, augmented reality, holographic projection, and 3D printing is affecting the way of thinking and creation of artists and designers, including the creation of public art. For example, there was a music performance called "Falling Like the Stars" on the stage of Britain's Got Talent, which combined holographic images with music and dance performances to interpret a touching love story jointly. Among them, James Arthur was both the performer of the song and the narrator.
of the story. The two dancers performed a wonderful dance performance with holographic technology. The heroine appeared and disappeared from time to time, showing the real body and star points. The perfect cooperation with holographic technology brightened the audience’s eyes. The artist Žilvinas Kempinas designed a tunnel made of tape in a historic cathedral at the “freedom journey” art festival held in Bordeaux, France. Dense lines blurred and distorted the surrounding scenery, brought light and shadow changes, and created a sense of space-time shuttle. It was an artistic work with the creative freedom theme and the cross-urban landscape. While blurring people’s vision, the artwork allowed people to better see where they are and who they are. Figure 2 shows these two examples.

2.2. Application of Digital Image and Visual Sensing Technology in the Real Performance. The public art of live performance differs from traditional performance. Tourists are the primary audience source, and the performance content is mainly the local characteristic culture of the scenic spot. China’s tourism performance shows characteristics, culture, and innovation based on the trend of mutual integration of culture and tourism [23–25]. Among them, the most representative is the landscape real scene performance. It is the unique cultural model with real mountains and water as the performance stage and local culture and folk customs as the main content. It integrates the masters of the performing arts and business circles as the creative team. It is an original creation of the Chinese people and a special product of the integrated development of culture and tourism. Tourism performance spreads a story, a kind of culture, and a complex. It should adopt measures suiting local conditions and pay attention to local cultural resources and connotation development. Figure 3 shows some typical examples of live deductive communication combining digital image, visual sensing technology, and public art.

Figure 3 shows the scene of China’s first large-scale landscape live performance, “Liu Sanjie impression,” directed by Zhang Yimou, Wang Chaoge, and Fan Yue, planned by Mei Shuaiyuan, and jointly completed by four leading creators. It opens a new model of integrated development of landscape, culture, and tourism. Large-scale song and dance performance called “Dream OCT” selects the most representative cultural image among Angkor’s cultural treasures and combines modern techniques to express it. It has a grand momentum and a large lineup. Cambodian and Chinese artists jointly create it. Modern high technology is used to enrich all the essence of the Angkor Empire, and it presents a multidimensional space with fantastic performances. The audience praises it as “Cambodia’s fresh culture and art museum.” It reveals that digital images combine various art forms and rely on technical means and artistic creation techniques to build a series of illusory performance stages. The improvement and perfection of computer image processing technology and 3D live projection technology have greatly expanded the creative scope of digital image art in live tourism performance and enhanced the expressiveness of digital image art in live tourism performance.

Digital image creation makes the topic of live performance no longer limited to time and space. It can highly restore the disappeared historical scenes and cultural relics through digital technology and use digital technology to construct a completely virtual scene and stage performance.
effect with the imagination of designers and creators. The content presented is no longer limited to the existing content. In the process of matching with various media, digital images give good interaction and immersive experience between real-life performance and the audience to shorten the distance with the audience. It will make the visual expression in real-life performance wealthier, more diverse, and more touching. Besides, the digital image also provides convenience in application mode for live performance. The switching between different scenes is free. The high-tech numerical control system can quickly switch scenes in a short time, and the figure is coherent and natural. The audience seems to be watching the real scene, and there will be no abrupt feeling.

Visual sensing technology is one of the seven categories of sensing technology. A vision sensor is a sensor that calculates the characteristic quantity of the object, including area, center of gravity, length, and position, and outputs data and judgment results by processing the image captured by the camera. Vision sensor is the direct information source of the whole machine vision system. It is mainly composed of one or two graphics sensors. Sometimes, it is equipped with light projectors and other auxiliary devices. The main function of a vision sensor is to obtain enough original images to be processed by the machine vision system. The vision sensor has thousands of pixels that capture light from a whole image. The clarity and fineness of an image are usually measured by resolution, expressed in the number of pixels. After capturing the image, the vision sensor compares it with the reference image stored in memory for analysis. Visual sensing technology includes 3D visual sensing technology. The 3D vision sensor has a wide range of applications, such as multimedia mobile phones, network cameras, digital cameras, robot visual navigation, and virtual reality. Figure 4 shows the working principle.

