

# Analyzing the Design of Virtual Humans in Chinese Museums: A Case Study of “Ai Wenwen”

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**Abstract:** In the current digital era, an increasing number of virtual humans entered the public's field of vision. Museum virtual humans introduced innovative exhibition forms for Chinese museums. However, focusing solely on external appearances without considering intrinsic features helped virtual humans realize their maximum potential. Currently, many Chinese museums blindly emulate successful foreign cases, leading to confusion in fundamental theoretical boundaries and neglect of key theoretical and practical aspects, becoming a significant issue in designing museum virtual humans in China. Therefore, there was a need for clearer theoretical and practical guidance in the design of virtual humans for Chinese museums. This paper delved into the theoretical implications of museum virtual humans and outlined the technological development process. Utilizing literature review methods and comparative analysis, it compared the characteristics of real museum staff with those of museum virtual humans, clarifying the latter's advantages. Combining the current status of museum virtual humans in China with an information model for these virtual entities, the paper proposed characteristics in three aspects: appearance, media forms, and service systems, guiding theoretical practice. Building upon this foundation, the paper conducted a case analysis of the relatively "Ai Wenwen" virtual human, examining the feasibility of the identified characteristics in the design of museum virtual humans in China. In addition, the comparative analysis of museum virtual humans and real museum staff sheds light on the advantages of virtual humans, offering valuable insights into their practical application in Chinese museums. The research results offered clear direction for the theoretical guidance of museum virtual humans and provided insights into the practical design of virtual humans in Chinese museums.

**Keywords:** Museum Virtual Human, Cultural Inheritance, Virtual Human Characteristics, Virtual Human Technology

## 1. Introduction

The widespread application and rapid development of virtual human technology have unleashed new momentum for the digital economy. According to reports, the scale of the virtual human industry in China surged to 107.4 billion yuan in 2021. Data released in the "China Internet Development Report 2022" indicates that the scale of the artificial intelligence-related industry exceeded 200 billion yuan. Against this backdrop, no industry can ignore the benefits brought by digital individuals, and museums are no exception. They are actively exploring virtual human projects as part of their awareness of digital transformation, which is worthy of in-depth discussion. However, the current

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research on museum virtual humans in China started relatively late and is still in infancy[1]. In most of China's museums, virtual humans are only used as substitutes for real museum staff, preventing virtual humans' advantages from being fully reflected. However, as a technological product of the digital era, virtual humans represent a new service strategy, not meant to replace real humans but to serve as an innovative means that emerges with the changing times. In the design of museum virtual humans, the technical characteristics of virtual humans should not be overlooked. Therefore, it is essential to review the technological development and advantages of virtual humans, clarify the design features of museum virtual humans, and provide a developmental direction in conjunction with the current state of Chinese museums.

## **2. Lecture Review**

Since the emergence of virtual museum humans, an increasing number of domestic scholars have conducted theoretical research on them. Scholar Xu Wenguang, taking user emotional experience as a starting point, has researched the expressive interaction design of museum virtual humans, proposing an a dynamic design approach for museum virtual humans[2]. Scholar Huang Kechen has conducted an analysis of real-time driving technology for virtual humans and, through practical application, introduced innovation and optimization to enhance the real-time driving capabilities of virtual humans[3]. Scholar Yuan Mengze conducts aesthetic analysis research on virtual humans as technological products through the theory of semblance[4]. Scholar Cheng Yutian has analyzed the current state of virtual human marketing practices from the perspective of marketing theory. Additionally, he has proposed marketing strategies for virtual humans[5]. From this, it can be seen that virtual humans in domestic museums are still in the early stages of development and are not yet mature. Consequently, there needs to be more research on the design characteristics of virtual humans in museums in China. The lack of exemplary practical cases and incomplete theoretical research has become a major issue in the current development of virtual humans in Chinese museums. This study takes the perspective of virtual humans, outlining theoretical concepts in the third part of the paper. The fifth part compares conceptual differences to determine the advantages of museum virtual humans. The study suggests design features of museum virtual beings from appearance, media forms, and service systems by combining the information model of virtual humans. Finally, in the sixth part, the study uses "Ai Wenwen" to demonstrate the feasibility of the identified characteristics. Compared to previous studies, this research aims to elucidate the theoretical features of museum virtual human design, fill existing research gaps, and explore implementation strategies in conjunction with practical cases, providing reference directions for the development of virtual humans in Chinese museums.

