# Exploring a digital technology framework for building rural security transformation

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**Abstract.** The safety of the original old buildings in the upgrading and remodeling of traditional rural landscape has become a key aspect that cannot be ignored. In particular, the age-old traditional buildings belong to the typical master and apprentice inheritance system of construction mode, there is no remaining architectural archives, architectural information is unclear, especially the hidden genes, it is difficult to comprehensively control the rural landscape transformation, and there is an urgent need for an effective technical means to support. By applying 3D scanning and BIM technology, engineers and technicians are able to efficiently obtain the relevant information of traditional village landscape, discover potential safety risks in advance, and take timely measures. The practice has an important application prospect in village landscape upgrading and reconstruction. The combination of 3D scanning and BIM technology in "safety renovation" can improve the level and effect of the renovation, and provide strong technical support for the smooth implementation of the traditional rural landscape upgrading and renovation.

## 1 Introduction

With the advent of the "stock era", the number of cases of adaptive use of old buildings has gradually increased, with many success stories and painful lessons. In recent decades, many digital media repositories have emerged, each containing a large amount of data about the historic urban landscape. Photographs, texts and plans are important sources of information for historical research [1,2,3]. The World Heritage Convention obliges the World Heritage Center (WHC) and its advisory bodies to report on the state of conservation of specific World Heritage properties under threat. In a recent report [4], the WHC delves into this important task, analyzing the factors that negatively affect these cultures. The safe refurbishment of ancient buildings does not stop at their own structural safety; the wider cultural DNA is destroyed in the process of refurbishment and restoration".

Safety renovation" has become a core area of concern in the enhancement of traditional rural landscape. In this context, 3D scanning has become a revolutionary tool for digitization of cultural heritage buildings, offering rich advantages for preservation, research and accessibility [5]. The technology captures complex details of structures, including intricately carved and weathered surfaces, creating high-fidelity digital models that surpass traditional recording methods. In addition, 3D scanning allows for detailed analysis of architectural styles, construction techniques, and potential damage, informing restoration efforts and ensuring the longevity of these irreplaceable cultural heritage buildings. Kantaros et al [6] explored the integration of 3D scanning and printing technologies in cultural heritage preservation, highlighting their ability to create detailed digital and physical replicas of artifacts and structures.

With the development of Building Information Modeling (BIM), the field of cultural heritage conservation is embracing a new era of intelligent documentation, incorporating the OpenBIM [7] concept proposed by buildingSMART. This innovative approach integrates information from different sources (including 3D scans, historical archives and archaeological finds) into a single dynamic model. Using this approach, it is possible to define a virtual environment in which complex details captured by 3D scans are seamlessly integrated with historical records and excavated artifacts to gain a comprehensive understanding of the past and present of a heritage site. In the field of cultural heritage, especially in complex buildings, the conversion of point clouds into BIM models continues to be the subject of experiments to identify automations that can make this process fast, reliable and accurate [8]. In addition, this process has not been heavily applied to the management and maintenance of cultural heritage assets, often using 2D methods with information sheets. Bridging the gap between BIM and cultural heritage preservation requires a nuanced approach that respects the unique needs of historic buildings while taking advantage of modern technologies.

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## 2 Case Studies

Located in Wulian Village, Anliu Town, Wuhua County, Meizhou City, Guangdong Province, China, Yanyilou is a famous ancient Hakka four-pavilion dragon house, which was honored with the title of "Historical Building of Meizhou City" in December 2016, and has a history of 163 years so far.

This house by the carp river Zhang's ancestor Ming Fu 18th grandson Dingyu Gong built in 1855, Dingyu Gong from a poor background, 17 years old began to use a flat stretcher from Hailiufeng picking salt to Jiangxi Province to sell, feet wearing straw shoes, a hundred catties on the shoulder, day walk dozens of miles of the mountain road, from the picker to the salt vendors, has experienced a thousand pains. Lasted more than thirty springs and autumns, to 1886 completion.

After the completion of the Yan Wing House, in order to remember that extraordinary period of time, and more to establish a good family style, so that future generations will always carry forward the spirit of hard work and thriftiness to create a family business, Ding Yu Gong will pick the salt of the stretcher hanging on the beams in the hall.

