Digital Protection of Hakka Condoms in Longnan Based on BIM and 3DGIS

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Abstract. In the BIM of digital protection of ancient buildings, in addition to providing three-dimensional information, it can also directly provide two-dimensional drawings for the restoration of ancient buildings, and visualize the repair process to preserve all stages of ancient buildings. Using the existing ancient architectural cultural heritage to make "clan" library, applied to architecture, BIM destroy the ancient architectural cultural heritage can complete the digital restoration of ancient architectural cultural heritage, BIM model not only supports the acquisition of ancient architectural geometric information, but also supports the management and preservation of attribute information. The combination of BIM and GIS, on the one hand, realizes GIS from outdoor to indoor, from macro to micro, and enriches the new generation of 3DGIS technology system; on the other hand, it enriches the application of BIM in the whole building life cycle. According to the list of the seventh batch of state key cultural relics protection units, there are 4296 national key cultural relics protection units, of which 1882 are ancient buildings, with 710 monuments and monuments.

Key words: BIM, 3DGIS, Longnan Hakka House, Digital Protection

1. Introduction
The cultural heritage of ancient architecture bears a profound historical and cultural heritage, witnessing the wind and rain course of a city for thousands of years. The ancient architectural style is unique and the cultural connotation is rich. It is the inheritor of traditional culture and superb technology and the crystallization of ancient wisdom. Since the reform and opening up, with the rapid development of China's economy, people have a further understanding of the concept of protection of ancient architectural cultural heritage, and the protection of ancient architectural cultural heritage in China has entered a stage of rapid development. Has become an important part of sustainable development strategy. The protection of ancient architectural cultural heritage has become the key work of national cultural relic protection. With the rapid change and application of surveying and mapping technology, the protection of cultural relics has entered the stage of digitization and information development. The protection of architectural cultural heritage is developing in the direction of scientific norms.
The research on digital protection of Longnan Hakka enclosed house based on BIM and 3DGIS has attracted the interest of many experts and has been studied by many teams. For example, some teams found that with the increasing awareness of the importance of the cultural heritage of ancient architecture, it is very important to preserve the cultural heritage of ancient architecture for a long time without damaging the building itself. However, due to the imperfect management mechanism of ancient architectural cultural heritage, the lack of clear norms and standards for surveying and mapping repair work, the shortage of professionals, the limitation of funds and other historical problems, which restrict the development of ancient architectural cultural heritage protection [1]. Because of the emergence of CAD technology, the mapping method of cultural heritage protection of ancient buildings has changed from traditional manual drawing to digital drawing. With the rapid development of information and digitization, the development of digital technology related to the protection of cultural heritage of ancient buildings has attracted wide attention. More modern technology has been applied to the protection of ancient buildings, greatly improving work efficiency, and the protection of ancient cultural heritage has begun to change from information preservation to information management [2].

Li DAR remote sensing, as a new surveying and mapping method, can be used to obtain point cloud data without contact with the measured objects. DAR remote sensing has the characteristics of fast scanning speed, short working time, convenient operation, saving manpower, comprehensive data and no omission. It is suitable for surveying and mapping irregular and curved objects such as grotto statues. The data is accurate, high precision, small influence of human error, non-physical contact, easy surveying and mapping inaccessible and unsuitable objects, there are many applications and successful cases in the field of ancient architectural cultural heritage protection at home and abroad [3]. Some teams found that Sukkar has done statistical research on the application of BIM in the world: in addition to the construction industry, engineering construction and other fields, more interdisciplinary collision communication research. Under the background of "Smart Earth" and "Digital City ", foreign institutions of higher learning and research institutions pay attention to the integration and development of GIS technology, BIM and GIS integration, LeonvanBerlo and RubendeLaat make a general review of this, urban GML can be used as a bridge between the two. Data Germany uses the city to build three-dimensional models of modern cities and apply them to transportation, urban planning, etc [4]. Some teams found that on the basis of Li DAR remote sensing, he Yibo and others proposed a scanning method based on point cloud data wall. Based on Li DAR remote sensing, the damaged area of inner city brick was scanned to obtain point cloud data. According to the characteristics of the ancient wall, the damaged area of the wall was calculated. During the same year, Zhu Shuguang and others took Leica scanning station P40 system as an example to illustrate its application in fine modeling of complex structures, focusing on point cloud data and modeling accuracy [5]. Although their research results are very rich, but there are still some shortcomings.

With the rapid development of information technology, computer technology is more and more widely used in the protection of ancient buildings, which makes the protection of ancient buildings progress rapidly. This technology combines information technology with traditional ancient architectural cultural heritage protection technology. Compared with traditional ancient architectural protection technology, digital technology can improve the efficiency of information processing and ensure the accuracy of information processing. Nowadays, digital protection of ancient buildings has become an important development direction in the field of cultural heritage protection, especially with the rapid development of BIM and GIS, the combination of modern surveying and mapping technology and digital technology of ancient buildings is a new method of protection of ancient buildings.

