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Research on the Interpretation of Chinese Grotto Art Connotation and Digital Protection of Artificial Intelligence Based on National Self-confidence



Abstract: - Chinese Buddhist grottoes are the testimony of history and the crystallization of human technology and culture as well as the physical remains of human creative activities. The neutral shape of Buddha statues reflects the aesthetic pursuit of “neutralization” in traditional Chinese culture. The solemnity and gentleness of the Buddha statues are expressed through external modelling technique and line carvings, which embodies the characteristics of “conveying the spirit with form” in China culture. This paper analyzes China Grottoes’ art from the aspects of “meaning”, “god is outside the form”, “expressing the spirit with the form”, phonology, “charm” and “expressing the spirit with the lines” through literature review, and then analyzes the awareness of digital protection, technical methods and key projects at domestic and overseas. In recent years, the digital protection of cultural relics has been continuously improved under the multi-disciplinary application of artificial intelligence, which not only enhances the influence of cultural communication, but also makes cultural relics more powerful and dynamic. Through the restoration of Buddha statues by digital simulation and the planning of restoration projects through the precise measurement given by this digital models can realize the complete digital filing and permanent preservation of important cultural relics and improve the protection and utilization of digital cultural heritage.

Keywords: Grotto Art, Material Cultural Heritage, National Self-confidence, Digital Restoration, Cultural Relics Protection, Artificial Intelligence.

I. INTRODUCTION

Buddhist grottoes statues in China is a product of religion, in the sense of contemporary civilization, the advancement of civilization can get rid of the early religious beliefs and ideas but cannot get rid of the human inner desire for beauty and spiritual pursuit. Buddhist grotto sculpture art, with its static human body’s grand outline, expresses highly generalized and admirable objects and ideals. This is exact the reason why religion is decreasing and dissimilating gradually, but the art related to it is more and more needed by more and more people.

China’s plastic arts have a long history and have a profound and rich development system. As a component of the overall culture, plastic art has formed its own unique features in the principles of creation and main aesthetic consciousness. China’s plastic arts and aesthetic culture maintain a unique artistic feature, which fully proves that this nation is inseparable from the art that it has created and the experience and full confidence it has accumulated in the creative process. Traditional experience has played a role in linking the past and the future in the long historical process. No matter how the artistic form of Buddhist grotto sculptures and effects of other factors change, the principle of creation will never change. It is precisely because of the persistence of ancient grotto sculpture art that the culture and aesthetics in Chinese Buddhist grotto sculptures can influence and nourish people’s hearts and enhance the overall humanistic spirit.

With the development and innovation of digital technology, cultural communication has been revitalized. As a large-scale immovable cultural relic, tourists cannot appreciate its artistic value at close range. However, digital technology can be used to “move” cultural relics to tourists, making the statues audible, visible and tangible, which not only solves the contradiction of cultural heritage protection and tourism promotion, but also serves as a way to spread excellent traditional culture through integrating technology and culture.

Although the inheritance of cultural heritage itself cannot create a new culture, through the inheritance and transcendence of cultural heritage, along with the innovation of technology, the way and content of protecting heritage can be continuously enriched. As a new way of carrying forward cultural heritage, digital means not only needs technical approaches to truly reappear ancient human art and its cultural connotation, but also pay attention to how to use artistic means to express, and emphasize the artistry of works, so as to enhance the inner appeal of works. At the same time, new media, and new methods are always needed to sustainably develop and creatively spread cultural heritage and make cultural heritage a real cultural industry.

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With the development of digital multimedia technology, AI can help automatically identify cultural relics through image recognition technology, and provide information about the original appearance of cultural relics through microscopic image analysis of cultural relics [1]. The protection and display of national cultural heritage will not be restricted by the geographical scope, but can reproduce the real historical geographic information in the virtual space, and show the national, regional and cultural characteristics of the heritage to the public in a more intuitive way, which is conducive to the exchange of national cultures resources in the overall pattern.

National cultural resources refer to the tangible and intangible cultural relics and elements related to the history, art, music, literature and other cultural expressions of a country. When a country has a rich cultural heritage, it can stimulate the pride and self-confidence of its citizens. Cultural resources can help people feel connected with their past and the achievements of their ancestors, which helps to form a positive sense of identity and a sense of belonging to a larger community. National cultural resources can also be used to enhance the country's overseas image and show its strengths and achievements. Establish relations between countries in the form of cultural diplomacy, and enhance understanding between countries.

