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Research on Digital Technology of Paleontological Skeletal Specimens and Its Application in Museum Display

Ruize Qi

Living Word Shanghai (LWS), Shanghai, China

Abstract. Digital technology plays an increasingly important role in the display of paleontological skeletal specimens. Through technologies such as high-precision scanning and virtual reality, viewers can immerse themselves in the living environment of ancient organisms and experience unprecedented interaction. In this process, there are also technical challenges, such as the fragility of specimens, the balance between scientific and educational display content, and so on. In order to fully leverage the advantages of digital technology, museums need to strengthen technological research and innovation, enhance audience education and guidance, and focus on cross platform cooperation and intelligent management. In the future, with the continuous advancement of technology, personalized and customized display experiences will become possible, bringing audiences richer and more vivid knowledge of paleontology. The application of digital technology not only enhances the display effect of paleontological specimens, but also injects new vitality into paleontological research and knowledge dissemination. Thoroughly studying the digital technology of paleontological skeletal specimens and its application in museum exhibitions is of great significance for promoting the development of paleontological research and enhancing public scientific literacy.

Keywords: Paleontological skeletal specimens, Digital technology, Museum Display.

1. Introduction

As a bridge connecting the past and present, paleontological skeletal specimens carry important information about the evolution of life on Earth [1]. These precious specimens are not only key physical evidence for paleontologists to study the origin, evolution, and extinction of organisms, but also an intuitive window for the public to understand Earth's history and explore the mysteries of life. Due to the rarity and fragility of paleontological skeletal specimens, their preservation, display, and research face many challenges [2].

With the rapid development of technology, digital technology has gradually emerged, bringing revolutionary changes to paleontological research [3]. Through advanced technologies such as 3D scanning and digital image processing, researchers can obtain high-precision and quantifiable digital data without directly contacting the original specimen, greatly improving the efficiency and accuracy of research. Digital technology also provides new possibilities for the preservation and display of paleontological skeletal specimens, enabling these precious legacies to be inherited and displayed for a longer and more extensive period of time [4].

In museum exhibitions, digital technology has demonstrated enormous potential application value. Through cutting-edge technologies such as virtual reality and augmented reality, viewers can immerse themselves in the living environment of ancient organisms and interact with them across time and space. This immersive and interactive display method not only enriches the audience's visiting experience, but also deepens the public's understanding and interest in paleontology, promoting the popularization and dissemination of scientific knowledge [5].

2. Specific implementation methods of digital technology for paleontological skeletal specimens

The specific implementation method of digitalization technology for paleontological skeletal specimens mainly relies on advanced scanning and processing technologies to ensure accurate three-dimensional digitization of paleontological skeletons [6].

Utilize high-precision 3D scanners to perform overall scanning of paleontological skeletal specimens. This step captures the details of the bone surface using laser or optical technology in a non-contact manner, generating a large amount of point cloud data. These point cloud data can accurately reflect the shape and structure of bones [7].

Process the obtained point cloud data. This step includes steps such as data cleaning, noise reduction, registration, and gridding. Data cleaning mainly involves removing redundant data and noise generated during the scanning process to improve the accuracy and reliability of data. Noise reduction further reduces the interference factors in the data, making it smoother. Registration is the process of merging multiple scan data into a complete 3D model, ensuring that the various parts of the skeleton are correctly aligned in digital space. Grid transformation is the process of converting point cloud data into a three-dimensional mesh model, making the model easier to process and analyze [8].

After the data processing is completed, use 3D modeling software to further optimize and repair the mesh model. Due to the possibility of damaged or missing parts in the bones of ancient organisms, software tools are needed to fill and repair them [9].

The digital technology of paleontological skeletal specimens can achieve precise three-dimensional digitization of skeletal specimens, providing strong support for paleontological research, teaching, and display. Table 1 clearly shows the specific implementation methods of digital technology for paleontological skeletal specimens.

Table 1 Specific Implementation Methods of Digital Technology for Paleontological Skeletal Specimens

Technology/Method	Describe	Objective
High precision 3D scanning	Using laser or optical technology to non-contact scan paleontological skeletal specimens and capture surface details	Generate accurate point cloud data that reflects bone morphology and structure
Data processing	Data cleaning, noise reduction, registration, and gridding	Remove redundant data and noise to improve data accuracy; Reduce interference factors and smooth data; Merge multiple scanned data into a complete 3D model; Convert point cloud data into a 3D mesh model
3D modeling optimization and repair	Using 3D modeling software to fill and repair mesh models	Repair possible damaged or missing parts of paleontological skeletons
Application	Paleontological research, teaching, and exhibition	Provide accurate 3D digital models that support multiple application scenarios

3. Research on the application of digital technology in the exhibition of paleontological skeleton specimens in museums

The application research of digital technology in the display of paleontological bone specimens in museums has been an important topic in the fields of museum science and paleontology in recent years. With the continuous development of technology, digital technology has brought revolutionary changes to the display methods of museums, especially in the display of ancient biological skeleton specimens, its application has shown enormous potential and value [10].

