Research on The Relationship between Residential Space Pattern and Traditional Culture based on Space Syntax: Taking Kejia House as an Example

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Abstract. This article uses the space syntax theory to analyze the space diagram of the typical traditional houses and houses in Southeast Hubei, and discusses the characteristics of the spatial pattern of the traditional houses. Using Depthmap software to analyze the spatial pattern of traditional dwellings, and calculating data indicators of integration, connectivity, and integration of horizons. Through analyzing the characteristics of spatial pattern, it reflects the characteristics of moral concepts, clan concepts, and living habits in Southeast Hubei.

Keywords: spatial syntax, spatial pattern, traditional culture, traditional residential houses.

1. Introduction
Space syntax is a new language for describing architecture and urban spatial patterns. Its basic idea is to divide the scale and partition of space, and link the description of space with users' behavior and social culture. It establishes a quantitative description system of spatial form, and provides the application direction of big data in architectural design and urban planning in the information age.

2. Analysis and Application of Space Syntax Theory in Civil House Architecture
Space syntax theory was proposed by Bill Hillier and others from Bartlett College, University of London. Space syntax theory takes "space itself" as the starting point. It proposes that there is a certain relationship between society and space in the spatial structure. As a single independent element, space analyzes the connection between architecture, society and cognitive fields [1]. According to the theory of space syntax, quantitative calculation indexes such as integration degree, connection degree and sight integration degree can be calculated to explore how spaces are organized together. Take the most typical large houses in the southeast of Jingchu as an example, calculate and analyze its accessibility and visibility.

2.1. Accessibility level
Draw the architectural plan of the traditional residential houses and abstract the plan as a combination of several convex spaces through relationship diagrams, and express the connection relationship between the convex spaces as a dot-line diagram, the convex space as a point, and the connection
relationship as a line to show that the topological structure of the dotted line graphically expresses the relationship between the spaces and the pedestrian path in the architectural space. In the Depthmap software, the rainbow color scale from red to blue is used to express the numerical value of the spatial connection relationship [2]. Calculate connectivity and integration values. Connectivity is the number of nodes connected to a certain spatial node. The higher the connectivity value, the better the spatial permeability. The degree of integration describes the degree of spatial accessibility. The higher the degree of integration, the better the spatial accessibility.

2.2. Visibility level
The plane space of the traditional residential houses is abstracted as a combination of grid points, and the wall is abstracted as a short line blocking the direct line of sight relationship between grid points. The Depthmap software is used to analyze and calculate each grid point, so as to integrate the view field integration map of the residential space.

3. Large houses in Southeast Hubei
Southeast Hubei is located in the north subtropical monsoon climate region. Heavy rains in summer make the environment hot and humid. Therefore, ventilation and drainage of residential buildings in the southeast area are very important. The traditional dwellings in southeastern Hubei are the same as most Jingchu dwellings, and they are dominated by patio-style traditional dwellings.

The important feature of large houses is "one bright and two dark", that is, there are three main rooms separated by partitions, the middle one is used as a main room for meeting guests, and the remaining two are used as study rooms or bedrooms. Add a wing room before the upper room, and add a "one light and two dark" in front of the wing room. In the middle is the upper and lower halls, and the upper and lower rooms on both sides are enclosed to form a patio, forming a space pattern of four water return halls with the patio as the center and side rooms on both sides.

traditional residential house dwellings are a common traditional dwelling form that appeared in the late Qing Dynasty. traditional residential house dwellings are often a place where a large family or even a family lives together. Traditionally, the ancestral hall will be set in the last entrance hall of the main axis, and the ancestral hall is also called the family shrine.

4. Analysis of the spatial pattern of large houses in Southeast Hubei——Taking Kejia House as an example
Kejia House is located in Jinhe Village, Mugang Town, Yangxin County, and has always been inhabited by the Ke family. The existing Kejia House is a typical representative of traditional houses in southeastern Hubei. And the unique housing unit form of row house appeared in the Ke family house. The row house is a living unit with obvious regional traditional cultural characteristics. The Kejia House was built in the late Qing Dynasty. It is composed of a courtyard with a five-bay and two-entrance patio and row houses on both sides, connected by 14 patios vertically and horizontally [3].

4.1. Accessibility level
Draw the architectural plan of the Kejia House, and illustrate the plan as a combination of several convex spaces through the relationship, transform the Kejia House’s plane space system into an interconnected relationship diagram.

Use a dotted line diagram to express the connection relationship between convex spaces, dots indicate convex spaces, short lines indicate connection relationships, and the topological relationship structure obtained by dotted lines illustrates the relationship between spaces and pedestrian paths in architectural spaces.
It can be seen from the topology diagram that the two rows of row houses are relatively independent, and are connected through two horizontal passages in the middle. The topological depth of the patio space of the two rows of row houses is relatively shallow, while the topological depth of the living units and hall spaces such as bedrooms is deeper. In the large house space, the residential buildings must pass through the patio space to reach other spaces in the room.

