

Innovative Application of Museum Spatial Interaction Technique

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Received: 25 August 2023 | Accepted: 5 October 2023 | Published: 31 October 2023

DOI: <https://doi.org/10.55057/ijbtm.2023.5.3.51>

Abstract: *In modern society, museums, as institutions for the protection and inheritance of cultural heritage, play an important role. However, with the rapid development of science and technology, the traditional museum exhibition can no longer meet people's demand for a good visiting experience. In order to attract more visitors and provide richer educational and entertainment experiences, museums began to actively explore innovative applications of spatial interaction technique. Spatial interaction technique refers to the combination of computer science, human-computer interaction technique and sensor technology, which integrates digital information into physical space and breaks the limitation of traditional two-dimensional interface. In the museum, spatial interaction technique can bring interactive, immersive and personalized visiting experience to visitors through augmented reality, virtual reality, gesture recognition and voice recognition. This paper discusses the innovative application of museum spatial interaction technique, and explore its effectiveness in improving the visiting experience and educational effect through empirical research.*

Keywords: museum, spatial interaction technique, innovative application

1. Introduction

This paper aims to conduct in-depth research on the innovative application of museum spatial interaction technique and explore how to utilize this technology to enhance the sense of user experience and interactivity in museums, and to achieve the function of museum publicity and education. Specifically, this study will analyze the development and application of museum spatial interaction technique, summarize existing research results and cases, and verify the effectiveness and user experience of innovative applications through empirical research. Based on the results of this study, it is hoped to provide museums with more creative exhibition methods, thereby attracting more visitors and promoting the spread of culture.

2. Overview of Museum Spatial Interaction Technique

2.1 The Concept of Museum Space

Museum space refers to all kinds of exhibition spaces and exhibition areas in the museum, which is used to show various collections such as cultural relics and artworks, and provide visitors with knowledge, education, and cultural experience (Tzortzi, 2017). The museum space aims to create an orderly, educational, and attractive environment so that visitors can deeply understand and interact with collections.

Museum space can generally be divided into an exhibition area, interaction area, multi-functional area, service area, education area, and others. It is a multi-functional, educational and attractive place. Through exhibition and interaction, it conveys cultural, historical and scientific knowledge to visitors and promotes public understanding and respect for cultural heritage and human history (Devine and Tarr, 2019). Therefore, the design of museum space is very important for improving visitors' experience.

2.2 Definition and Characteristics of Interaction Technique

In modern society, museums, as institutions for the protection and inheritance of cultural heritage, play an important role. However, with the rapid development of science and technology, traditional museum exhibitions can no longer meet people's demand for a good visiting experience (Pan, 2018). In order to attract more visitors and provide richer educational and entertainment experiences, museums began to actively explore innovative applications of spatial interaction technique. The spatial interaction technique refers to the combination of computer science, human-computer interaction technique, and sensor technology, which integrates digital information into physical space and breaks the limitation of the traditional two-dimensional interface (Yang, 2017). In the museum, spatial interaction technique can bring interactive, immersive, and personalized visiting experiences to visitors through augmented reality, virtual reality, gesture recognition, and voice recognition.

2.2.1 Definition of Interaction Technique

In the museum, interaction technique refers to the application of various technologies to the museum space to promote the interaction and exchange between visitors and the exhibits (Price, 2017). It encourages visitors to actively get a more personalized experience. By allowing visitors to interact with the exhibits, the interaction technique improves the experience of visitors.