2. Method

2.1. Calculation Formula of Coordinates
Coordinate axes in Li DAR remote sensing scanning equipment are usually defined as: the origin of the coordinates is located at the laser beam emission, z axis is located in the vertical scanning plane of the instrument, x axis perpendicular to the z axis, y axis perpendicular to the instrument. Assuming $\alpha$ is the horizontal angle of the laser beam, $\beta$ is the vertical angle of the laser beam, $S$ is the oblique distance from the instrument to the measured point. Li DAR measurement point $P (X, Y, Z)$. The coordinate formula is [6]:

$$x = S \cos \beta \sin \alpha$$  \hspace{1cm} (1)

$$y = S \cos \beta \cos \alpha$$ \hspace{1cm} (2)

$$z = S \sin \beta$$ \hspace{1cm} (3)

After obtaining the spatial coordinates of each sampling point on the surface of the measured object, the device Li DAR, us to obtain a set of points, called the "point cloud ". The initial observations for each point are one distance value and two angle values. The Li DAR device finally converts the original observations for each point into the spatial 3d coordinates $(x, y, z)$, and stores the data in a specific format in the file [7].

2.2. Determination of Sample Density

The sample density was determined according to Archimedes principle, the sample was cleaned and dried in thousands of $m_1$, then put into deionized water, vacuum 30 mim weighing the weight of the sample in deionized water $m_3$, after the surface water was dried, weigh the weight of the sample in the air $m_2$, the formula for calculating the sample density is [8]:

$$\rho = \frac{m_1}{m_2 - m_3} \times \rho_{H_2O}$$ \hspace{1cm} (4)

2.3. Determination of Evaluation Standard for the Protection and Development of Hakka Surroundings in Longnan

The evaluation system scoring standard will be studied and discussed with experts and scholars through the reference of the national current evaluation system index scoring standard, and adjusted appropriately according to the specific conditions and characteristics of Hakka houses in Longnan. After determining the evaluation system, each evaluation index and scoring standard, the score adopts 100 points system, retains two decimal places, and scores the present situation of Hakka house in Longnan. results are calculated using the following formula [9]:

$$A = \sum_{i=1}^{n} a_i \eta_i$$ \hspace{1cm} (5)

$A$: comprehensive evaluation score; $a_i$: the final level of an evaluation factor score; $\eta_i$:the weight of an evaluation factor on the last layer. According to the evaluation results, the evaluation grade: the score is 90-100: I grade (very good protection, very suitable for development); Score 60-89: U, Suitable for development); a score of 30-59: IV, not suitable for development); a score of 0-29: V, very unsuitable for development). Among them, The I,II class Longnan Hakka enclosure is a suitable building for development and utilization [10].

3. Experiment

3.1. Source of Experimental Data

On the basis of Li DAR 3D modeling and combining the characteristics of ancient architecture, this paper studies the theory and method of 3D fine modeling of ancient architecture. On this basis, the BIM model of ancient architecture is established based on point cloud data. Realize the management
and preservation of ancient building information. Lastly, using BIM technology and GIS technology to realize the digital protection of the three-dimensional model of ancient architecture and the management and analysis of various spatial and attribute information of ancient architectural cultural heritage. Based on the application of Li DAR, combined with the subject of architectural engineering, using the latest research results of the main digital technology and three-dimensional modeling technology, to obtain and preserve the cultural heritage information of ancient buildings, and to provide more accurate engineering materials for the restoration of cultural relics.

3.2. Experimental Design
1. The Li DAR theory and method of 3D fine modeling of ancient architecture; 2. The BIM model of ancient architecture based on point cloud; 3. Digital restoration of cultural heritage of ancient architecture based on BIM.

4. Result

4.1. Data Preprocessing
Point cloud data is affected by the environment and its own system in the process of acquisition, point cloud data can not be used directly, need to be preprocessed, point cloud data preprocessing mainly includes point cloud drying, point cloud splicing and point cloud cutting. Target splicing is the most commonly used method of point cloud splicing. When setting up a scanning site, three target balls should be placed in > common area of at least two sites, with a 1/4 scanning resolution within a specific scanning distance, the target distance scanner <18 m, the target distance <60 m. In which the data of five stations are imported. Based on the target splicing, the average distance of point cloud splicing is <4 mm, which can fully meet the requirements of splicing accuracy, as shown in Table 1 below.

