Research on Intelligent Service for Smart Museum Users under Artificial Intelligence

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Abstract. With the rapid development of artificial intelligence (AI) technology and the rise of the trend of intelligence, smart museums, as an important place for cultural inheritance and educational exchanges, are faced with the challenge and opportunity of how to use AI technology to enhance the user service experience. Starting from user needs, this study constructs a theoretical framework of perceived affordance in the study of intelligent service for users of smart museums through the theory of perceived affordance in the field of human-computer interaction and the method of rooted theory. According to this framework, suggestions for the optimization of smart museum construction and service based on user demand service are proposed, aiming to provide theoretical reference and practical significance for the development of smart museum user intelligent service under artificial intelligence.

Keywords: smart museums, perceived affordance, user intelligent services.

1 Introduction

In the context of the rapid development of information technology and the rise of the digital era, museums, as an important place for cultural inheritance and educational exchanges, are also constantly exploring how to integrate modern technology to enhance services and user experience[1]. The construction of smart museums is not only a digital transformation of traditional museums, but also an innovation and enhancement of traditional cultural inheritance methods. With the development of artificial intelligence, big data, Internet of Things (IoT) and other technologies, smart museums are characterized by digitization, interactivity, and personalization to provide people with a richer and deeper sense of experience.

Although the research on smart museums in China started relatively late, it has achieved some success in intelligent equipment, technology development and platform construction. At present, there are some limitations in the development of smart museums in China. First, smart museums have been practiced specifically in some first-tier cities in China, but there is a lack of unified standards and mature models, and the theoretical research support available for reference is relatively insufficient. Secondly, the construction of smart museums in China focuses more on technology application,

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while there is a certain lack of user experience. The design of smart museums often lacks an in-depth understanding of user needs and experiences, resulting in an interaction experience within the museum that is not smooth and personalized enough to meet the smart services of diverse users.

To address these issues, this study starts from user demand services and uses the theory of perceived affordance to guide the construction and service optimization of smart museums. Through users' activities and interactive behaviors in the museum, the theoretical framework of user perceived affordance is constructed to provide constructive suggestions for the construction and service of smart museums.

2 Smart museum

The smart museum is a new type of museum gradually formed with the rapid development of information technology and the rise of the digital era [2]. Advanced information technology, such as artificial intelligence, big data, and Internet of Things, is utilized to enhance various services, display effects, and audience experience in museums, to better disseminate and display cultural heritage, and promote cultural exchange and education. For example, China's Palace Museum is one of the typical representatives of smart museums. The Forbidden City Museum has launched the Smart Forbidden City project, which provides visitors with a personalized visiting experience through the introduction of advanced technologies such as intelligent guide systems and virtual reality technology. Visitors can take virtual tours and learn more about history and culture at different times and in different places through the cell phone APP. This not only enriches the audience's visiting experience, but also feels a more humanized intelligent service. Therefore, the upgrading of service technology, the improvement of service concept and the innovation of management mode of the future smart museum are the new direction of its development.

With the rapid development of artificial intelligence technology and in various fields, the current smart museum has entered the stage of user intelligent services under artificial intelligence. Through the analysis of user needs and behavior by artificial intelligence technology, the museum provides users with more intelligent and personalized services, while the application of big data also enables the museum to better understand user needs and further improve the user experience and the effect of the visit. Therefore, the current development trend of intelligent services in China's smart museums mainly includes the application of augmented reality and virtual reality technology to provide a more immersive visiting experience; at the same time, the use of artificial intelligence technology and big data analysis, mining user information, user emotions and user preferences, etc., to provide tourists with personalized exhibit recommendations and customized guided tours in order to enhance the interactivity and personalized experience of the visit.

3 Perceived affordance

"Perceived affordance" is a concept that deals with human perceptual and cognitive abilities and has been widely discussed and studied especially in the fields of technology and design. It mainly refers to the ability of design and technology to enable users to perceive and understand the characteristics, functions, and states of a system, product, or environment so that they can interact with and use it more effectively. Currently, perceived affordance has become the focus of research in many fields, including human-computer interaction, design theory, cognitive science, and artificial intelligence[3]. Researchers are committed to developing new techniques and design approaches to improve user perception of systems and products and to promote better user experiences and interactions[4]. Scholars conduct design interfaces and interactions that enable users to perceive the state of the system more intuitively and how it operates[5]. Scholars use the theory of perceived affordance to study the use of sensing technology and data visualization means to enhance the user's ability to perceive the environment [6].