II. METHODS

A. *Research on Chinese Grotto Art from the Perspective of Traditional Chinese Aesthetics*

This paper mainly appreciates the Chinese grotto art from the perspective of Chinese traditional aesthetics. The Confucian classic "The Doctrine of the Mean" says that "Zhong, the emotion in the inner heart of people, is the nature of human being, "He" (Harmony), venting oneself at a moderate degree without hurting others, are the common rules that people must obey, and realizing Zhonghe could make the whole world operate smoothly and all the living creatures dynamic [2]. The beauty of moderate is the ultimate pursuit of Chinese ancient art creation, which embodies the fundamental spirit of ancient Chinese art.

The basic meaning of "Zhong" is "impartiality", which is the aesthetic standard emphasized by Confucianism represented by Confucius. In Buddhism. It refers to the impartial road, viewpoint and method which are divorced from both sides or two extremes. It is regarded as the highest truth of Buddhism. "Harmony" is not only the extension and development of "Zhong", but also the supplement and improvement of "Zhong". "Harmony" is the unity of various factors, including the unity of opposites. "Being gentle and honest but not stupid" and "being knowledge and approachable but not superior" put forward by Confucius are the ideological and artistic qualities advocated by Confucianism whose core is the beauty of "Zhonghe". The so-called "being gentle and honest" is not blindly soft, without masculinity. That kind of "art" that kills the will is meaningless and will never be valued. The beauty of moderate requires the combination of hardness and softness. The artistic requirement of balancing hardness with softness is related to the ancient Chinese theory of yin and Yang. It is a tradition of Chinese aesthetics to advocate the beauty of neutrality, which was not only advocated by Confucianism, but also advocated by Taoism. For example, in Zhuangzi God's Will, there is a saying that "the combination of yin and Yang should be used "[3]. The Book of Changes also emphasizes "middle" and "harmony", emphasizes the harmony of "Yin" and "Yang", and the combination of "hardness" and "softness" and "image" is used to obtain "meaning" and "changes" to seek "a way out"[4]. If one is rigid but not soft, or soft but not rigid, then, "hard is not strong, soft is not gentle." Hardness and softness could produce artistic beauty only if both of them coexist and combine with each other.

At the same time, Chinese aesthetics attaches great importance to realm, that is, the pursuit of "implied meaning" and "God beyond form". The pre-Qin scholars all paid attention to the understanding of "meaning". Chinese traditional culture can be said to be a cultural construction centered on "meaning". The relationship between "form" and "spirit" is an important issue in Chinese painting theory and even all plastic arts. "Shape" is a means of modeling, "spirit" is an aesthetic concept, and "using form to express spirit" and "vivid portrayal" are important propositions since Wei, Jin, southern and Northern Dynasties. In the plastic arts, it emphasizes "the accordance between form and spirit", emphasizing expression and emotional factors. By means of modeling, the solemn and quiet temperament of Buddha was vividly depicted by artists.

Vividness is the highest aesthetic requirement of Chinese art. Chinese Buddhist grotto sculpture art all inherited the fine tradition of "using form to express spirit". When expressing the characters' thoughts, feelings and temperament features, they all conveyed the characters' individual characteristics through vivid pictures and lines. Under the Buddha statues and rituals about the "32 standard images of buddhas" and "80 outstanding features of appearance", each Buddha and Bodhisattva showed free inspiration and creative artistic conception [5]. As the saying goes, facial expressions could well reveal people's thoughts and feelings. At this time, the theory of emphasizing form rather spirit was further transformed into a true creative experience of art, the solemnity of Buddha, the kindness of Guanyin, the angry Vaiśravaṇa and the sturdy Hercules all must be conveyed through the

subtle changes in the eyes and lips, and the eyes cannot be separated from the harmony of the facial features, and the expression cannot be separated from the signs of posture and gesture. For example, the technique about Bodhisattva's finger "made with emotion", etc. These are all the creative development and flexible use of traditional technique "the accordance between form and spirit". In addition to the vividness of the individual image itself, vividness is also expressed in the relationship between characters and the huge statues. All these have set a model for the aesthetic creation of Chinese art.

