The Use of Digital Advancement Technology in Protecting the Longmen Grottoes Art

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Abstract. Longmen Grottoes, one of the four major grottoes in China, has been listed on the “World Heritage List” and its excavated time was as long as four hundred years ago, which had gone through six different dynasties. Due to the different excavated times, this Buddha statue in each hole or niche has its unique features in clothing, face, body shape and other aspects. Due to climatic changes of wind, rain, frost, and snow, many of these Buddha statues have lost their original appearance. Hence, this study aims to use modern digital restoration technology to restore these grottoes in order enabling many people to appreciate these type of arts through the internet. This method will not only reduce the secondary destruction, but also may allow people to understand and appreciate better the grotto art through the internet. Furthermore, through this restoration, the complete history from a broken Buddha statue can be learned, and even more the culture of ancient China can be explored. The digital restoration of these grotto Buddha statues mainly adopts the modern technological means and detailed research materials of digital virtual restoration, the solemn dharma images that the real thing cannot be traced back are reproduced by virtual technology. The digital simulation is carried out by analyzing the apparel, face, and figure of the Buddha statues in the representative niches of different dynasties. The digital technology for restoring the Buddha statues not only avoids destruction of the Buddhas but also can be seen as efforts in restoring and protecting the grotto art.

1. Introduction
Longmen is located at approximately 12 kilometers of the southern suburbs of Luoyang. Longmen got its name because it is located between two mountains and looks like a stone gate. The time of the grottoes to be excavated took more than 400 years, and they went through six dynasties, such as the Northern Wei Dynasty, the Eastern and western Wei Dynasty, the Northern Zhou Dynasty, the Northern Qi Dynasty, Sui Dynasty and Tang Dynasties. As the most concentrated place to make vows and statues for the royal aristocrats in the Northern Wei and Tang Dynasties, Longmen Grottoes have a typical royal artistic style. There are almost 100,306 Buddha statues, 39 pagodas, and more than 3,600 inscriptions. It is the most well-preserved and relatively complete grottoes in the cave niches at present. The themes of the grottoes are simple, clear, concentrated, and the sculpture art is secularization, the mysterious color of the early Buddhist art was shed, the faces and costumes of the grottoes characters gradually had converted into Chinese characteristic: most of the main portraits of the grottoes have the comers of the mouth upturned, slightly smile and give people a sense of intimacy. In year 2000, the Longmen Grottoes were listed in the “World Heritage List” by UNESCO.
The world heritage represents a unique artistic achievement, it is an elapsed civilization, and a special testimony of cultural traditions. It represents the spirit and culture of a country and a nation; it is the spiritual home of modern people. The World Heritage, Longmen Grottoes is the pinnacle of Chinese stone carving art and the artistic expression of Buddhist culture. It reflects the development and changes of ancient Chinese politics, economy, religion, culture, and other fields from different sides.

However, due to natural disasters and man-made destruction (social riots or wars), many Buddha statues in Longmen Grottoes have lost their original appearance. In order to protect this grotto art, the scenic spot adopts the semi-open form for viewing, which makes the tourists who watch the grottoes can only be near the entrance of the cave. This method not only restricts the tourists’ visual appreciation, but also makes it difficult to feel the artistic charm of the space inside the cave. Hence, the method of artificial restoration of the grottoes may improve the integrity of these Buddha statues.

2. Application of digital technology in the cultural Relic protection

Modern digital technology can be used as the method to protect and inherit this traditional culture. With the development and advancement of digital technology, every aspect of social life including protecting and restoring these statues can be infiltrated. At present, the traditional intangible cultural heritage resources are generally protected and displayed by means of museum preservation, display of cultural relics, protection of intangible cultural heritage inheritors, teacher training, professional training of universities, and development of local tourism resources. With the help of computer technology and related equipment such as different types of high definition digital camera technology, database processing technology, computer animation and virtual reality technology and other emerging digital technologies, digital method can be used to digitize all kinds of information contained in Longmen Grottoes and store them permanently in computers which then can protect and promote these Longmen Grottoes of the world heritage even better.