| Set scan group | Connector number of targets | Maximum distance /mm | Average distance /mm | Maximum horizontal distance Separation /mm | Average horizontal distance Separation /mm | Maximum vertical distance Separation /mm | Average vertical distance separation /mm |
|---------------|---------------------------|----------------------|---------------------|------------------------------------------|------------------------------------------|----------------------------------------|------------------------------------------|
| s001          | 3                         | 5.6                  | 2.9                 | 0.5                                      | 0.3                                      | 5.6                                    | 2.8                                      |
| S002          | 3                         | 5.6                  | 3.0                 | 2.2                                      | 0.6                                      | 5.6                                    | 2.9                                      |
| S003          | 3                         | 5.2                  | 2.8                 | 2.2                                      | 0.7                                      | 4.8                                    | 2.7                                      |
| S004          | 4                         | 2.3                  | 1.6                 | 0.9                                      | 0.5                                      | 2.2                                    | 1.4                                      |
| S005          | 1                         | 1.3                  | 1.1                 | 0.9                                      | 0.8                                      | 1.1                                    | 0.7                                      |

4.2. Distribution Characteristics of Typical Residential —— Surrounding Houses
The enclave, as a Hakka-specific defensive dwelling, mainly distributed in the southern part of Ganzhou city, envelopes contain many sub-types and different types of enclosures, its spatial distribution is different. According to the statistical analysis of the village, as shown in table 2 below, the number of squares is 178, 83.57 per cent; irregular enclosure, ring house, the number of rings is 46, 25, 18, 21.60%, 11.74%, the proportion is 8.45. Square enclosed houses are widely distributed in Sannan, Xinfeng, Anyuan and other southern regions, they are scattered in Huichang, Yudu, Shicheng, but most concentrated in Longnan and Dingnan; irregular enclosed houses are mainly located in Longnan and Dingnan counties; the enclosure is mainly distributed in Longnan, Dingnan, a few villages in Xunwu.
### Table 2. Number of enclosed houses

| Type of Population | Square Wai House | Ring House | Wai Lung Wai House | Irregular Rnclosed Roof |
|--------------------|------------------|------------|--------------------|------------------------|
| Number of Villages (Individual) | 178          | 25         | 18                 | 46                     |
| Ratio(%)           | 83.57          | 11.74      | 8.45               | 21.6                   |

#### 4.3. Distribution Characteristics of Roadway Form

Classification of all village sample roadways, as shown in figure 1, through data analysis, most villages are in the form of roadways, the number is 679, 62.12% of the total sample; second, irregular grid type roadways, the number is 233, 21.32 per cent of the total; again, there are many regular grid roadways and linear roadways, less quantity, 10968, 9.97 per cent and 6.22 per cent of the total; in very few villages, the roadway form is regular grid, only four, it accounts for 0.37% of the total. Villages without roadways are most widely distributed in Ganzhou, most common, in Ganzhou counties (cities), mainly concentrated in Ganzhou edge; irregular and regular grid roadways are mainly distributed in northern Ganzhou, with a gradual weakening from north to south, the coverage of irregular grid roadway and regular grid roadway has strong regional characteristics, mainly concentrated in the west of Ganzhou Xinfeng County, a few villages in the form of conventional grid roadways are located in Dayu county.

#### Figure 1. Statistical table of laneway forms of Hakka traditional villages in Ganzhou

#### 4.4. Cultural Landscape Features

There are more villages in this cultural district, in the song and yuan dynasties, this period is mainly for the north-central Jiangxi migration and moved here; in addition, and a lot of villages were built late, in the Ming and Qing dynasties, this period is more Fujian Hakka return to this area, the vast majority are single villages. The village is in the valley basin, next is the hilly plain, the hilly basin, the maximum slope of the village is 0-5, next to 5-10, a few in 10-15, few are located in 15-20. villages are spread over sunny and shady slopes, Yangpo village more than Yinpo village, most villages are
built along the water, 4th class river (10 meters ≤ width), water flows are mostly around villages, adjacent side. The main type of house is Tang Heng house, and some single-row houses, the number of dragon houses and enclosures is small; village layout is mainly strip type, scattered type, and a small number of concentrations, blocks and village enclosures, most of the villages formed have no roadways, villages are mainly small (≤ 2 hectares), big (≥ 5 ha), most villages have geomantic pools, free to form the largest number of wind pools, the villages are basically feng shui forests, as shown in figure 2 below.

![Proportion of dwellings](image)

**Figure 2.** Proportion of residential types

5. Conclusion
The combination of BIM and 3DGIS can meet the needs of daily maintenance and regular restoration of ancient architectural cultural heritage, thus improving the quality and efficiency of protection and management of ancient architectural cultural heritage. The digitization of ancient architecture can not only realize the resource sharing of ancient architectural cultural heritage information, but also apply the existing ancient architectural resources to many aspects: in the aspect of protection and application, it can provide basic data and reference materials for reconstruction scheme formulation, exhibition design, etc. In social service, it can provide information for exhibition, publicity and education of ancient architectural cultural heritage.

Acknowledgments
This work was financially supported by Fund Project: 2020 Science and Technology Research Project of Jiangxi Provincial Education Department "Research on the Digital Security of Longnan Hakka Enclosed Houses Based on BIM and 3D GIS", Moderator: Xiao Yinglin. (Project Number: GJJ206310)

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