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Optimization Of Spatial Form Of Ancestral Temples In Guangfu

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ABSTRACT

Ancestral temples are important spaces for village development, which contains profound clan culture. In the process of urbanization, the traditional spatial form of ancestral temples has been unable to adapt to the development of the times, and the existing spatial form of ancestral temples is not the optimal form. This papers carries out quantitative analysis based on three quantitative criteria of integration degree, selection degree and total depth value of spatial analysis. Using the strategies of "topological model" and "convex space model" in space syntax, this papers makes a comparative study on the specific cases of Chen Clan Ancestral Temple in Guangzhou and Yu Zhongxiang Ancestral Temple in Kaiping. Through the research, it is found that there are similarities and differences between the Chinese-style ancestral temple and the ChineseWestern hybrid style combination ancestral temple. According to the calculation of Depthmap software, the scientific analysis data were obtained, and finally the optimization strategies of "propagation-type" and "inheritance-type" were proposed for the spatial forms of Chen Clan Ancestral Temple in Guangzhou and Yu Zhongxiang Ancestral Temple in Kaiping.

Keywords: Space syntax; Ancestral temples; Spatial form; Optimization strategy

Declarations of interest: There are no conflicts to declare.

1 Background and introduction of Chen Clan Ancestral Temple in Guangzhou and Yu Zhongxiang Ancestral Temple in Kaiping

1.1 Background

Located at No. 34 Enlongli, Zhongshan Seventh Road, Liwan District, Guangzhou City, Guangdong Province, Chen Ancestral Temple was built and completed during the reign of Guangxu in the late Qing Dynasty. Chen Ancestral Temple is a joint venture of the Chen clan, and it is the largest existing ancestral temple building in Guangfu area. Chen Ancestral Temple is the Guang Dong folk arts museum. It belongs to the national key cultural relic protection unit and is rated as the national AAAA historical scenic spot.

Yu Zhongxiang Ancestral Temple in Kaiping is located in Fengcai Middle School, Taiping Road, Kaiping City, Jiangmen City, Guangdong Province. Surrounded by water on three sides, the building has an open river, extending to the Tanjiang River like a dragon at sea. It was built in the late Guangxu years of the Qing Dynasty and completed in the three years of the Republic of China. The Yu Zhongxiang Temple in Kaiping was built by the Yu clan in Taishan and Kaiping of Guangdong Province to commemorate their ancestor Yujing. It is now a provincial protected scenic spot.

Guangzhou is a world-famous port. People from Guangfu migrated overseas in the Tang Dynasty with the continuous promotion of trade along the "Maritime Silk Road" (Mo Yuling & Sun Enle, 2014). Guangzhou and Kaiping area belong to the Guangfu culture, and the Tang Dynasty people called this area Guangfu. In the Ming

and Qing Dynasties, people called it "Guangzhou Fu". In the early Ming Dynasty, the local administration was changed from "Lu" to "Fu", which occupied 1 prefecture and 14 counties, so the people of Guangzhou prefecture were referred to as Guangfu people, most of whom were Han people (Huang Dongyang, 2022). Chen Ancestral Temple in Guangzhou and Yu Zhongxiang Temple in Kaiping are both located in Guangfu. Figure 1 shows the general situation of the two ancestral temples.

Name	Chen Clan Ancestral Temple in Guangzhou	Yu Zhongxiang Ancestral Temple in Kaiping
Field photograph		
Location	Liwan District, Guangzhou City	Kaiping City
Main Building	6400 ㎡	5364 ㎡
Clan Surname	Chen	Yu
Building layout	9 halls, 6 courtyards, 10 wing rooms and corridors	3 entrances, 6 courtyards, 15 halls
Start and end time of construction	First built in 1888 and completed in 1894	First built in 1906, completed in 1914 and inaugurated in 1915.
Structure	A mixture of brick, stone and wood	A mixture of brick, stone and wood
Style	Traditional Lingnan Chinese style	A mix of Chinese and Western styles
Changes of building type	Clan ancestral temple, academy, school, middle school, copier factory, craft hall, library, museum, tourist destination.	Primary school, middle school, ancestor worship.

Fig. 1 The Overview of Chen Ancestral Temple in Guangzhou and Yu Zhongxiang Ancestral Temple in Kaiping

1.2 Introduction

Due to the rapid development of urban and rural areas, traditional building spaces are left idle or abandoned. The original space was destroyed, and the ancient buildings showed a disorderly development state (Xiaojun Yang et al., 2019). The two ancestral temples selected in this papers have important symbolic significance in Guangfu area. These two ancestral temples are in urgent need of attention and protection in the process of rapid development in the current era. Chen Ancestral Temple in Guangzhou is the largest traditional Chinese ancestral temple in Guangfu area. Yu Zhongxiang Ancestral Temple in Kaiping is the largest ancestral temple combining Chinese and European styles in Guangfu area. These two ancestral temples have experienced the baptism of time and significant spatial changes have taken place. Although they have gone through a hundred years of history, there are still some deficiencies and unreasonable problems in their spatial form. For example, places with high accessibility are in a deserted state or just play the function of corridors, and spaces with a selection degree of 0 are always deserted or have chaotic functions. Places with high total depth value are arranged as the main space to display culture. Obviously, the utilization and rationality of space are unscientific and unreasonable. With the development of society, ancestral temple space has attracted more and more attention, and its spatial form needs scientific optimization.

As for the construction of traditional space, more attention has been paid to the qualitative research of space, but there is a lack of quantitative research. Based on this, this papers adopts space syntax for research, and uses Depthmap software for scientific measurement of space, and then obtains relevant data. Space syntax can analyze the integration degree, selection degree and total depth value of a space. The calculated data is a very scientific parameter of spatial analysis, the distinction of color blocks has a high degree of recognition, the connection between the space is also very intuitive and clear. Designers can make appropriate adjustments to the space according to the results obtained from the analysis, which plays a very important role in optimizing

the spatial form. Many contemporary designers use space syntax to solve environmental space design problems.

