Research on Comprehensive Evaluation and Early Warning System of Ancient Building Health

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Abstract. At present, the protection of world cultural heritage has changed from passive protection based on rescue to active protection based on prevention. The traditional protection method of ancient architecture is to find the damage through on-the-spot observation, and then protect it. The information in the protection process is mainly saved by written records. Because of the insufficiency of the artificial measurement method, the subjectivity is strong, the frequency of collecting information is low, and it needs to spend manpower and material resources to collect data at the site of ancient buildings. Aiming at the sensitivity of the collected data and the visualization of the problem, this paper studies the application of the 3D reconstruction of the ancient building based on the angle sensor and the transmission analysis system, which aims at solving the problems of the complex, low efficiency, long period and high cost of the ancient building processing and the existing protection methods, and realizes the whole division of the ancient building reconstruction model, so that the damage situation is clear at a glance and can be directly displayed; and it has high application value in the ancient building protection.

Keywords: protection of ancient buildings · sensor technology · 3D modeling · early warning platform

1 Introduction

In the standards issued by the State, mainly based on qualitative and cyclical assessment, which is supplemented by quantitative analysis, most of them are judged by traditional experience [1], a few of them are tested by instruments, and the corresponding data are obtained by comparison with the standards [2]. The assessment results cannot reflect the real situation of the buildings. Preventive protection and sustainable development are based on the establishment of a health monitoring system from the inside out, and the existence of a sustainable cultural heritage is often accompanied by hidden security issues that lead to its damage or even direct destruction [3, 4].

Through the routine monitoring management to ensure timely discovery of problems, to create an active heritage monitoring management model, adjust management

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measures to achieve all-round dynamic monitoring of ancient buildings. (Advantages of the Method) Therefore, the scientific research on the protection and restoration of ancient buildings is attracting the general attention of academia and industry, and has become a hot research topic. With the advent of the Internet Plus era, information technologies such as wireless sensor networks, big data and cloud computing are playing an increasingly important role in the protection and restoration of ancient buildings.

2 The Structure of an Ancient Building

2.1 Significance of Protection of Ancient Buildings

Ancient architectural sites are non-renewable cultural treasures, symbols of human wisdom, and important materials for experiencing different regional cultures and promoting national economy. They have left gorgeous stories in the architectural history of China, have unique artistic atmosphere and architectural components, highlight the material carriers handed down from ancient Chinese people, and have different characteristics of ancient buildings in different periods and nationalities [5, 6]. It is not difficult to see the development of other sciences in the same period and the level reached at that time from the exploration of ancient buildings. Therefore, the maintenance of ancient buildings has a profound significance for historical and cultural research. In recent years, with the promotion of the national cultural soft power strategy and the continuous improvement of people's living standards, the protection, research and utilization of cultural relics have been strengthened, and the historical culture has been revealed. Therefore, the ancient buildings have come into people's sight again. Therefore, the protection of the ancient buildings can better show their unique charm to the masses and inherit the excellent traditional culture of our country.

2.2 Overview of Digital Information Processing Technology

This kind of digital information processing technology, including computer, Internet, multimedia and artificial AI, is a technical means to realize digital information processing [7]. Moreover, the effective use of digital information processing technology can provide data services for professionals, enhance the potential application value of data information, and greatly reduce manual errors.

3 Research Processes and Methodologies

3.1 Establishment Process of the System

As Fig. 1 Shown, after investigating and investigating the reconnaissance planning of ancient buildings and detecting the collection device, the collected data shall be collected; then the pictures taken by the UAV and the digital images scanned by the 3D laser scan shall be combined with the point cloud, and with the communication technologies of ZETA and 5G shall be transmitted to the database of the analysis platform to locate the fault point [8], and then an intelligent solution shall be analyzed according to the situation of the problem, so as to alert the serious problem immediately and quickly let the professionals to deal with the problem on the spot. This will visualize the problem, so that more protection of the ancient building.

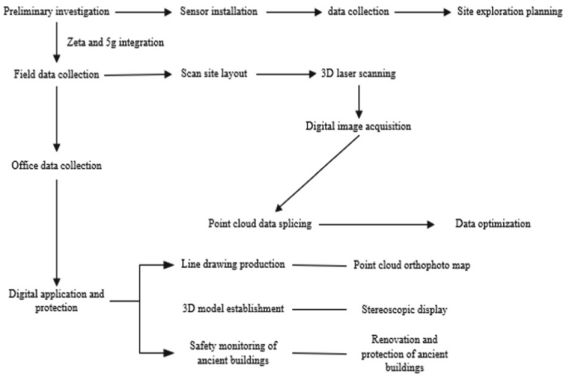

Fig. 1. Establishment of the system

3.2 Research on Tilt Angle Sensor

Using biaxial obliquity measurements; shown in Fig. 2 [9]

$$\alpha = \arctan\left(\frac{g_x}{g_y}\right) \tag{1}$$

When both gx and gy are positive, the dip is in the first quadrant, and the true dip equals the calculated value of the formula (1). When both gx and gy are negative, the dip is in the third quadrant, and the true dip equals the calculated value of the formula (1) minus 180°. When gx is positive and gy is negative, the dip is in the second quadrant and the true dip is equal to the calculated value of the formula (1).

