Management of Intelligent Manufacturing in Dong Ethnic Group Building Modeling

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Abstract. Traditional Chinese ethnic cultural buildings contain historical and cultural heritage, but are limited by the difficulty of reproducing the actual project, and the current technology loss is serious. Building Information Modeling is a three-dimensional graphic-based, object-oriented, architecturally relevant computer-aided design. It constructs a database by 3D modeling of current Dong architectural models. Using stable diffusion and other technologies, the model design with Dong characteristics can be created by secondary development. Finally the design is improved using augmented reality technology. And use 3D printing technology to produce models that can be used for museum preservation and related teaching work.

Keywords: Intelligent Manufacturing, Architectural Model, Traditional Culture, Building Information Modeling

1 Introduction

Dong wooden building construction technology is an important traditional handicraft in Sanjiang County, Guangxi Province, China, which is a form of national traditional cultural expression closely related to the life of the Dong people, and a cultural resource of great value that unites the unique temperament, artifact-making technology and practical experience of the Dong people. It is world-famous for its wooden architectural arts such as drum towers, wind and rain bridges, and Dong dwellings. The "Dong wooden building construction technology" has intact humanistic connotation and social function, which contains the historical origin, spiritual value, way of thinking and aesthetic interest of the Dong ethnic group, and truly records the traditional architectural style, traditional folk customs, and primitive spatial form of the Dong ethnic group, which is of high value for protection and development and utilization.

2 Protection and Inheritance Mode and Difficulties Faced by "Dong Wooden Architecture Building Techniques

2.1 Protection and inheritance methods

There is no written record of the inheritance of "Dong wooden building construction skills", which has been passed down from generation to generation through oral folk skills. Later on, with the continuous transformation of the society and economy, the demand for traditional

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skills expanded, and the Dong masters of wooden building construction have realized the inheritance of their skills while recruiting and hiring apprentices to carry out construction activities. Therefore, the inheritance of Dong wooden building construction skills is realized through both family inheritance and master-apprentice inheritance. The point cloud technology is adopted to obtain the structure of the building and dataset for analysis [1-4].

In addition, to better protect the Dong wooden building construction techniques, the government, scientific research institutions, and civil organizations have also established a protection system through the following aspects: first, the establishment of the national, provincial, municipal, and county intangible cultural heritage protection lists; second, the application including meta modeling [5-6] for the recognition of the national, provincial, municipal, and county representative inheritance lists; third, the systematic collection and collation of literature, collection of physical objects and other basic work to implement the informational protection; fourth, the protection of the Dong wooden buildings using a family inheritance and master-apprentice inheritance. The fourth is to carry out representative restoration and conservation work with the material carriers of Dong wooden buildings as the objects of restoration and conservation.

2.2 Difficulties

(1) The inheritance of skills is in an endangered state. Most of the people who master the building techniques of Dong ethnic wooden structures are old, and because of the influence of various interests and customs, the inheritance of techniques is mostly inherited by the family, which results in the techniques being mastered in the hands of only a few people, making the wooden structures and related techniques in an endangered state!

(2) Suffer the impact of modern new technological innovation. With the development of society, the innovation of modern information technology, making people's old concept of more fundamental changes, in the modern concept of living, modern building materials, the use of modern equipment, modern camping concepts and other technological innovations under the influence of the Dong ethnic wooden building construction techniques have been unprecedented impact.

(3) There are many drawbacks in the archiving of architectural data and information. The archiving of architectural data information of the "Dong wooden building construction techniques" is one of the focuses of research in the field of architectural conservation, but there are many drawbacks in the archiving of architectural data information, in the past, the archiving of architectural data information of the "Dong wooden buildings" in China was mainly done through drawings, forms, text, images and other ways, In the past, the archiving of architectural data and information of "Dong wooden architecture" in China was mainly done through drawings, tables, texts, images and other ways. In the past, the archiving of architectural data and information of Dong wooden buildings was mainly through drawings, tables, texts and images. However, there are many disadvantages in these archiving methods, such as the large workload of data processing, imprecise abstract expression of information, and the difficulty of searching information.

3 Characteristics and Advantages of Dong Wooden Architecture Constructed Based on BIM Technology

Building Information Modeling (BIM) is a digital representation of the physical and functional characteristics of engineering project facilities. A perfect building information model can connect data, processes and resources at different stages of the life of a construction project, is a complete description of engineering objects, and can be commonly used by all parties involved in a construction project.BIM has a unified basic data, which supports the creation, management and sharing of dynamic engineering information during the life of a construction project.BIM is an engineering data model that integrates all relevant information of a construction project based on three-dimensional digital technology, and BIM is an engineering data model of the construction project. BIM is an engineering data model based on 3D digital technology, integrating various related information of construction projects, and BIM is a digital expression of the entity and functional characteristics of project facilities. A perfect information model can connect data, processes and resources at different stages of the life of a construction project, is a complete description of engineering objects, and can be commonly used by all parties involved in a construction project.