2 Literature Review

2.1 Ancestral temple space and its research status

The Free State of Bavaria, one of Germany's largest agricultural states, was the first to propose rural revitalization in the world. This state carried out land reform and renewal to achieve the goal of equal land in urban and rural areas, and this experiment achieved great success (Li Yuheng et al., 2019). The 18th National Congress of the CPC proposed the strategy of rural revitalization, and the 20th National Congress of the CPC proposed that "Chinese-style modernization is the modernization of harmonious coexistence between man and nature", emphasizing the development line of production development, prosperity of life and sound ecology (Xiang Hongling et al., 2023). Ancestral temple is the most representative rural public space in the process of urbanization. Ancestral temple is not only a place to worship ancestors, but also an important place for clan meetings and the exercise of privileges. Space is not only the product of social construction, but also part of social life (Jin Yongguang & Xiang Jiquan, 2020). The concept of Guangfu people was first proposed by Luo Xianglin, a Guangdong scholar, in his *Introduction to Hakka Studies* in 1933. Guangfu is the center of Lingnan region, and the ancestral temple of Guangfu is a typical representative of the ancestral temple of Lingnan region. It is the main research place of the form change of rural public space in the process of urbanization, as well as the true portrayal of regional aesthetics, clan culture, custom characteristics and spatial layout. It is a living fossil for the study of social production and has strong research value (Chen Chuanwen et al., 2023). In terms of theoretical research, many scholars at home and abroad have provided certain insights on the ancestral temple of Guangfu. By comparing the roof decoration and attribute characteristics of ancestral temple in Daling Village of Guangfu, its regional attributes are analyzed. So as to improve the understanding of village culture and strengthen its conservation significance (He Jingwei & Zhang Huang, 2022). The ceramic ridge decoration is taken as the perspective of ancestral temple research, and the research methods of art, architecture and sociology are used to reflect the overall style of traditional architecture from the aspects of decoration, shape, composition, color, subject matter and modeling. Reflect the macro life in the city of Guangfu from a micro perspective, so as to discover a window into the local culture of Lingnan (Jiang Chen et al., 2021). Temple architecture in ancient China was constructed through a strict social ritual and spatial sequence. This allows participants to experience a dynamic, time-related and psychologically changing experience while on the move, creating an atmosphere of solemnity. However, the space design of folk ancestral temples is a combination of freedom and rules. In the context of traditional rites, the overall layout of the building is in harmony with the surrounding landscape, not pursuing regular layout, but organically growing (Zhang Xinwei et al., 2023). By studying the ancestral temples of Duan Clan Ancestral Temple in Yingshan, Hubei Province, it is found that the new ancestral temples are more fastidious in site selection, scale, materials, decoration and spatial layout. However, in terms of style, the design is similar to the style of ancient ancestral temples. The newly built ancestral temple is like a royal palace, and the overall construction is more luxurious (Fang Shengde, 2016). With the development of society, a large number of ancestral temples have been destroyed or transformed for other purposes. While protecting the ancestral temple, we should start from the contemporary social civilization and dig out its historical value. The mode of "VR+ ancestral temple" can enhance the immersive and interactive experience and promote the development of ancestral temple culture (Yi Jiahao & Cao Kai, 2020). Based on the seven ancestral temples in Taiping District, East Anhui Province, the spatial layout and structure of the ancestral temples were analyzed. The research finds that each ancestral temple is affected by natural environment, financial resources, social environment and other aspects, and each presents different characteristics. Using the form of chart statistics, the spatial layout characteristics were analyzed (Chen Kezhen et al., 2016). Radical political reform transformed ancestral temples from traditional places for ancestor worship and clan activities into agricultural production gathering places, sports venues for singing red songs and small production and processing factories. The use, function and meaning of space have changed a lot. Architect Feng Wen used his professional knowledge to renovate and transform the Liang Ancestral Temple in Beiting Village, Guangzhou University Town. It not only retains the traditional culture in the ancestral temple, but also gives new life to the abandoned ancestral temple, so that the ancestral temple shows the value of creative and sustainable utilization (Ma L, Woods O & Zhu H, 2019). Fire dynamic simulation (FDS) was used to calculate and evaluate the fire performance of Chenjiaci in Guangzhou. It is concluded that the upper structure of the roof of the ancestral temple should be divided into smoke prevention zones through longitudinal fire glass, and set up a separate natural smoke exhaust skylight. Gable wall and Qingyun lane can reduce the incident heat flux of external wall by about 3/4 in case of fire in main hall. The long-distance ignition risk of fire should be vigilant when the wind speed exceeds 4m/s (Yi Xiaolei & Zheng Lipeng, 2021). At present, there are many wonderful and insightful researches on the ancestral temple of Guangfu. However, there are few articles concerning the comparison of spatial form studies of Chinese-style ancestral temples and those combining Chinese and European styles, as well as spatial quantitative studies. Therefore, this papers takes Chen Ancestral Temple in Guangzhou and Yu Zhongxiang Ancestral Temple in Kaiping as two representative buildings under the

background of Guangfu as specific cases. The analysis and demonstration in this papers are based on space syntax and adopt quantitative and qualitative research methods, and on this basis, put forward the optimization strategy. Through this papers, I hope to make my contribution to the inheritance and development of traditional culture of Guangfu and the optimization of ancestral temple space in the process of urbanization.

2.2 Space syntax theory and research status

Space syntax is a tool for spatial quantitative analysis. It was proposed by B. Hillier of Bartlett School of Architecture, University of London in the 1970s. After more than 50 years of development, a systematic and complete theoretical system has been formed, and it is a professional spatial analysis technique (B. Hillier, 1999). The advantage of space syntax is that it combines theoretical and practical methods in architecture, city, regional scale and planning. It is a powerful tool to describe physical space and spatial form. It has practicability and can provide powerful research methods for sustainable and unsustainable space. There are also some problems with space syntax, such as the lack of metric attributes in migration networks, which were solved by the introduction of line segment graphs at the 5th International Space Symposium. The theory of space syntax still tends to be constantly improved (Yamu, C et al., 2021). Space syntax is a scientific and quantitative description of architecture, planning, interior, space, etc. It is a theory and method to study the relationship between space organization and human activity. Space syntax is the spatial fabric of traditional rural public space (Chen Jianhua et al., 2022). In Brazil, which has the highest traffic death rate in the world, spreading cycling is important for reducing traffic accidents. Currently, Brazilian cities have no policy on the construction of bicycles, leading to the decline of the bicycle as a means of transportation. Space syntax is an effective technique for analyzing urban and architectural Spaces. A study of Rolandia-PR, a city in southern Brazil, used surveys and software to measure the data to come to some conclusions. Space syntax plays an important role in improving the city's transportation, popularizing bicycles, and reducing traffic accidents (Danae Fernandes et al., 2021). By using space syntax and Depthmap software, we calculate Bashe Village in Sanyuan County, Shanxi Province. It is found that Baishe West Street has the highest integration degree and the strongest accessibility. It has the highest control value, good accessibility and permeability, and belongs to the core village. The area north of Baishe West Street has a low degree of local integration and poor accessibility and convenience. New town and the old city of several streets have a certain connection value, the use rate is relatively high. Based on the above quantitative data, the space optimization strategy of "people-oriented" and "adapting to local conditions" was developed. To protect the original spatial structure of Bashe Village, improve the unreasonable spatial form, and provide a scientific basis for the protection and development of spatial form (Yang, XJ et al., 2019). The spatial evolution of Xiamen port area is quantitatively analyzed by using space syntax. The results show that from incubation period to stable period, the degree of global and local integration decreases, and the spatial relationship is weak. With the enlargement of spatial scale, the integration degree increases and the centrality also increases. Spatial pattern changes from single form to multi-dimensional form (Yu Jingping & Zhao Zhiqing, 2017). The analysis of the evolution of Tianshui ancient City is to explore the internal correlation between spatial structure and function through the superposition analysis of its morphological features by using space syntax, so as to put forward suggestions for improvement of the ancient city (Tian Xiaobo et al., 2021). Taking Wangping abandoned coal mine in Men Tougou District of Beijing as an example, space syntax is used to analyze the accessibility, spatial visibility, functional connectivity and correlation of building clusters at three dimensions of street, site and building cluster, and to propose updating strategies from four aspects of upper planning, road system, site space and cultural memory. This provides suggestions for the renewal and cultural inheritance of the site (He Lijie & Xu Minhui, 2022). A quantitative and qualitative study is conducted on the spatial form of Hakka dwellings in southern Jiangxi by using space syntax, and relevant indicators are given to provide optimization strategies for the construction of dwellings (Chen Chuanwen et al., 2022). Space syntax is used to analyze the Songdo Convention and Exhibition complex in South Korea, and it is found that the total integration degree of all facilities is above 1.0, indicating good accessibility. On the other hand, the total integration of Songdo Convenience Store, the core facility, was lower than the average. Finally, suggestions were put forward to add some facilities to improve the total integration of convenience stores and enhance their accessibility (Seok et al., 2022). It is found that Henan Road and Fuxing East Road have high centrality and connectivity in the walking system of Shanghai old City. Based on the research, the papers puts forward the following spatial optimization strategies: (1) Strengthening the visual guidance function of the street; (2) Strengthening the intelligent construction; (3) Strengthening the sidewalk construction at the entrance and intersection of the scenic spot (Ruolin Wang & Wuzhong Zhou, 2020). To sum up, space syntax has been studied more in traditional village space, but less in ancestral temple space. Based on this, on the basis of constructing the original spatial form, this papers compares the representative ancestral temples in Guangfu area. Quantitative analysis is carried out to obtain scientific data, so as to propose optimization strategies for the spatial form of ancestral temples.

