The Research on the Online Publishing Platform of Point Clouds of Chinese Cultural Heritage Based on LIDAR Technology: A Case Study of Chen Clan Academy in Guangzhou, Guangdong Province

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Abstract. Cultural heritage protection has always been accompanied by production activities of human society. With the wider application of digital technology in the protection and inheritance of cultural heritage, this study intends to use the non-contact high-speed laser measurement method to obtain the 3D surface array geometry data of the typical hall of Chen Clan Academy, which is the national key cultural relic protection unit and the most distinctive artistic architecture of the existing ancestral halls in Guangdong, in the form of point clouds. Moreover, it tries to complete the automatic extraction and 3D modeling of millimeter-level accuracy images and establish the original database for cultural heritage, so as to obtain the 3D high-precision, real and measurable massive point cloud data. Independently designing the online publishing platform of point cloud data as well as realizing the browser's rapid publishing, measurement and application of massive point cloud data can explore a new technical method for the protection of cultural heritage and the restoration and reconstruction of cultural relics in China.

1. Introduction

China attaches great importance to the protection and inheritance of historical and cultural heritage, and "The 13th Five-Year Plan" has proposed that it is necessary to build the inheritance system of China's excellent traditional culture and strengthen the protection of cultural heritage. At present, domestic and foreign scholars believe that the traditional repair methods cannot meet the needs of the current cultural heritage protection, and the digital technology has begun to be applied in the protection of cultural heritage [1, 2]. Studies have shown that the ground laser radar scanning can accurately measure the 3D point clouds of the surface of cultural relics and generate the relevant 3D models and digital orthophoto images, so it has become a more popular new technology for the protection of cultural heritage [3, 4]. LIDAR technology can be used to make the digital orthophoto map of cultural relic buildings and realize the rapid 3D reconstruction of cultural relics [5, 6]. With the characteristics of high-speed, high-precision, full-range and long-distance scanning data, LIDAR

technology can obtain the massive data of 3D surface of cultural heritage in a short period of time, and the precision can reach the millimeter level. Meanwhile, it can establish the original database for cultural heritage, provide the detailed and accurate data for cultural heritage archiving and provide the carrier for the protection, education, propaganda and cultural inheritance of cultural heritage under the premise of the maximum reduction of the destruction of cultural relics.

For the massive 3D point cloud data collected by the ground laser scanning system, the data volume poses a great challenge to the subsequent data processing (such as point cloud filtering, segmentation, target recognition, 3D reconstruction, visualization, etc.) [7]. In order to achieve the spatial analysis and visualization of the massive point cloud data, there is a need to efficiently complete the scheduling and query of point cloud data in real time. The key of spatial data scheduling lies in the index and retrieval of data, and the performance of the index directly affects the efficiency and analysis ability of the system [8]. Therefore, how to establish the reasonable spatial index mechanism is the key to solving the problem of the organization and rapid scheduling of massive spatial data. Many landmark index methods have been widely used in the retrieval, query, storage and management of spatial data, such as quadtree, r-tree, octree, etc.. However, if quadtree, r-tree or octree is established to index the point cloud data in the LAS file, there will be numerous empty leaf nodes and invalid storage spaces [9, 10]. Thus, in order to solve this problem, firstly, this study divides the 3D point clouds along the scanning path into a series of continuous regional blocks, and each block only contains a part of the data. In this way, the storage spaces of the index files can be saved by reducing the empty leaf nodes, and the height of the index tree can be reduced effectively. At the same time, the performance of retrieval and the speed of point cloud loading can be improved. Furthermore, adopting a method of massive 3D point cloud data management and real-time visualization based on internal and external storage scheduling, this study establishes the online publishing platform of point clouds by using Internet technology, so that users can smoothly retrieve and visualize the 3D point clouds on desktop computers or in the network environment. This also provides new technologies and methods for the digital preservation of cultural relics and historic sites as well as the inheritance of cultural heritage.

