

# Research Report on the Activation of Grotto Mural Dance and Digital Protection in China Based on the Research of Yungang Grottoes in Datong, Shanxi in 2025, Shanxi Media College and Shanxi Film Academy

Li Jiayan

---

Li Jiayan from Shanxi Film Academy, Shanxi Communication University

Date: April 2025

---

## Abstract

---

Grotto mural dances represent a vital legacy of ancient Chinese music and dance culture, possessing immense artistic and historical value. However, their preservation and transmission face severe challenges due to natural weathering, human destruction, and technological limitations. In recent years, the rapid advancement of digital technology has opened new possibilities for documenting, restoring, and revitalizing these murals. Nevertheless, practical implementation still encounters technical bottlenecks, funding shortages, and cultural misinterpretations.

Based on PEST model (political, economic, social, technical), this paper systematically discusses the status quo and core contradiction of the dance revitalization and digital protection of the cave murals in China by combining literature analysis, field research and case study.

## Key words

---

Cultural relic revitalization, Revitalization path, Cave mural dance, Cultural identity

## I. Introduction

The project's core lies in leveraging digital technology to transform two-dimensional images into three-dimensional forms, thereby revitalizing dance

movements. Building on this foundation, it examines the achievements and challenges in current cultural heritage conservation and revitalization efforts. It explores how cutting-edge digital technologies can address complex issues, while refining talent development systems to

cultivate interdisciplinary professionals. Additionally, it outlines diversified funding channels to attract investments in digital technologies, laying a solid groundwork. Ultimately, this approach aims to comprehensively enhance the preservation of cave mural dances, amplify their cultural impact, and ensure the sustainable inheritance and advancement of cultural heritage.

## II. Main Text

### 2.1 Literature Review

Throughout human history, a vast number of ingeniously crafted stone relics have been constructed, including magnificent architectural complexes such as the Egyptian, Greek temples, and Angkor Wat, as well as grand cave temple complexes like the Bamiyan Buddhas in Afghanistan and the Yungang Grottoes in China. It is well known that stone possesses remarkably stable properties, allowing for long-term preservation. However, due to natural phenomena such as weathering and corrosion, the aging rate of cave temple relics is accelerating, and the protection and research of these relics have garnered widespread attention. According to the analysis of the CNKI Academic Attention Index, the number of Chinese-related literature on cultural relic revitalization showed a gradual upward trend from 2010 to 2020, with a significant increase after 2017. Additionally, based on the search results of keywords such as cultural relic revitalization, cultural relic big data, cultural relic informatization, and cultural relic digitization in CNKI over the past decade, it can be observed that alongside research on cultural relic revitalization, the research intensity on cultural relic big data, cultural relic informatization, and cultural relic digitization has also shown an upward trend, particularly with the growth momentum of cultural relic digitization being exceptionally remarkable.

### 2.2 Research Background

#### (1) Vulnerability of material carriers

Natural weathering and erosion: most of the cave murals are located in open-air or semi-open-air environment, which are affected by the natural factors such as wind, rain, sunlight, temperature and humidity change, and the pigment layer peeling off, fading and alkali

problem are serious (such as Yungang Mogao Grottoes, Yungang Grottoes, etc.).

Human-induced damage: Tourists 'inhalation of carbon dioxide, physical contact, and improper restoration methods (such as the early 'painting protection' practice) accelerate the deterioration of murals.

#### (2) Technical Bottlenecks in Dance Activation

The difficulty of action restoration: the dance posture of the mural is mostly static two-dimensional image, lacking of continuous motion record, the body movement and rhythm need to rely on speculation, which is easy to deviate from the historical reality.

The lack of interdisciplinary collaboration: the communication between choreographers and archaeologists and art historians is not smooth, which leads to the controversy of "over-modernization" or "rigid restoration" in the revitalization of works (e.g. some commercial performances are criticized as "distorted").

#### (3) Challenges of Digital Protection

Technical standards are inconsistent: there are no industry-wide specifications for scanning precision (millimeter or micrometer level) and color accuracy (due to variations in pigment mineral composition), making data sharing difficult.

Low utilization of digital resources: High-cost 3D models and multispectral images are mostly used in academic research, while public communication is limited to simple VR displays with insufficient interactivity.

### 2.3 Theoretical Design

#### (1) Theories of Cultural Heritage Protection

The authenticity principle (Venice Charter): the digital restoration should strictly follow the original form of the mural, and distinguish the boundary between "archaeological restoration" and "artistic creation".