3 Research Methods

In this papers, three parameters, Selection degree, Integration degree and Total depth value, are used as evaluation factors of spatial fabric, as shown in Figure 2.

Index	Attribute	Functional Summary
Selection degree	Possibility	The frequency of the shortest topological distance between two nodes
Integration degree	Accessibility, Centrality	Degree of agglomeration and dispersion between elements
Total Depth degree	Accessibility	Sum of average depth values of each node

Fig.2 Index variables of space syntax

Space syntax mainly includes the following analysis methods: convex space method, axis map analysis method, spatial view method and human flow simulation method. This research mainly adopts convex space method, supplemented by topological model research. Axis map analysis is more used in large street and rural Spaces. The spatial vision and people flow simulation are usually combined with the axis map to simulate and study people flow density. Therefore, they are not in the scope of this papers.
Convex Space refers to the transformation of a three-dimensional space to a two-dimensional plane space, and analyzes the visualization of any two points inside, called "all see all" in English. Set up a number of Spaces, and connect them, and then analyze its research results. In space syntax, the degree of integration is the core variable. The higher the degree of integration is, the higher the reachability is, the higher the degree of integration is, and the two are interdependent.

3.1 Selection degree

Selection degree describes the number of times each node is traversed by the shortest topological path between any two nodes within a certain range, and describes the traversability of the node. The calculation method of selection degree is the same as that of integration degree above. The only difference is that the Choice button should be selected in the lower left corner to observe its selection data. The corresponding spatial selectivity can also be calculated through field measurement. The calculation formula is as follows:

$$NAch(x) = \frac{\lg(ch(x)+1)}{\lg(dept(x)+3)} \quad (1)$$

$$ch(x) = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n}\delta(i,x,j)}{(n-1)(n-2)} \quad (2)$$

$$dept(x) = \sum_{i=1}^{n} d\theta(x,i) \quad (3)$$

ch(x) is the travel Angle, representing the sum of the times that a certain space *x* is traversed by the shortest path between any space *i* and *j*. *dept(x)* is the total Angle depth, representing the sum of the topological distances between a certain space and all other Spaces in the space. *NAch(x)* is the normalized angular travel degree, and *dθ(x,i)* represents the angular topological distance between *x* and *i*.

3.2 Integration degree

The Integration degree refers to the degree of agglomeration or dispersion between one element and other elements in a spatial system. It is obtained from the standardization of the average depth value, and the influence of the number of system nodes *n* on the average depth value (MDi) is eliminated. In the integration picture in Figure 3, red indicates the highest integration, decreasing in order of red, orange, yellow, green, cyan, and blue. Import CAD-dxf format of convex space map into Depthmap software, and create a new map - convex map in the map. Select the transition in the map to draw the map. The new map type is selected as convex map. Select the link button and link the space according to the spatial topology. Select the operating diagram analysis in the tool and calculate the integration result. Field measurement can also be used, and the data can be imported into the formula to calculate the corresponding spatial integration degree. The calculation formula is as follows:

$$RA_i = 2(MD_i - 1)/(n-2);$$
$$D_n = 2\left\{n\left[\log 2((n+2)/3) - 1\right] + 1\right\}/(n-1)(n-2);$$
$$RRA_i = RA_i / D_n;$$
$$I_i = 1/RRA_i$$

Among them, *RAi* is the result after a standardization of *MDi*, aiming to make the parameters normally distributed. *Dn* is a standardized parameter; *RRAi* is the result obtained after secondary standardization using *Dn*.

J-diagram is often used in the study of architectural space. It describes the structural relationship of the system with the diagram of nodes (representing space) and lines (representing connection relation).

3.3 Total depth value

It is defined in terms of the amount of space that passes through a selected or given starting point in the system (Claudia Yamu et al., 2021). It represents the sum of the average depth values of all nodes in the system. The ancient saying "good wine needs no bush" refers to the concept of total depth value. The total depth value is related to the cost that people need to spend to reach the node. Contrary to the integration degree, the larger the depth value is, the lower the reachability is, and the higher the cost distance is. The total depth value is specifically understood as the sum of the depth of each room to all other rooms, and it differs from the average depth by multiplying by the spatial coefficient minus itself. The calculation method of total depth value is the same as that of integration degree above. The only difference is that the Total connectivity button needs to be selected in the lower left corner to observe its selectivity data. It can also be measured on site to calculate the corresponding total space depth value. The calculation formula is:

Mean Depth× (Total number of Spaces -1) = Total Depth

4. Analysis of spatial form of ancestral temple in Guangfu

4.1 Case Overview

After years of baptism, the overall shape of the plane space of Chen Ancestral Temple in Guangzhou has not changed much, while the interior space form with the development of history, interior function and layout have undergone some changes.

Yu Zhongxiang Ancestral Temple in Kaiping went through the Qing Dynasty, the Republic of China and the People's Republic of China. The overall form of the temple was well protected. Except for the surrounding schools changing from private to public, the space did not change much.

4.2 Creation and analysis of space syntax model

4.2.1 Creation and analysis of topological space model

The planar graph (Figure 3) of Chen Ancestral Temple in Guangzhou was transformed into a convex space model (Figure 4), which was then used for topological model analysis. Topological model is a method to study the relationship between spaces. Topological connection is made in series between large space and roadway, some transition spaces are discarded, and then the connection between spaces and roadway is formed to form a topological model, and finally the topology diagram of Chen Ancestral Temple in Guangzhou is obtained (Figure 5).

