

Kaihuasi: Buddhist art and architecture in virtual reality

Jianwei Zhang and Lala Zuo

The Kaihuasi (開化寺) is a Buddhist monastery located about 17 km northeast of the city of Gaoping (高平) in southeast Shanxi province. The monastery was established in the 6th century and expanded in the late 9th to early 10th century under the supervision of the Chan Master Dayu [大愚]. The Kaihuasi is especially known for its main hall, the Daxiongbaodian [大雄寶殿] [Mahāvīra Hall], which was built in 1073 during the Northern Song. The interior of the Daxiongbaodian is decorated with exquisite Buddhist mural paintings that have been preserved from the 11th century.

In 2017, a research team of the Experimental Teaching Center for Virtual Reality and Simulation in Archaeology of Peking University used Virtual Reality (VR) technology to record the monastery including the main hall and its murals. First, the team deployed drones to take pictures of the monastery complex from an aerial view. Then panoramic photography was used to record both the interior and exterior of each building (fig. 1). In order to virtually reconstruct the building structure and mural paintings in the Daxiongbaodian, the team took 480 high-resolution photographs and used photogrammetry to create a 3D model of the Daxiongbaodian (interior) with surface texture and color information. In other words, the photos were applied as skins to precisely cover the surface of the 3D model of the building's interior (fig. 2). After all data was collected, the team located all buildings on a map using the Geographic Information System (GIS). The links to the panoramic photographs were pinpointed on the aerial picture according to the real locations where the photos had been taken. The links to the 3D models with surface texture were also displayed on the map.

Aside from documentation, this VR project has also been applied to enhance the experience of museum visitors. In the spring of 2017, the Arthur M. Sackler Museum of Art and Archaeology at Peking University exhibited high-resolution life-size photocopies of the wall paintings from the Kaihuasi. In addition to viewing the paintings in two dimensions, visitors were able to wear a VR headset and immerse themselves in the virtual scene of the Daxiongbaodian to appreciate the paintings and the building structure in their original spatial context. VR would help museums to redesign and/or upgrade traditional exhibitions, and to protect historical architecture from potential damages made by flocking visitors.

Using the VR technology to document art and architecture is only the team's first step.