On this basis, the method of digital art reproduction can be used to correct and supply the artistic characteristics of cultural relics, and can quickly and efficiently solve the repair work of cultural relics damage caused by the external reasons, perform artistic analysis on the missing parts, and realize the virtual restoration of the close to the true historical original appearance of the niches. This repair method based on two-dimensional (2D) digital technology can provide an image basis for the repair of the subsequent three-dimensional (3D) digital reproduction model to a large extent and solve the situation that there is no accurate entity reference when the three-dimensional digital model is repaired. When digital art is reproduced, the original appearance of the grotto art can be restored in the maximum extent. It can also reduce the destruction of cultural relics caused by human factors, and to show the unique charm of grotto art as a national material cultural heritage.

The 3D modeling method for cloud service processing 2D image data has been used for the protection of cultural relics in many countries, such as the digital protection of the archaeological site at Pompeii and the Jaini Temple in India. The structure of the sculpture is not only get a complete performance, but also the artistic effect of the work has been well protected. These advantages are mainly manifested as follows: firstly, the requirements for the construction structure and geographical location of the digital protected objects are not high; Secondly, the equipment purchase cost is very low, only need one photographic instrument and an ordinary computer to operate, which is affordable for the general cultural relic protection institutions; the last is the operation simple and fast, the professional skills for the operator requirements are not high.

At present, there are relatively mature software on the market to convert 2D images to 3D models. For the Buddha statue of partial damage, it is necessary to further repair the missing parts. In the repair process, it needs to use the image contrast method and the analysis method of human body proportional structure, meanwhile combined with the aesthetic principles to repair. In the whole process of digital restoration, it is necessary to collect images, analyze features, and infer the missing
parts based on evidence, and then make up the missing part of 3D Buddha in the later stage, so as to complete the restoration of a complete digital Buddha.

3. Exploration and research on the restoration of the Lucia Buddha in Fengxian Temple

At the beginning of this study, some relevant literature review and field survey have been carried out and at the same time, an in-depth study on the main Buddhas in the representative niches of each dynasty summarizing the Buddha statue’s characteristics of the face, clothing, accessories, body shape structure and so on have been done. Hence, for the purpose of this study, the giant Buddha of Lucia in Fengxian Temple that built by the Tang Dynasty will be used as a case study.

The giant Buddha of Lucia in Fengxian Temple is currently located at the south of Longmen Mountain. It is the largest and most exquisite group of grottoes in the Longmen Grottoes. It was claimed to be carved in the time of Li Zhi, Emperor Gaozong of the Tang Dynasty, and was completed in 675 A.D[1].

The most impressive figure is the giant Buddha of Lucia sitting cross-legged on the eight-square lotus throne. It is 17.14 meters (about 56 feet) high, and the height of Lucia’s head is 4 meters, the Lucia’s ears are nearly 1.9 meters long. The clothes of Lucia show Kasaya of Shoulder-covering Style. The robe wraps from the right shoulder to the left, from top to bottom wrapped around the Buddha sitting on the lotus. The Buddha statue is carved with the round knife carving method to highlight the rounded face, graceful body and the elegant and moving clothes [2]. The whole Buddha statue size is used in inverse proportion: the head and body are larger, while the hands and feet are relatively small, which gives people visual errors.

The craftsmen took full advantage of the difference in height among the Buddha statue, the mountain and the Buddha worshippers, and delicately worked out the golden ratio between the Buddha statue body and the head, the angle of the lower jaw, the position of the eyes [3-4]. The effect of virtual movement was amazing. From the overall posture, the figure of Buddha statue is solemn and serene, from a fluffy curly hair in a bun, the shorter three-court, the delicate lips and the reserved chin, the whole posture show a gentle feminine image.