3.1 Parameterization of model information

Through the establishment of BIM model information and the addition of building frame object name, structure type, building materials, engineering performance, and other design information, to solve the problem of the abstract and imprecise expression of the information modeling information of the Dong wooden architecture. The parameterization of model building shows a powerful function in spatial positioning, which is not only accurate and convenient, but more importantly, it can solve many potential problems.

3.2 Visualization of model information and virtual creation

BIM technology can present construction animation, virtual roaming screen, 3D, 4D simulation of the construction program, the first time to find the problem to solve the problem, but also to carry out the corresponding visualization of the handover, to solve the Dong wooden building information model information is not easy to find the problem.

3.3 Consistency of model information

The model information is consistent at different stages of the building life, the same information does not need to be input repeatedly, and the information model can evolve automatically, the model object can be simply modified and extended at different stages without re-creation, which avoids the error of inconsistent information, and solves the problem of large workload of data processing in the information model of the Dong ethnic wooden building.

4 Countermeasures for the construction of the information model of "Dong Ethnic Wooden Architecture" based on BIM technology

The digitization of the "Dong wooden architecture" can provide a comprehensive technical means for the formulation of relevant policies and regulations in the field of intangible cultural heritage protection in China and the understanding of the intangible cultural heritage protection status at this stage. In the past, China's intangible cultural heritage protection is mostly individual but lacks of wholeness, which is due to the lack of effective technical means. The use of digital technology can build a data information base of "Dong wooden architecture". The data and information database of "Dong wooden architecture" includes entity information database and ideology information database, which comprehensively records the relevant information of "Dong wooden architecture" and provides the most accurate information for the protection and renovation of "Dong wooden architecture". It provides the most accurate information basis for the protection and renovation work. To establish the BIM model, the detailed information of the examples are collected and analyzed, and in-depth analysis and research on the selected examples from the perspective of surveying and architecture, to reach the starting stage of building information modeling, and to provide scientific data basis for the further construction of the model. Based on the constructed building information model, relying on the size of the components and the information of craftsmanship practices recorded in the information model, the damaged components can be repaired or replaced; based on the size of the components and the information of materials recorded in the information model, the missing components can be made up according to the original system. The problems of architectural data protection, using the characteristics and advantages of BIM technology parameterization, visualization and diversification, through the measurement, extraction, collation and analysis of the basic data of architectural heritage of the research case, to carry out the preliminary design of the information modeling ideas and strategies of the "Dong wooden architecture", the specific design process and ideas are as follows. The design process and ideas [7-8] are as follows Figure 1:

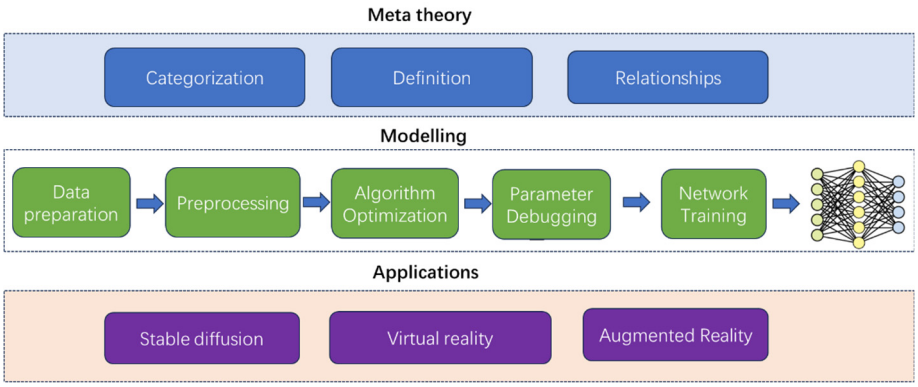

Figure 1. Smart modelling framework

4.1 Parameterized protection of the implementation process of Dong wooden architecture construction

In the research of Dong wooden architecture, the research of the building body is limited by time and space, which brings great convenience to the research work, and the BIM model can be used to conduct an all-round research on the layout, texture, color and historical information of Dong wooden architecture, and the BIM model can even do the local detailing, and the research of Dong wooden architecture through the BIM model can get a high interactive effect, and all kinds of related information can be concentrated together more easily for the researchers to explore and analyze. effect, all kinds of related information can be more easily concentrated together, which is convenient for researchers to explore and analyze.