The theory of living inheritance: through the dynamic restoration of dance, the static murals are endowed with contemporary vitality, such as the symbolic deconstruction and reconstruction of the movements of the "Ji Yue Tian" in Yungang.

#### (2) Theories of Dance Anthropology

Body language: Analysis of the temporal and spatial characteristics of the mural dance (such as the axial rotation of the "Hu Xuan Dance" in the Northern Wei Dynasty and its connection with the Western Regions

culture).

The ritual field reconstruction: The cave dance was originally a part of the religious ritual, and its revitalization needs to restore its sacred and secular context.

### Current Status of Protection of Grotto Dance Mural



In view of the distribution of key Buddhist grotto temples in China, the protection and revitalization of grotto murals and dances have made some progress, but still face challenges such as technical bottleneck, lack of funds and interdisciplinary collaboration.

## 2.4 Basic protective measures

(1) Physical protection: Most key grottoes (e.g., Yungang Grottoes, Dunhuang Mogao Grottoes) have implemented measures such as temperature and humidity control and visitor flow limitation, but smaller grottoes (e.g., some caves at Maijishan in Gansu) still face the threat of natural weathering.

(2) Digital archiving:

High-precision scanning: Laser scanning has been completed for some caves in the Yungang and Longmen grottoes (with an accuracy of 0.1mm), but only 30%-50% of the open caves are covered.

Multispectral imaging: Used to reveal the original appearance of faded murals (e.g. the color restoration of the "Reversed Pipa" dance posture in the Yungang Cave 220).

### primal problem

(1) Disease aggravation: more than 60% of the murals have problems such as alkali efflorescence and flaking, and the speed of restoration lags behind the speed of deterioration.

(2)Data silos: The inconsistent digitization standards among various grottoes hinder data sharing (e.g., Yungang employs RGB+ multispectral imaging, while prioritizing 3D modeling).

### Status of Dance Activation Practice

Main activation forms (Table analysis)

form	case	superiority	limit
the living theatre	Yungang Long Sleeve Dance, Yungang Festival, Flying Apsaras and Music	Strong visual impact and broad audience reach	Artistic Exaggeration and Doubtful Historical Accuracy
virtual restoration	Follow the mural characters to learn to dance with AR device	Immersive Interaction, Protecting Cultural Relics	High equipment costs and low penetration rates
short video communication	"Digital Dunhuang + Yungang: Music and Dance"	Rapid dissemination and appeal to younger demographics	Easy to be superficial, lack of cultural connotation

## 2.5 Focusing on Contradictions

Historical authenticity versus artistic innovation: Some reimagined works cater to market demands through excessive adaptations (e.g., reimagining Tang Dynasty palace life)

Ting Dance (a blend of traditional and modern street dance styles).

Academic Research vs Mass Communication: Scholars emphasize rigorous reconstruction, while the public prefers entertaining expressions. We have listed the preset solutions for each case:

Clarify the boundaries of adaptation, consult with professionals before changes, and determine which aspects can be innovated and which must be preserved. For instance, costumes and movements should retain historical authenticity, while musical rhythms, lighting, and stage design should be moderately innovated to restore historical accuracy.

Build a communication bridge, let scholars participate in the early planning of mass communication works, and at the same time, use more popular and understandable ways to package academic achievements, and present the rigorous restoration content in a popular way to the public.

### ·Current Status of Digital Technology Applications

(1) Technological Advances · 3D Modeling

The limitation of the method is that the simulation

accuracy of complex posture (e.g. the dynamic of flying apsaras) is not enough.

### ·Motion capture

Combined with the analysis of modern dance, such as the Tang Dance in Beijing Dance Academy, the challenge is that the static images of the murals cannot provide the data of the continuous movements.

(2) Technical pain points

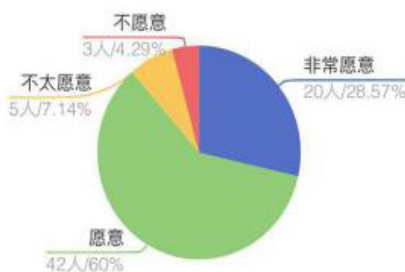
Color Reproduction Deviation: Mineral pigments (e.g., lapis lazuli, cinnabar) tend to exhibit distortion on digital screens.

Data storage pressure: The scanning data of a single cave can reach the TB level, and the long-term maintenance cost is high.