Besides that, rhyme is a special category of Eastern aesthetics. The sculpture art of Chinese Buddhist grottoes uses vivid shapes and images, expressing infinite affection in a limited form, and depicting the vivid state of all living objects by the movement of air. It can be said that spirit and charm are the most basic and highest symbol of plastic art. In Chinese Buddhist sculptures, a line of artistic rhythm was often used to express the harmony of various parts of the human body and the composition of their various relationships with the circular curve of the most common Tai Chi Pisces pattern in Chinese art. This circular curve keeps both the same and ever-changing. Therefore, the sculptors decorating the statue's clothes patterns, streamers, and decorating the appearance and body of the statue used the ever-changing curves, and therefore, statues had a beauty of spirit and charm. Just like those big Buddhas that we have seen, in any case, we cannot see the burning of inner desire, nor the extreme fear. Instead, they are peaceful, calm, and superficial, showing a harmony with the lines that deal with their clothing and expressions, expressing the beauty of "human body".

Ji, [6] listed "spirit and charm" as the common point of Chinese and Indian aesthetics and proposed to explain the category of "Rhyme" with suggestiveness and implicitness. Rhyme is a manifestation of vitality, the rhythm of life, in any art. The most important feature of rhyme is the sense of orderly dynamics. Like music, there is a regular sound movement.

The expressive power of heavy lines in Chinese painting also affects the style of Chinese sculpture. Statues use volume as the main means of expression, supplemented by lines that are expressive and beautiful in form, which gives traditional Chinese sculptures a distinctive oriental national style in world sculptures.

Compared with sculptural modeling methods that highlight clumps and light and shadow effects, highlighting lines is a highly general modeling method. Li, [7] said that Chinese art is the art of lines, emphasizing expression, paying attention to rhythm and taste. Chinese sculpture uses abstract forms and lines to summarize the appearance of objects and can achieve a perfect three-dimensional effect. This effect is not in the physical form of the sculpture, but beyond the form. Instead, it is produced in the mind of the viewer, and is a three-dimensional sense of space supplemented by the spirit of the subject.

Finally, Chinese cultural traditions converge to the pursuit of aesthetic spirit, which is marked by the "spirit of music and dance" and has reached a considerable degree in terms of breadth, depth and height [8]. From the overall characteristics of Chinese art, the relationship between grotto sculpture art and painting is quite similar to that of music and dance in Chinese art, with music in the leading position supplemented by is dance.

Traditional Chinese art pursues reaching the realm of dance in appearance. First of all, it pursues the momentum of birds and beasts in shape and uses the posture of flying to gain psychic powers. No matter how mysterious it was in traditional Chinese art to regard gods and Taoism as souls, once the form of gods and Taoism is to be expressed in perceptual form, and once this perceptual form needs to reflect the abstraction of beauty, images with perceptual experience from nature would not help. The most mysterious images without perceptual experience in ancient times was the image of birds and beasts. This was reflected in the decoration of Buddha statues in the cave statues, such as the Bodhisattva in Cave 11 of Yungang; in Cave 27 of Yungang, the lower part of the costume of the statue is sharp. Some are like spreading bird wings, which means that a Buddha is flying down from the sky. And the flying image on the wall of the grotto was also shown vividly through the light and flying posture of the character itself and the fluttering silk dress, flying freely in the void. This kind of flying images became more and more vivid, ascending and descending freely, as comfortable and natural as eagles flying in the sky and fish swimming in the sea [9]. The graceful beauty of a Bodhisattva is not manifested by wings, but by two moving and dynamic belts.

It is precisely because the statues of Chinese Buddhist grottoes have so many artistic and aesthetic meanings, its protection is even more indispensable.

B. The Birth of Historical and Cultural Heritage Consciousness

At present, the digitization of historical and cultural heritage is mainly used in cultural preservation and reproduction.

The digitization of material culture heritage is developed with the development of science and technology. With the gradual maturity of computer hardware and software technology in the 1990s, digital technology has gradually entered the public's field of vision; In China, the digitization of material culture heritage, compared with European and American countries, is obviously lagging behind. Only since the mid and late period of 1990s, had the concept of computer science and technology been widely known to people. At that time, the biggest contributing factor in the development of digitization was the national policies, the development of computer science and technology, and people's perception of digitization. By the mid-1990s, Photoshop, 3ds max and other software began to become popular, and a large number of training materials about these software appeared, then digital technology gradually entered the public's field of vision. At the end of the 1990s, digital art was fully involved in design, advertising, packaging and printing industries. It was since this time that the digital technology of China had really begun to be used in the material cultural heritage industry [10].