In the display of paleontological skeletal specimens, digital technology provides advanced technologies such as 3D scanning, virtual reality, and augmented reality, allowing viewers to view and learn these precious fossils in a new way. Through 3D scanning technology, museums can obtain high-precision digital models of paleontological bone specimens, which can be displayed on computers, tablets, or mobile phones, allowing audiences to appreciate and learn anytime, anywhere.

The application of virtual reality technology further enhances the visitor experience. Viewers can wear glasses and feel as if they are in the living environment of ancient creatures, engaging in face-to-face communication with these extinct creatures. This immersive experience not only allows the audience to have a more intuitive understanding of the living habits and ecological environment of ancient organisms, but also stimulates their interest and curiosity in paleontology.

Augmented reality technology allows viewers to interact with real-life paleontological bone specimens through intelligent devices. Viewers can view virtual tags of bone specimens on their mobile phones or tablets, and learn about the names, ages, and places of discovery of the specimens. At the same time, they can also zoom in or out of specimens by touching the screen, and even perform virtual dissection to gain a deeper understanding of the internal structure of ancient organisms.

The application of digital technology in the display of paleontological bone specimens in museums not only enhances the fun and interactivity of the display, but also expands the learning channels and methods for the audience. The application of this technology not only benefits the popularization and dissemination of paleontology, but also opens up new paths for the future development of museums.

4. Challenges and countermeasures of digital technology in the display of paleontological skeletal specimens

4.1 The technical challenges of digital technology in the display of paleontological skeletal specimens

Although digital technology has brought unprecedented opportunities in the display of paleontological skeletal specimens, it also faces some technological challenges.

Paleontological skeletal specimens are usually ancient and have fragile textures, which requires extremely high requirements for digital scanning technology. How to obtain high-precision and high-resolution 3D data without damaging the specimen is a huge challenge. In addition, paleontological skeletal specimens often have defects, damages, or petrification, which pose higher requirements for the adaptability and data processing capabilities of scanning equipment due to their complex morphology and texture.

The storage and management of digital data is also a technical challenge. The digital data of paleontological skeletal specimens usually contains a large amount of 3D models, texture maps, and metadata information. How to effectively store this data and quickly retrieve and call it when needed is an important problem faced by museums.

The application of virtual reality and augmented reality technology also faces technological challenges. How to ensure the realism and immersion of virtual scenes, how to design a reasonable interactive experience, and how to solve device compatibility and user adaptability issues are all technical challenges that museums need to overcome when promoting digital displays.

Although digital technology has great potential in the display of paleontological skeletal specimens, it also requires continuous overcoming of challenges at the technical level to achieve better display results.

4.2 The display challenges of digital technology in the display of paleontological skeletal specimens

Audience acceptance and engagement are one of the main challenges faced in presentation. Although digital technology can bring new display experiences, some viewers may lack interest or participation in digital displays due to technological unfamiliarity or inertia dependence on traditional display methods. Therefore, museums need to take effective measures, such as providing detailed usage guides, setting up interactive experience areas, etc., to attract and guide audiences to better participate in digital exhibitions.

Balancing the scientific and educational aspects of display content is also a major challenge. Digital display not only provides a rich visual experience, but also needs to ensure the accuracy and scientificity of the displayed content. Museums need to convey knowledge and information about paleontology to audiences through interesting and vivid displays, while ensuring scientific rigor.

The maintenance and updating of digital display equipment is also a major challenge. With the continuous development of technology, display equipment needs to be constantly upgraded and updated to meet new display needs. Museums need to invest sufficient resources to ensure the normal operation and timely updating of equipment, in order to ensure the stability and sustainability of display effects.

Although digital technology has great potential in the display of paleontological skeletal specimens, it also requires overcoming a series of challenges at the display level to achieve better display effects and educational significance.

4.3 Strategies and suggestions for digital technology in the display of paleontological skeletal specimens

In the display of paleontological skeletal specimens, digital technology undoubtedly brings viewers a new viewing experience and learning methods, but at the same time, it also faces a series of challenges. In order to fully leverage the advantages of digital technology and overcome the challenges it brings.

Strengthening audience education and guidance is crucial. Museums should provide detailed navigation services to introduce the characteristics and usage methods of digital display to the audience, helping them quickly adapt and enjoy this new display method.

