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Database Construction and protection of Inner Mongolian Rock Paintings

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Abstract: Inner Mongolian rock paintings are one of the oldest rock paintings in the world, spreading from Inner Mongolia to surrounding areas, and have had a profound impact on East Asia, Central Asia, West Asia, and Europe. Inner Mongolian rock paintings are characterized by rich content and complete preservation and are the main distribution area of rock paintings in East Asia, with high historical, scientific, and artistic value. Inner Mongolian rock paintings are known for their large quantity, wide distribution, and large scale. Some of the rock paintings depict the production and living conditions of our ancestors during specific periods, as well as their knowledge of nature and society. Therefore, for the better protection of rock painting resources and serve the construction of social and economic development, local government should establish a complete system starting from database construction and establish a scientific and standardized management mechanism.
Keywords: Inner Mongolia; rock paintings; database; protection; research.

0. Introduction

Inner Mongolian rock paintings are one of the oldest rock paintings in the world. They are an important testimony to the development and progress of human civilization that ancient humans utilized the wonders of nature [1-2]. These petroglyphs are widely distributed, rich and realistic content, vivid imagery, complete preservation, and are known as "living fossils of ancient animals [3-4]. Over ten thousand rock paintings have been discovered in the Inner Mongolian grasslands and surrounding areas. Based on the available data, the Inner Mongolian rock paintings are known as one of the most widely distributed and largest ancient animal sites in the world, among which grassland rock paintings are the most prominent ones. Since the Han dynasty until modern times, numerous ancient animal fossils have been unearthed in the region, mostly prehistoric archaeological data and ancient petroglyph topiaries have also been preserved. These precious rock painting materials show the relationship between human beings, nature and the achievements made in transforming nature, providing important and rich materials for the study of ancient civilizations, ancient cultures, and ancient geography. However, as people's living standards continue to improve and tourism development intensifies, a large number of precious rock painting relics have been abandoned or even destroyed because they have not been properly protected.

Multimedia digital technology is a mean that develops information resources, optimizes image feature extraction, and enriches the multidimensional observation of rock paintings. Multimedia digital technology originated from data information processing based on computer technology, network technology, and multimedia technology that can effectively contribute to the construction of the rock painting cultural heritage database [5]. This technology can effectively extract image recording information of Inner Mongolian rock paintings, improve the protection capability of rock painting entities, and have a positive promotion effect on the construction of the rock painting cultural heritage database [6]. Using digital technology, a large scale the physical patterns of rock paintings can be collected, and Inner Mongolian rock painting research can be processed and standardized in a timely manner. In the early stage, through pre-shooting, sampling, photography, scanning, and electronic topography of Inner Mongolian rock paintings, the later graphic design effects of Inner Mongolian rock painting entities can be improved. This can be achieved by realizing Inner Mongolian rock painting 3D modeling and other works, reaching the digital transformation of Inner Mongolian rock painting images, and improving the accuracy of the document information of the rock painting cultural heritage database [7]. From the research perspective Inner Mongolian rock paintings and application of the rock painting cultural heritage database, multimedia digital technology can be divided into five stages: discovery, recording, preservation, research, and development. Discovery, recording, and preservation belong to the database construction stage, while research and development belong to the scope of rock painting research and application [8]. The rock painting cultural heritage database should has unlimited storage space, clear digital images of rock paintings, and 3D rock painting simulation, which can improve the protection effect of Inner Mongolian rock paintings.

1. Artistic Characteristics of Inner Mongolian Rock Paintings

Inner Mongolia is one of the regions in China with the richest variety, the best preservation effect, and largest number of rock paintings, which fully demonstrates the characteristics and artistic value of rock paintings in northern China and is an important part of China's rock paintings. The petroglyphs in Inner Mongolia are distributed from east to west according to

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the topographical and geomorphic features of the region. The content of the rock paintings in the region is based on each distinctive terrain, combined with the natural conditions and geographical distribution of the area, and depicts animal descriptions, hunting behaviors, grazing activities and other subjects, fully displaying the living conditions and cultural characteristics of the primitive society in Inner Mongolia and the northern nomadic economy.