## **3. Theoretical Research**

### **3.1 Virtual Human**

Virtual humans are typically seen as human-like characters on a computer screen or speaker with embodied life-like behaviors, including speech, emotions, locomotion, gestures, and movements of the head, eyes, or other parts of an avatar body[6]. Its origin can be traced back to the 20th century. In the 1980s, the Japanese anime character "Lynn Minmay" released an album in 1982 and made it to the Oricon music charts. This phenomenon has provided confidence for the future development of virtual humans and has positively influenced the progress and application of entertainment-oriented virtual humans. The term "virtual human" originated from the Visible Human Project (VHP) launched by the National Library of Medicine in 1989[7]. According to the "2020 Development White Paper on virtual humans," virtual humans possess the following characteristics: first, they have specific personal traits,

such as gender, appearance, and personality; second, can express themselves using language, facial expressions, and body movements; third, they can recognize the external environment and engage in communication and interaction with humans[8]. The virtual human studied in this article refers to a fictional character created through digital technology and artificial intelligence algorithms that stimulate human appearance, behavior, and interaction.

### 3.2 Definition of Museum Virtual Human

Many museums, rooted in tradition, are no longer confined to traditional approaches and are beginning to explore the integration of virtual humans with museums. The virtual human "Marx" introduced by the Hans-Nietsch-Stiftung Museum in Germany in 2005 is an illustrative case[9]. It provides a valuable reference for exploring the research on dialogue behavior between museum virtual humans and users. Another example is the virtual human "Coh" launched by the National Museum of Emerging Science and Innovation in Japan in 2021[10]. This virtual human possesses a realistic and nearly perfect human appearance, and its functionalities align with contemporary trends. In the experimental exhibition "LANDSCAPE" at the National Museum of Emerging Science and Innovation in Japan, "Coh" takes on the role of a guide. Users need to wear the specified smart glasses, "NrealLight," and "Coh" will appear in the exhibition area where the user is located, providing natural explanations based on user requests. While virtual humans in Chinese museums are still in the early stages of development[9][11], many museums are actively making attempts[11]. In 2021, the Sanxingdui Museum launched the virtual human-centered rock band "Dui Dui Band." While this virtual band does not possess functionalities related to museum services, it has contributed to the museum's marketing and the integration of cultural exchange. In 2022, China's first virtual human museum with service and communication capabilities, "Wen Yaoyao," made its official debut. "Wen Yaoyao" is affiliated with the China Cultural Relics Exchange Center and serves as an interpreter. In September 2022, the virtual human "Ban Zhao" appeared at the Qiqiao Cultural Museum in Guangzhou, allowing users to explore the museum online by scanning QR codes and experiencing the tour guided by "Ban Zhao." Museum virtual humans, originating as technology-driven functional virtual characters, have formed an independent subdivision within the field of virtual humans. The concept of museum virtual humans is relatively new, but a specific definition has yet to achieve unanimous consensus. Through in-depth analysis and integration of early materials, this paper tentatively proposes a definition for museum virtual humans: Museum virtual humans are comprehensive virtual humans driven by technology tasked with cultural exchange functions for museums.

### 3.3 Digital Humanities

The concept of Digital Humanities originated in the 1940s when Italian scholar Roberto Busa utilized computer technology to create the landmark "Index Thomisticus," a comprehensive index of the works of Thomas Aquinas, marking the beginning of a data revolution in the humanities[12]. Digital Humanities represents the organic integration of digital technology with humanities research, with its current academic definition generally revolving around the processing, services, research, and education activities related to the digitization and application of resources within the humanities and social sciences. Virtual humans are a product of the development of computer technology, and as museum exhibitions gradually transition to digital formats, the emergence of virtual humans provides museums with innovative display methods and communication tools. The methods and perspectives of Digital Humanities can offer theoretical guidance and practical approaches for the development of

museum virtual humans, optimizing their applications, expanding channels for cultural display, and enhancing the ability to disseminate culture.