Due to the natural and man-made reasons, the arms and legs of the Lucia Buddha have been severely damaged. Based on the field investigations and the information acquired, it can be found that the upper body of the Lucia Buddha is basically complete, sitting on the Sumeru seat with the eight corners present a kind of bundle waist overlapping acerbity. The rock of legs collapsed severe and the shape was temporarily uncertain. According to the same function in the same dynasty characteristics of figure of Buddha images can do the following conclusions.

Mudra: The rulers of the Tang Dynasty expected the Giant Buddha of Lucia to bestow favors on their descendants and bless the long-term stability of the Li family dynasty [5], at the same time to satisfy the wishes of all living beings, so there should be a wish seal in the handprint.

Sitting posture: from the curved transition state of the carved surface between the two forearms of the Buddha of Lucia in Fengxian temple, it can be seen that the curved surface between the two forearms of the Buddha is in an asymmetric form, and his left shoulder inner side is obviously higher than its right shoulder inner side, which should be the result of placing the back of the right foot on the left leg [6-7]. Therefore, it can be inferred that the sitting posture of the Buddha is an auspicious sitting in the cross-legged sitting.

Pedestal: because the pedestal is not completely destroyed, it can be inferred that the total number of the upper three layers of lotus petals is 87, there are 4 Door Gods and 8 God Kings in the middle and the total number of grounded lotus is 25. Figure 1 below shows the image of the Buddha of Lucia in Fengxian Temple.
To sum up, this study proposes four kinds of options for restoring the missing part of the Buddha of Lucia.

Option 1: The right hand of the giant Buddha of Lucia is abhaya mudra, the four fingers of the left hands point to the upper, half grip. The shape of the legs is that the right foot lies on the left thigh, and the left foot lies on the right thigh. It belongs to an auspicious sitting in a cross-legged sitting.

Option 2: The right hand of the Buddha of Lucia is abhaya mudra, four fingers of the left hands point to the upper, half grip, turning inward slightly. The posture of his legs is relatively simple. The feet are hidden in the clothes, which is the right foot first press on the left thigh, the left foot back press on the right thigh. It belongs to the demonic sitting in a cross-legged position.

Option 3: The right hand of the Buddha of Lucia is abhaya mudra, the little finger and ring finger of the left hands are bent upward, and the index finger and middle finger are extended down. The posture of his legs is relatively simple. The feet are hidden in the clothes, which belongs to cross-legged sitting.

Option 4: The right hand of the Buddha of Lucia is abhaya mudra, the palm of the left hand is upward, the four fingers are slightly bent downward and the posture of his legs is relatively simple. The feet are hidden in the clothes, which belongs to cross-legged sitting.

Based on the above four schemes, the right hand of the Buddha of Lucia is abhaya mudra, and there are many possibilities for the left hand. However, from the modeling form of Lucia in Dongda Temple, Japan, the possibility of option 4 is more likely. For the leg modeling, according to the results of field investigation, the possibility of option 2 is more likely.

Applying this idea to all restoration studies of Buddhas. The fixed-point collection of the body joint of the Buddha is mainly to obtain the angle value of the body shape. Combining technology with art, firstly it is carried out the digital information collection of the Buddha which has the same functions as the Giant Buddha of Lucia, and use Firebase software for data analysis. By collecting data from 10 Buddhas with the same functions, dozens of sets of data from the same part will be obtained. After analyzing these data by software, it is studied the aesthetic taste and the excavation technology characteristics of people at that time. At last, the missing part of the Buddha statue which best conforms the historical original appearance and meets the data requirements is restored by digital technology.

4. Conclusion
As a conclusion, from the above findings, it can be seen that the digital reconstruction of a Buddha statue requires a complete understanding and collecting of its entire history. The digital restoration can make the Buddha statue to be preserved for a longer period of time. At the same time, in today's development of internet, using the network software to promote the digital technology will provide more options and possibilities for the restoration and protection of material of cultural heritage. It is very helpful to understand and inherit the grotto art and protect it on the basis of minimizing damage to the original material of cultural heritage.
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