4.2 Implementation of architectural visualization and protection for building construction of wooden structures of the Dong nationality

Through two-dimensional and three-dimensional technical software: AutoCAD, 3Dmax, Sketchup the appearance of these three-dimensional visualization and design software strongly compensates for the communication difficulties caused by the lack of comprehension of traditional architectural drawings, but due to the conceptual and functional limitations of these software, there exists a considerable gap between such a three-dimensional visualization presentation and the conservation of the Dong ethnicity's wooden architectural preservation and research. Two types of Drum Tower are classified in Table 1.

Table 1. Drum Tower Metamodel Classification

Conventional	Construction logic	metamodel
Single loop	One-pillar drum tower	Basic metamodel
	Outerfour drum tower	
Double loop	Similar polygons inside and outside	Variational metamodel
	quadrilateral to hexagon	
	quadrilateral to octagon	
	Inside quadrilateral to octagon	Similarity metamodel

In addition, the traditional CAD platform mainly uses three-view drawings such as flat, elevation, section, etc. as well as text description to express and show the information of cultural relics and buildings, which is very easy to make mistakes due to the tools. This kind of information fragmentation caused by tools is very easy to make mistakes when encountering the complex structure of Dong ethnic wooden buildings, BIM not only has a three-dimensional visualization tool, but what you see is what you get, more importantly, through the enhancement of the tool, you can use three-dimensional thinking to complete the architectural scheme, and at the same time, really get rid of the limitations of the technical barriers. The BIM model is established according to the Dong ethnic wooden building construction plan, and Revite technology is used to summarize the relevant information of each project, eliminate the information silos in the project, and organize and store the obtained information combined with the three-dimensional model, to be prepared for the sharing of all the relevant parties of the project at any time in the whole process of the project. According to the use of the BIM model of the heritage to determine the accuracy of the details of the BIM model, at the same time, only one BIM tool can not complete all the work, so you can use the "segmented" BIM modeling methods

5 Stable diffusion and 3D print application

Creative design and physical modeling by traditional artists can to a certain extent pass on the culture. However, due to financial and labor costs, handmade models inevitably have certain deviations and are difficult to promote on a large scale. Stable Diffusion is an artificial intelligence-based 3D model generation tool that can convert 2D images into 3D models. In Dong modeling, Stable Diffusion can help designers quickly generate 3D models of original IP images, thus realizing the effect of 2D to 3D. A 3D model is given in Figure 2.

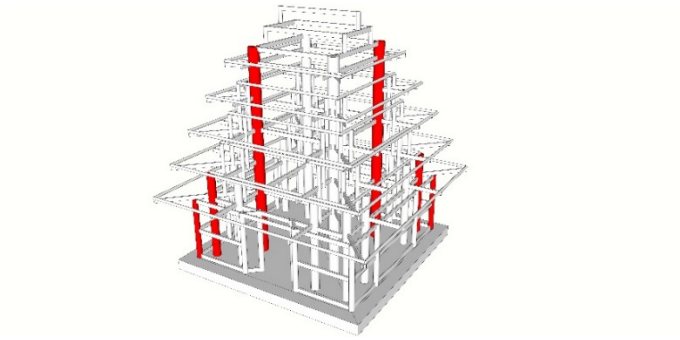

Figure 2. 3D modelling

3D printing technology can transform 3D models into solid models, and this technology is also widely used in Dong modeling. Through 3D printing technology, designers can transform 3D models generated by Stable Diffusion into solid models to better demonstrate the unique charm of Dong culture. Stabilized Diffusion works based on deep learning, using a neural network structure called Stabilized Diffusion Network, which converts 2D images into 3D models. The training dataset of the Stabilized Diffusion Network contains a large number of 2D images and corresponding 3D models, which help the Stabilized Diffusion Network learn how to convert 2D images into 3D models. 3D printing technology is a kind of rapid prototyping technology, which can transform 3D models into solid models.3D printing technology works by layering 3D models and then printing them out layer by layer, finally forming a complete 3D solid model.3D printing technology is widely used in Dong modeling, which can help designers to better display the unique charm of Dong culture. The main modelling progress are described in Figure 3.

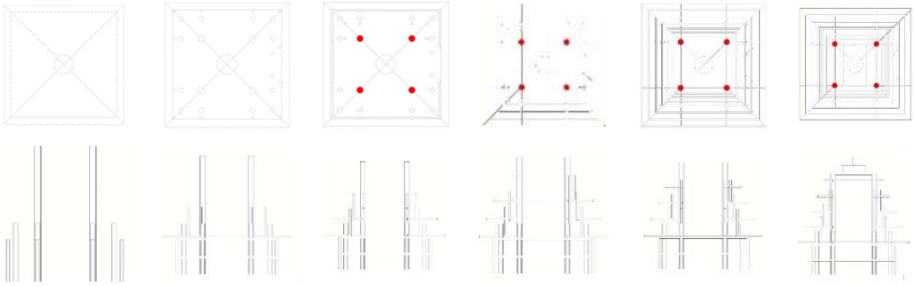

Figure 3 Modelling design progress

6 VR demonstration

Through BIM technology, the three-dimensional model is linked with the progress of the project and the spatial and temporal information can be integrated into the BIM model to intuitively and accurately reflect the entire building construction process. With the BIM model of the building maintenance simulation, can be a very intuitive understanding of the entire maintenance process of the time nodes and maintenance procedures, and clearly grasp the difficulties and key points in the maintenance process, but also can be further optimized and improved on the original maintenance program to improve the maintenance efficiency and safety of the maintenance program.