2.2.2 Characteristics of Interaction Technique

The Museum Spatial Interaction technique has many characteristics:

- a. Interaction: The interaction technique promotes real-time communication and interaction between visitors and the exhibits, breaking the traditional one-way communication mode. It gives visitors the opportunity to actively interact with the exhibits and obtain a more personalized experience.
- b. Immersion: Through virtual reality and augmented reality, interaction technique creates an immersive environment and shows different cultures or historical events to visitors, which can arouse visitors' curiosity.
- c. Personalization: Spatial interaction technique allows museums to customize the visit according to people's personal preferences and interests. By collecting audience behavior and preference data, it can provide personalized recommendations.
- d. Education and participation: By offering informative content, interaction technique can help visitors to comprehensively know the exhibits.
- e. Accessibility and inclusiveness: Interaction technique can solve the problems faced by some visitors, such as visitors with physical disability or language disorders. It provides an alternative way for them to obtain a good experience and creates a more inclusive museum environment.
- f. Data collection and analysis: Interaction technique also brings benefits to museums by collecting valuable data on audience behavior and preferences. These data can be used to improve the design of exhibits, understand visitors' interests, and enhance the satisfaction of visitors.

Interaction technique in museums is transforming the traditional static and passive viewing experience into a dynamic and interactive journey (Yang Wanjing, 2016). By applying spatial interaction techniques such as augmented reality, virtual reality, gesture recognition, and voice recognition, the museum shows its collections and interacts more closely with visitors.

2.3 Application Advantages of Interaction Technique in Museums

There are many advantages in the application of interaction technique in museums, which provide many possibilities for museums to enhance the exhibition methods, and at the same time greatly improve the experience of visitors. The following are the application advantages of interaction technique in museums:

- a. Enhance the viewing experience. Interaction technique breaks the traditional passive viewing mode and makes the visitors become the masters of the exhibition. Visitors can explore different information about the exhibits, making the viewing experience more interesting and unforgettable.
- b. Personalized experience. Interaction technique can provide personalized experiences according to visitors' interests and preferences. By collecting relevant data, the system can recommend relevant exhibits or provide customized services.
- c. Enhance immersion. With the help of virtual reality and augmented reality technologies, interaction technique helps to create an immersive exhibition environment, and visitors can get a more immersive and realistic experience.
- d. Education and interaction. The interaction technique integrates educational elements into the exhibition, which improves visitors' learning effect on the exhibits. By participating in the interaction, it is easier for visitors to understand and remember the historical and cultural background of the exhibits.
- e. Innovative exhibition. The interaction technique provides a new way for museums to show their collections. With the help of augmented reality and virtual reality technology, exhibits can be shown in a more vivid way.
- f. Attracting young visitors. Interaction technique especially attracts young visitors, who are more familiar with and interested in digital technology. By applying interaction technique, museums can attract more young visitors and stimulate their interest in cultural heritage.
- g. Data collection and analysis. The interaction technique provides a channel for museums to collect visitor behavior and relevant data. By analyzing these data, the museum can understand visitors' preferences, optimize the exhibition and content presentation, and improve visitors' viewing experience and satisfaction.

The interaction technique has brought tangible benefits to museums. It not only enhances visitors' visit experience but also ensures the inheritance of cultural heritage. Through continuous innovation and optimization of the interaction technique, museums can attract more visitors.

3. Application Analysis of Museum Spatial Interaction Technique

Augmented reality technology, virtual reality technology, gesture recognition technology, and voice recognition technology all have unique advantages in museums (Tzortzi, 2017). They provide museums with richer and more interactive exhibition methods and bring visitors a more personalized viewing experience. At the same time, these technologies also provide opportunities for museums to collect and analyze data, thus continuously optimizing exhibitions and improving visitors' satisfaction.

3.1 Application Fields

3.1.1 Exhibition design and augmented reality application

Present the information of exhibits: Using augmented reality technology, museums can mark AR signs next to exhibits, and visitors can obtain detailed information, historical background, and cultural connotation related to exhibits by scanning AR signs with smart devices, which can make the information of the exhibits more vivid, and enhance visitors' understanding of the exhibits.

Interactive exhibition experience: Augmented reality technology can help to create an interactive exhibition experience for visitors. Visitors can interact with the exhibits through AR technology, such as rotating the exhibits, magnifying the details, and others.

3.1.2 Application of virtual reality in museums

Virtual Visiting Experience: Museums can use virtual reality technology to provide visitors with a virtual visiting experience. By wearing VR glasses, visitors can feel as if they are in cultural sites or places.