It is crucial to enhance the scientific and educational nature of the display content. When planning digital exhibitions, museums should ensure the accuracy and authority of the displayed content, while paying attention to the fun and interactivity of the content. By designing vivid and interesting display scenes, introducing virtual reality and augmented reality technologies, the audience can learn about paleontology in an immersive experience.

Strengthening technological research and innovation is also essential. Museums should closely monitor the development trend of digital technology, continuously introduce new technologies and equipment, and improve the technical level and display effect of digital display.

Museums should increase investment and support for digital displays. Ensure the stable operation and sustainable development of digital display, including funding investment, talent cultivation, equipment updates, and other aspects.

In response to the challenges posed by digital technology in the display of paleontological skeletal specimens, museums should strengthen audience education and guidance, enhance the scientific and educational nature of display content, strengthen technological research and innovation, and increase investment and support. These measures and suggestions should be taken to fully leverage the

advantages of digital technology and overcome the challenges it brings. Table 2 clearly presents the strategies and suggestions for digital technology in the display of paleontological skeletal specimens.

Table 2 Strategies and Suggestions for Digital Technology in the Display of Paleontological Skeleton Specimens

Challenges and Issues	Countermeasures and suggestions	Key technology	Implementation points
Low audience acceptance and participation	Strengthen audience education and guidance	Detailed navigation services	Provide a guide to introducing the characteristics and usage methods of digital displays
Balancing scientific and educational content display	Enhance the scientific and educational nature of display content	Virtual reality (VR) and augmented reality (AR) technologies	Design vivid and interesting display scenes to ensure content accuracy and fun
Insufficient technological research and innovation	Strengthen technological research and innovation	Digital scanning, image processing, etc	Introducing new technologies and equipment to enhance the technological level of digital display
Insufficient investment and support	Increase investment and support	Capital investment, talent cultivation, and equipment updates	Ensure the stable operation and sustainable development of digital displays

5. The future development trend of digital technology in the display of paleontological skeletal specimens

The future development trend of digital technology in the display of paleontological skeletal specimens will lead us into a new era of more diverse, interactive, and immersive exhibitions.

With the continuous advancement of technology, digital technology will achieve deeper integration with the display of paleontological skeletal specimens in the future. High resolution 3D scanning technology, advanced image processing algorithms, and cutting-edge technologies such as virtual reality and augmented reality will continue to be optimized and improved, providing more realistic and vivid display effects for the digital display of ancient biological bone specimens.

The future display of paleontological skeletal specimens will pay more attention to the personalized needs of the audience. By collecting and analyzing audience behavior data and preferences, museums can provide customized display content and interactive experiences for audiences. Viewers can choose different display paths, interactive methods, and learning content according to their own interests, obtaining a more personalized visiting experience.

Digital technology will promote cooperation between museums and other fields and platforms. Museums can establish close cooperation with research institutions, educational institutions, entertainment industries, etc., and jointly develop digital display projects for paleontological bone specimens. This cross platform and cross domain cooperation will promote the popularization and

dissemination of knowledge in the field of paleontology, while enriching the cultural life of the audience.

In the future, digital technology will also promote the intelligence and automation of museum management. By applying advanced technologies such as artificial intelligence and the Internet of Things, museums can achieve digital management, intelligent monitoring, and remote maintenance of paleontological bone specimens. This will greatly improve management efficiency, reduce operating costs, and provide visitors with a safer and more convenient visiting environment.

Driven by digital technology, future displays of paleontological skeletal specimens will place greater emphasis on sustainable development and environmental protection concepts. Museums will adopt more environmentally friendly display materials and methods to reduce their impact on the environment; At the same time, through digital technology, the long-term preservation and inheritance of ancient biological skeletal specimens are achieved, leaving valuable cultural heritage for future generations.

6. Conclusions

The application of digital technology in the display of paleontological skeletal specimens has shown enormous potential and value. Faced with technological challenges such as high-precision scanning of fragile specimens, ensuring a balance between scientific and educational display content, and achieving cross platform cooperation, the museum industry is actively exploring effective strategies and suggestions. In the future, with the deep integration and innovation of technology, we can expect more personalized and customized display experiences, as well as deep cooperation across platforms and fields. These changes will not only enrich the visitor experience, enhance their interest and understanding of paleontology, but also promote the intelligence and automation of museum management, achieving sustainable development and environmental protection concepts. Digital technology has brought not only formal innovation to the display of paleontological skeletal specimens, but also profound impacts on paleontological research and knowledge dissemination. We have reason to believe that with the assistance of digital technology, paleontological skeletal specimens will be revitalized and revitalized.

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