2. The Historical Value of Inner Mongolia Rock Paintings

Most of the Inner Mongolia rock paintings are from the Neolithic to the Bronze Age of primitive era. During this period the creation of rock paintings was more abundant and stable under the influence of geographical and climatic conditions due to frequent farming and labor activities. Inner Mongolia rock paintings were created by adopting various techniques such as grinding, cutting, hammering, chiseling, and engraving, which made their carving styles consistent and promoted cultural exchanges and integration in primitive societies. Under the influence and exchange with southern and northern regions of China, the expression of Inner Mongolia rock paintings has been improved and given unique features, fully reflecting the essence of Chinese civilization.

The content of Inner Mongolia rock paintings mainly depicts hunting and animal figures. Since Inner Mongolia belongs to the northern pastoral ethnic groups, most of the petroglyphs depict hunting and grazing activities. However, there are also symbol descriptions, characters of farming and working, and specific human faces that reflect the culture of the primitive society. Inner Mongolia rock paintings have unique historical heritage value, carrying the fusion, development, and inheritance of various ethnic cultures in China. By preserving and researching Inner Mongolia rock paintings, it can effectively strengthen the cultivation of common awareness among all ethnic groups in China and promote the study of historical culture.

3. Inheritance effect of rock painting culture in Inner Mongolia

Inner Mongolia rock art is one of the largest existing, culturally rich, and valuable rock art forms in China. The Yinshan rock paintings in Inner Mongolia have artistic, historical, and cultural values and higher research level, value and are a splendid living fossil of human civilization in China. By studying the Inner Mongolia Yinshan rock art of the Mongolian ethnic group, we can effectively research the psychological and cultural characteristics of northern pastoral ethnic groups, ethnic cultural genes, and spiritual cultivation level of hunting and herding people. A comprehensive study of Inner Mongolian rock art can shape the national image, deepen the effect of traditional cultural inheritance, enhance China's cultural soft power, and help us fully understand the philosophical thoughts, aesthetic tendencies, production and labor behaviors, and economic life of ancient people in primitive societies.

Inner Mongolia rock art can better display its unique artistic charm and rich humanistic connotation, which is conducive to spreading ethnic characteristics and inheriting Chinese civilization. The specific process and revitalization effect of cultural value protection of Inner Mongolia rock art are essential to recognize the important figures and their different efforts in cultural protection exploration during the development and inheritance process of Inner Mongolia rock art.

4. Construction methods of Inner Mongolia petroglyph cultural heritage database

Inner Mongolia petroglyphs can be regarded as a living fossil for studying the life and spiritual status of northern nomadic ethnic groups. The content of rock art fully reflects the life and spiritual status of ethnic groups. Therefore, Inner Mongolia rock art can be used as a supplement to historical documents to expand the archaeological and cultural information. Most of the Inner Mongolia rock art is large in size and cannot be moved, so it will accelerate the weathering process of some rock art under the influence of natural weathering and climate. Inner Mongolia rock art is unique, and if it is destroyed, it cannot be restored. Its cultural value will be reduced. Effective protection of rock art cultural heritage can be achieved through information collection, feature extraction, and database construction. Therefore, under this background, the construction of a rock art cultural heritage database can improve the protection and research effectiveness of Inner Mongolia rock art, make its rock art culture more vibrant, and extend the life of Inner Mongolia rock art.

The construction of the Inner Mongolia rock art cultural heritage database can effectively save costs. After the rock art is digitally scanned and stored in the database, space can be effectively saved. At the same time, the database has the replicable characteristics, which can increase the value of Inner Mongolia rock art. By querying the relevant features of rock art, the cultural dissemination effect of rock art can be enhanced. The digitization of Inner Mongolia rock art entities can improve the storage capacity of rock art in the cultural heritage database through digital information and processing procedures. By constructing a rock art cultural heritage database with functions such as modification, retrieval, matching, and output, the protection effect of Inner Mongolia rock art cultural heritage can be improved.

