

Parametric Analysis of Spatial Construction Characteristics of Traditional Villages

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Abstract: This study uses parametric means to analyze the village space, and extracts the overall spatial structure characteristics of traditional villages through spatial syntax. The wind environment and thermal environment of the village are analyzed by CFD. The research shows that traditional villages embody the construction wisdom of skillfully borrowing, adjusting measures to local conditions and adapting to nature, excavate the construction laws and spatial characteristics of traditional villages, and carry out adaptive inheritance design, which has important practical significance for the continuation of the style in the current rural construction.

1. Introduction

As an important material carrier of local culture, traditional villages have significant regional and overall characteristics, forming a rich settlement landscape. This study takes parameterization as a means, on the basis of respecting the spatial construction logic and cultural inheritance context of traditional villages, quantitatively interprets the internal laws of spatial construction of traditional villages by using parameterized means such as spatial syntax and wind heat environment analysis, explores the spatial construction characteristics of traditional villages, and applies these characteristics to the protection practice of traditional villages after screening and optimization, Guide the planning and design of traditional village spatial form, and provide effective and new technical means for the research and planning methods of traditional village spatial form.

At present, the research on traditional villages by means of parameterization mainly focuses on historical evolution, genetic mechanism, features and development strategies. Through comprehensive combing, the current application of parametric technology in the research of traditional villages mostly takes foreign theories or technologies as reference, pays less attention to the particularity of the research object and geographical factors, and ignores the differences in the application situations of parametric technology at home and abroad in some aspects. It still needs to be deeply explored based on the local cultural background and the reality of the construction of traditional villages.

2. Research Methods and Technical Route

2.1 Spatial Parsing Method

Spatial syntax theory is a language to describe the spatial pattern of architecture and city (village). Its basic idea is to divide and divide space, and analyze its complex relationship. In spatial syntax analysis, we not only pay attention to local spatial accessibility, but also emphasize the overall spatial accessibility and relevance. Through the analysis of the CAD plan of the study area, it is found that the traffic relationship is clear and the spatial style is complete, which meets the basic conditions of spatial syntax research. In the process of quantitative analysis using spatial syntax, the street space is abstracted as an axis, and the architecture is abstracted as a domain. Through the convex spatial analysis method and axis analysis method in spatial syntax analysis, this study selects the integration degree, intelligibility and other parameters to quantitatively analyze the

spatial structure characteristics of traditional villages from different spatial scales, and analyzes the road level, spatial accessibility and convenience, and the integration degree of vision of traditional villages, so as to extract the overall spatial structure characteristics of traditional villages.

2.2 Analysis Method of Wind Environment and Thermal Environment

In the analysis of wind environment and thermal environment, CFD (Computational Fluid Dynamics) fluid analysis method is used to simulate the wind direction flow in the space under the introduction of real meteorological data. Through the wind speed simulation and thermal radiation simulation of the spatial form of traditional villages, the coupling relationship between the form of traditional villages and the characteristics of wind speed and thermal radiation in villages is studied.

2.3 Technology Roadmap

The traditional spatial parametric analysis of villages is a process of transforming spatial elements into parameters and rules. Firstly, the spatial elements such as village plots, roads and buildings are decomposed and the parameter set is constructed. The spatial integration, intelligibility, choice and horizon of villages are analyzed by spatial syntax theory and Depthmap software, Study the accessibility and convenience of village spatial connectivity. On the basis of parameter setting, the coupling relationship between village wind speed flow and thermal radiation environment is analyzed by CFD software. Based on the comprehensive spatial syntax analysis and the analysis of wind environment and thermal environment, this paper refines the spatial morphological characteristics of traditional villages and explores the wisdom in village construction.

3. Overview of Research Objects

Fangyu village is located in Xiaoli Town, Changqing District, Jinan City. It is located in a mountain valley at the west end of the central Shandong mountain area. It is listed in the fourth batch of Chinese traditional villages. The village is built close to the mountain. The traditional streets and alleys are basically well preserved, the traditional pattern is clear, the stone house buildings are concentrated and distributed, the architectural heritage is rich, and the historical and cultural accumulation is profound. It is a relatively complete and large-scale traditional residential building group in Jinan. The evolution of village spatial form has experienced three periods: germination period, development period and maturity period.