### 3.4 Technology Development

Technological innovation has continually expanded virtual humans' application areas and capabilities, gradually evolving from simple image or dialogue generation tools into virtual entities with more complex, intelligent, and human-like features. AR and VR technologies are widely adopted[13]. Virtual humans have become crucial elements in museums' cultural exhibition and preservation, as they can emulate historical figures, storytellers, visitors, and private guides and assume the role of guiding visitors within the museum[14]. In a previous study, Effie Karuzaki and colleagues introduced a cost-effective method to create real-time interactive virtual humans[15]. These virtual humans were designed to provide information about the machines exhibited at the Chios Mastic Museum and narrate the people's lives from that era to visitors through narratives. The study provides a detailed description of the steps involved in creating and presenting virtual humans in virtual environments, including VR and AR, offering practical experience and methods for the technical construction of virtual humans. Research by scholars has also demonstrated that virtual humans can enhance user engagement and attract a larger number of human visitors[16]. The development of artificial intelligence also brings additional potential for the advancement of virtual humans a period Generative AI models such as ChatGPT, Midjourney, and DeepBrain are among the most disruptive technology breakthroughs in recent years[17]. Building upon this foundation, this paper categorizes the essential technologies constituting virtual humans into three aspects: character generation, character driving, and character interaction [Table 1]. In this context, character generation, referring to the creation of the appearance of virtual humans, currently encompasses various advanced technologies, including computer graphics, deep learning generative models, static scanning, and custom parametric models. Character-driving technology refers to the set of techniques and methods used to animate virtual characters, enabling them to move, interact, and behave realistically within a digital environment. This technology relies heavily on computer vision, a field within computer science that focuses on enabling computers to interpret and understand visual information from the real world. In the context of virtual humans, computer vision technology is employed to capture and track the movements of real-world objects or individuals, such as human actors or performers. This process involves utilizing cameras and sensors to record motion data from multiple viewpoints, enabling the creation of accurate digital representations of human movements. Multi-angle motion capture refers to the process of capturing movement data from various perspectives simultaneously. This approach allows for a more comprehensive and detailed recording of motion, as it captures nuances and subtleties that may not be evident from a single viewpoint. By incorporating data from multiple angles, virtual human animations can be more lifelike and natural, enhancing the overall realism of the digital characters. Continuous improvements in capture precision refer to ongoing advancements in technology and techniques aimed at increasing the accuracy and fidelity of motion capture systems. This includes developments in camera technology, sensor technology, motion tracking algorithms, and data processing methods. As these technologies evolve, they enable more precise and reliable capture of motion data, resulting in virtual human animations that closely mimic real-world movements with greater accuracy and realism. Regarding rendering technology, breakthroughs in hardware capabilities and algorithms have significantly enhanced rendering speed and effects, resulting in a more realistic representation of virtual humans. Character interaction in virtual humans refers to the ability of digital characters to communicate with users in a manner that simulates human-like interaction. This interaction can take various forms, including verbal communication, gesture recognition, facial expressions, and body language. Speech recognition technology allows

virtual humans to understand and interpret spoken language input from users. This technology involves the use of algorithms and machine learning techniques to analyze audio signals and convert them into text, which can then be processed and understood by the virtual human. Natural language processing (NLP) is another essential technology for character interaction, enabling virtual humans to understand and generate natural language text. NLP algorithms analyze and interpret the meaning of text input, allowing virtual humans to engage in meaningful conversations with users, answer questions, and provide information or assistance. Text-to-speech (TTS) technology enables virtual humans to convert written text into spoken language output. This technology synthesizes human-like speech from text input, allowing virtual humans to communicate verbally with users in a natural and intelligible manner. Additionally, other technologies may be utilized in character interaction, such as gesture recognition, facial expression analysis, and body language interpretation. These technologies enable virtual humans to respond to non-verbal cues from users, such as hand gestures, facial expressions, and body movements, enhancing the overall realism and immersion of the interaction. Through the collaborative application of these technologies, virtual humans can achieve multimodal interaction, meaning they can interact with users through multiple channels simultaneously. For example, a virtual human may engage in a conversation with a user using speech recognition and natural language processing while also responding to their gestures and facial expressions. This multimodal interaction enhances the immersive experience for users, making the interaction with virtual humans more engaging, realistic, and intuitive.