Using both axes to measure tilt angles has two benefits:

(1) The measurement of an oblique angle distinguishes each quadrant so that the oblique angle can be measured within [0°, 360°] as shown in Fig. 3;

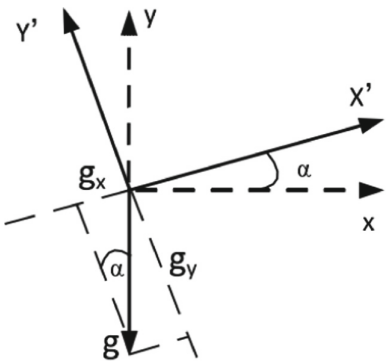

Fig. 2. Sketch of biaxial measurement of accelerometer inclination

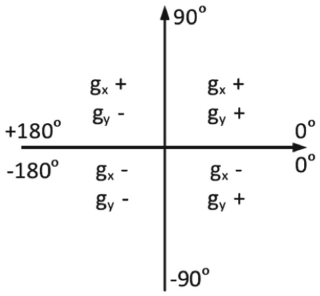

Fig. 3. Sign and dip quadrant relationship of acceleration components

(2) The second advantage is that, even if a third axis is tilted, a known two-axis accelerometer can be used to accurately measure the angle of rotation corresponding to the two-axis plane, compared to a uniaxial tilt angle measurement.

3.3 Transmission Device

Get Data from Device Zeta transmits data to the device using large area low-power Internet of Things communications technology, and via 5G mobile communications from the device to the platform. Based on the patent of intelligent router technology, ZETA uses a special network developed independently by longitudinal technology. The smart router is battery-powered and covers the local network without power. On the other hand, ensuring network coverage and stability can reduce costs and reduce total costs for customers by 30 to 50 percent. Access authentication, data encryption and management network, user terminal management, security management database server and other levels to achieve ZETA security network, the use of KEELOQ and AE128 wireless communication and access to external data encryption combination interface to ensure the security of the entire network.

Ultra-narrow-band communication technologies have extremely narrow channel bandwidth (0.6 to 4 kHz) and support transmission rates of 100bps to 50kbps. Even in environments with complex sources. In addition, the success rate of data transmission can be 100% guaranteed through a complex mechanism network.

To meet the Internet's demand for things, based on zeta technology, the list can be based on ancient building software and hardware applications, showing a variety of scenarios to meet the Internet's demand for things. Based on the investigation of the current situation, this paper analyzes the shape and layout of the existing ancient buildings, and makes a detailed investigation of the security of ancient buildings. Based on the collected data, the main factors affecting the health of each building were found on it, leading to more targeted solutions for reinforcement and maintenance.

3.4 Comprehensive Analysis Platform and Processing of Ancient Buildings

1) Field Data Collection.

First, in the initial stage of the survey, according to the field survey and the analysis of the environment around the old building, the use of ground scanning photographic flight to supplement the data, multi-angle scanning can accurately match the point cloud data collected later. Secondly, in the process of scanning each position, it tries to avoid the interference caused by human walking.

2) Domestic Data Processing.

After the field data collection, complete the site data collection, preview point cloud data, links, accuracy inspection and other internal data processing. First, the data is fed into the old external building database, and then the complete point cloud data picture is obtained. The point cloud data model captures data from ancient buildings by optimizing data utilization. After ensuring accuracy, we will reduce data interference as a minor problem and eliminate some data noises that do not belong to the old building itself during scanning. This work is divided into two parts: reducing noise in a large range and refining the blur caused by processing camera quality problems. After completing the above steps, extract each image data point cloud from the ancient building. These data are integrated point cloud models after recording the images. Only after data has been recorded can point clouds provide accurate data on future protection and use of older buildings. In addition, data need to be simplified to improve the effectiveness of point cloud data.

3) Three-Dimensional Modeling.

This project uses 3D modeling software to model the ancient buildings.

After the interior point cloud data processing, the third party modeling software is used to build the 3D model of the ancient building based on the point cloud data. Point cloud data and BIM can also be used to establish a parametric model of ancient buildings to record the real size, building materials, appearance, historical culture and other attribute information of ancient buildings, so that digital protection information of ancient buildings can be provided to the cultural relics protection departments to meet the needs of archiving, database establishment, multi-department cooperation and other work, and the obtained data can be utilized and digitized archiving can be used to facilitate the technical personnel to read the information, make use of data repetition research and secondary design. The obtained detailed data information can be digitally archived in 3D for professional information reading, research or redesign.