Budding period: due to the demand for water source, the settlement is built according to water, the water wells become the origin of the initial settlement, and the settlement units show a trend from single point agglomeration to parallel dispersion along the river.

Development period: when the contradiction between space capacity and space demand becomes more and more tense, under the blood bond organization of gathering families, the individual construction unit shows the growth track of family family, and forms a spatial construction trend from scattered points (families) to groups (families) in space.

Mature period: with the development of the village, the social structure, spatial structure and business structure of the village have been reconstructed, which is directly reflected in that the main roads have replaced the river and water wells and become the pattern axis of organizing village life and spatial relations. The village road system has clear primary and secondary, and connects the village traffic through primary and secondary roads and roadways.(Table 1).

Table 1 Analysis of Village Space

Development Stage	Budding Period	Development Period	Mature Period
Spatial form expression			

4. Spatial Parsing Results

4.1 The Overall Spatial Accessibility of the Village is Good

The integration degree is used to describe the distribution degree of each node in the space system. The higher the integration degree, the better the spatial accessibility. According to the analysis chart of axis integration degree (the integration degree of axis color gradually decreases from red to blue), the accessibility in the middle of the village is the highest, and the integration degree value of nearby areas is 2.2. Combined with the analysis of the current situation, this area is the core of Fangyu Village space cluster, the village trunk road runs through it, the streets are open, the lanes are connected smoothly, the flow of people is concentrated, and the overall accessibility is good, which is the core of village production. The core area of life and traffic organization. The integration degree on the north side of the main road is 1.8-2.02. This area is connected by village sub trunk roads and serves some regional clusters of villages. With the main and secondary trunk roads as the center and extending around, the spatial integration degree gradually decreases. The integration degree in the South and west of the village is the lowest, with the integration degree value of 0.85-1.16. Due to the limitation of land area and landform, the number of households in the residential group is small in the west of the village, which is connected with the trunk roads through alleys, and the flow of people is small. While the south is the original prototype space of the village. With the development of the times, The residential population is gradually small, and the height difference between this part of the area and the main road is large, which limits the traffic flow. Through the analysis of integration degree, it can be seen that the layout of village road traffic system is reasonable, the connectivity of main and secondary trunk roads and roadways is strong, the density of road network is high, all kinds of spaces in the village are well connected, and the overall accessibility of space is good, which is consistent with the spatial order formed by the linear growth of roads in the process of village development. (Figure 1)

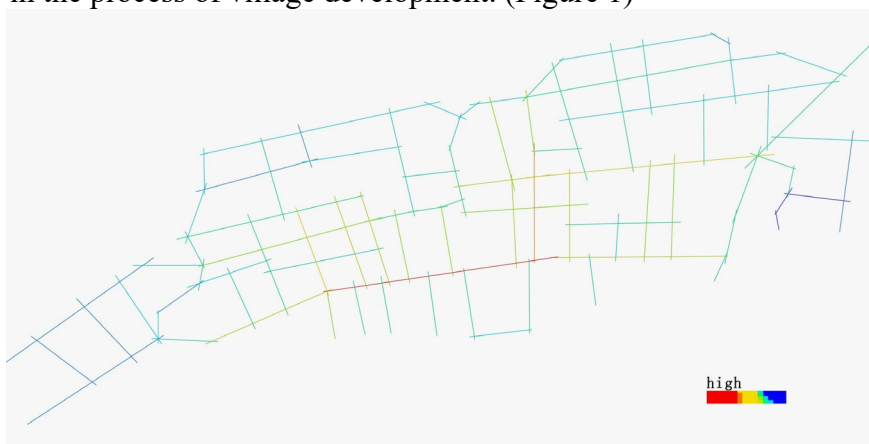


Fig.1 Axis Integration Analysis Diagram.