2. Study area and data sources

Located in the 7th Zhongshan Road, Guangzhou, Guangdong Province, China, Chen Clan Academy was built in 14th year of Qing Emperor Guangxu (1888) and completed in the 20th year of Qing Emperor Guangxu (1894), and it was jointly constructed by Chen families from 72 counties of Guangdong Province in the late Qing Dynasty. As the relatively well preserved folk architecture in the late Qing Dynasty in Guangdong, it is the building complex consisting of a total of 19 building monomers, and the individual buildings are independent and interconnected. The architectural structure of Chen Clan Academy can be divided into three axes and three rows, and the building area reaches 8000m^2. Chen Clan Academy is famous for its exquisite decoration technology, and its building widely uses the wood carvings, stone carvings, brick carvings, pottery figurines, clay sculptures, colored paintings, copper and iron castings and other different styles of technologies for decoration. It has become the important cultural heritage and the cultural relic protection unit in China.

The data of this study mainly come from the project of "Development and Application of Protection and Inheritance Platform of Cultural Heritage based on LIDAR Technology" conducted by Tourism Management College of South China Normal University. The research group collected the survey data from Chen Clan Academy in January and February 2018, and the main survey items included the historical background and cultural inheritance, building volume, material, color, style and other statistical data. Through the field survey, the typical hall of Chen Clan Academy was scanned to obtain the 3D high-precision, real and measurable massive point cloud data of Chen Clan Academy, so as to provide the detailed data foundation for the design, development and testing of the online publishing platform.

3. Protection Status and Existing Problems of Chen Clan Academy

3.1. Protection Status of Chen Clan Academy

In 1988, the State Council announced that Chen Clan Academy was listed as the third batch of the national key cultural relic protection units. The restoration process of Chen Clan Academy is based on the principle of "restoration in accordance with the original appearance of cultural relics", trying to maintain the original appearance and not to interfere with the surrounding geo-environment. At present, Chen Clan Academy has formed a unique protection mode of cultural heritage, and the development at the current stage is the protection and management of immovable cultural relics. The establishment of Chen Clan Academy Museum mainly provides the space for the protection of immovable cultural relic sites and reduces the possible damage factors. At the same time, the relevant management departments carry out the routine maintenance and damage repair. Many non-governmental cooperation organizations also participate in the protection and play a crucial role in the protection and inheritance of intangible cultural heritage, such as "seal cutting", "paper cutting", "manuscript line drawing", etc..

3.2. Existing Problems of Chen Clan Academy

In Chen Clan Academy, it is difficult for many brick carvings to present the original appearance, and the flower cover of wood carvings is broken, while the wall is cracked. There are many problems in the protection and renovation of "the synthesizer" of lingnan architecture, which integrates technology with aesthetics. On the one hand, the repair technology is lost, while the brick carvings of Chen Clan Academy are dominated by characters and the carving technology is relatively difficult, so the appropriate technologists cannot be found to repair the brick carvings; on the other hand, the visitor flow is large, and the number of visitors hits a historical high every year. Chen Clan Academy suffers non-artificial natural losses and human destructions. In addition, there are many problems in the development of Chen Clan Academy, such as extremely small positioning scope, insufficient research planning and excessively single form. Firstly, the lack of text information and the limited space of ancient architecture of Chen Clan Academy make the development of cultural heritage and resources more difficult; secondly, the cultural space provided by the museum as the carrier of cultural relics is, to a certain extent, harmful to the historical and cultural sites as cultural relics; thirdly, the researchers are lack of the in-depth theoretical support and the systematic development and protection mode.

Thus, in order to better protect the ancient architecture of Chen Clan Academy, it is necessary to pay more attention to the use of digital technology to collect the original information data and realize the publishing and application of the data, so as to provide more technical support for the later restoration and cultural inheritance of Chen Clan Academy and provide convenience for the theoretical research and data use of the relevant researchers.

