

3D LASER SCANNING AND DIGITAL RECORDING OF DAMAGE FOR CHINA CANGZHOU IRON LION

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KEY WORDS: Cangzhou Iron lion, 3D laser scanning, Digital Recording, disease, digital restoration

ABSTRACT:

Cangzhou iron Lion, with the damages of crack and rupture for 1000 years and incorrect preservation in recent years, has divided into more than 20 pieces. In 2007, Chinese Academy of Cultural Heritage (CACH) decided to find a way to stabilize the sculpture so that the support tubes could be removed. Comprehensive engineering drawings or a 3D model of the sculpture would be required to create the finite element analysis (FEA) model. To obtain the required data, CACH and Beijing Dynasty Digital Technology used laser scanner to create photorealistic 3D images for dimensionally accurate CAD models and digital disease recording. Further, we attempt to do some digital restoration based on available documents.

1. INSTRUCTIONS

Cangzhou iron Lion was cast in 953 A.D., which is 6.2m(long)x2.82m(wide)x5.31m(high) in size. As one of national-protecting-level historical sites, Cangzhou iron Lion is the largest one in existence, which represents the highest level of iron-cast in ancient China. Cangzhou iron Lion, with the damages of crack and rupture for 1000 years and incorrect preservation in recent years, has divided into more than 20 pieces, and it can only stand up through the support of steel frames, facing with the risk of collapse. (WANG YuFang, 2008) Cangzhou iron Lion is representative in large-scale relics with the complex structures.



figure 1. Cangzhou iron Lion Present condition (exterior)

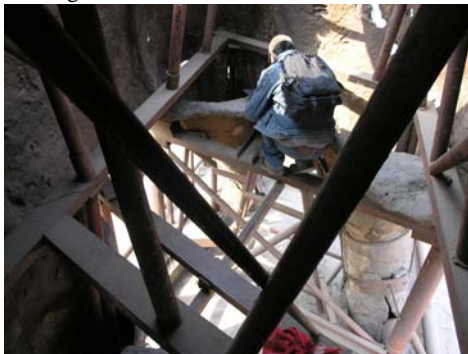


figure 2. Cangzhou iron Lion Present condition (interior)

A series of research have been developed to Cangzhou iron Lion since two years ago. As a basic, we have completed 3D laser scanning modelling of Cangzhou Iron Lion.



figure 3. old picture (Thomas T. Read, 1907~1910)



Figure 4. hanging and moving of Cangzhou iron Lion (1984)

2. 3D LASER SCANNING MODELING

In 2007, officials at the Chinese Academy of Cultural Heritage decided to find a way to stabilize the sculpture so that the scaffolding could be removed. Comprehensive engineering drawings or a 3D model of the sculpture would be required to create the finite element analysis (FEA) model. To obtain the required data, CACH and Beijing Dynasty Digital Technology used a FARO LS 880 laser scanner, which is designed to create photorealistic 3D images for dimensionally accurate CAD models.

On that basis, we set up a Three-Dimensional FEA Model and performed the Numerical Analysis to evaluate Iron Lion's structural safety, then establish the schemes of Cangzhou Iron Lion's structure reinforcement techniques. The 3D digital model is the most correct so far, is made of tetrahedral element, and involve of all information about the iron Lion: outline,

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shape, thickness, crack, fragment, hole and inside and outside bracket that was built up with more than 20 steel tubes.



figure 5. the scene of outside scanning

To avoid setting targets on the iron surface, a four-person survey team set control points around the outside of the hollow sculpture as well as inside it through the opening underneath. The data was validated by setting targets and then acquiring them with a Leica TPS703 total station. Scanning under the lion allowed surveyors to see both the interior and exterior control targets simultaneously, which enabled them to register 12 scans in the lion's tight interior without touching the iron. To scan the top of the sculpture, the team mounted the scanner on a specially constructed 5-by-5-foot platform stabilized by ropes and anchors. This scaffold also allowed the team to see additional control targets inside the lion through an opening in the top of the sculpture. Scanning on a scaffold is always a challenge, and there was some trial and error involved. Sometimes, a couple of scans had to be done to pick the best one. But without the scaffold, top of the lion would be captured. Within three days onsite, about half a gigabyte of data was gathered from each scan setup for a total of 13 gigabytes. These data were sent to the office, where FARO's software suite was used to register point clouds before exporting the data to other modeling software for further processing, including building the digital renderings that would be required to develop the FEA models. The accuracy of the model is far more than similar result few years ago. (WU Di Ping, etc, 2006)