In summary, this study, in the context of the development of user intelligent services in smart museums, analyzes people's information behaviors such as person-to-person interaction and person-to-environment interaction in smart museums on the basis of the theory of perceived affordance, and constructs the theoretical framework of perceived affordance in smart museums, to provide the future construction and service of smart libraries with theoretical reference and practical reference suggestions for future smart library construction and service.

4 Perceived affordance for smart museums theoretical framework

This study utilized rootedness theory as a methodology and conducted interviews with six museum curators from first-tier cities in China who have rich experience in museum practice. The services provided by smart museums were synthesized and summarized, including the design of smart museums, system function planning, quality of collection resources, and quality of exhibition services, and open-ended manual classification was conducted. Based on Hartson research[7], perceived affordance was categorized into perceived physical affordance, perceived cognitive affordance, perceived controllable affordance, and perceived emotional affordance, and added perceived emotional affordance in combination with the service context of smart museums. The classification and concept of perceived affordance in smart museums are shown in Table 1. In the actual context of smart museums, users interact with the system, In the actual situation of the smart museum, when users interact with the system, product or environment, these five categories of perceived affordance complement each other, and users will perceive them at the same time.

Table 1. Classification and concept of perceived affordance for smart museums

Perceived Affordance Classification	Conceptual Explanation
perceived physical affordance	Attributes of design elements or features within a museum that are accessible through the user's senses to enhance the visitor experience and information accessibility
perceived cognitive affordance	Attributes of design elements or features within a museum that aid and promote users' comprehension and cognitive behavior towards exhibits and museum services.
perceived controllable affordance	Design elements or features within a museum that allow visitors to actively choose and control the attributes of their level of engagement and experience during their visit.
perceived emotional affordance	An attribute of a design element or feature within a museum that prompts one or more emotional responses from visitors.
perceived emotional affordance	The attributes of a design element or function within a museum that can be perceived by visitors to obtain and autonomously access the appropriate services.

Next, these five different theoretical concepts are transformed into specific application models to better illustrate the application scope of the perceived affordance concept. Finally, the application scope of perceived affordance is refined in more detail to summarize the ways in which smart museums can realize different functional services and present different perceived affordance manifestations by describing the specific functions of smart museums. Theoretical framework of perceptual affordance for smart museums is shown in Figure 1.

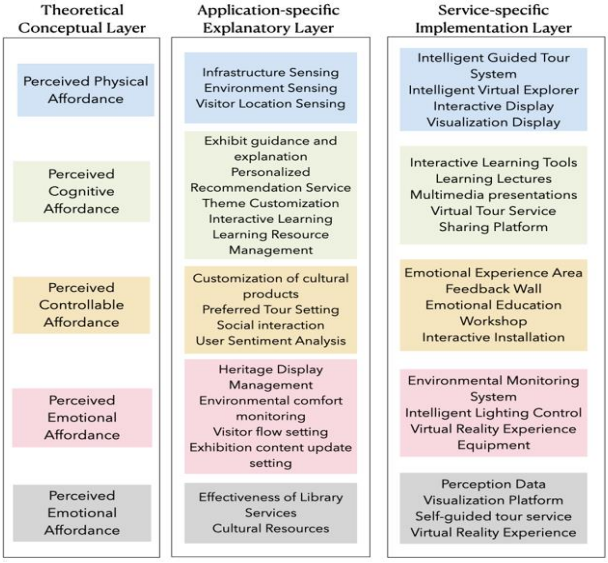

Fig. 1. Theoretical framework of perceptual affordance for smart museums

Through the theoretical framework of user perceptual affordance, this study clearly delineates the facility functions, exhibit resources, specific services, and system functions of smart museums. It provides an intuitive guide for smart museums to guide users to complete their information activities and behaviors and helps to better study the optimization scheme of smart museums' "user intelligent services" at the present stage.

5 Smart museum construction and service suggestions

Based on the theoretical framework of perceptual affordance for constructing smart museums, this study distills the construction and service improvement ideas of smart museums from five dimensions corresponding to perceptual affordance.

5.1 Optimize Infrastructure Construction and Enhance the Initial Experience of Users

The infrastructure of smart museum infrastructure includes intelligent operation equipment and physical perception facilities. In terms of intelligent operating equipment, a face recognition access control system is introduced to improve the safety and convenience of users entering the museum with simple facial recognition. Meanwhile, a self-service interpretation device is established to allow users to select exhibits of interest and obtain relevant interpretation and background information through touch screen or voice interaction. In addition, interactive display devices are set up to allow visitors to interact with exhibits through touch screens, projections, or other sensory technologies to enhance the interest and participation of the visiting experience.