Virtual reproduction of historical scenes: Using virtual reality technology, museums can reproduce past historical scenes. Visitors can personally participate in historical events, feel the charm of history, and deepen their understanding of history.

3.1.3 Application of gesture recognition and voice recognition in the exhibition

Gesture interaction system: Based on gesture recognition technology, museums can design interactive exhibition systems. Visitors can control the display mode of exhibits through simple gestures, such as zooming in and zooming out.

Spoken instructions and interaction: Voice recognition technology can be applied in the spoken instruction system, and visitors can ask questions or give instructions by voice to obtain information about the exhibits. In addition, voice recognition can also be used to interact with exhibits, such as triggering specific functions of exhibits through voice.

The application fields of these interaction techniques provide more opportunities for museum space, which can enhance visitors' viewing experience and ensure the inheritance of cultural heritage. By constantly innovating and optimizing these techniques, museums can attract more visitors.

3.2 Analysis of Development Trend

The development of museum spatial interaction technique can be traced back to the end of the 20th century. With the continuous development of computer technology and virtual reality technology, related techniques began to be applied in museums. In recent years, with the rapid development of mobile devices and sensor technology, the museum spatial interaction technique has made great progress.

Future development trends include more intelligent interactive systems, such as using artificial intelligence and machine learning algorithms to build a more intelligent spoken instruction system; More personalized viewing experiences, such as customizing exhibits recommendation and visit routes according to visitors' interests and characteristics; A more immersive experience, such as using holographic projection and 3D sound technology to build a more realistic virtual environment (Yang, 2017).

Generally speaking, the application of the museum spatial interaction technique has great potential, which can provide visitors with a more interactive and personalized viewing experience (Cui and Zhang, 2017). However, it is necessary to overcome many challenges, such as technical cost, user experience, and content design, in order to achieve a more comprehensive and successful application. Future research and practice should focus on technological innovation and users' needs, so as to provide support and guidance for the further development and application of museum spatial interaction technique.

4. Innovative Design of Museum Exhibition Spatial Interaction

4.1 Narrative Interactive Design of Exhibition Space

Narrative design of exhibition space refers to adding narrative elements to the space and enhancing the on-site experience of visitors through various design elements, visual effects, scene changes, background music, and interactive exhibitions. For exhibition design, an exhibition theme is the key to space innovation design. On the whole, there is a complementary relationship between the exhibition theme and the space design of the exhibition hall. Designers should carefully consider the connotation of the exhibition theme in all levels of space design and implement this concept to every detail of the exhibition space design from beginning to end.

The elements of the narrative design of the exhibition space are mainly divided into four narrative elements, narrative theme, and narrative content. The so-called "narrative design" means telling a story, telling the exhibition content, and conveying the information by telling a story, which requires the story itself, the storyteller, the place, and the listener. These four elements constitute the four elements of "narrative", namely, the exhibition content, the designer, the exhibition space, and the visitors. These four elements determine the overall direction of narrative design. After determining the overall direction, it is necessary to connect the story to the exhibition space.

4.1.1 Show the formal elements of narrative design

The story in the narrative exhibition space can only be conveyed to the viewer through certain ways and arouse the viewer's emotion. And these ways can be analyzed from two perspectives, namely narrative media and narrative structure.

Narrative media is simply the carrier of stories. Narrative media is generally a kind of "language". Designers can combine a series of exhibits and arrange them logically according to the determined theme, thus creating a story-telling exhibition space, and convey information to viewers and tell stories through exhibits (which can be words, photos, video materials, and others). In addition, multimedia and other scientific and technological means are also important media for narrative exhibition space. By means of interaction techniques such as sound, film, television, and holographic projection, these special and valuable exhibits can communicate with visitors in an all-around way.