The ancient house is grand in scale, with three symmetrical horizontal houses in the upper, middle and lower seven rooms, a large perimeter dragon and four watchtowers, containing nine halls and eighteen wells, with a total of 99 rooms, covering an area of about 5,000 square meters (Figure 1).

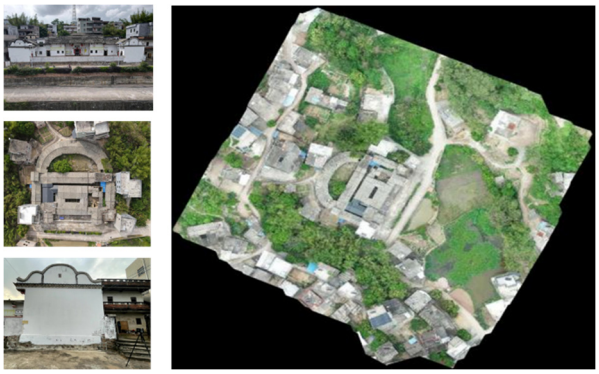

**Fig. 1.** Excerpts from interior and exterior photos of the Swallow Wing Building.

In addition to natural damage, ancient buildings were destroyed during China's "Cultural Revolution", some exquisite architectural, flower carvings and stone and wood materials were dug up and stolen, traditional craftsmen were unable to repair them, and the broken walls and broken beams of some buildings were forever left with regrets. In order to preserve the original style of the area, there is an urgent need to establish building information models using 3D scanning plus BIM technology, which is not only conducive to the protection of rural cultural and spatial characteristics of the heritage, but also provides a systematic support of digital models for the revitalization of the use of traditional villages.

## 3. Methods

### 3.1 Digital technology system construction

In the safety transformation of traditional village landscape, the detection of building structure safety and the extraction of traditional factors is an important aspect. The use of 3D scanning technology data acquisition and BIM model establishment, the building structure can be accurately three-dimensional modeling, to facilitate the structural designers to more accurately understand the important cultural factors of the traditional village landscape and the structural stress, timely detection of potential safety risks, and structural analysis and design optimization from the early stage. The technology can also realize real-time monitoring and coordinated management in the process of traditional village landscape safety renovation. During the construction process, the BIM model can be connected with sensors and monitoring equipment to obtain real-time data from the construction site, and analyze and provide early warning.

The technology can also play a role in the later maintenance and operation phase. Maintenance personnel can use the BIM model to understand the specific conditions of the building structure and formulate a corresponding maintenance plan to carry out repairs and maintenance in a timely manner to ensure the safety and stability of the building structure (Figure 2).

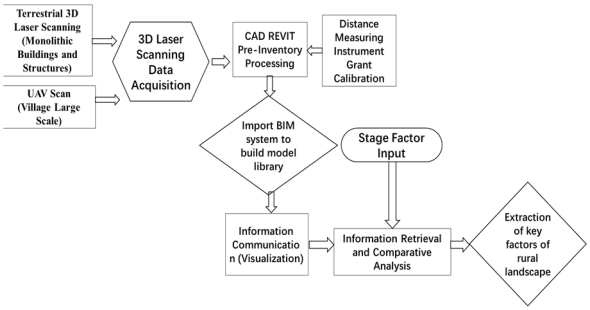


**Fig. 2.** 3D scanning BIM technology system construction flowchart.

The use of 3D scanning and BIM technology can realize the whole process management in the renovation of traditional village landscape safety. In order to truly play the role of this technology in traditional village landscape safety renovation, at the level of village craftsmen, it is also necessary to strengthen the training and promotion of the new technology, and to improve the technical quality and application ability of practitioners.

### 3.2 3D scanning and BIM technology

3D laser scanner to capture the data is based on the surface of the object to launch the laser point cloud obtained from the three-dimensional data coordinates of the point. Will directly present the three-dimensional image of the point cloud, a clear and intuitive response to the real situation of the object being measured, 3D laser scanning system using laser point cloud for mapping and scanning, non-

contact, high precision, high speed, access to data integrity is the characteristics of the technology.