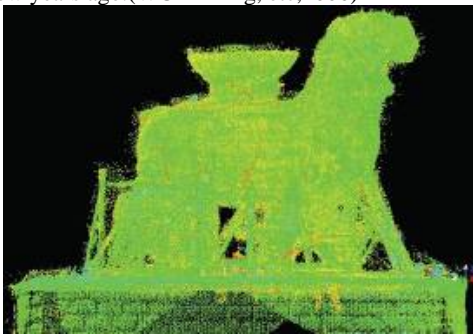


figure 6. Cangzhou iron Lion point clouds

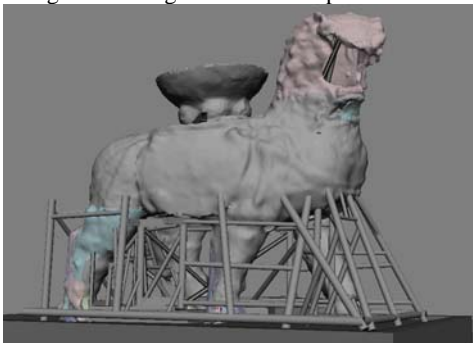


figure 7. 3D model with bracket

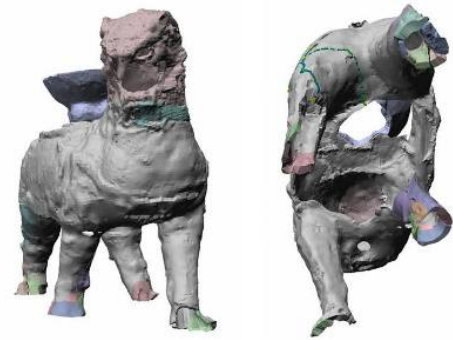


figure 8. 3D model
(different colours represent different fragments)

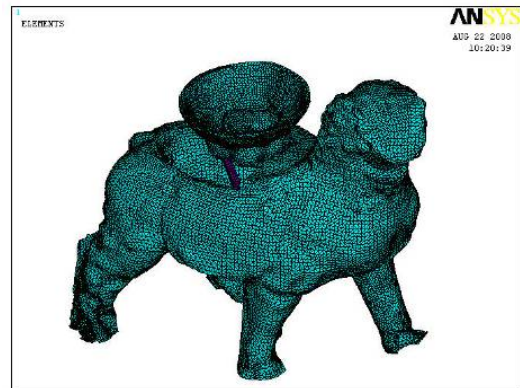


figure 9. FEA model According to the scanning

3. DIGITAL DISEASE RECORDING

In addition, based on Numerical simulation technology above, a Digital disease recording approach has been developed. We completed the 3D impression of Iron lion's disease, rupture and casting defect. It combined 3D digital model with mapping technique.

To document the diseases on the surface of the sculpture, the preservation experts of CACH and China National Museum and the engineers at Beijing Dynasty Digital Technology went to site again. The purpose of this visit was to accurately locate the diseases and summarize the different kind of diseases. Based on the model created from the previous effort, with a combination of surveying and photography techniques, the attribute data of diseases were collected along with accurate location.

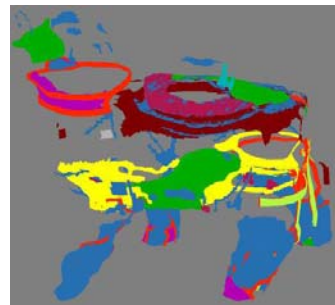


figure 10. disease position Reflect to the model

The collected information was then brought into the office and the diseases were mapped on the body surface of the iron lion. A fully rendered 3D model was created with the diseases annotated. Finally, a color animation was produced not only showing the existing of the iron lion, but also demonstrating the location and type of the diseases on the surface.



figure 11. 3D impression of Iron lion's disease

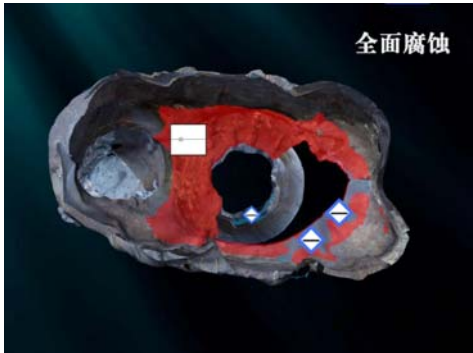


figure 12. section of 3D impression of Iron lion's disease

4. DIGITAL RESTORATION

Some digital restoration has been done based on the 3D model and other available documents, such as the same period statues and murals. It should be noted that the digital model is a very preliminary attempt far from the history authenticity.

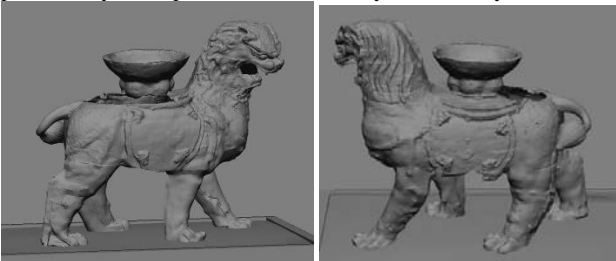


figure 13. a speculate of original of Cangzhou iron Lion

5. CONCLUSIONS

Through above research, it can be took a conclusion that 3D Laser scanning modelling is an effective means to the culture heritage conservation.

REFERENCES

- WANG Yu Fang, 2008. *Cangzhou iron Lion and Cangzhou old city*. Science press, Beijing
 Wu Diping, Yi Honggang, Shi Xiaolu, Qin Qin, Zou Jiayang, 2006. Configuration Measuring and 3-d Modeling of Cangzhou Iron Lion. *Computer Engineering and Applications*, 42(10)

ACKNOWLEDGEMENTS

In gratitude to the China National Science and Technology Support Project, The research was supported by it and the project serial number: 2006BAK20B03.