Narratology originated from literature, and the exhibition space is often arranged into independent exhibition areas by designers according to their opinions, and they are connected in series according to clues to form the narrative structure of the whole story. Just like the "connecting link" in the literary structure, its role in the creation of exhibition space is to make the space design more integrated and logical.

The "narration" of the exhibition space design helps the viewer to understand the spatial narrative nodes. When the viewer visits and experiences according to a specific script in the exhibition space, it will help the viewer to have a deeper understanding of the theme information conveyed by the exhibition.

4.1.2 Analysis of the Application Method of Narrative Design

Narrative design is a design method based on story, plot, and story characters, which emphasizes the story and emotional appeal of space design and is also an important part of space personalization.

Extract story elements: Before narrative design, designers need to extract story elements from the display theme, including theme, plot, role, time, and space. These elements are the core of the design process, and also the main storyline.

Design adventure experience: The focus of narrative design is to immerse visitors in an interactive environment and experience the story in a way of exploration and discovery. Designers can use props to build a narrative space and enhance the emotional experience of visitors.

Create emotional resonance of characters: Narrative design needs to build a lively and interesting exhibition space with emotional resonance through space, props, stories, and other means so that visitors can explore and discover in the process of interaction, and then feel the charm of the exhibition content. Designers can imagine and shape multiple characters, and based on their identities and experiences, they can enhance the connection between visitors and characters through various means in the design process.

Strengthen the multi-level experience: Narrative design usually allows visitors to gradually understand the exhibition content and story in the process of exploration and discovery. Designers can add multi-level elements, such as sound effects, interactive devices, etc., to improve visitors' participation and enhance visitors' knowledge and understanding of the exhibition content.

4.2 Visual Interactive Design of Exhibition Content

Visual design refers to presenting information or data through visual elements (such as colors, shapes, graphics, charts, etc.) in order to convey clearer and more intuitive information. Visual design can show a large number of data and information in a form that conforms to the laws of human vision, make full use of human's ability to recognize intuitive contents such as graphics and images, transform information from intangible to tangible, and show the focus, logic, and trend of information in a concrete way, so as to improve human's observation, memory and understanding of things (Jun, 2019).

The innovative design of exhibition space requires the designer to create an experiential atmosphere in the space to achieve a better visiting effect. To create a good atmosphere, designers need to accurately understand the exhibition content and information and make visual designs. On the one hand, the visualization design is applied to show the exhibition content, which helps visitors to understand and communicate through multiple visual forms; On the other hand, in the management of exhibition space and the development of exhibition items, visualization design is used to improve the quality and efficiency of management services, create a smart exhibition hall and enhance the experience of visitors.

4.2.1 Artistic Techniques

The design of exhibition space can't ignore the creation of aesthetic feeling. Designers can let visitors get special experiences through multi-dimensional space and get different feelings in different spatial structures. The function of exhibition space is to create an exhibition atmosphere, highlight exhibits, and facilitate visitors to visit. The mission of visual design is to guide the viewer to discover through visual information, and to establish data and images at the visual level, so as to form a clearer, more complete, and extensive connection with them (Li, 2018).

If visitors pay too much attention to the space design, their attention will be shifted to the space and the exhibits will be ignored. Therefore, the design of the exhibition space should make visitors ignore the artificial division of space and visit according to the designed route. Designers can use some special artistic techniques to better show exhibits, and with the help of some techniques, visitors can obtain a novel experience.

Sun Paper Culture Museum is a visual design work with interesting, unique, and attractive visual effects. Its visual design is no longer confined to traditional thinking such as simple chart presentation and picture display, but based on the accuracy of conveying information, it creates a visual presentation mode that is easy to understand and explain. By using sound, light, and panoramic equipment such as LED electronic screens and electronic touch screens, and using pictures, words, objects, video materials, and other forms, a paper cultural and historical corridor was created, which was from ancient times to the paper making in Cai Lun in the Eastern Han Dynasty and then to the modern paper making civilization. It has high academic research and educational value. Therefore, visitors can feel the charm of the museum.