In the topology, the two rows of row houses are relatively independent and connected by two horizontal passages in the middle. The topological depth of the atrium patio space of the two rows of row houses is relatively shallow, and the topological depth of the living units such as bedrooms and the lobby space is deeper. In the large house space, the residential buildings must pass through the atrium patio space first to reach other indoor spaces.

By comparing the floor plan and the overall integration map, it is concluded that the spatial integration corresponds to the importance of the space on the plan. The ancestral hall in the traditional residential house dwellings is huge, and it is the most core space in the entire plane space. The other living units are allocated in order according to the traditional culture of the order of elders and children and the principle of upper left. Therefore, the ranks of ancestral halls and row houses are 27>15>34>12>8>6 from high to low. It can also be seen from the overall integration diagram that the integration degree from the middle to the two sides and from top to bottom gradually decreases. The higher the overall integration value, the higher the feasibility of the space, the easier it is to reach the space, and the easier it is to start from this space to other spaces, and the actual users of the traditional residential house have better control over the space of the traditional residential house. In traditional culture, the concept of orderly growth and orderliness has changed into differences in the right to use space.

By comparing the floor plan and the local integration map, it is concluded that the spatial integration corresponds to the importance of the space on the plan. In the short-distance depth space, the patio connecting the various functional rooms is undoubtedly the most core space, and the rest of the middle ancestral hall is the upper part. According to the distribution of people after the hierarchical system, the patio around the ancestral hall and two rows of vertical. The status of the patio next to the house is 27>15>34>12>8>6 from high to low. It can be seen from the degree of local integration that the degree of local integration from the middle to the sides and from top to bottom is gradually decreasing. The higher the degree of integration, the higher the space accessibility, the easier it is to reach, and the easier it is to reach other spaces of a certain depth from this space. Make the actual users of the traditional residential house better control the local space of the traditional residential house. The integration diagram better shows that the courtyard houses are based on the idea of harmony between man and nature. The courtyard is the center and the upper and lower halls, upper and lower rooms and wing rooms are arranged around the courtyard, forming an etiquette system where the middle is respected and the rear is inferior, reflecting the traditional residential house. The characteristics of the plane space corresponding to the actual controller and the status of the occupant in the family.
Figure 3. Overall integration. Figure 4. Local integration.

From the connection diagram, it can be found that the connections of Nos. 12, 15, 26, and 35 are higher than those of No. 6, 8, 27, and 34. Numbers 27 and 34 are the patios connecting the space of the traditional residential house ancestral hall. The spatial integration value of this area is the highest, but the connection degree is relatively low. The core part of the ancestral hall of the traditional residential house is connected to the row houses on both sides by two corridors. Obviously, this part of the regional space is not free to pass through. The corridor separates the sacred ancestral hall space from the secular living space, creating the solemn atmosphere of the ancestral hall. The patios No. 6, 8, 38, and 25 are the patios that connect the front yards of the two rows of row houses. The doors of the upper and lower houses and the wing rooms open to the patio. The patio is highly connected, and this space is not easy for occupants. This gathering, such a flat space layout limits the communication and interaction of different unit spaces. Different spaces define different active plane spaces by calculating and analyzing the numerical difference of the degree of connection, so as to restrict or allow the residents to come and go, stop and other life behaviors.

Figure 5. Connectivity graph. Figure 6. Diagram of integration and connectivity.

According to the depthmap analysis of the integration and connectivity of the Kejia House floor plan, by analyzing the data of each spatial distribution map, each convex space analysis association table is derived and sorted out.

The control value is the degree of the control value of the intersecting space. Through the data, the convex space control value of the residential unit can be obtained. From this, it can be concluded that the communication between the two rows of row houses and the surrounding rooms and patios is less, which is different from other spaces. Larger, reflecting the life etiquette system of the traditional culture of respect and inferiority.

In the data, the integration value of No. 27 and No. 34 is higher, but the value of its connection value is not high in the plane convex space. It can still be concluded that the central axis is more unique in the plane space and the system level is more prominent. It can be seen from the plan that there is not much space near the central axis, but through the patio, which is a secondary public space that connects all spaces, making the central axis more independent and prominent. It shows that the central axis has a higher level and a stronger sense of order in the plane space. Due to the gradual separation of spatial form and function, the hierarchical space is integrated from the regular public
space into a complete directional space, making the vertical order more prominent, and with the end of the Mingtang sacrificial space, a complete hierarchical activity ritual site is formed.