In terms of physical perception facilities, the Smart Museum monitors environmental parameters such as temperature, humidity, and light in the museum in real time by deploying an intelligent environmental monitoring system to ensure the protection of exhibits and the comfort of the viewing environment. In addition, holographic projection technology is utilized to display holographic projections of cultural relics in specific areas, allowing users to appreciate the three-dimensional form of exhibits in 360 degrees and providing an immersive viewing experience. Finally, multi-sensory experience areas are designed to utilize sound, light and shadow, tactile and other sensory technologies to give visitors an all-round experience of the cultural and artistic charms brought by the exhibits.

5.2 Updating and Improving Technical Applications to Enhance User Awareness

First, augmented reality (AR) technology is utilized to provide visitors with an immersive exhibition experience. Through AR glasses or cell phone applications, visitors can see virtual exhibits in the actual exhibition halls and display related information, animation, sound, etc. to interact with the exhibits and gain an in-depth understanding of their history, production process and other details. Secondly, an intelligent voice guide system is developed, adopting natural language processing technology and voice

recognition technology. Visitors can interact with the tour guide system by voice, ask questions or express interest, and the system can provide relevant answers and tour information according to the user's needs. Finally, an intelligent security monitoring system is developed to monitor the status of exhibits and visitors' behavior in real time using IoT technology and artificial intelligence technology to safeguard the safety of exhibits and visitors.

5.3 Expanding Resources and Innovative Businesses to Enhance User Engagement

First, museums can expand the scope of resources by increasing the diversity and number of collections. Actively collect new exhibits to expand the variety of exhibits and increase the attractiveness of exhibitions. Digital technology is used to digitize and store cultural relics materials for easy access to the public and digital management and display of resources. In addition, to expand social impact through collaboration with the community and various sectors. Conduct social service activities, such as community exhibitions and social research, to strengthen ties with the community and promote cultural exchange and social integration. Cooperate with schools, educational institutions, and other cultural institutions to jointly carry out educational programs and cultural activities to enhance the status and image of museums in society. Finally, innovative business models and technology applications are key to realizing the expansion of museum resources and operations. Utilize new display methods and technologies, such as virtual reality and augmented reality, to attract more visitors and enhance the visiting experience. Conduct online exhibitions and digital education programs to expand the reach and impact of museums.

5.4 Enriching Cultural Functions and Promoting Users' Emotional Resonance

The Smart Museum promotes users' emotional perception and creates a resonant exhibition experience through emotional exhibition design and intelligent technology. In the exhibition design, the order of exhibits and plot settings are carefully arranged to guide the audience to emotional experience and resonance. Through the plot arrangement and visual presentation, the audience can create emotional resonance and connection during the visit. Secondly, the intelligent guide system is used to provide personalized guide services and exhibition explanations, allowing users to customize the exhibition content and experience according to their interests and preferences, and enhancing the sense of emotional involvement. Regularly organize emotional interactive activities related to the exhibition, such as lectures, workshops, art creations, etc., so that users can emotionally connect with the exhibition through participation in the activities and deepen their understanding and perception of the content of the exhibition.

5.5 Upgrade all-round services and improve professional service quality

First, it is crucial to improve the digital literacy and data analysis ability of curators. Modern museums need to operate with digital technology, and curators need to be able

to process and analyze data. To this end, museums can organize training courses or workshops to help librarians master data analysis tools and skills and improve digital literacy. Second, the introduction of robots equipped with intelligent question-and-answer functions and assisted and guided by professional curators can enhance service efficiency. Finally, continuous learning and professional training are crucial to improving the service quality of museum staff. Museums can organize a variety of training activities on a regular basis, including attending industry conferences, learning new technologies and tools, and sharing best practices and experiences, to continually improve the professionalism and service quality of their staff. The comprehensive service upgrading of smart museums requires museum staff to possess professionalism in various aspects such as digital skills, robot operation skills and customized service capabilities.

6 Conclusion

In the rapid development of information technology, smart museums, as an important place for cultural heritage and educational exchange, have ushered in the era of digital transformation. At present, smart museums are in the development stage of "user intelligent service". This study constructs a theoretical framework of perceived affordance of smart museum services through the theory of perceived affordance and puts forward suggestions for the next construction and services of smart museums from five dimensions.

The development of smart museums not only needs the support of technology, but also needs to emphasize user experience, be oriented to user needs, and take user perception as the goal. The construction and service development of smart museum is a long-term process, which requires all parties to work together to actively explore the new path of smart museum construction and service and make more contributions to the sustainable development of smart museum.

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