4.2.2 Technical Method

The visual design of exhibition content integrates the research fields of social science, art, psychology, intelligent interaction, and other complex disciplines. It is a new discipline in recent years and a popular trend in modern art design (Pan, 2018). Its essence is to integrate and refine information by using related technologies and finally present it in an appreciative and easy-to-understand form, so that the communication between information and visitors becomes more effective, and its core is clear logic and technical method.

The visual design is also reflected in its combination with digital technology. With the emergence of more and more new technological means, such as virtual reality technology and immersive experience, the visual design of exhibition space has changed from static to dynamic, from independence to interaction. The combination of visual design and digital technology can vividly show information. Through various means of exhibition, the public's demand for the exhibition can be met.

The interactive exhibition "Taking Confucius as the Teacher" in Confucius Museum shows Confucius' idea of "providing education for all people without discrimination" through interaction technique, so that visitors can understand the Chinese traditional etiquette culture. The ancient ceremony of paying homage to a teacher involves many body movements and ritual processes, and it is difficult to understand its essence only through pictures, texts, and videos. In the exhibition, visitors are guided to stand in the best interactive position. As soon as visitors enter the interactive area, the human body outline and bones corresponding to the visitor's position appear on the interface. The small palm in the center of the screen will also move with the palm of visitors, so that visitors can feel the connection between their body and the virtual world, prompting visitors to control objects through the movement of their palms

and arms. In the demonstration animation of the "learning ceremony", the role of the demonstration characters is presented from the same perspective as visitors, which is convenient for visitors to understand the relationship of the left and right hands in the action of worshipping the teacher with their own bodies as the center, so as to make correct gestures. So that visitors can naturally participate in the interaction.

4.3 Intelligent Interactive Design of Display Means

The intelligent interactive design of the display means combining artificial intelligence technology with display means to provide a more intelligent and personalized experience for visitors (Yang, 2016). This design can better meet the needs of visitors, provide richer and more interesting exhibition content, and enhance visitors' sense of participation. The following are some examples of the intelligent interactive design of display means:

- a. Intelligent guide system: Based on artificial intelligence technology, museums can develop intelligent guide systems, and visitors can download corresponding apps through smartphones or computers. The system recommends personalized tour routes according to the interests and needs of visitors.
- b. Face recognition interaction: Face recognition technology is used in the exhibition area. When visitors approach the exhibits, the system can recognize visitors' faces and push relevant information about exhibits according to visitors' interests, thus bringing them a more intelligent and personalized interactive experience.
- c. Natural language processing: With the help of natural language processing technology, visitors can interact with the exhibits through voice. Visitors can ask questions or express their opinions, and the system can intelligently understand visitors' intentions and provide corresponding answers and explanations.
- d. Emotion recognition and interaction: Through emotion recognition technology, the system can analyze the emotional state of visitors. When visitors show interest or curiosity, the system can adjust the information on the exhibits according to visitors' emotions, providing a better viewing experience.
- e. Intelligent recommendation system: Using the recommendation algorithm of artificial intelligence, the system can recommend relevant exhibits and contents according to the historical visiting data and preferences of visitors.
- f. Augmented reality gamification experience: By combining augmented reality and gamification design, visitors can participate in virtual games and interact with exhibits.
- g. Intelligent feedback and data analysis: The system can collect the feedback and opinions of visitors, analyze and mine them through artificial intelligence technology, help the museum understand visitors' preferences, and optimize the exhibition design and content.
- h. Intelligent projection and holographic technology: Using intelligent projection and holographic technology, the exhibition content can be more vivid and realistic, and visitors' sense of participation can be enhanced.

Through intelligent interactive design, the museum can better meet the needs of visitors, and they can obtain a more personalized and interesting viewing experience. This intelligent interactive design not only enhances the attraction of the museum but also brings more data and insights to the museum, which is helpful for the museum to optimize the exhibition planning and improve visitors' satisfaction.