[Table 1] Virtual Human Technology Overview

Module	Technologies Used
Character Generation	Computer Graphics, Deep Learning Generative Models, Static Scanning Modeling, Dynamic Light Field Reconstruction, Custom Parameterized Models
Character Driving	Computer Vision-based Motion Capture, Optical Motion Capture, Inertial Motion Capture, AI and Behavior Modeling
Character Interaction	Speech Recognition, Natural Language Processing, Text-to-Speech Conversion, Virtual Reality, Augmented Reality

Virtual humans represent a fusion of modern information technology, and technological advancements are conducive to museums developing new service approaches in the contemporary era. Simultaneously, it showcases the prospects and potential of digital technology in the cultural industry.

#### 4. Research Methods

This paper adopts a theoretical approach, beginning with a literature review methodology. The selection criteria for sources include relevance to the topic, recency, and credibility. Data collection involved systematic searches of academic databases, institutional repositories, and relevant websites, focusing on scholarly articles, conference proceedings, and official reports.

Through a multidimensional interpretation of the definition of virtual humans, the research focuses on virtual humans created through digital technology and artificial intelligence algorithms. By organizing early data and existing examples of museum virtual humans domestically and internationally, the paper proposes a preliminary definition for museum virtual humans, providing a conceptual framework for understanding the concept. Additionally, the paper compiles the technology development process for museum virtual humans, providing an initial exposition of the technical support content. The technological content of museum virtual humans is organized into the theoretical

framework of this paper, serving as a foundation for subsequent research on the design characteristics. In the design process of museum virtual humans in China, there needs to be more thorough clarification regarding the attributes of real museum staff and museum virtual humans. This has resulted in an inability to leverage museum virtual humans' distinctive features and advantages fully. To address this issue, this research compares and contrasts actual humans with virtual humans from museums, summarizing and evaluating the benefits of virtual humans. It constructs an information model for museum virtual humans, supporting subsequent research. In the study of the characteristics of museum virtual humans, three key features have been identified: diverse appearances, innovative media forms, and sustainable service systems. This work lays the groundwork for further research.

Finally, the above theoretical framework and characteristics are validated utilizing a case study approach. Taking the museum virtual human "Ai Wenwen" as an example, the paper analyzes relevant interview data, functional positioning, and media communication forms. Simultaneously, it explores the application strategies of Chinese museums in designing museum virtual humans, offering reference points for future development.

## 5. The Design Features of Museum Virtual Human

### 5.1 Research Process

#### 5.1.1 Comparative Analysis: Virtual Humans and Real Humans in Museum Environments

The integration of the virtual human industry in China is still in its early stages, particularly with limited sample applications in museums. Virtual humans are often utilized as substitutes for real human staff rather than fully capitalizing on their unique advantages. This study compares virtual humans with traditional museum staff regarding Appearance Generation, Interactivity, Cost, Adaptability, Sustainability, and User Experience. The analysis will focus on identifying differences across these six aspects, ultimately summarizing the advantages of virtual humans.

[Table 2] Comparative Analysis: Virtual Humans vs. Museum Staff in China

Comparison Criteria	Virtual Human	Museum Staff (Real Human)
Appearance Generation	customizable and realistic appearance	Realistic appearance but less adjustable
Interactivity	Real-time interaction and speech recognition technology	Natural interaction, but constrained by time and space
Cost	Lower production and operational costs	High costs, including salaries and training expenses
Adaptability	Adaptable to different cultures and contexts	Limited to specific cultures and contexts
Sustainability	Can remain fresh through updates	Limited by lifecycle and physiological conditions
User Experience	Multi-modal display, providing an immersive experience	Realistic feel and human touch

By comparing the table, we can see significant differences between virtual humans and real humans across various dimensions. Regarding appearance generation, virtual humans provide customizable and lifelike appearances, whereas real humans, although authentic in appearance, have relatively limited adjustment capabilities. Regarding interactivity, virtual humans excel in real-time interaction and speech recognition technology, while the interaction of museum staff is highly natural but

constrained by time and space limitations. In terms of cost, virtual humans have lower production and operational costs compared to real humans, who incur higher costs, including salaries and training expenses. In adaptability, virtual humans demonstrate high adaptability to different cultures and contexts, while real humans are confined to specific cultural and contextual limitations. Sustainability-wise, despite potential privacy issues in the data handled by virtual humans, they can maintain freshness through continuous data updates; in contrast, the sustainability of real humans is constrained by lifecycle and physiological conditions. Finally, in user experience, virtual humans provide an immersive experience through multi-modal displays, while real human interaction emphasizes realism and human touch.