### 2.6 PEST Summary: Cross-Contradictions and Countermeasures

bedding	core contradiction	policy orientation
politics	Strong policy support but fragmented implementation standards	Establishing National Technical Specifications for Grottoes Digitization
economy	The Contradiction of High Investment Demand and Low Commercial Return	Explore the "public welfare + business" model (e.g., IP licensing and development)
society	Popular Communication Is Hot, but Cultural Interpretation Is Shallow	Enhance academic translation (e.g., combining short videos with expert commentary)
technology	Frontier technology application and data sharing are insufficient	Establish cross-institutional data platform and open source part of the algorithm

您是否愿意为石窟壁画舞蹈活化与数...



The significance of activation and digital protection: Inheritance of cultural heritage. 61.4% of the participants think that inheritance of cultural heritage is the main significance of

activation and digital protection, which emphasizes the cultural value of protection work. No specific data was provided in the survey, but it can be inferred that the participants may think that the current technology has some shortcomings in the accuracy of restoration and dynamic expression when presenting the cave dance, and further technological progress and innovation are needed.

In conclusion, the dance revitalization and digital protection of cave murals in China have been widely supported by the public.

## 2.7 Cross-media Narrative Matrix

media form	type of action	case
augment reality (AR)	Immersive experience of superimposed reality and illusion	AR projection of flying apsaras in the cave
Holographic theater	Reconstruction of 3D Spatial Narration	"Millennium in a Moment" 4D Dance Show
interactive device	Audience Participation in Cultural Production	Motion capture mimics flying movements

## 2.8 Safeguard Mechanisms

### (1) Organizational Structure

Joint Leading Group: Headed by the Vice Governor of Shanxi Province, comprising 12 departments including cultural relics, tourism, and industry and information technology

Expert Committee: Establish an Archaeological Group (responsible for authenticity review), a Technical Group (responsible for data security), and an Artistic Group (responsible for creative supervision).

### (2) Financial Guarantee

Special Fund Pool: An annual fixed investment of no less than 80 million yuan (50% from provincial finance, 30% from national grants, and 20% from social capital).

## III. Conclusion

The revitalization and digital preservation of cave-dwelling mural dances present both technical challenges for cultural heritage transmission and cultural propositions for the contemporary revival of traditional arts. Taking the Yungang Grottoes as an example, the dance figures such as Flying Apsaras and Celestial Musician not only carry the historical memory of multicultural integration during the Northern Wei Dynasty, but also gain new vitality through digital technology.

This research systematically explores the "living" inheritance of cave dance art through high-precision digital collection, artificial intelligence action restoration, and immersive interactive experiences. We must also clearly recognize that technological applications should be grounded in rigorous academic research to avoid cultural misinterpretation and excessive commercialization, ensuring a balance between preservation and innovation.

In the future, with the evolution of technologies such as the metaverse and AI generation, the digital preservation of cave art and the revitalization of dance will embrace broader possibilities. We hope that the experience of the Yungang Grottoes can provide reference for other similar cultural heritage sites, promoting the creative transformation and innovative development of China's traditional art in the global digital era, allowing the thousand-year-old dance movements to transcend time and space, and continue to dance in the cultural lives of contemporary people.

Let technology continue civilization and dance tell history.

## IV. Acknowledgments

The successful completion of this research report is attributed to the support and assistance of numerous experts, institutions, and teams. We extend our sincere gratitude to all involved.

The protection and innovation of cultural heritage is a sustainable mission, and we hope that all sectors will join hands to protect the treasure of human civilization.

## V. References

### 1. Academic Works

- [1] Yungang Grottoes Research Institute. Complete Works of Yungang Grottoes. Cultural Relics Publishing House, 2014.
- [2] Wang Kefen. History of Dance Development in China. Shanghai People's Publishing House, 2004.
- [3] Zheng Ruzhong. Research on Music and Dance in Dunhuang Murals. Gansu Education Press, 2002.

- [4] Li Song. *Buddhist Art Archaeology: From India to China*. Cultural Relics Publishing House, 2018.

**2. Journal Articles**

- [5] Zhang Qingjie. "Research on the Musical and Dance Images in the Yungang Grottoes." *Cultural Relics*, 2016(5):56-68.
- [6] Liu Enbo. "Music and Dance Culture in the Pingcheng Period of the Northern Wei Dynasty". *China Musicology*, 2019(3):45-52.
- [7] Zhao Shengliang. "Application and Prospects of Digital Technology in Grotto Conservation." *Dunhuang Research*, 2020(4):1-10.
- [8] Wu Manying. "Digital Restoration and Dynamic Presentation of Dunhuang Dance Postures." *Journal of Beijing Dance Academy*, 2021(2):88-95.