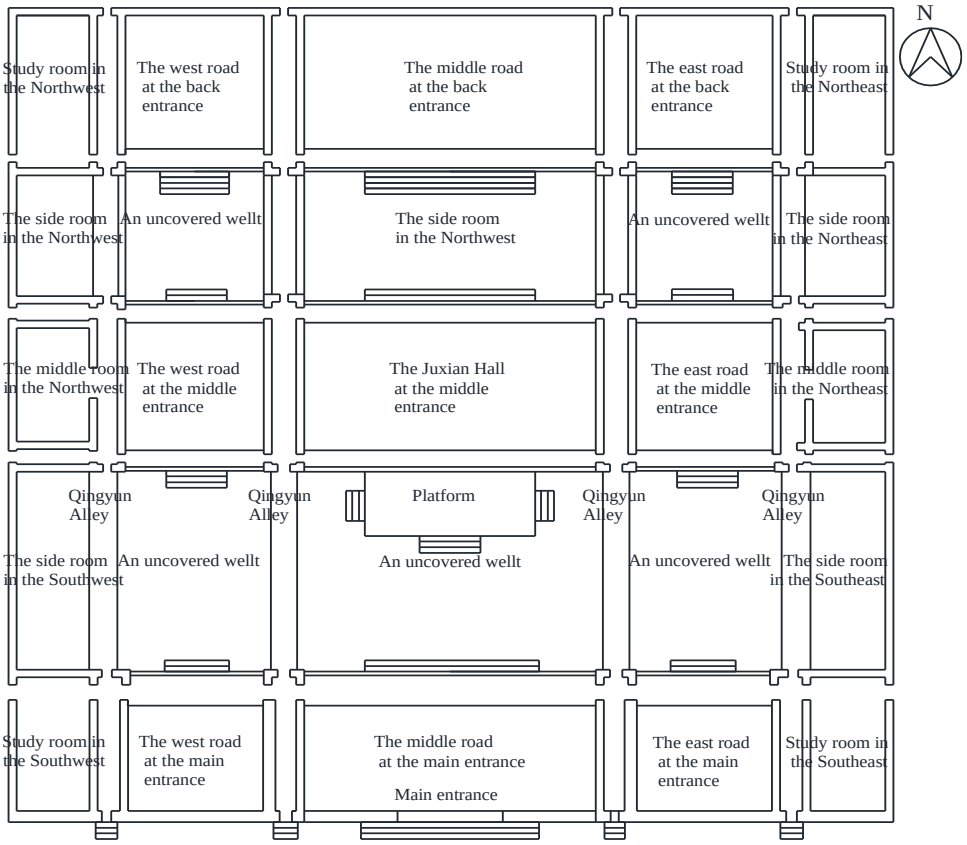


Fig.3 The Floor Plan of Chen Ancestral Temple in Guangzhou

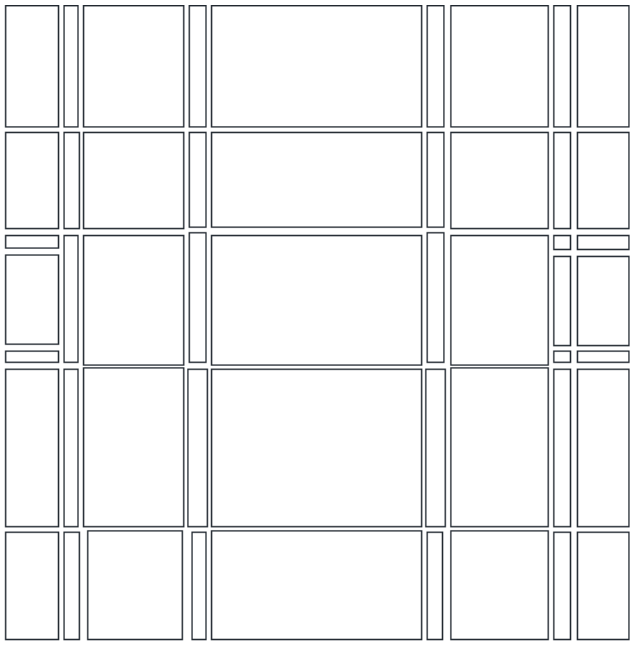


Fig.4 Convex space diagram of Chen Ancestral Temple in Guangzhou

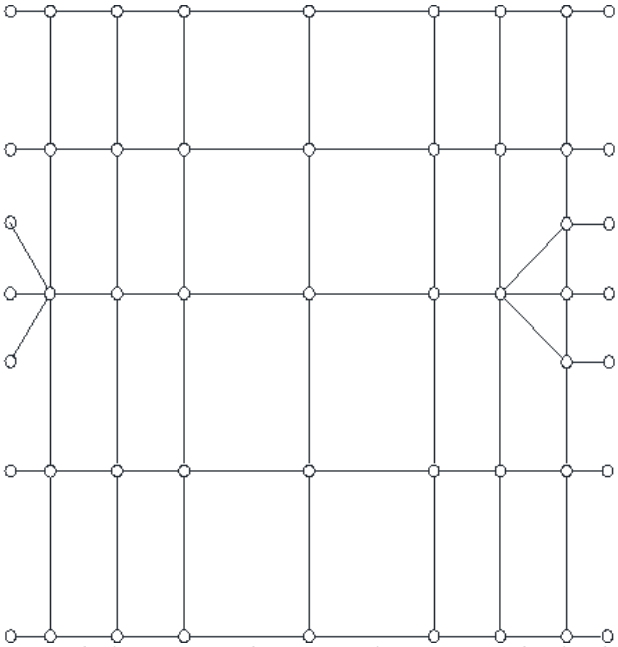


Fig.5 A topological view of the Chen Ancestral Temple in Guangzhou

The planar graph of Yu Zhongxiang Temple in Kaiping (Figure 6) was transformed into a convex space model (Figure 7). As the ancestral temple is a combination of Chinese and European design style, the plane layout is also relatively distinctive. Considering that this papers mainly analyzes the interior of the space, it does not include the external space and the style building outside the ancestral temple. In addition to the design of laneway, the interior of Yu Zhongxiang Temple in Kaiping also added the design of details such as corridors. Through the analysis of the planar graph, a new topology is obtained (Figure 8).