BIM (Building Information Modeling) can be used as the meso level of traditional village protection, involving structures in small and medium scales, and it can unify the management of all kinds of information related to the landscape of traditional villages in the form of digitization and visualization display and communication in the form of models, which is conducive to the coordination and cooperation of various disciplines, and shorten the construction period and reduce the development and construction risks of traditional villages. It is conducive to the coordination and cooperation of various disciplines, shortens the construction period of traditional villages and reduces the risk of development and construction.

The integration of 3D scanning plus BIM technology involves comparing, converting and coordinating the BIM model with the corresponding 3D scanned model for the purpose of assisting in project quality checking, rapid modeling and reduction of rework.The proposal of 3D scanning plus BIM technology stems from the shortcomings of the traditional architectural design and construction model. The traditional building design mode mainly relies on two-dimensional drawings, and there are problems such as untimely and inaccurate information transfer, which leads to inefficient design and difficult to ensure the quality of construction. 3D scanning plus BIM technology, by integrating building information into a unified model, can be updated in real time, collaborative work, and improve the management efficiency and quality of the design and construction process.

The core of 3D scanning plus BIM technology is the building information model, which is a three-dimensional model containing information on all aspects of the traditional village landscape. This model contains not only the geometry of the building, but also information related to the building's structure, equipment, materials, and processes. At the same time, the BIM model also has information related to time, cost, risk, quality, etc., so that all aspects of the traditional village landscape can be managed collaboratively on a unified platform.

## 4 Results

3D scanning and BIM technology has a wide range of applications, including building design, construction management, equipment management, supervision and other aspects. In terms of management in rural landscape upgrading and renovation, 3D scanning plus BIM technology can provide real-time safety information and intelligent safety analysis tools to help managers find and solve safety risks in a timely manner.

In this study, 3D scanning and BIM technology are used to simulate and analyze the digital collection of Yan Yilou traditional village landscape, to discover and solve potential problems in advance, and to improve the quality and safety of the project. For the ancient buildings in the Yanwilou traditional village, 3D laser scanning technology can quickly and accurately form electronic records and digital archive information, which is convenient for subsequent repair and remodeling work. In addition, for the construction state that is difficult to modify on site, the 3D laser scanning technology can be used to obtain the real information and can be edited for decorative components; the comprehensive application of BIM and 3D scanning technology not only improves the efficiency and accuracy of the construction quality inspection, but also provides a basis for the further design of the protection and restoration of the traditional buildings. (Fig. 3.4.5.6)

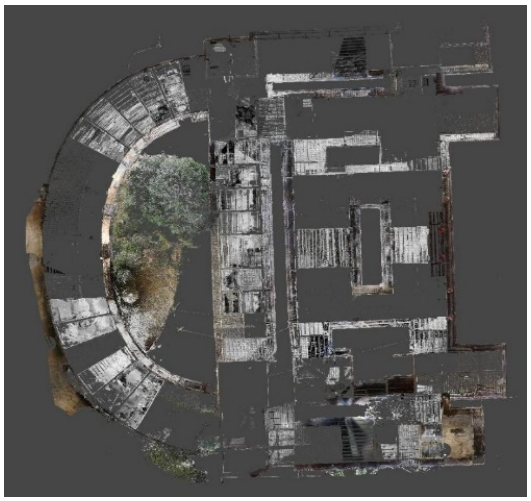

**Fig. 3.** Data Acquisition (Excerpted Drawing - Roof Plan of Swallow Wing Building)

**Fig. 4.** Data Acquisition (Excerpted Drawing - Floor Plan of the Swallow Wing Building)

**Fig. 5.** Data Acquisition (Excerpted Drawing - Swallow Wing Building Elevation)

**Fig. 6.** Data Acquisition (Excerpted Drawing - Swallow Wing Building Section)

## 5 Conclusions

3D scanning and BIM technology provides certain theory and practice in rural landscape safety renovation, and has outstanding advantages in rural landscape safety renovation, including real-time visualization, multi-dimensional information integration, collaborative design and other functions. It is believed that with the continuous progress of the technology and the popularization of its application, the technology will play a greater role in the upgrading and transformation of rural landscape and make a positive contribution to the safety transformation and sustainable development of traditional village landscape.

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