The use of modern VR technology, panoramic mode to show the Dong drum tower, wind and rain bridge and bird's-eye view of the actual features. Interactive experience of mortise and tenon technology points. Embed the 3D model of mortise and tenon structure and its derivatives in the panoramic picture, and give full play to the immersive advantages of VR through voice explanation, UI interaction and model interaction, so that the experiencer can personally participate in the assembly of the wooden structure while roaming the virtual space of the Dong Drum Tower to learn about the Dong wooden structure technology and cultural background, and embedded with an e-commerce platform to provide a way to buy the inheritor's handiwork and the related mortise and tenon technology handicrafts. The VR model of Dong Drum tower is shown in Figure 4. The data management structure is provided in Figure 5.

Figure 4 Dong Drum Tower VR Model

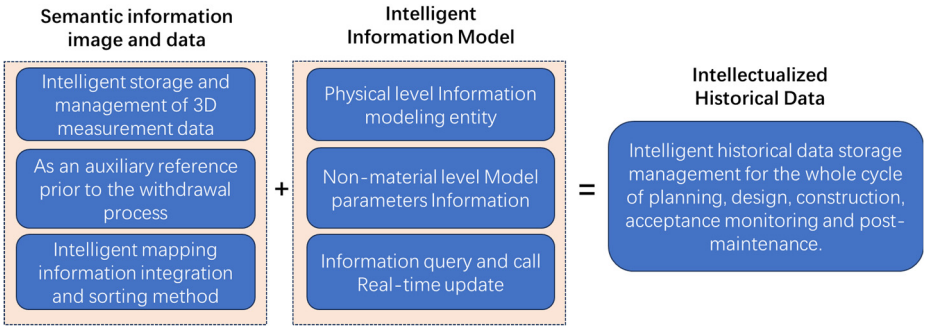

Figure 5. History data management

7. Conclusions and future work

The use of machine vision as a technological tool for the conservation and revitalization of architectural heritage is of great theoretical and practical significance and is technically feasible. This study confirms that machine vision technology can be used as a powerful technical support for architectural heritage preservation and revitalization research by combining it with existing meta-modeling research results. The architectural discipline itself needs to be based on a large number of drawings and images in the research process; from point to point, replacing the human eye with the machine eye, and transitioning from artificial to intelligent, the direction of the future will become clearer and clearer.

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References

[1] Andriasyan M, Moyano J , JE Nieto-Julián, et al. From Point Cloud Data to Building Information Modelling: An Automatic Parametric Workflow for Heritage[J]. Remote Sensing, 2020, 12(7):1094.

[2] Pierdicca R, Paolanti M, Matrone F , et al. Point Cloud Semantic Segmentation Using a Deep Learning Framework for Cultural Heritage[J]. Remote Sensing, 2020, 12(6):1005.

[3] Croce V , Caroti G , Luca L D,et al. From the Semantic Point Cloud to Heritage-Building Information Modeling: A Semiautomatic Approach Exploiting Machine Learning[J].Remote Sensing, 2021, 13(3):461.

[4] Matrone F , Martini M . Transfer learning and performance enhancement techniques for deep semantic segmentation of built heritage point clouds[J]. Virtual Archaeology Review, 2021, 12(25):73.

[5] J. K. Hammond,R. Chen,V. Mallet. Meta-modeling of a simulation chain for urban air quality[J]. Advanced Modeling and Simulation in Engineering Sciences,2020,7(1).

[6] Hoeijmakers M J M M,Waechter-Stehle,Weese J,Van de Vosse F N. Combining statistical shape modeling, CFD, and meta-modeling to approximate the patient-specific pressure-drop across the aortic valve in real-time.[J]. International journal for numerical methods in biomedical engineering,2020,36(10).

[7] E García-Macías., Venanzi I., Ubertini F., Metamodel-based pattern recognition approach for real-time identification of earthquake-induced damage in historic masonry structures- ScienceDirect[J]. Automation in Construction, 120.

[8] M. K. Bracht, A.P. Melo, R. Lamberts.,2021. A metamodel for building information modeling-building energy modeling integration in early design stage - sciencedirect. Automation in Construction, 121.