In China, the Dunhuang Academy was the first to realize the opportunities brought by computer image technology to cultural relics protection. Since 1993, the Dunhuang Academy has carried out a number of scientific research projects, such as "Research on the computer storage and management system of Dunhuang murals" and "Research on the computer storage and reproduction system of endangered and precious cultural relics"; later, it cooperated with Germany to establish the Dunhuang information website; In 1997, it cooperated with Zhejiang University to establish the National Natural Science Foundation for "multimedia and intelligent technology integration and art restoration", It has completed the digital photography and preservation of Mogao Grottoes murals and colored sculptures, and the digital restoration of mural image colors and the simulation of historical evolution process. It has developed the virtual display and roaming system of grottoes, the computer-aided system for Grottoes protection and restoration, and the intelligent pattern-aided design system that can copy and create patterns with Dunhuang style. In 1998, it jointly carried out with Northwestern University and the Mellon foundation "The cooperation research of Dunhuang mural digitization and international digital Dunhuang Archives Project", establishing a set of techniques to realize the digitization of plane murals. "Since 2004, Dunhuang Research Institute and Institute of computing technology, Chinese Academy of sciences have carried out 3D digitization of cave 45 and 196 in Mogao Grottoes. So far, Dunhuang Research Institute has completed the three-dimensional walkthrough animation of 40 caves. "Other projects, such as the digital forbidden city, the digital display of Along the River During the Qingming Festival, and the panorama of Yungang Grottoes, further demonstrate the achievements of digital protection, restoration and display of Chinese cultural relics [11].

In foreign countries, the digital research of material and cultural heritage is in full swing. In 1999, Stanford University and Washington University of the United States cooperated with the Italian government and launched the "digital Michelangelo project", which uses three-dimensional laser scanning technology to digitally record large-scale sculptures such as Michelangelo's "David", which has provided experience for the later research on data acquisition, three-dimensional model building and drawing of large-scale stone relics Research experience. Forma Urbis Romae, in the University of Virginia in the United States, has digitally preserved 1163 pieces of marble fragments by means of digital scanning, so as to restore the topographic map of ancient Rome [12]. However, because the size and thickness of each fragment are not consistent, the traditional method may not process image stitching efficiently enough. Therefore, they complete the work by splicing the 3D model and then transforming it into the splicing of physical fragments. In 2006, Michael Jansen used a three-dimensional laser scanner to reconstruct the three-dimensional image of Buddhas of Bamiyan destroyed by the war in Afghanistan, and built a three-dimensional model of the fine Buddha statue based on the cultural relics photos collected before. In 2015, the team from China used Facade mapping and precise model to restore the 3D mapping of Bamiyan Buddha, and protected the cultural heritage in another way. Taylor's NRC 3D imaging technology for Museum and heritage applications proposed that a real and complete 3D model of niche 264 in Dazu stone carving was constructed by recording plane images. In Automatic 3D Reconstruction: An exploration of the state of the art, the researchers used a more advanced modeling method, and the object collected was a wall in a Jain temple in India. The researchers carried out automatic modeling through the digital photos of the relief wall. The whole process was time-saving and effective, which was highly valued in terms of promotion and practicability [13]. The technology used in this article is the most advanced two-dimensional photo modeling software developed by Autodesk company. It is easy to use and cost-effective, which only needs to collect the image of the object to be collected. This method does not have the huge data processed by the computer required by 3D scanning modeling.

Although digital image restoration technology is inspired by art restoration, the current digital image restoration technology is still mainly focused on the restoration of old photos and the restoration of the images on which the words or objects are removed. This technology can work in restoring the actual art images, but it is obviously far

enough to achieve the best effects. In fact, in the protection of cultural heritage, it is very necessary and urgent to adopt this technology, because traditional manual restoration is time-consuming and laborious, and due to the coexistence of flexibility and randomness of individual differences, it is highly possible to put the artistic and cultural heritage at a risk of secondary damage in the restoration process, and this loss is even more difficult to make up for.