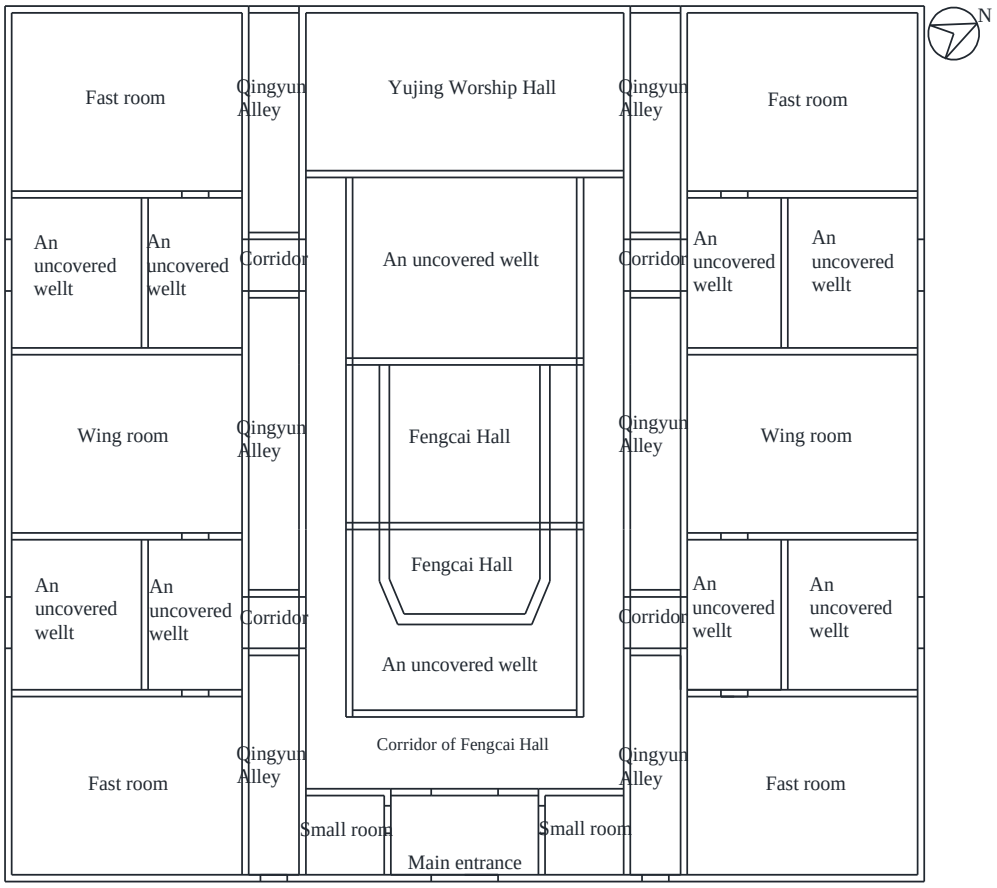


Fig.6 The Floor Plan of Yu Zhongxiang Ancestral Temple in Kaiping

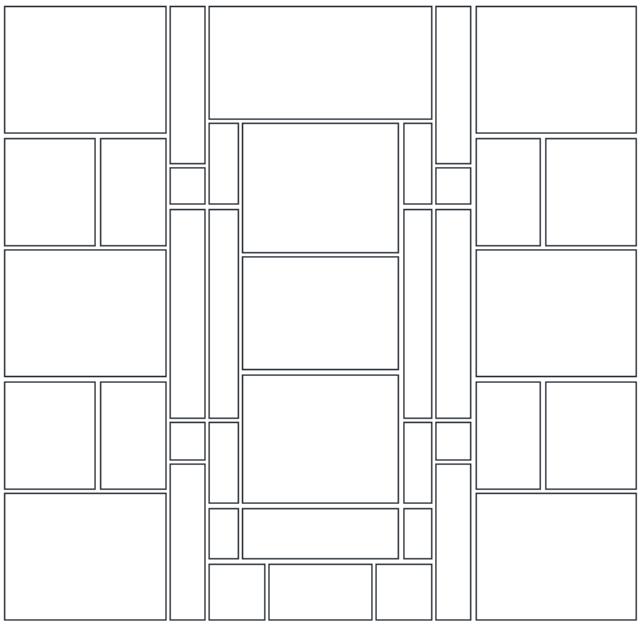


Fig.7 Convex space diagram of Yu Zhongxiang Ancestral Temple in Kaiping

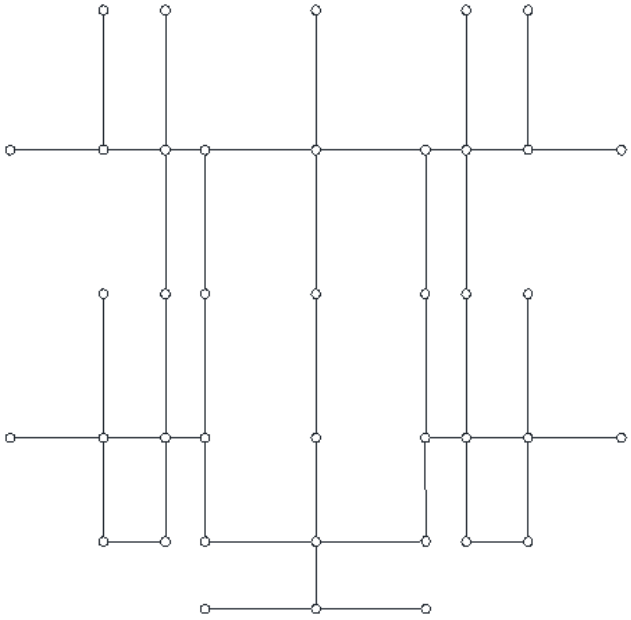


Fig.8 A topological view of Yu Zhongxiang Ancestral Temple in Kaiping

By comparing and analyzing the two topology maps, it is found that although the two ancestral temples are different in style, they are similar in form.

First, the contrast of virtual-real processing of the two ancestral temples is very clever. Guangzhou Chen Clan Ancestral Temple is made up of four *Qingyun* alleys, and a *Chuantang* alley is connected between the spaces. The treatment of this virtual space makes the spatial connectivity of Guangzhou Chen Clan Ancestral Temple very good. The processing of physical space along with the development of history is also very cleverly arranged, there are museums, exhibition halls, exhibition halls, bookstores, stores, reading halls, VR exhibition spaces, cultural exhibition spaces, etc. Yu Zhongxiang Ancestral Temple in Kaiping has two *Qingyun* alleys

distributed on both sides, and the interior is equipped with exquisite European style corridors, as well as the courtyard space distributed in four directions and the ornamental gallery of lime sculpture. All these are the treatment of virtual space. The arrangement of the physical space includes the designs in Fengcai Hall, such as the iron art space, the Yujing worship Hall, the display wall, the meeting hall, the classroom, the goods room, etc.

Second, the layout of the two ancestral temples is symmetrical, and the end of the ancestral temple is the ancestor worship space. Both traditional Chinese style space and European style space layout pursue the middle axis symmetry layout. This layout has a strong sense of space, ceremony and form. The worship space is arranged in the middle end of the layout, representing the arrangement of the space thought form of Confucianism and the system of "*Zhaomu*", representing the inheritance of ancestors' thoughts and culture, the descendants should respect their ancestors, but also suggesting that the descendants should work hard to inherit the ancestral temple culture. The meaning of "*Zhaomu*" refers to the generation and seniority of male relatives with the same surname, which can be replaced by the word "*beifen*" (Zhu Fenghan, 2022).

Third, the two ancestral temples have a square shape with strong cohesion and centripetal force. A bird 'seye view of the two ancestral temples shows a square shape, showing the orthodox thoughts of the traditional ancestral temple culture. Through the square shape design of full encirclement, a strong encircling layout form is formed, showing the trend of members supporting the clan culture. The center of Chen Clan Ancestral Temple in Guangzhou is the *Juxian* Hall, and the center of Yu Zhongxiang Temple in Kaiping is the *Fengcai* Hall. Both ancestral temples have an important central hall culture. They both define the ancestral temple as an important parliamentary center. The design form of the central hall shows a strong centripetal force.

There are some differences in the shape of the two ancestral temples, which are mainly reflected in the following aspects.