Through the rock art cultural heritage database, the physical Inner Mongolia rock art can be effectively protected. Basic feature information of Inner Mongolia rock art can be efficiently queried through the database. When the research time and conditions are limited, using the database to retrieve Inner Mongolia rock art entities can shorten the query and

description time of Inner Mongolia rock art and enhance the research effectiveness of Inner Mongolia rock art. Based on the description information of Inner Mongolia rock art in the rock art cultural heritage database, detailed feature research can be conducted through digital image restoration methods, thereby enhancing the research capabilities of Inner Mongolia rock art and improving the research on the life habits of northern nomadic ethnic groups.

5. Rock Art Preservation Methods for Rock Art Cultural Heritage Database

5.1 Data Collection

Rock art, as a special form of cultural expression, is a product of human civilization in the long history of humanity. For various reasons, rock art is distributed in multiple regions around the world. However, due to the influence of natural conditions and geographical environment, rock art in Inner Mongolia Autonomous Region is relatively well preserved. The object of rock art data collection is the rock art image, which includes one or more images of rock art. When processing rock art images, digital photos taken with a digital camera should be used as a basis, and the images should be converted into a file format like the digital images stored in a computer after digital processing. The information in the photographic images is digitally processed, and the digital images are processed accordingly. Photoshop, Inspire and other tools are used to beautify the digital images. The data collection is performed using multiple PCs connected to a network, and the graphics and images are collected on a computer using Visual Studio 2022. Digital image processing includes three aspects: 1) image feature data collection, including image feature information collection for one or more images of rock art, digital point cloud data collection, rock art three-dimensional model data collection, etc. 2) Encoding rock art information: organizing image features and text information in a certain way, converting image information into binary format, and then visualizing rock art data for unified management and retrieval in a database. 3) Establishing a computer database system using digital processing software. The processed data is imported into the rock art database. The binary data format visualized after image processing can be well connected with the original files, and the images can be combined based on this to make the subsequent data analysis of rock art more accurate.

The collected rock art data is entered into a database. Improving the data collection system is the foundation of database construction. By reconstructing the three-dimensional images of rock art and storing image data within a certain time and space range, rock art data analysis and extraction can be achieved. The Inner Mongolia rock art database uses three-dimensional digital image analysis technology to determine the database data processing system, use digital image processing technology to solve problems such as data extraction and image analysis of rock art works, establish a digital model, and retrieve and display information based on the model. The construction of the Inner Mongolia rock art database will promote the efficiency and quality of cultural relic protection work in Inner Mongolia and provide a timely and effective management tool for cultural relic protection departments, as well as a scientific basis for decision-making by government leaders at all levels and relevant departments.

5.2 Data Analysis

The rock art in Inner Mongolia mainly reflects the culture of the northern nomadic ethnic groups, so it is necessary to conduct a deeper research and analysis of the information contained in the rock art of the northern regions. It is necessary to analyze and organize the relatively complete, accurate, and artistically valuable rock art data drawn and preserved in Inner Mongolia. As one of the birthplaces of prehistoric civilization, Inner Mongolia Autonomous Region has a wide variety and large quantity of rock art, which needs to be analyzed through efficient data analysis to enhance the cultural connotation of historical cultural relics. The main classifications of rock art data information include chronological information, content information, image information, and rock art attributes. By analyzing the chronological information of these rock art pieces, the cultural origins of rock art content in different regions can be obtained. By studying the relationship between the types of animals in the pictures and their living environment, it can be concluded how different regions used them for production and daily activities at different times. By comparing the production period and artistic style of rock art in the same region or period, one can understand the human activities in that region at different times, as well as their impact on the environment and social life. For the image data, if there are similarities or commonalities in form and structure between different rock carvings, that is, the same type of image has the same artistic characteristics in different periods, it will provide a basis for rock art research. By comparing the size, dimensions, and area ratios of each image patch in the image data, corresponding characteristics can be obtained through statistical analysis. By using statistical principles to analyze the distribution of rock art quantity during different periods, corresponding statistical data can be obtained.

The analysis of rock art data information mainly includes two parts: raw data and statistical data. Raw data refers to the original data recorded in text form and already entered the computer system. Statistical data refers to the raw data collected on the basic characteristics of rock art, and systematically analyzed and studied to generate tables and other files. By utilizing computer and internet technologies to achieve functions such as resource data storage and analysis, a rock art database software with portability and scalability has been developed, which divides rock art into basic information categories such as type, size, age, and author. At the same time, according to the image recording content and pattern types of rock art, the classification and summary of animals and human figures can be analyzed to study the interaction between human beings and nature.