By using digital technology, it is possible to clone the “grotto”, that is, the three-dimensional reconstruction technology of the images of cultural relics constructs the spatial model of grottoes, so that the grottoes can be moved from the field to the computer, then be save on the computer, and can be displayed from all aspects on the screen. Therefore, the digitization of grottoes can be achieved.

III. RESULTS

A. *The Artistic Charm of Chinese Grottoes*

Through the above description, the artistic aesthetics of Chinese grottoes can be summarized into the following aspects:

- Harmony-the beauty of moderate.

These aesthetic thoughts were embodied in the Buddhist grottoes, that is, the images were chosen that had the characteristics combining males and females in the two opposite images of yin and Yang. The neutral shape of the Buddha image reflects the aesthetic pursuit of “Neutrality or moderate” in Chinese traditional culture. Throughout the context of Chinese Buddhist thought, although the theories of different historical periods and sects were different, there was still a consistent philosophical thought. The concept of “Neutrality” is an obvious feature of Chinese Buddhist culture and has become a hidden factor influencing the formation of neutral modeling of Buddhist statues.

In addition, the neutral shape of the Buddha statue is one of the expressions of the combination of words and meaning. The artist used the square that represents the hardness, and the circle represents the softness to form a plump modeling style, as well as lines with different styles to conveys the ultimate beauty of the balance between feminine and masculine with implicit and plump modeling styles and artistic language. The mysterious smile of the Buddha makes people have infinite reverie. For example, what does this universal God think and smile about. In the system of Chinese aesthetics, the more vague and neutral “words” are, the closer they are to the real “meaning”. The Buddhist thought of seeking “meaning” with “words” had influenced the Chinese traditional plastic arts’ emphasis on “freehand brushwork” and “vivid expression and bold outline”. From the perspective of art concept, the understanding and grasp of the subject of art creation is no longer analog and pictographic, but transcendental and imaginative, which has become a unique artistic learning approach and aesthetic appreciation concept of Chinese aesthetic culture.

- Vivid -- both spirit and form.

The most beautiful human body sculptures in the grotto’s art, such as flying Apsaras, Bodhisattvas and patrons in the prosperous Tang Dynasty, were often dressed in gorgeous and expressive clothes. Great attention was paid to the clothing depiction in China’s human body sculptures, which shows the extraordinary artistic creativity. Not only the light and heavy texture of the clothes on statue can be vividly depicted, but also the movement and body shape of the human body can be expressed through the change of the clothing patterns, and even the spiritual temperament and internal personality of the characters can be set off by skillfully using the features of the clothing patterns. However, most of the Western sculptures are nude figures, without clothing as a tool to express the emotions of the characters. hence Everything is expressed through the exposed muscles, facial expressions and external dynamic posture. This is also a major feature of Chinese sculpture.

- Spirit and charm-Outside the state.

In Buddhist grotto sculptures, thick and hard lines were often used to depict the “thin” of Kassapa and the “mighty” of the Vaiśravaṇa, and the horizontal lines under the neck of the Bodhisattva were depicted with thin and soft inscribed lines to show the plump and delicate skin. The beauty and vitality of the statues were also fully revealed through the rhythm of the lines. The skills and charm of the lines can be seen in the treatment of the characters’ clothing patterns. For example, the statues of the Buddha’s niches on the stele of Maiji Mountain have shown the outstanding line skills. The wide coats and dress of the third Buddha in the niche were clustered and hung into folds because of the sitting position. The hard stone was carved into a light and soft fabric, like silk and velvet, and the stone was finely carved so that it had the luster of textiles. These lines were often expressed as handy as a writing brush. The layers of the clothes and dress turned freely, the movement of the human body under

the clothes was subtly expressed, and the beauty and vitality of the lines themselves were also fully realized through the rhythm of the lines.

- Sublimity -- the spirit of music and dance.

Each kind of art has its own unique image to represent the external reality. However, these images serve to objectify the internal reality, that is, subjective experience and emotion. The aesthetic pursuit of grotto sculpture art is consistent with the “music and dance spirit” of Chinese art. The artistic style shown in Buddhist grottoes statues could be researched to explore the root of the spirit of music and dance in Chinese art.