First, ancestral temples have different styles. Guangzhou is an important treaty port in Southern Guangdong, the provincial capital of Guangdong, and the center of Guangfu culture. Guangzhou has a very advantageous geographical advantage. As the gathering place of Lingnan culture, Guangzhou people are very proud of their native traditional culture. The overall style of Chen Clan Ancestral Temple in Guangzhou is traditional Chinese style. On the basis of traditional Chinese style, part of Western culture is introduced, but a very small amount. And Kaiping Yu Zhongxiang Ancestral Temple is the combination of Chinese and European design style. Its architectural structure and interior space adopt a large number of European elements, such as Corinthian column, Ionic column, Roman column, European colonnades, iron art and a large number of European carvings. Kaiping is an important hometown of overseas Chinese in Lingnan. A large number of overseas Chinese from Europe and America donated money to build this ancestral temple, so the ancestral temple presents European and American architectural styles.

Second, the spatial layout is different. Chen Clan Ancestral Temple in Guangzhou has undergone a lot of spatial function transformation in its historical evolution, and now it has become the Guangdong Folk Craft Museum, which not only has the function of ancestor worship, but also has the function of traditional culture display and commercial function. A ticket office is set up at the entrance of the ancestral temple, which has a mature commercial operation mechanism. The Chen Clan Ancestral Temple in Guangzhou has developed a self-renewing restoration routine. The Yu Zhongxiang Ancestral Temple in Kaiping serves more of the function of displaying family culture, holding related ceremonies for the family and providing a place for gathering and meeting. The treatment of space is relatively simple, and some of the space is not used effectively.

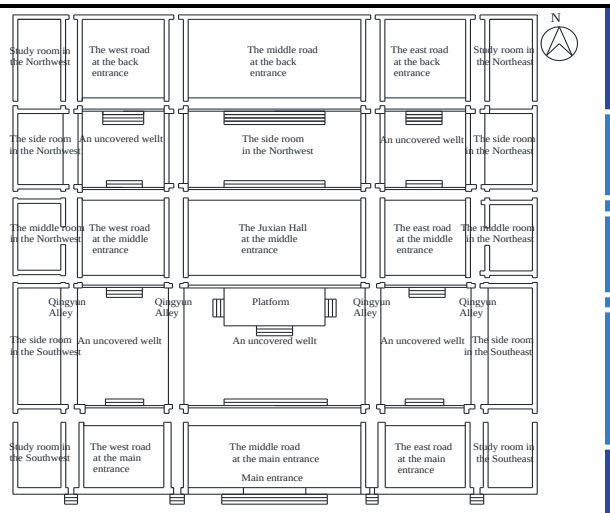
Third, the floor plan is different from the topology. The internal moving line of Chen Clan Ancestral Temple in Guangzhou is very regular and smooth, and the connection between each space is very traditional, showing the connection form of up and down, left and right. The whole ancestral temple has only one floor, with reasonable spatial distribution and strong connectivity. Part of Yu Zhongxiang Ancestral Temple in Kaiping has been designed as a double layer, and the space has been expanded vertically. Two *Qingyun* allay runs through the front and back of the ancestral temple, which plays the role of dividing the space. The core point of the ancestral temple has been carefully processed, while the secondary place has been simply processed, highlighting the primary and secondary points and conveying the culture of high power of ancestors.

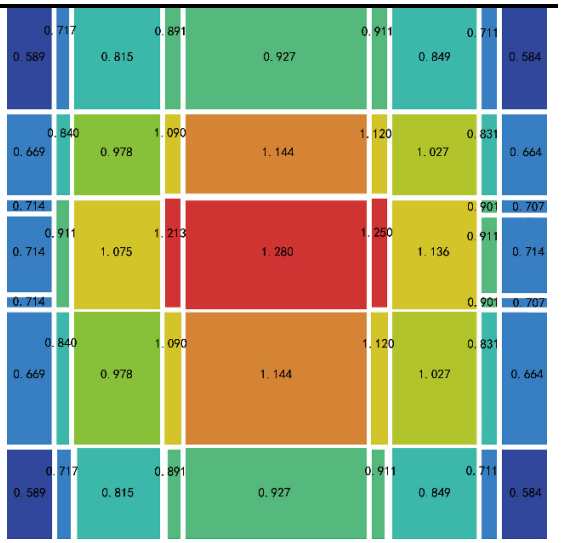
4.2.2 Creation and analysis of convex space model

Depthmap was used to analyze the convex space model of two ancestral temples, namely, Chen Clan Ancestral Temple in Guangzhou and Yu Zhongxiang Ancestral Temple in Kaiping, as shown in figure 9 and figure 10. The quantitative data of integration degree, selection degree and depth value were calculated, and the primary and secondary relationship, spatial division and cultural characteristics among related units were obtained through calculation. The overall model and the spatial weight and design logic of each unit can be clearly and intuitively obtained by introducing relevant data to draw conclusions of color and value changes through field measurement.

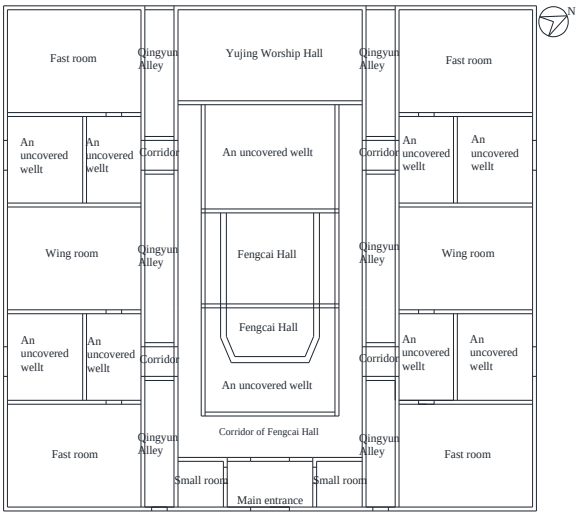
Case name	Planar graph	Integration degree