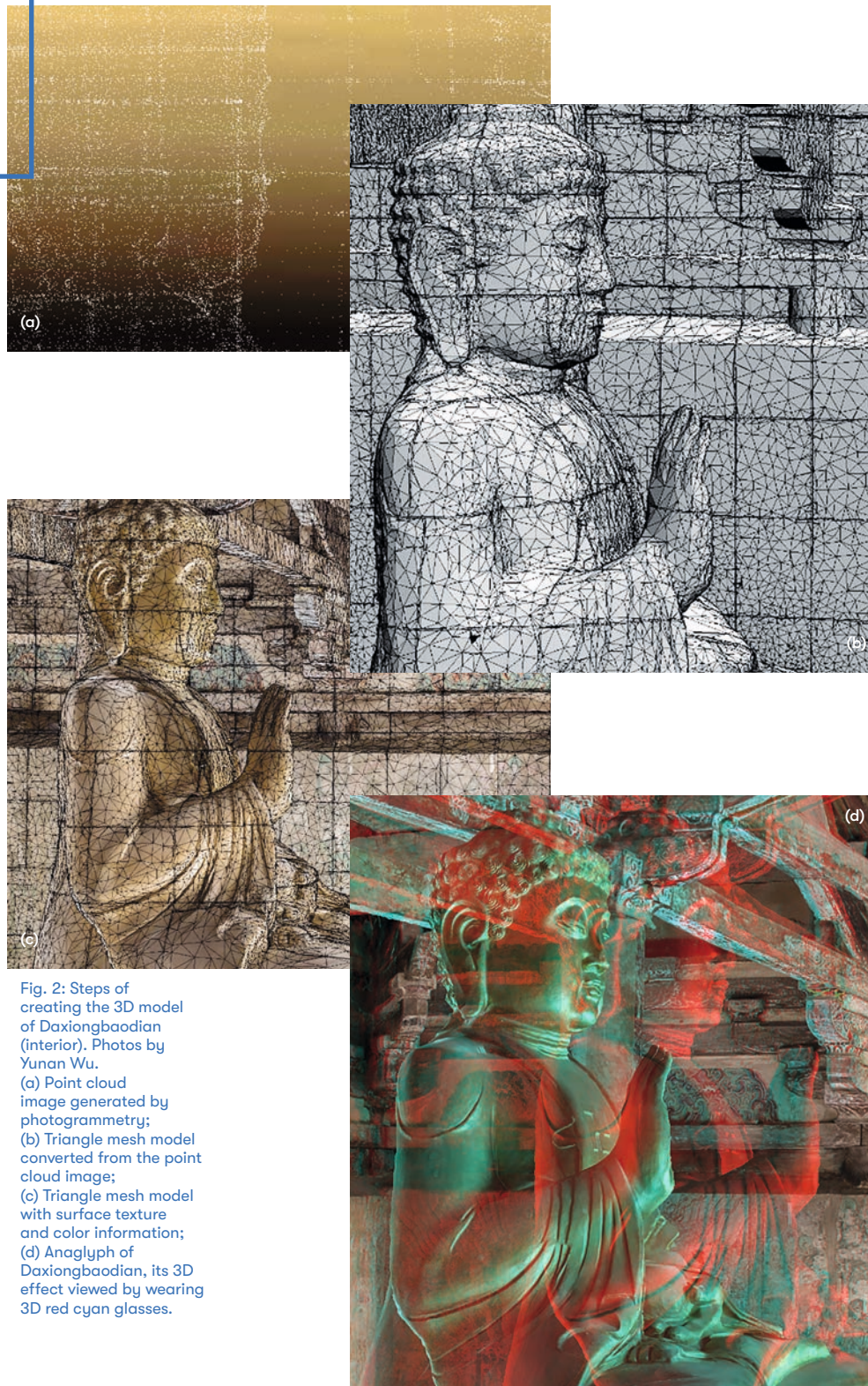


Fig. 2: Steps of creating the 3D model of Daxiongbaodian (interior). Photos by Yunan Wu. (a) Point cloud image generated by photogrammetry; (b) Triangle mesh model converted from the point cloud image; (c) Triangle mesh model with surface texture and color information; (d) Anaglyph of Daxiongbaodian, its 3D effect viewed by wearing 3D red cyan glasses.

The Kaihuasi is only one example in the team's database called VR-Heritage that stores hundreds (currently around 150) of temples and buildings dated from the 10th century to the early 20th century. This database can help scholars, professors, and students to discover new problems and generate new research topics. For example, the team has developed several themes such as 'Song-Jin architecture in southeast Shanxi', 'Yuan-Ming architecture in Sichuan', and 'Liao pagodas in Inner Mongolia and Liaoning'. Most of the objects are Buddhist architecture or monuments.

The benefits and challenges of the application of VR and other digital technologies will be further discussed in a panel titled 'Digital Humanities and New Directions in Studying East Asian Art and Architecture' at the 2018 Annual Conference of the Association for Asian Studies (AAS), to take place in Washington D.C. this March. The panel, organized by Professor Lala Zuo, will present more original digital humanities projects and explore new directions in East Asian art and architectural history.

Jianwei Zhang is an Assistant Professor at the School of Archaeology and Museology, and the Associate Director of the Experimental Teaching Center for Virtual Reality and Simulation in Archaeology at Peking University zhangjianwei@pku.edu.cn

Lala Zuo is an Assistant Professor at the Languages and Cultures Department of the United States Naval Academy zuo@usna.edu

Notes

- 1 Miller, T. 2008. 'The Eleventh-Century Daxiongbaodian of Kaihuasi and Architectural Style in Southern Shanxi's Shangdang Region', *Archives of Asian Art* 58:4.
- 2 The VR-Heritage is a database developed by Peking University in 2017. It aims to record important cultural heritage sites with panoramic photography, oblique-imagery 3D modeling, and other VR technologies. It is currently under construction and will be accessible for academic use in 2 or 3 years.



Scanning a Buddha statue in one of the Grottoes.

Longmen Grottoes: New Perspectives

Fletcher John Coleman

On 25-26 October 2017, Harvard University welcomed a team of experts from the Longmen Grottoes Research Academy to inaugurate an international joint-initiative focused on digital conservation and restoration. An enduring legacy to Chinese art, the UNESCO World Heritage Site of the Longmen Grottoes represents over a millennium of religious and creative activity. The 'Longmen Grottoes: New Perspectives' workshop brought together Longmen Academy researchers with specialists on Buddhist art from across the globe to promote cutting-edge efforts at digital preservation, archaeological work, and documentary projects taking place at Longmen.

Spearheaded by Eugene Wang, Abby Aldrich Rockefeller Professor of Asian Art at Harvard University, and Hou Yuke, Director of the Material and Information Center at the Longmen Grottoes, the two-day event was centered on overviews of recent digital programs at Longmen. Tasked with addressing centuries of damage and dispersal of the magnificent limestone grotto sculptures, the Longmen Grottoes Research Academy began a comprehensive program of 3-D scanning over a decade ago. Having built an extensive database of cave scans, the Academy uses the information to conduct new efforts at preservation – including the redressing of groundwater and other environmental damage. The precision of the digital data has also driven exciting new archaeological discoveries in the eastern cave district at Longmen.

With technological efforts reaching a mature phase at the Longmen Grottoes, the Research Academy has turned its attention to the digital restoration of sculpture removed from the site during the early 20th century. The 'Longmen Grottoes: New Perspectives' workshop represented the inaugural partnering of Harvard University and the Metropolitan Museum of Art with the Longmen Grottoes Research Academy to begin a 3-D digital scanning project of all known Longmen sculptures housed in institutions around the world. As data is collected, the caves will be digitally restored using a combination of virtual and augmented reality technologies. Algorithms are used to match fragmentary pieces with their original cave locations, allowing for the accurate virtual recreation of the sculptures to their original forms. Workshop participants were able to explore the Longmen Academy's most recent sample cave restorations through a virtual reality experience. The Academy plans to build a site museum of digital restorations, as well as an immersive travelling exhibition.

Workshop participants were also treated to presentations on exciting new academic research being conducted on the Longmen Grottoes. Ranging from explorations of female agency in Buddhist patronage at Longmen to exciting new archival discoveries on the collecting history of the site, traditional research continues to play a crucial role in broadening our understanding of the Longmen Grottoes. Scholars remain eager to explore further horizons in their research through the new digital tools offered by the Longmen Academy.

Fletcher John Coleman is a PhD Candidate in the Department of the History of Art and Architecture at Harvard University fc Coleman@fas.harvard.edu



Fig. 1: Panoramic photograph of the Daxiongbaodian at Kaihuasi (built in 1092). Photo by Yunan Wu.