These comparisons highlight the unique advantages of virtual humans in aspects such as appearance, adaptability, and sustainability while acknowledging museum staff's inherent qualities, such as naturalness and authenticity. The differences outlined in the table emphasize that virtual humans serve as a valuable complement to interpersonal interactions rather than a substitute for real human staff, showcasing their unique value in museum environments.

### 5.1.2 The Information Model of Museum Virtual Humans

Based on the above research and combined with the applications of virtual humans in museums both domestically and internationally, this study has constructed an information model for museum virtual humans [Fig. 1]. It is believed that virtual humans possess four advantages in two aspects, which can effectively enhance the service quality of museums.

Firstly, virtual humans demonstrate two advantages: diverse roles and immersive experience in the realm of innovative showcases within the museum.

(1) Diverse roles. Highly anthropomorphic virtual humans can adeptly mimic staff and users, creating a novel form of interaction and introducing an innovative paradigm for presenting cultural content. For instance, virtual humans can be storytellers, dynamically giving cultural content through immersive narrative techniques. Concurrently, they can disrupt users' preconceived notions of staff stereotypes.

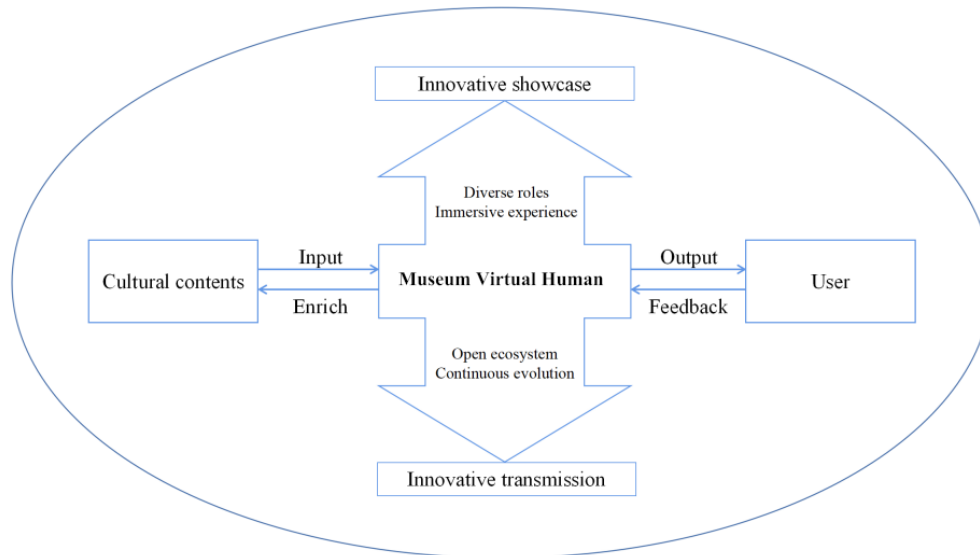
(2) Immersive experience. Virtual humans can simulate real scenarios, delivering knowledge and providing services in a manner that blend the virtual and the real. For example, leveraging virtual human technology allows the simulation and presentation of historical figures, incorporating them into museum exhibitions. This display method offers opportunities for a profound understanding of historical events and figures and provides audiences with interactive experiences with historical personalities.

Furthermore, this study summarizes the advantages of innovative transmission: an open ecosystem and continuous evolution.

(1) Open ecosystem. Virtual humans can be crucial in various aspects, such as resource integration, data enhancement, and contextual reconstruction. This transforms users from mere museum spectators into active participants, enabling them to contribute rich content to the museum's resources and knowledge. This shift disrupts traditional resource generation models by constructing an open ecosystem through a decentralized User-Generated Content (UGC) model. Communities play a pivotal role in this ecosystem, becoming a potent force for preserving and transmitting of cultural content.

(2) Continuous evolution. Virtual humans achieve ongoing iteration and evolution through continuous learning and training with domain knowledge and user data[19]. This learning process enables virtual humans to continuously optimize user experience, providing services that better align with user expectations, thus effectively promoting improved cultural content transmission. In interactions with users, virtual humans can glean more information about user preferences, needs, and

feedback from each interaction. By monitoring and analyzing user behavioral data, virtual humans can offer users personalized knowledge, tools, or targeted guidance[20]. As data accumulates, the virtual human system undergoes continuous evolution and upgrades, thereby enhancing the museum’s service level and user experience.