B. *Digital Preservation of the Grottoes*

Grottoes, undoubtedly, are the most important historical and cultural heritage. Data retention of important cultural relics and historical buildings using advanced technology is a necessary means to protect cultural heritage and ensure that cultural heritage can be passed down from generation to generation. From a technical perspective, through the use of big data and related technologies, it has been possible to realize the complete digital archiving and permanent preservation of important cultural relics, which has become an important means to protect cultural heritage. From the perspective of the inheritance of Cultural Heritage, improving the digital protection and utilization of cultural heritage is also conducive to improving the cultural communication. Digital protection and archiving also make cultural relics more powerful and dynamic.

In addition, such digital data can be used for many applications that aim to restore real objects through digital simulation and to plan restoration projects through precise measures given by such digital models. And by creating multimedia content from digital data, a user can view digital contents through the Internet from anywhere in the world, without moving the objects or visiting the sites.

The meaning of digitization of material cultural heritage is that first of all, it provides the most reliable means for the preservation and reproduction of material cultural heritage. In the internet era, the use of digital information acquisition, multi-dimensional database, big data, visualization research, AI technology and other high-tech means make it possible for the permanent preservation of cultural heritage, and also make cultural heritage experiencing the vicissitudes for thousands of years stay young and lively as it was before. Secondly, it provides the most solid foundation for the inheritance of material cultural heritage. With the advent of the digital age, a variety of new media appear in the public view, and the dissemination media of grottoes cultural heritage also update day by day. From the perspective of the dissemination and inheritance value of grottoes and relationship of historical inheritance of grottoes, cultural heritage about grottoes is one of the main carriers of historical information transmission. By understanding and exploring the historical background of grottoes, people can improve their personal aesthetic ability and artistic attainments, enhance the breadth and depth of cultural communication, grasp the historical evolution track and the connotation, significance and characteristics of cultural development, so as to stimulate people’s awareness of cultural protection and identity.

Culture is the soul of a country. China is rich in historical and cultural resources. Reasonable and effective protection and development of historical and cultural resources will greatly promote the soft power of Chinese culture and promote the prosperity and development of cultural undertakings and cultural industries. There are not many monographs on the protection and development of historical and cultural resources in China. Some monographs equate cultural resources with historical and cultural resources, and analyze the protection and utilization of cultural resources from the perspective of the concept of cultural resources, mainly including Hu’s, introduction to cultural industry [14], Hu’s Cultural Resources [15], Lv’s development of cultural resources industry [14], etc. Another monograph focuses either on protection or development. This kind of works mainly include the protection and planning of famous historical and cultural cities written by Professor Ruan [16]. In this book, the overall protection of historical and cultural cities is advocated. That is, we should not only protect the cultural relics and buildings, but also pay attention to the protection of the historical traditions of cities, which is also the trend of world historical and cultural heritage protection. Professor Wang explained the value and significance of intangible cultural heritage protection in his book introduction to intangible cultural heritage, and proposed that intangible cultural heritage should be protected by legislation, personnel training, and increasing financial investment [17,18].

IV. CONCLUSIONS

In China, the current protection activities of grotto cultural heritage have extended from maintenance only to the comprehensive protection by scientific research, innovation and dissemination; the objects protected include stone Buddha statues, murals, inscriptions, etc.; the scope of protection also has extended from the material aspects

of grottoes to the historical and cultural background behind, as well as the cultural landscape and cultural space derived from grottoes. Grotto heritage, inherited with time and space, embodies the development process of a dynasty or even a country.

Introducing the history and artistic charm of the grottoes to the younger generation through school courses, museums, exhibitions, etc., is helpful to enhance the aesthetic awareness of young people. The preservation and restoration of the existing grottoes can make these priceless art treasures have a longer life. It shows that through international cooperation with other countries, it is helpful to show the oriental charm of China's material culture and grotto art to the world, so as to enhance the status of China culture in the world, enhance the right to speak of the nation, and enhance national self-confidence.

Digitization of world historical and cultural heritage is necessary for the protection of material cultural heritage. It is an inevitable choice to preserve, reproduce and restore the Chinese Buddhist grottoes with digital technology. Digital restoration will become a necessary means to inherit the art of grottoes.

Digital data of heritage objects can be obtained by using modern computer vision techniques. Once these data have been acquired, they can be preserved permanently, and then safely passed down to future generations.