5.3 Data Organization

To make the structure of the database more rational, it is necessary to organize the various elements uniformly during data processing. In the Inner Mongolia Rock Art Database, the area involved in rock art is relatively large. To ensure the quality of rock art data, it is necessary to organize the data in the database in a reasonable and effective manner. Through the digitization of multimedia, the text records, pictures, videos, and other information of Inner Mongolia rock art are comprehensively organized to form a basic preservation method for the cultural heritage of Inner Mongolia rock art. The content information is recorded and saved truthfully, comprehensively, and systematically. In the process of analysis and research on Inner Mongolia rock art, there will be periodic documentation, tabular registration information, and other document-type data. Due to the relatively complex matching between the documents and the Inner Mongolia rock art entities, the Inner Mongolia rock art can be digitized by photography or scanning with the help of the database, forming a slide with image information. In the rock art cultural heritage database, the image information slide is matched with the Inner Mongolia rock art entity to complete the carrier preservation. The Inner Mongolia rock art entity is transformed into unstructured data information, and text image retrieval technology is used to perform image retrieval on it. The Inner Mongolia rock art is described in text to refine the external characteristic elements of the shape and size, image elements, volume, and painting type of the Inner Mongolia rock art. Based on the characteristic information of Inner Mongolia rock art, a cultural heritage index database for Inner Mongolia rock art is constructed to achieve rapid retrieval and output of Inner Mongolia rock art image information.

In the Inner Mongolia rock art database, the most numerous rock art images are animal images, symbols and images, and symbols and images have certain correlation. Since the images of rock art are mostly flat, to better display the content depicted in the rock art, the images must be cropped when organizing the data in the database. After the rock art image data is organized, it is processed according to certain technical standards and corresponding results are formed, and they are published through graphical output. Since the rock art image data is textual information, it needs to be normalized, that is, the textual information in the rock art image data is grouped together, and the field types in the rock art image data are organized to facilitate the retrieval of rock art information. Based on the built database resources, the information between various nodes is associated and maintained to form a complete information chain.

6. Conclusion

Rock art is an ancient culture with a certain historical and scientific value. Inner Mongolia Autonomous Region is one of the provinces with the most ethnic minorities in China, with 23 ethnic groups including Mongol, Han, Hui, and Manchu. So far, nearly 10,000 rock art paintings have been discovered in Inner Mongolia, many of which have high historical and scientific artistic value. Inner Mongolia's rock art is not only a valuable natural heritage resource, but also a precious cultural treasure. With the advancement of technology and the arrival of the information age, it is necessary to start from multiple aspects to build a database system, establish a complete system, and strengthen protection and management work to serve social and economic development. By collecting, analyzing, and integrating data, establishing a rock art database system, updating existing rock art achievements in a timely manner, improving the effectiveness of real-time rock art protection work, and developing and utilizing rock art resources reasonably.

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7. References

[1] Cui, Y., & Cui, Y. H. (2018). "One Belt, One Road" construction and the inheritance and protection of grassland rock art culture. Social Scientist, 33(04), 157-160.
[2] Tong, Y. S. (2020). The Dual Attributes of Natural Environment and Ethnic Culture: Interpretation of Primitive Farming and Animal Husbandry Culture in North China Rock Art. Chinese Agricultural History, 39(06), 118-128.
[3] Vahdati, A. A. (2021). Newly found rock painting sites in the Upper Atrak Valley, Northern Khorasan, North-eastern Iran. Archaeological Research in Asia, 28(01), 100317.
[4] Van Rooyen, P. (2015). Rain and prehistoric pregnancy in a hunter-gatherer rock painting from Namibia. Journal - Namibia Scientific Society, 63(01), 135-150.
[5] Liang, R. (2022). The path of wall painting image language representation. Art Observation, 28(03), 148-149.
[6] Wei, F. A., & Mǒ, J. L. (2022). The unity of Chinese culture from the perspective of the rock painting culture of Zuojiang Huashān. Guangxi Ethnic Studies, 38(02), 166-173.
[7] Shu, X. H., & Pan, G. F. (2022). A new exploration of the protection mode of rock painting cultural heritage under the perspective of digital humanities. Guizhou Ethnic Studies, 43(01), 141-148.
[8] Zhang, Y. S., Wei, L. S., & Zhāng, X. X. (2022). Opportunities and challenges: Chinese rock art in the perspective of digital humanities. Guizhou Ethnic Studies, 43(01), 149-153.
[9] Li Ji. Early Chinese Civilization [M]. Shanghai: Shanghai People's Publishing House. August 2007.
[10] Wang Jianping, Zhang Chunyu. Yinshan Rock Paintings (Volumes 1, 2, 3 and 4) [M]. Shanghai: Shanghai Ancient Books Publishing House. 2011.