[Fig. 1] The Information Model of Museum Virtual Humans

As shown in [Fig. 1], the outermost circle represents the museum's service scenarios. The museum virtual human organizes and stores cultural content, providing output to users and serving as an innovative showcase. Virtual humans' continuous iteration and evolution play a role in innovative transmission. Museums showcase cultural content to users through virtual humans, while virtual humans offer users opportunities for supplementary information and interaction with cultural content. A two-way bridge is formed between the museum, virtual humans, and users.

## 5.2 Results and Discussion

The above research indicates that the design of museum virtual humans must ensure diverse appearances, innovative media forms, and sustainable service systems. The advantage of museum virtual humans lies in their ability to disseminate cultural content through various technological means, facilitating effective interaction between users and cultural artifacts. Conceptual distinctions and analysis of information models indicate the necessity of maintaining their diversity, innovation, and developmental potential in their design. This maximizes the dynamism between cultural content and virtual humans, as well as between virtual humans and users, ensuring the service system remains in an organic and dynamic balance. Therefore, diverse appearance, innovative media forms, and sustainable service systems as core features in the design of museum virtual humans.

In conjunction with the theoretical framework of Digital Humanities, museum virtual humans, as integrated entities of digital technology, will play a significant role in the fields of culture and communication. Virtual humans can showcase museum collections and cultural content to global audiences through various media forms such as social media and video platforms, thereby expanding the influence and visibility of museums. However, in terms of technology, while virtual human technology has been effective in audio-visual aspects, there is still room for improvement in ensuring user privacy and data security protection. Future advancements in virtual human production will not



only focus on enhancing external performance but also addressing ethical security issues. Solutions may include strengthening data encryption and other technological measures. Although the primary focus of this study is on museum virtual humans in China, given the rising application of virtual humans in museums, international cooperation and standardization will become crucial. International collaborative projects on museum virtual humans may emerge in the future, requiring the establishment of technical standards and data security policies to ensure their sustainable development and secure global application. Future research will delve into these aspects.

In conclusion, this study complements previous research on museum virtual humans, systematically outlining their technology and providing an information model for museum virtual humans. It discusses the future development and research directions of museum virtual humans, emphasizing the importance of maintaining diverse appearances, innovative media forms, and sustainable service systems in both theoretical and practical processes of designing these virtual entities.

## 6. The design strategy of "Ai Wenwen"

### 6.1 Diverse Appearance

The name "Ai Wenwen" in the Chinese context conveys the meaning of being based on artificial intelligence technology, showcasing a love for civilization, culture, cultural relics, and enthusiasm for work. The appearance of the virtual human can be controlled[21]. As a museum virtual human, "Ai Wenwen" possesses diverse appearances empowered by technology. The "New Youth" T-shirt worn by "Ai Wenwen" is inspired by the cover of "New Youth" from the collection of the National Museum of China, conveying the spiritual beliefs of the new youth in the new era. The image of an ancient girl draws inspiration from costumes and makeup featured in the "Exhibition of Ancient Chinese Costume Culture" currently showcased at the National Museum, showcasing the profound roots of traditional Chinese culture. The earring worn by "Ai Wenwen" is creatively derived from museum artifacts and is also one of the creative products of the National Museum. As a museum virtual human, the image of "Ai Wenwen" not only extends to modern society but also delves into ancient times, bridging the communication between the past and present.

Through advanced technological means, including 3D modeling, speech synthesis, motion, and facial capture, "Ai Wenwen" possesses a lifelike appearance and realistic facial expressions. Lip movements are synchronized in real-time with the voice, enabling the ability to express emotions and engage in communication. With movements and expressions resembling those of a real person, even the hair and clothes sway with the wind, creating an immersive experience for users as if they can transcend time and personally listen to the ancient girl narrate historical stories. The application of such technology makes the image of "Ai Wenwen" more vivid and closer to reality, providing users with a sense of being present and deepening their firsthand experience of cultural content. Through these technological means, the museum virtual human "Ai Wenwen" serves as a digital display medium and offers audiences a rich cultural experience.