4 Practical Application and Online Testing Platform

4.1 Inclination Sensor

See Fig. 4 for a monitor model of an ancient building, where OX is along the wire, OY is perpendicular to the wire, and OZ is plumb. OA is the projection of OB on plane YOZ, OC is the projection of OB on plane XOZ, OB is the projection of OB on plane XOY,

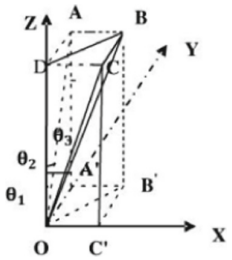

Fig. 4. Simplified model for building slope monitoring

and OD is the height of monitoring point from ground. Theta 1 is the angle between OD and OC, and theta 2 is the angle between OA and OD. Theta 3 is the angle between OD and OB, which is called synthetic inclination.

As shown in Fig. 4, the relationship between the paraelectric tilt angle, the transverse tilt angle and the comprehensive tilt angle can be obtained [10]:

$$\tan\theta_3 = \sqrt{(\tan\theta_1)^2 + (\tan\theta_2)^2} \tag{2}$$

For order $G_X = \tan\theta_1 \times 1000$ (mm), the calculation result is the straight slope. For order $G_y = \tan\theta_2 \times 1000$ (mm), the calculation result is the straight slope. According to the formula (2) and the order $G_s = \tan\theta_3 \times 1000 = \sqrt{G_X^2 + G_y^2} \times 1000$ (mm), the calculation result is the comprehensive inclination. Tilt threshold: 0.5%

4.2 Overall System Structure

The system structure chart structure is to the software system overall design graph performance, embarks from the system development angle, this is one kind of function design. The system is divided into functional hierarchies so that each part can perform simple functions and each part can remain connected.

System Class Diagram
The early warning platform for ancient buildings has several aspects:

1) Recording information.

Update daily data in real time, timely change and delete error data, every two hours back up, data comparison, data backup in the cloud, in case of loss, every night at 11: 00 regular updates.

2) Status Testing.

Carries on the real-time condition monitoring and the collection and the preliminary evaluation module to the ancient building, has functions and so on remote inspection,

risk forecast. Monitoring data of ancient buildings can be tracked and retrieved in real time.

3) Supervision of Early Warning.

The risk of typical section involved in the risk forecast of ancient buildings is dynamically managed and controlled. The development status of identified risk sources and whether the structure is safe are tracked and recorded, and the problems can be timely repaired and protected.

4) Health assessment.

Through the collection devices deployed inside and outside the ancient building, we can process and analyze the data of the building inclination, cracks, damage degree, etc.

5) System Report.

The system analysis report is the comprehensive summary of the work in the system analysis stage, and also the main achievement in this stage.

4.3 Virtual Restoration of Ancient Buildings

Based on 3D laser scanning technology, all the collected data and information can be converted into 3D models, while displaying the ancient building models. Based on the characteristics of ancient architecture and its cultural connotation, a suitable environment atmosphere is created dynamically in 3D space from different angles. In fact, in order to protect and restore ancient buildings, the first use of three-dimensional laser scanning technology to scan the ancient buildings, and then around the huge point cloud obtained three-dimensional connection. At the same time, consult a large number of documents, complete the construction of three-dimensional model, the main size of the doors, windows, beams, etc. Based on the 3D model of the ancient building, we can build a virtual building restoration system. Through processing and integrating the point cloud data, all kinds of disease information of ancient buildings can be input into the system, which is convenient to view and count. Using virtual reality technology and computer image processing technology, we can carry out virtual maintenance, build a 3D model to show the status of the repaired ancient buildings.

4.4 Health Monitoring and Protection of Ancient Buildings

Today, Chinese ancient architecture is generally more complete for the Ming and Qing dynasties. Because of the long time of building completion, these ancient buildings have some problems, which threaten the safety of ancient buildings. Therefore, it is necessary to strengthen the monitoring of the health status of ancient buildings, carry out regular safety tests, timely discover problems in ancient buildings, and develop effective measures to maintain and strengthen the protection of old buildings. Based on 3D laser scanning technology, the original shape, material and color of ancient buildings can be obtained completely and accurately, and the original data of each building can be verified. Once the problem can be found accurately and quickly, the disease of the ancient

building can be understood in detail, and the corresponding maintenance plan can be made according to the problem. With the improvement of cultural heritage protection in China, 3D laser scanning technology has been widely and deeply applied to the detection, maintenance and protection of ancient buildings.

5 Conclusion

To sum up, in the golden age of the Internet today, it is more conducive to the protection of ancient buildings to achieve the establishment of goals, to achieve efficient data collection and processing, strengthening the protection of ancient buildings. With the rapid development of the city, the culture it contains is gradually losing. And the ancient buildings are the history of the city that we can touch. Therefore, in the future optimization of protection of ancient buildings, we should pay attention to digital technology, to better reasonable, scientific and efficient protection of ancient buildings, so that the cause of protection of ancient buildings can continue to develop, but also reflects the glory of China's Internet age.

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