4.4 The Interactive Design of Spatial Information

The interactive design of spatial information refers to the process of how to effectively convey the information of exhibits through various design methods (Irwin, 2016). The key in this process is to conduct accurate research on the visitors and make a targeted exhibition plan to

convey information such as product characteristics, brand image, and industry trends so that visitors can understand the products, brands, and values of the enterprise during their visit to the exhibition hall.

4.4.1 Innovation of Information Dissemination Mode

Innovative design with digital technology: The development of digital technology has brought unprecedented innovative opportunities for the information communication design of exhibition space. Digital technology can be used to create interactive exhibitions, for example, virtual reality technology can be used to bring visitors into the world of exhibition items. In addition, apps can be used.

Introducing social elements: In the exhibition space, introducing social media elements can enhance visitors' experience. For example, letting visitors take photos in the exhibition or participate in online community discussions can promote interaction between visitors.

Focus on audience needs: The information design of exhibition space needs to focus on visitors' needs and learn about visitors' preferences, hobbies, and knowledge levels, so as to provide more accurate and personalized information dissemination. According to different visitors' backgrounds and needs, various customized communication methods, such as personalized guides and multilingual support, are designed to make visitors understand the display information more quickly and comprehensively. For example, for readers with strong reading ability, such as graduate students, we should provide knowledge that can meet their professional needs.

Innovative exhibition form: The information communication design of the exhibition space can also explore and innovate the exhibition form, such as using elements such as color and shadow to make the design of the exhibition space more creative. At the same time, the exhibition information and modeling design can cooperate with each other to highlight important information. In addition, sustainable materials and design elements can be used to show visitors the ecological problems.

Emotional communication: Information needs to be conveyed to visitors through emotional communication. Visitors can better understand the exhibition information by appreciating the music, video, and other elements in the space. In order to attract more visitors, the information communication design of the exhibition space can also use distinctive, novel, and unexpected elements to surprise visitors.

4.4.2 Impact of Information Communication Design

In the aspect of spatial information communication, the development of science and technology directly leads to the change of its artistic communication mode, and designers need to start from a new way and find a breakthrough (Wang Weihang, 2018). Nowadays, in the information age, interactive design that combines art and technology has been sought after by more people. This new design concept has attracted a lot of attention because of its interaction and openness. In the information age, digital technology makes exhibition design more diversified, and the development of technical means leads to the virtual presentation of communication methods, and the relationship between human beings and multimedia becomes closer. The future exhibition space will face more challenges. However, regardless of the development of technical means, the ultimate goal of information communication is to balance the relationship between art and technology.

5. Conclusion

The purpose of this paper is to study the innovative application of museum spatial interaction technique and explore its effectiveness in improving the visiting experience and educational effect through empirical research. During the research, the researcher conducted a detailed investigation and analysis of the interaction technique in the museum and collected feedback and data from visitors to comprehensively evaluate its application effect.

The research found that the innovative application of museum spatial interaction technique has brought many advantages to visitors. First of all, the interaction technique enhances the experience of visitors, enabling them to understand the cultural relics and historical background in an all-around way. With the help of technologies such as virtual reality and augmented reality, visitors can feel as if they are in a historical scene, which enhances the interest and attraction of the visitor. Second, the interaction technique strengthens the educational function of museums. Multimedia displays and interactive tours provide visitors with more knowledge and information, which enhances the dissemination of culture and knowledge.

The innovative application of museum space interaction technique can enhance visitors' viewing experience. However, we need to pay attention to technology cost and user experience, and constantly explore and innovate to improve the sustainable development of technology. Therefore, when introducing interaction technique, we suggest that museums should fully consider the needs and characteristics of visitors, choose appropriate technical solutions, and regularly evaluate user experience and update technology to ensure that museum space interaction technique can continuously provide high-quality cultural experience and educational services for visitors. At the same time, scholars should continue to pay attention to the development of museum spatial interaction technique, explore more forward-looking application methods in combination with new technologies, and contribute more research results to the development and innovation of museums.

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