Guangzhou Chen Clan Ancestral Temple





Kaiping Yu Zhongxiang Ancestral Temple



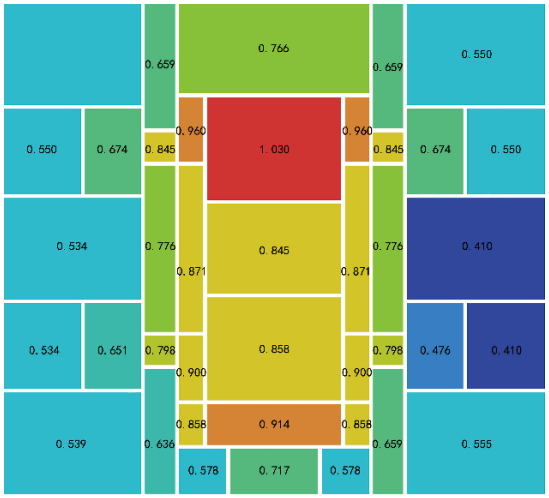


Fig.9 Planar graph and integration analysis

Case name	Selection degree	Total depth value

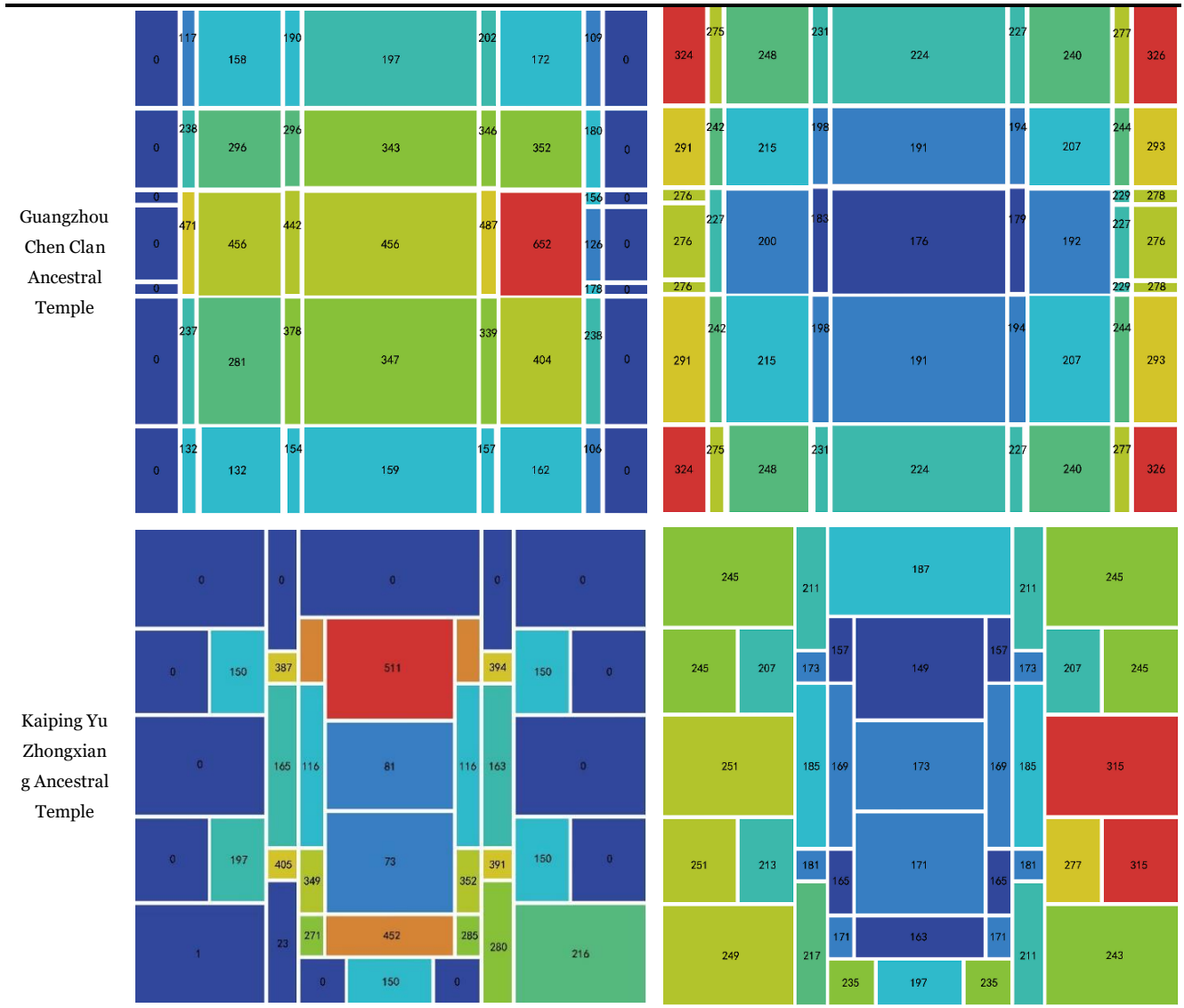


Fig.10 Selection and total depth value analysis

(1) Integration degree and Total depth value analysis: In Depthmap software, values are distinguished according to the order of red, orange, yellow, green, green, blue and purple. The more red it is, the higher it is; and the more blue it is, the lower it is. The degree of integration refers to the degree of dispersion or agglomeration between one element and other elements in a spatial system. It measures the ability of a space to attract incoming traffic as a destination and embodies the centrality of the space within the overall system. The higher the degree of integration is, the higher the accessibility and the stronger the centrality are (Qian Caiyun et al., 2020). Through calculation, the results are analyzed and compared: the integration degree of *Juxian* Hall in Chen Clan Ancestral Temple in Guangzhou is at the forefront. *Juxian* Hall is located in the center of the whole ancestral temple. It connects all the main spaces inside the ancestral temple and reflects its centrality, and its spatial importance is self-evident. The west study and east study have the highest total depth value and the lowest integration degree. People in the *Guangfu* area believe that family matters are more important than anything else, and important matters need to be discussed in a central space. It can be observed from the integration degree of space that *Guangfu* people are very united and have a strong cohesion. From the total depth value of space, we can also observe the career initiative of *Guangfu* people who work more than live. The integration degree of Yu Zhongxiang Ancestral Temple in Kaiping and Chen Clan Ancestral Temple in Guangzhou is close, and the highest integration degree of the whole is between the Fengcai Hall and Yujing Worship Hall. This is a patio space with plenty of light. The large area and good location ensure the tolerance and accessibility of the population gathering. The highest total depth value is arranged in the wing room and its vicinity. This ancestral temple has a lot of pavilions, which is related to its geographical location, geographical culture. In the old society, there were a lot of bandits in Kaiping. When people were threatened, they could run to the second floor or the top of the building, and use the high walls, the top of the building and other spatial and geographical advantages to resist the bandits, so as to play the purpose of military defense and protect the safety of the ethnic group. Important property and materials can be displayed in the second floor space to ensure its safety. The wing

room and its vicinity have the lowest accessibility. It is far away from the noisy central area and connected with the courtyard. Flowers and bonsai are planted in the courtyard and balcony space to create a comfortable living environment.

(2) Selection degree analysis: The selection degree of Jindong Road in Chen Clan Ancestral Temple in Guangzhou is the highest, followed by the courtyard corridor, which indicates that these two parts, as the central transportation hub of the space, have certain passability. As a private space, the calculation result of the room used for fasting and the wing room is 0, which does not have the passability. It shows that the traditional *Guangfu* people have made a certain distinction between the public and private space. With the historical transformation, the contemporary space has its own functional attributes. The corresponding fasting rooms and wing rooms have been transformed into exhibition halls, bookstores, libraries, shops, cultural centers, etc., and its selection data has also been improved accordingly. The design of traditional space reflects the ancient people's superior wisdom of space design.

The calculation result of the selection degree of the courtyard space between *Yujing* Worship Hall and Fengcai Hall of Yu Zhongxiang Ancestral Temple in Kaiping is red, which indicates that it plays a very important role as a major transportation hub for worship. The second is the corridor of the Fengcai Hall, which is a corridor connecting the main spaces and adopts the European design style. It indicates that the ancestral temple is a traditional ancestral temple founded by the organization of European and American expatriates. Yujing Worship Hall is in the middle position, with a selection degree of 0, indicating the prominent status of ancestors and a certain sense of distance between ancestors and their people. The selection degree of fast room, wing room and small room is 0, which reflects certain privacy of space. The right front fast room is the main meeting room in the contemporary era, with relevant meeting tables, ethnic culture, ethnic history display cabinets, etc. Later generations regard it as a place for family gathering, family affairs discussion, ethnic culture exchange and dissemination.