Using machine vision based on visual sensing technology in digital image real-time performance can obtain high-resolution pictures. Moreover, it can improve the picture quality of digital projection and virtual scenes and increase the digital image expression form of real-time performance. Among the common forms of live tourism performance, the Light Emitting Diode (LED) screen has become the most common image expression form because of its high brightness, wide viewing angle, convenient installation and maintenance, and easy display area control. With the assistance of optical imaging, digital projection combines digital technology with virtual reality to obtain a complete spatial three-dimensional sense. For example, the common landscape real scene is to project the three-dimensional image into the real scene through digital projection, carry out virtual and real combination and splicing, and quickly stack and switch to raise the presentation effect of the visual image to another height. Figure 5 shows the effect of mountain projection in the famous Xiangshan legend and Dream Seeking Dragon and Tiger Mountain.

The present live performance stage will also integrate some AI elements. The performance form has also evolved from multiple staff intensive performances to the description...
of story details and contents, paying more attention to the strange landscape formed by visual images and the audience’s demand for visual stimulation. Computer technology has also become an indispensable part of live performance. The application form of the digital image has changed from the original LED screen to the direction of high definition, high reduction, high authenticity, and high visual richness with the assistance of visual sensing and AI.

However, the following problems will often lead to homogenization and lack of novelty of real performance projects in the future. It includes only relying on the convenience brought by advanced technologies such as digital imaging technology and AI to the real performance, editing works through quick means such as copying and misappropriation, and not paying attention to the development of original content. Therefore, public art needs the support of advanced science and technology, adheres to developing original ecological resources, and deeply excavates original content to make infectious and sustainable public artworks. Real performance differs from general public art. It usually spreads the history and culture of a place, with strong regional characteristics and unique particularity. Therefore, new network technology and digital technology are needed to give new vitality to local culture in the creative process.

2.3. Promotion Analysis of Live Performance Strategy Based on Attention-Satisfaction Analysis. As a new force in the development of cultural tourism, live performance should meet the market needs. The real landscape picture and real person interpretation make the real performance have a kind of unique charm. However, the development of public art, such as real performance, has also encountered a bottleneck period due to the aggravation of the industry homogenization and blindly following the trend of large-scale production and market. As a vital evaluation standard for the quality of live performance, tourist satisfaction can most intuitively reflect tourists’ satisfaction with performance products. It is of great significance to study and evaluate the tourism market, business conditions, and follow-up project improvement. 

It is the first work in the return series directed by Zhang Yimou, known as the replacement of live acting. However, like other live acting, it has also fallen into business difficulties. It is typical to take it as the research object. Return to the Three Gorges is a joint-stock business model invested by the government. It has been fully marketed since 2019. The initial average attendance rate was 33.6%. The weakness of various industries caused by COVID-19 has led to scarce tourists. The Customer Satisfaction Index is designed according to the current situation of Return to the Three Gorges. A questionnaire survey is conducted based on the evaluation indexes. The Delphi method is used to determine the evaluation system, and the final reliable conclusion is drawn by making full use of the experience and knowledge of experts. Here, the experts selected include 10 graduate students in tourism major of Southwest University, 10 tourism investment managers of Chongqing, 10 managers of Return Impression Company, and 10 authoritative experts in other tourism industries. Likert’s five-point evaluation method is adopted. The importance is measured through the five grades that are very unimportant, unimportant, general, important, and very important. Additionally, the tourists’ satisfaction is measured by the five grades that are very dissatisfaction, dissatisfaction, general, satisfied, and very satisfied. Please refer to Figure 6 for the process of tourist satisfaction evaluation.