4.2. Visibility level

Abstract the floor plan space of the Kejia House into a number of spatial combinations, and transform the plane space system of the Kejia House into a schematic diagram composed of interconnections. The plane is abstracted as a schematic diagram of grid points, and the wall is abstracted as a line that blocks the visual relationship of each grid point. Using Depthmap software to calculate and analyze the visibility of each grid point, so as to obtain the view field integration map of the entire residential space.

![Figure 7. Schematic diagram of Kejia House.](image)

![Figure 8. Horizon integration with grille.](image)

It can be seen from the spatial view integration map of the traditional residential house dwellings that the two horizontal axes and three vertical axes have a high degree of integration. The line of sight relationship between the two rows of row houses only passes through the horizontal corridor space, and the connectivity between the row houses in the line of sight is very low, thus ensuring the privacy of life in each space. It can be seen from the figure that the patio space in the ancestral hall is open and highly visible. The patio space of the side hall is also highly visible. For each row of row houses, the lobby space is blocked by screens or doors, so the integration of the line of sight is low, blocking the sight of passing outsiders. It can be seen from the degree of integration of the horizon that the degree of integration of the horizon from the door to the front yard has been greatly increased, and the vision gradually opens up from the door to the front yard, creating a comfortable and open family public living space. From the front yard space to the central patio area and then to the backyard space, the value of the integration degree of the horizon continues to decline, reflecting that the backyard space is a private living space with strong privacy. Through the analysis of the integration of the horizon and the floor plan, the Kejia House creates an open, bright or narrow atmosphere by grasping the scale of the spatial pattern. Through the layout of screens, doors, and patios, we can grasp the line of sight between outsiders and occupants, and block the sight of male and female residents by grasping the spatial scale. The cultural theory of "giving and receiving incompatibility between men and women" is reflected in the spatial form of large houses [4].

The residential space is a relationship system composed of different spaces. This system reflects the relationship between worship and life, the owner and guests, men and women in the large houses. The residential space shows the transformation of social organization relationships, residential cultural concepts and living habits in traditional rural culture.

The above-mentioned data analysis with Kejia House as an example can reflect the cultural characteristics of traditional houses in Southeast Hubei:

Residential buildings are deeply influenced by the doctrine of "Harmony between Man and Nature" respected by Chinese feudal society. The uncertain factors of nature and the underdevelopment of science and technology of ancient people make people a gift to fully understand nature. People’s respect and awe of nature are fully reflected in large houses: for example, people set up patios in the
middle of the courtyards to make full use of the laws of natural climate. In southeastern Hubei, there are heavy rains in summer, making the environment hot and humid. The setting enables the whole building to be ventilated in all seasons, warm in winter and cool in summer. At the same time, it also solves the rainy natural environment in southeastern Hubei. The treatment method of "fertile water does not flow out of people's fields" in the rainy season reflects that people use nature and respect nature. The architectural concept of living in harmony with nature is a concrete manifestation of the theory of "harmony between man and nature".

During the Ming and Qing dynasties, the parallel residential pattern of row houses and multiple bays was widely developed, but most of the houses were the sacred space part of the backyard ancestral hall. Ancestral hall is the spiritual space of clan power, a manifestation of authority, and symbolizes clan power. The Kangxi imperial decree "Dun Xiaodi pays attention to human relations, and the clan to Zhao Yongmu" provides an authoritative reference for the importance of the ancestral hall. The spatial layout and distribution of houses in large houses reflect the concept of superiority and inferiority and hierarchy. For example, the main hall of the inner courtyard can only be occupied by people with high status or as an ancestral hall. Its accessibility and visibility are high, while the rest Clan groups are mostly distributed in residential units such as row houses. It can be seen that the concept of the lineage of distinguished respect and inferiority and orderly age is embodied in the residential space.

Most of the self-housing in rural villages are constructed spontaneously. Residents design their own houses and participate in part of the construction. They adjust the spatial structure of the houses according to the transformation of their living habits into needs. With the needs of modern life and the comfort and convenience of life, these changes in life are constantly affecting the spatial structure of residential buildings. The spatial structure not only needs to meet the requirements of modern living habits but also reflect the regional traditions. culture. The structure of space guides people's behavior and vision, and reflects regional cultural concepts and behaviors. Through the quantitative analysis of space syntax theory, the objective spatial relationship is connected with the subjective behaviors such as human behavior and line of sight, so that the traditional residential space adapts to the change of cultural customs and living habits.

5. Conclusions
The layout of the architectural space restricts people's behavior and vision, and reflects regional traditional culture. Through the quantitative analysis of space syntax theory, it is possible to link people's action range, sight range and space, so as to more intuitively reflect the influence of traditional culture in southeast Hubei on local regional architecture.

In fact, the quantitative analysis conclusions of space syntax need to be verified by combining the experience of specific venues and a large number of subjective feeling descriptions.

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