4. The application of the online publishing platform of point clouds of Chen Clan Academy based on LIDAR technology

4.1. The application of the online publishing platform of point clouds

The application of the online publishing platform of point clouds of Chen Clan Academy based on LIDAR technology. Through the independent-developed online publishing platform, the massive laser point cloud data are sliced and layered, so that the users can roam the point cloud echo data acquired by various types of ground laser scanners in the 3D visualization environment. At the same time, through the back-stage management module of the platform, the point cloud items on the platform can be added and deleted, and the basic information can be edited. The platform has the functions of point cloud distance measurement, area measurement and point cloud management.

4.2. The laser point cloud browsing of Chen Clan Academy

The online publishing platform of point clouds of cultural heritage can provide users with the 3D large scene browsing of laser point clouds. As shown in Figure 1, the 3D large scene map of laser point

clouds of Chen Clan Academy allows users to experience different browsing feelings more stereoscopically and truly and obtain diversified geographic information from a variety of browsing methods.
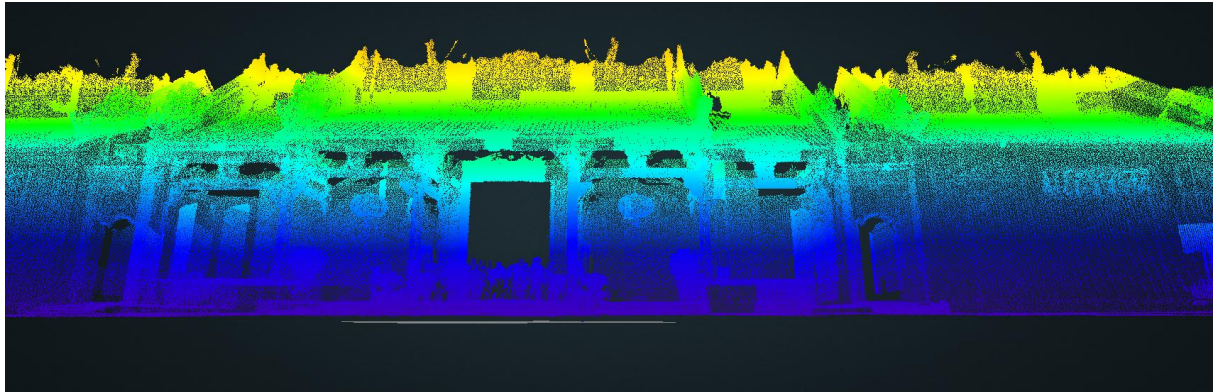

Figure 1. 3D large area sketch map of local laser point cloud of Chen Clan Academy.

4.3. The laser point cloud measurement of Chen Clan Academy
The laser point cloud measurement mainly includes distance measurement and area measurement. When the distance measurement tool under the geometry tool is selected in the tool bar, the starting points and ending points of the line segments or polygonal lines that need to be measured are respectively selected, and the measurement is ended by double click. The measurement results are shown above the line segments (Figure 2). When the area measurement tool is selected in the tool, the side lines of the polygons that need to be measured are respectively selected, and the measurement is ended by double click. The measurement results are presented above the polygons (Figure 3). As a result, the data can be more intuitively reflected, and the measurement and storage of a large number of data can be more convenient.
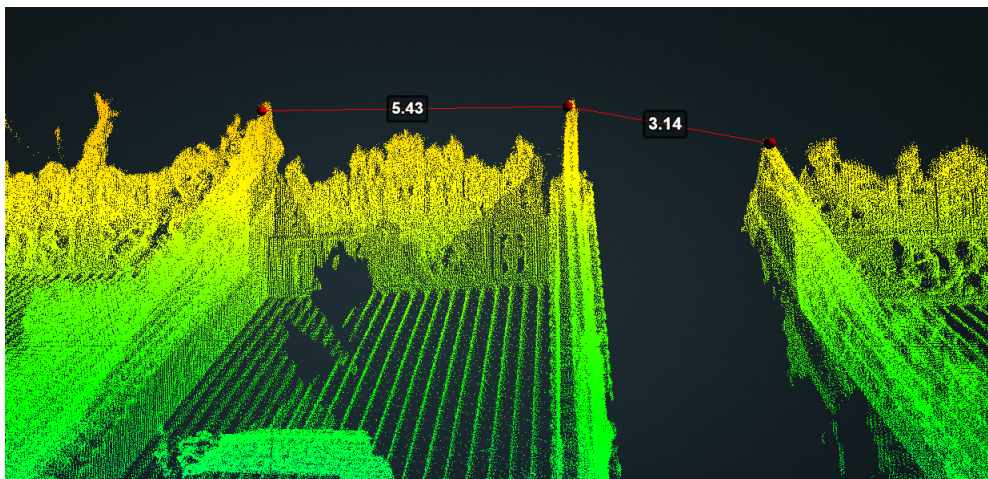