The questionnaire design is divided into three parts: tourists’ overall perception, tourists’ attention-satisfaction scale to each evaluation index, and demographic analysis. A questionnaire is conducted for tourists from October 1 to November 1, 2021. Overall, 378 questionnaires were distributed, 5 nonstandard and invalid questionnaires were removed, and 373 valid questionnaires were recovered. The reliability test of the tourists’ attention-satisfaction scale of the evaluation indexes is as follows. Cronbach’s α coefficient value is 0.983, which meets the requirements. The Kaiser-Meyer-Olkin (KMO) value of the validity test is 0.892, which is greater than 0.8. In Bartlett’s test, $p = 0.000$, which is less than 0.05. The reliability and validity analysis meets the requirements.

3. Results and Discussion

In this section, the results of the current research are analysed in a comprehensive manner and a thorough discussion has been provided. The contents of this section are descriptive statistical analysis results of the tourist population of live performance and survey results of live performance based on the attention-satisfaction analysis.
3.1. Descriptive Statistical Analysis Results of the Tourist Population of Live Performance. Figures 7 and 8 show the age structure and education level distribution. Figure 7 shows that young tourists are in the majority among the audience of this kind of live performance public art performance, and tourists aged 26 ~ 50 years old account for 75.7%, indicating that live tourism performance is more attractive to young- and middle-aged groups. Figure 8 shows that 69.8% are tourists with a college education or above. It reveals that most tourists have a higher level of education.

3.2. Survey Results of Live Performance Based on the Attention-Satisfaction Analysis. Tourist satisfaction depends on the difference between expectation and perception. Figure 9 and 10 are the statistical results. Figure 9 shows that the proportion of tourists who choose “greatly differ from expectations” and “fail to meet expectations” reaches 41.9%. The gap between perception and expectation will make tourists dissatisfied with the tourism experience, so tourists will not have a high evaluation of the real experience project. Only by making tourists feel that the real value is higher than the expected value, can they win high praise, generate positive word-of-mouth communication, and usher in more tourists and profits. Figure 10 shows that the proportion of tourists who choose “dissatisfied” and “very dissatisfied” reaches 26.7%. It indicates that the audience’s audio-visual experience of the performance of the Return to the Three Gorges cannot meet expectations to a great extent.

Customers’ willingness to revisit and recommend can show tourists’ loyalty to the performance project. Figure 11 shows the survey distribution of tourists’ willingness to Return to the Three Gorges. Figure 11 shows that 45.3% of tourists in this survey choose the “very reluctant” and “unwilling” options in terms of revisit intention, indicating that they are unwilling to watch the project again. Regarding recommendation willingness, 30% of tourists choose the “very reluctant” and “unwilling” options, indicating that tourists’ loyalty to the Return to the Three Gorges project is low. In addition, the proportion of tourists unwilling to recommend is lower than that unwilling to watch again, indicating that although some tourists feel dissatisfied, they are still willing to recommend, indicating that tourists are more rational, and most of them are still willing to recommend.
Figure 7: Statistical results of age structure.

Figure 8: Statistical results of education level.

Figure 9: Expected achievement distribution chart.
Figure 10: Overall satisfaction distribution.

Figure 11: Distribution of revisit intention and recommendation intention.

Figure 12: Distribution of importance and satisfaction of each dimension.
Figure 12 shows the overall satisfaction and attention of tourists to performing arts projects. Figure 12 shows that, in terms of performance content, performance form, and performance service, the scores of tourists’ attention are higher than tourists’ satisfaction. It indicates that although tourists value the real tourism performance, tourists’ satisfaction is low and needs to be focused and improved.

4. Conclusions

The prompt development of AI made big data and various network technologies, digital image, and visual sensing technologies to provide unlimited possibilities for live tourism performance with their unique technical means and artistic charm. In this article the expression form of public art, the principle of digital image, and visual sensing technologies are studied. Moreover, their examples and applications in real performance are analyzed. \textit{Return to the Three Gorges} is used as an example to conduct a specific survey of tourist satisfaction. The results claimed that digital image technology has gradually become the most widely used and innovative part of real performance. In future, many new and different forms will be presented, showing the endless charm of the integration of science and technology and art, with broad development prospects. However, there are still some deficiencies. Since this paper carried out the analysis from the perspective of exploration experience, more application examples are needed for specific verification. In the future, more exploratory efforts should be made in combination with more examples of integrating science and technology and public art.

Data Availability

The data have been included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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