### 6.2 Innovative Media Forms

On June 10, 2023, the "2023 Annual Outstanding New Media Communication Project for Chinese Cultural Relics," organized by the State Administration of Cultural Heritage and the Cyberspace Administration of China, announced the recognition of "Ai Wenwen." Ai Wenwen garnered extensive media attention, with professional media publishing over 700 articles and online media sharing more than 3,300 related pieces of information. Her audio and video content accumulated nearly 1.4 million views across various online platforms, with Weibo readings surpassing 1.15 million.

Through the "cloud exhibition of Chinese civilization" mini-program, Ai Wenwen transforms into a guide for the museum's digital twin cloud exhibition space, leading viewers along different thematic exhibition routes to deeply appreciate cultural content. Simultaneously, Ai Wenwen actively shares short videos and original songs online, using various forms to promote the richness of Chinese culture. Users can experience Ai Wenwen's explanations through the "China National Museum" app and mini-program. This paper outlines the communication media involved with Ai Wenwen, these innovative media approaches not only enhance user engagement but also accelerate the dissemination of cultural content. Through these media platforms, users can gain a more comprehensive and multi-angle understanding of the cultural content of the China National Museum.

[Table 3] Media Platforms Involved in Ai Wenwen

Media Platforms	Platform Names
Professional Media	China Central Television (CCTV)
Social Media	Weibo
Video Platforms	Bilibili, TikTok (Douyin)
Application	China National Museum APP
mini-program	cloud exhibition of Chinese civilization
Music Platform	music.migu

### 6.3 Sustainable Service Systems

As a museum digital entity, it requires an aesthetically pleasing appearance and an engaging personality. Artificial intelligence, serving as one of the driving "brains" of the museum, is both a core element enabling the virtual character to perceive actions and provide feedback and a key factor in mastering and learning skills. It is also the foundation that allows "Ai Wenwen" to undergo self-evolution and iteration.

In content construction, the museum must undertake substantial foundational work to provide 'Ai Wenwen' with information input. Museum knowledge information can currently be broadly categorized into two types. The first includes service-oriented information such as traffic details, opening hours, and facility services. The second encompasses knowledge-oriented information, including exhibition details, artifact information, historical facts, and general and specialized knowledge. "Ai Wenwen" possesses exceptional self-learning and adaptive abilities, continuously updating and enriching her knowledge base. Ai Wenwen has constructed a rich reservoir of knowledge and interactive skills on a foundation of over 1.4 million items in the museum's collection.

## 7. Conclusion

The progress of science and technology has opened up new possibilities for the functionality of virtual humans. In innovative presentation and dissemination of museum cultural content, museum virtual humans can play a more significant role in leveraging these advantages. However, research on museum virtual humans in China is still in its early stages, facing various theoretical study and practice issues. Clarifying the distinctions between museum virtual humans and real staff is beneficial for the rational utilization of virtual human resources, harnessing the unique characteristics and advantages of museum virtual humans.

This paper, grounded in the current status of museum virtual human design in China, outlines the design features suitable for Chinese museum virtual humans. In this study, emphasizing diverse

appearances, innovative media forms, and a sustainable service system become the foundational characteristics of museum virtual humans. This paper fills the research gap in domestic museum virtual humans, providing technical analysis and an information model for the study of museum virtual humans, and also anticipates the future development of virtual humans. As a relatively successful example of a museum virtual human in China, "Ai Wenwen" effectively validates these foundational characteristics in various aspects. Additionally, it provides more concrete methods for the practical application of museum virtual humans in China, offering valuable insights.

The analysis in this paper focuses on one aspect of the design characteristics of museum virtual humans, lacking targeted theoretical analysis. Ensuring data security and user privacy poses a significant challenge in the practical implementation of museum virtual humans, and ethical and legal issues arising during their application warrant thoughtful consideration. In the case analysis of museum virtual human designs, variations among different designs must be acknowledged; a sole focus on "Ai Wenwen" is insufficient. Over time, theories will continuously evolve and develop, and China is expected to witness the emergence of more museum virtual human models. In the future, this paper aims to comprehensively analyze the design strategies of Chinese museum virtual humans by incorporating perspectives on cultural diversity and emotional interaction.

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