[11] Su Bingqi. A New Probe into the Origin of Chinese Civilization [M]. Shenyang: Liaoning People's Publishing House. 2009.
[12] Northwest Second Nationalities University. Helan Mountain Rock Paintings [M]. Shanghai: Shanghai Ancient Books Publishing House, 2007.
[13] The Second Northwest Institute for Nationalities. Damaidi Rock Paintings [M]. Shanghai: Shanghai Ancient Books Publishing House, 2004.
[14] Chen Zhaofu. The Discovery History of Rock Paintings in China [M]. Shanghai: Shanghai People's Publishing House. 1991.
[15] Wu Jiacai. Hongshan Rock Paintings [M]. Inner Mongolia: Inner Mongolia Culture Publishing House. 2008. [16]R. A. Haubt. The global rock art database: developing a rock art reference model for the RADB system using the CIDOC CRM and Australian heritage examples[J]. ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences,2015,II-5/W3(1).
[17]M. Citra Ramadhan,Ivan Lanovara,Tan Kamello. Indonesian Traditional Arts Database: Future Legal Protection Act[J]. Studies in Media and Communication,2014,3(2).
[18]Gu Na-Yeon. Art Database or a New Art Museum? - The Boom in Internet Art Museums[J]. Platform,2012.
[19]Paula A. Baxter. DATA BASES IN ART LIBRARIES: USING AN ART DATABASE IN AN ACADEMIC LIBRARY[J]. Art Documentation: Journal of the Art Libraries Society of North America,1983,2(3).
[20] DPI Consortium Launches Prior Art Database to Assure Network Security[J]. Telecomworldwire,2022.
[21]Wenhart Nina. Imaginative Rationalisation and Speculative Archiving. Thoughts about language in media art database archives.[J]. Artnodes,2013,0(13).
[22]Schmitt Bernard, et al."From RGB camera to hyperspectral imaging: a breakthrough in Neolithic rock painting analysis." Heritage Science 11.1(2023). doi:10.1186/S40494-023-00940-5.
[23]Domingo Inés,Barreda Usó Gemma. Knowledge-building in Open-air Rock Art Conservation: Sharing the History and Experiences with Levantine Rock Art[J]. Studies in Conservation,2023,68(2).
[24]Jalandoni Andrea,Zhang Yishuo,Zaidi Nayyar A.. On the use of Machine Learning methods in rock art research with application to automatic painted rock art identification[J]. Journal of Archaeological Science,2022,144.
[25]Zainuddin K.,Majid Z.,Ariff M. F. M.,Idris K. M.,Darwin N.. 3D MODELLING METHOD OF HIGH ABOVE GROUND ROCK ART PAINTING USING MULTISPECTRAL CAMERA[J]. The International Archives of the
[26]Photogrammetry, Remote Sensing and Spatial Information Sciences,2022,XLVI-2/W1-2022.
Gao Temule,Zhang Qun. ROCK PAINTING ART AND GRASSLAND CULTURAL PSYCHOLOGY OF NORTHERN NOMADS[J]. Psychiatria Danubina,2021,33(S8).
[27]RiutortMayol Gabriel,GómezRubio Virgilio,Lerma José Luis,del HoyoMeléndez Julio M.. Correlated Functional Models with Derivative Information for Modeling Microfading Spectrometry Data on Rock Art Paintings[J]. Mathematics,2020,8(12).