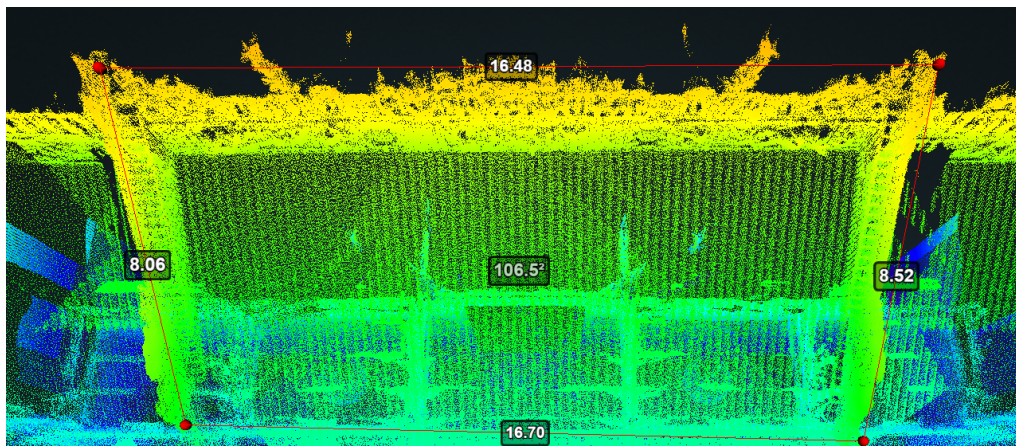**Figure 2.** The local distance measurement.

Figure 3. The local area measurement.

4.4. The back-stage management of the online publishing platform of laser point clouds

The back-stage management of the online publishing platform of laser point clouds. The back-stage management module of the online publishing platform can provide point cloud management, group management, user management and other functions. Among them, the point cloud management module can add, delete and modify point cloud items, such as setting the title, subject information, acquisition time, subordinate unit and browsing permission of point clouds. The group management module is mainly used to group the point clouds. Through different groups, the source or unit of point clouds can be distinguished to achieve effective management. Finally, through the user information management, users can be added or deleted, and user information can be modified, while passwords can be changed.

5. Conclusion

Through the 3D laser scanning of Chen Clan Academy, the cultural heritage in Guangdong Province of China, without direct contact with the objects of surveying and mapping, this study quickly obtains the information of geometry, color and texture of Chen Clan Academy, so as to avoid the possible damage caused by traditional measurement methods to cultural heritage. Meanwhile, the scanner's "WYSIWYG" can obtain the real, complete and accurate massive point cloud data of precious cultural heritage. The independent-developed online publishing platform of cultural heritage can realize the visualization of the point cloud data, make the acquired 3D laser scanning data have perfect query performance through browser publishing and effectively manage and retrieve the point cloud data. The use of LIDAR technology can establish the original database for precious cultural relics, provide the basis for subsequent research and restoration and bring the new experiences for users.

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