4.2 The Connection Value of Family Settlements in the Middle of the Village is High

Connection value represents the visual permeability of space, which is positively correlated with spatial permeability. Through the spatial integration analysis of Fangyu Village (the color gradually decreases from red to blue), it can be seen that the area with high spatial connection value is located in the settlement group formed by the clan settlement of Wujia courtyard and Fangjia courtyard near the main and secondary trunk roads of the village, and the overall connection value of this area is the highest. Through the comparative analysis with the axis integration, it is found that the space with higher connection value basically coincides with the axis with higher integration, which shows that these spaces have great influence and close connection with the village space, and further shows that the village space has the characteristics of open and closed coexistence, and the space group formed by clan settlement is an important factor in the spatial morphological characteristics of the village. (Figure 2)

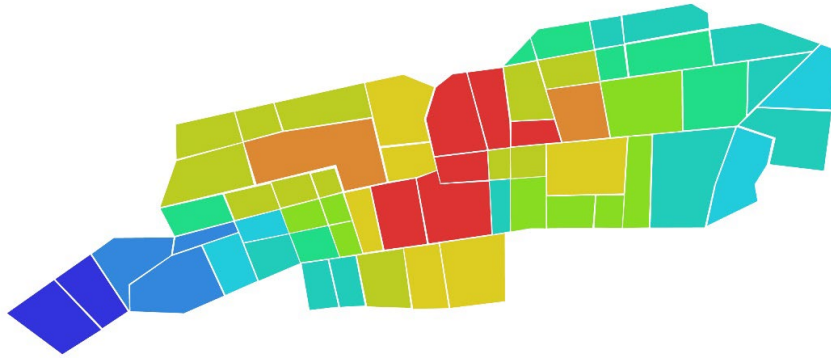


Fig.2 Spatial Integration Analysis Diagram.

4.3 The Perception of Village Space is High

Intelligibility is the individual's understanding of the global system in the process of experiencing the local spatial system. The value of intelligibility is positively correlated with the degree of spatial cognition. Through the linear regression between the global integration degree (x-axis) and the local integration degree (Y-axis), the intelligibility R2 of Fangyu village spatial system can be obtained. When the value of R2 is less than 0.5, it is generally considered that the local integration degree is not related to the global integration degree, and when the value of R2 is between 0.5 and 0.7, it is considered that the local integration degree is related to the global integration degree, When the R2 value is greater than 0.7, it is considered that the local integration degree is significantly correlated with the global integration degree. When the local integration R3 is selected, the intelligibility R2 is 0.7493, and when the local integration R7 is selected, the intelligibility R2 is 0.9957. There is a significant correlation between the local integration and the global integration, which shows that the overall space of Fangyu village maintains a high consistency with the local space, and can infer the overall spatial characteristics from the local space, which is easy to be recognized. Combined with the current situation of the village, Fangyu village has a clear road level system and a more reasonable organization to form a spatial order, which constitutes the skeleton of the village spatial structure. The architectural features on both sides of the street are complete, and the width of the street is coordinated with the spatial proportion of the buildings on both sides, forming a more unified spatial attribute and order and enhancing the perception of space. (Figure 3)

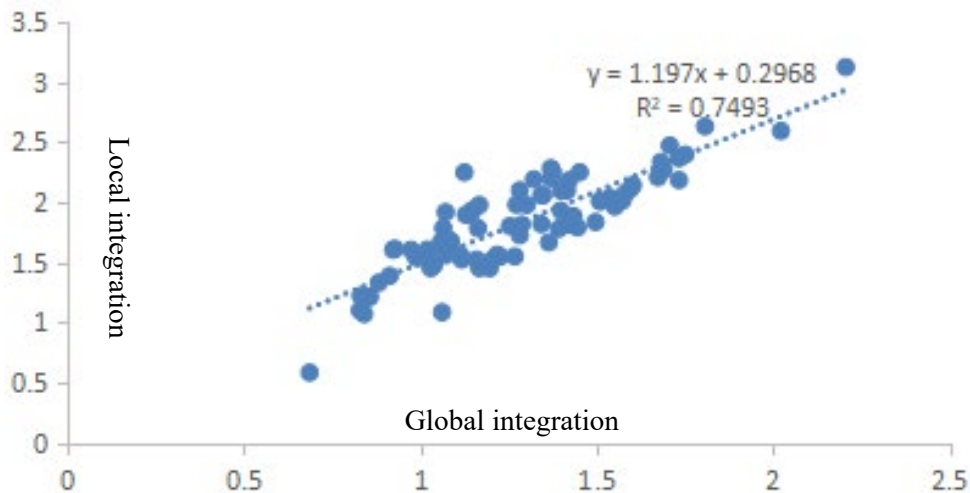


Fig.3 Intelligibility Analysis Chart.