As a world historical and cultural heritage, Chinese Buddhist grottoes are the testimony of history and the crystallization of human technology and culture, as well as the physical remains of human creative activities. Protecting Chinese Buddhist grottoes is protecting history and culture and also is inheriting excellent traditional culture. In today's increasingly materialized society, it is extremely urgent and important to protect Chinese Buddhist grottoes.

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REFERENCES

- [1] Han Yeting, "Ancient art restoration combined with artificial intelligence," *GuangMing Daily*, April. 2022, doi: 10.28273/n.cnki.ngmrb.2022.001826
- [2] Gao Jianwei, "Anysis the mean and its value implication in the Analects of Confucius," *Sinogram Culture*, vol. 2, 2024, pp. 221-223, doi:10.14014/j.cnki.cn11-2597/g2.2024.02.072.
- [3] Ge Jingchun, "The Harmonious Idea of Du Fu's Aesthetic Thought," *Zhongzhou Academic Journal*, March. 2007, pp.205-209, doi:10.3969/j.issn.1003-0751.2007.03.059.
- [4] Yu Bowen, "On the Thought of the Middle Way in I Ching," *Confucius Studies*, April. 1989, pp.13-19, doi:CNKI:SUN:KZYJ.0.1989-04-002.
- [5] Shi Ruting, "Image Aesthetic Analysis of Zhou Fang's 'Picture of Ladies with Hairpin Flowers'," *Journal of Chaohu University*, vol. 21, 2019, pp. 21:74-79, doi:10.12152/j.issn.1672-2868.2019.02.011.
- [6] Ji Xianlin, "About Shen Yun," *Literature and Art Studies*, vol. 1,1989, pp. 34-38, doi:CNKI:SUN:WYLL.0.1989-03-032.
- [7] Li Zehou, *The Course of Beauty*. Cultural Relics Publishing House, 1989.
- [8] Peng Jixiang, "Dance: The Spirit of Music and Dance in Traditional Chinese Art-Line Art," *Art Panorama*, vol. 6, 2017 , pp. 46-49, doi:10.3969/j.issn.1002-2953.2017.04.006.
- [9] He Rong, "City Life and Religion in Ancient China: Reflections Based on Weber Theory and Investigation of 'Luoyang Jialan'," *Annual Review of Sociology*, vol. 7,2020, pp. 68-81, doi: 10.3969/j.issn.2095-5154.2019.06.005.
- [10] Li Deren, "The Application of Virtual Reality Technology to Cultural Heritage Protection," *Journal of Yunnan Normal University(Humanities and Social Sciences Edition)*, vol. 4,2008, pp. 1-7, doi:10.3969/j.issn.1000-5110.2008.04.001.
- [11] Peng Dongmei, Pan Lusheng, & Sun Shouqian, "Digital Protection—A New Means of Intangible Cultural Heritage Protection," *Chinese Painting and Calligraphy*, vol. 4,2006 , pp. 193-195, doi:CNKI:SUN:MUSE.0.2006-01-010.
- [12] Shao Yong, "The French state has established a heritage protection education and practice system and its enlightenment to my country," *Bulletin of Chinese Academy of Sciences*, vol. 4,2017 , pp. 735-748, doi:10.16418/j.issn.1000-3045.2017.07.008.
- [13] Lu Xin, "Research on Digital Inheritance and Protection of Grotto Art." Master's thesis, Zhengzhou University of Light Industry,2020, doi:10.27469/d.cnki.gzzqc.2020.000043.
- [14] Hu Huilin, *Introduction to Cultural Industry*. Kunming: Yunnan University Press, 2005.
- [15] Hu Zhengli, *Cultural Resources*. Guangming Daily Publishing House, 2016.
- [16] Ruan Yisan, "A new exploration of the protection practice of historical and cultural cities," *China Ancient City*, vol. 7,2011, pp. 10-13, doi: 10.3969/j.issn.1674-4144.2011.07.002.
- [17] Wang Wen (Ed.), *Introduction to Intangible Cultural Heritage*. Educational Science Publishing House, 2013.
- [18] Lv Qinghua, "Several issues of the development of cultural resources industry," *Business research*, vol. 12, 2006 , pp. 94-96, doi:10.13902/j.cnki.syyj.2006.12.031.