5. Spatial form optimization strategy of ancestral temples in Guangfu from the perspective of rural revitalization

Through the above quantitative and qualitative analysis, according to the data conclusion obtained from the case situation and calculation, based on the perspective of rural revitalization, corresponding optimization strategies are respectively proposed for the two ancestral temples. The "dissemination type" and "inheritance type" ancestral temples should be built respectively. This strategy is a micro spatial transformation based on the original structure, which has positive significance for the inheritance and protection of the two ancestral temples.

5.1 Optimization strategy of Chen Clan Ancestral Temple in Guangzhou

After a hundred years of culture, Guangzhou Chen Clan Ancestral Temple takes building a " propagation-type " ancestral temple as its main goal. " Propagation-type " mainly refers to cultural communication. The culture here includes intangible heritage culture, ethnic culture, architectural culture and so on.

5.1.1 Intangible heritage culture

As an important city of Lingnan culture, Guangzhou has important cultural connotation in the aspect of intangible heritage. At present, Chen Ancestral Temple in Guangzhou displays major intangible cultural heritages, such as Cantonese embroidery, wood carving, lime sculpture, ivory carving, stone carving, brick carving, *Shiwan* pottery, Canton porcelain, etc. All kinds of intangible cultural heritage products are made with exquisite techniques and have good cultural inheritance value. The main intangible cultural heritage can be arranged in the space with high integration degree, and the high integration degree means high accessibility. Part of the interior space can be transformed to sell relevant intangible cultural heritage simulation products, increase commercial income and promote cultural exchange and inheritance.

5.1.2 Ethnic culture

The Chen Clan Ancestral Temple in Guangzhou is the largest ancestral temple of the Chen clan in Lingnan, which should retain a large amount of the history and culture of the Chen ethnic group. Excellent historical and contemporary celebrity biographies will be displayed in a highly integrated location to inspire the descendants of Chen clan and people from other ethnic groups. The display and dissemination of ethnic culture can highlight the positive energy. The memorial tablet of Chen's ancestors should be placed in the north of the space for later generations to worship and express their reverence for their ancestors with practical actions.

5.1.3 Architectural culture

The Chen Clan Ancestral Temple in Guangzhou is the best preserved and largest *Guangfu* building in Lingnan area. It shows the traditional culture of "three carvings, two sculptures, one casting and one painting" in Lingnan architecture, namely wood carving, brick carving, stone carving, pottery sculpture, gray sculpture, copper and iron casting and painted murals. Some of them have been listed on the national intangible Cultural

Heritage list, showing the superb craftsmanship of their ancestors and the exquisite workmanship of architecture.

5.2 Optimization strategy of Yu Zhongxiang Ancestral Temple in Kaiping

Yu Zhongxiang Ancestral Temple in Kaiping should take "inheritation-type" ancestral temple as the main goal. "Inheritance type" mainly refers to the inheritance of ethnic culture. The ethnic culture here includes Yu Jing culture, contemporary Yu culture, architectural culture and so on.

5.2.1 Yu Jing Culture

Yu Jing was an official in the Northern Song Dynasty. He was devoted to his country all his life. He is a successful example of the "Yu surname" ethnic group in the Lingnan area. The whole ancestral temple should be developed around the Yu Jing culture. This is not only enlightening to the contemporary youth, but also plays an important role in enriching the cultural connotation of ancestral temples.

5.2.2 Contemporary Yu Clan Culture

Based on Yu Jing culture, the development of contemporary Yu culture is an important direction of the cultural development of today's people. To take Yu Jing as an example, it is more important to cultivate excellent offspring of the ethnic group. The excellent deeds of the main representatives of outstanding descendants of ethnic groups in various periods can be displayed in the ancestral temple, such as people with doctor's degrees, people with higher official positions, outstanding entrepreneurs, and the contemporary Yu family who have made important contributions to the development of the ancestral temple. Good deeds can be printed in books for the clan to read. The distribution of contemporary Yu culture should be equal and extensive, and it should also be distributed in areas with low selection degree, so that tourists can be imperceptitiously influenced by ethnic culture.

5.2.3 Architectural culture

Yu Zhongxiang Ancestral Temple in Kaiping is the largest ancestral temple combining Chinese and European styles in Lingnan region. In the ancestral temple, exquisite traditional construction and decoration techniques such as stone carving, wood carving, pottery sculpture, clay sculpture and iron casting are used. It has a large number of Romanesque wall arch, Arch of wooden architecture structure, European style column and other European style design. The fusion of Chinese and European design styles makes the ancestral temple show noble temperament. In particular, the application of European style shows that the people have an open mind, as well as the recognition of foreign excellent culture.

6. Discussion and conclusion

6.1 Discussion

Ancestral temples are important architectural spaces in rural revitalization and development. It usually occupies a major geographical advantage in the countryside, and it is an important link in the development of rural culture. Nowadays many village activities are based on ancestral temples. Selecting two very representative ancestral temples in Guangfu area as the research object is the main content of scientific research of ancestral temples in Guangfu. The study of space syntax follows the basic principle of graph theory, carries on the topological analysis of space accessibility, and makes space optimization specific, clear and definite. Using space syntax theory as the research entry point can better make up for the shortcomings of traditional space (Shen Zhen et al., 2022).

The theories and methods of space syntax also have their limitations. At present, they cannot reveal the inner laws of the behavior and function of micro space, but can only be used to explain the mode selection of the existing space form (Yang Tao, 2022).

The space syntax shows that the development of Chen Clan Ancestral Temple in Guangzhou should highlight the role of *Juxian* Hall and carry out related work around this area. The development of Yu Zhongxiang Ancestral Temple in Kaiping should focus on the middle patio of Yu Jing Worship Hall and Fengcai Hall. As these areas are the most spatially accessible, they should be developed with priority (Meng et al., 2022). This papers discusses the spatial form of Guangfu, takes two representative ancestral temples in Lingnan as examples, and uses space syntax to conduct scientific and quantitative analysis on them, so as to obtain relevant optimization strategies, which is of great significance for the inheritance and development of ancestral temple culture.

6.2 Conclusion

Based on the theory of space syntax, this study adopts quantitative analysis and qualitative analysis to make a quantitative analysis of two representative ancestral temples in Guangzhou, namely, Chen Clan Ancestral Temple in Guangzhou and Yu Zhongxiang Ancestral Temple in Kaiping. The topological space model and convex space model are established, and the integration degree, selection degree and total depth of the space are calculated. Finally, relevant conclusions are drawn: the two ancestral temples have rich cultural context.

They have certain differences in design style. Spatial morphology changes over time. The settings of different spaces should be adjusted adaptively according to the data calculated from the integration degree, selection degree and total depth value of the space. Ancestral temples are deeply influenced by Confucianism, sacrificial culture, commercial environment and spatial development. Finally, based on the quantitative data and analysis results, targeted strategies are proposed to create " propagation-type " and "inheritation-type" ancestral temples. Based on the background of rural revitalization, this study promotes the cultural inheritance and development of ancestral temples in the development of villages.

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