5. Analysis Results of Wind Environment and Thermal Environment

In the study, the weather tool and winair plug-in in Ecotect are used for wind environment and

thermal environment analysis, SketchUp software is used for modeling, the meteorological data of Jinan City are imported into the analysis system, and the wind environment and thermal environment data are parameterized and analyzed.

5.1 Relationship between Wind Speed Variation and Space

The wind speed is positively correlated with the road direction. When the wind direction coincides with the road direction, the wind speed is higher. The lower the degree of coincidence, the lower the wind speed. The main reason is the barrier of buildings to the wind. The layout of the main roads in the village is perpendicular to the wind direction in winter, which can reduce the monsoon wind speed in winter and basically parallel to the dominant wind direction in summer, accelerate the flow of wind, take away the heat inside the village, and form the climate benefit of warm in winter and cool in summer.

From the analysis data, the overall ventilation effect of the village is good, which has a great relationship with the layout of streets and lanes. The village buildings expand laterally along the main road and form a roadway parallel to the dominant wind direction longitudinally; The building height at the air inlet on the north side of the village is controlled appropriately, which will not hinder the wind flow; The layout of the building basically follows the contour line, and forms a reasonable ventilation corridor, which promotes the flow of wind and forms a good ventilation environment in the village.

5.2 Relationship between Thermal Environment and Space

It can be seen from the temperature change trend chart that the temperature of the selected points changes little, and there is no heat island effect similar to that in cities, but the temperature change trend is negatively correlated with the wind speed change trend. The higher the wind speed is, the lower the temperature is. The unblocked north-south roadway and the main road parallel to the summer wind can accelerate the flow of gas in the village and optimize the thermal environment of the village.

In traditional villages, the building layout conforming to the terrain and reasonable and efficient road system create a good ventilation environment, promote the flow of air in the village, and can better reduce the high-temperature environment in summer, while the building layout perpendicular to the wind direction in winter can reduce the flow of wind speed and reduce the impact of cold air in winter on the village.(Figure 4)

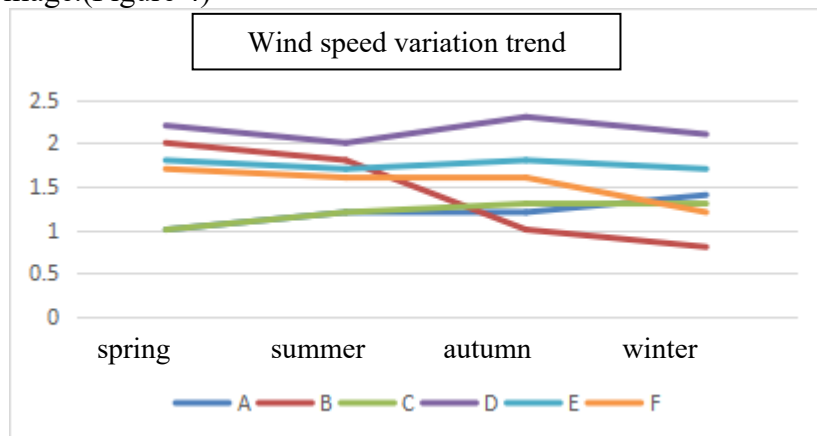


Fig.4 Variation Trend of Wind Speed and Temperature.

6. Conclusion

The spatial pattern, architectural layout and road traffic system formed in the development of traditional villages reflect the construction wisdom of skillfully borrowing, adapting to local conditions and adapting to nature, which not only meets the needs of residents' life and production, but also creates a good landscape style and living environment, excavates the construction laws and spatial characteristics of traditional villages, and carries out adaptive inheritance design. It has

important practical significance for the continuation of the style in the current rural construction. Due to the spontaneity of traditional village space formation, the flexibility of spatial form and the complexity of spatial organization, field investigation and interview should be conducted as carefully as possible in the process of adopting parametric analysis, so as to find out the actual spatial situation, so as to achieve the application and matching with parametric analysis, eliminate the interference of subjective factors in the algorithm as much as possible, and set the parameter index set objectively. The judgment, extraction and effective application of analytical results are also worthy of further research.

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