Research on Landscape Layout Configuration Generation Method Based on Public Space Accessibility Optimization

YuXin Qian and LinLin Sun(✉)

School of Art and Design, Hubei University of Technology, Wuhan, China
874473372@qq.com

Abstract. This paper takes the urban village of Jiahe Wanggang community in Guangzhou City as the research object, uses spatial topology and Depthmap digital simulation and other methods to estimate the activity space of residential population in the small area, discusses the accessibility of residential population in the process of urban village transformation, then proposes the idea of improving the frequency of site use, compares the nodes with the spatial combination elements and road network distance that affect spatial accessibility as an example We analyze the existing community cases, construct the residents' behavioral paths and spatial accessibility networks, screen the site accessibility data consistent with residents' behavioral habits through spatial syntax and topological structure generation analysis, and judge the spatial accessibility of public spaces with quantitative indexes, based on which, we propose corresponding renewal design strategies for specific spaces.

Keywords: Urban Village · Space · Accessibility · Renewal · Generative Design · Practice

1 Introduction

This paper comes from an experimental project in an urban village. In the study of the relationship between spatial pattern and accessibility of the square in front of the ancestral hall, we try to use the spatial syntax numerical technique. Accessibility" of public space is a measure of the extent to which residents have easy access to public space resources, focusing on the potential of people to reach spatial activity points, i.e. its broad concept covers the influence of various factors such as residents' wishes, transportation costs and spatial characteristics. This is also a literature study at the empirical level of landscape layout configuration, which focuses on the accessibility of public space, i.e., the micro accessibility of space is judged from the behavioral habits of residents to the expression of quantitative indicators [1]. This study focuses on micro accessibility, and only studies the main spatial nodes within the enclosed area of the ancestral hall front square of Wanggang community at the community micro scale, and the results require relative accuracy. Therefore, especially at the level of public space accessibility, we import and

K. Subramanian et al. (Eds.): CTMCD 2022, ACSR 99, pp. 196–206, 2023.
https://doi.org/10.2991/978-94-6463-046-6_24

analyze with the help of spatial Depthmap software, and combine with spatial syntactic relationship diagrams and other methods to describe the configuration of the site space, so as to explore the various factors affecting accessibility. In the selection of the research sample, we believe that: firstly, it is representative; secondly, it is located in the center of Guangzhou; thirdly, it has a long history and can better reflect the urban history of Guangzhou. Based on the above three points, we chose Wanggang community as our research sample.

2 Materials and Methods

Wanggang community is located in Wanggang Street, Baiyun District, Guangzhou, covering an area of about 1000 square meters (see Fig. 1). The public square is located in front of the Li's Great Ancestral Hall, which is also the central part of the plot that serves as the public space for this study. The plaza is adjacent to the pond and the ancestral hall, and is a necessary route to the main road of the community, forming two landscape axes, horizontal and vertical. Most of the existing studies on public space accessibility focus on macro and meso levels, studying the accessibility of urban services such as green areas, parks and medical facilities, proposing evaluation methods such as mechanistic and empirical models, focusing on elements such as traffic distance and spatial attractiveness, analyzing the influence of location conditions on spatial accessibility, and there are fewer studies on the accessibility of public space in settlements from micro perspectives.

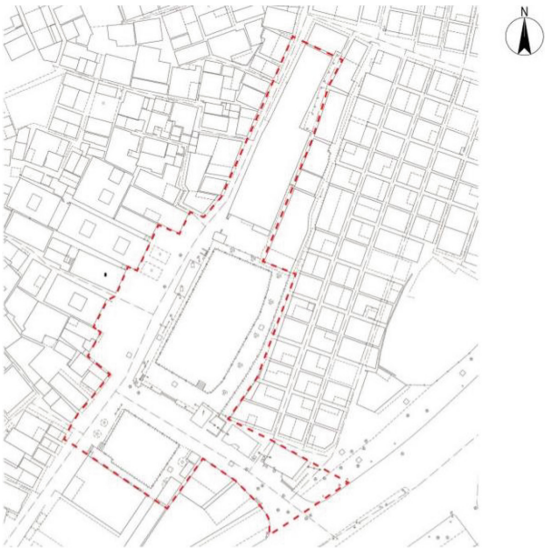

Fig. 1. Plan of Wanggang Community.

3 Results and Discussion

Detailed research on the layout of public space and residents' behavior network in selected communities, using the behavior network as the basis for accessibility evaluation, and fitting and analyzing with the public space element network to derive empirical rules and corresponding parameter data, can be used as the basis for community public space transformation. There are many spatial characteristics that affect the accessibility of public space, including distance of road network, number of paths, sight lines and pedestrian flow lines, etc. To measure the accessibility of space, a comprehensive evaluation of all of the above is needed [6]. Due to the limitation of space, this paper only takes the two spatial elements of "spatial field of view" and "number of paths simulation" as examples, uses spatial syntax and topological structure analysis to construct residents' behavioral paths, analyzes the fitting relationship between residents' behaviors and public space layout, and analyzes the micro accessibility of community public space. We also studied the micro accessibility of community public space.

The research can be divided into the following steps: *A.* research the selected range of old communities, draw a public space network map, this map can reflect the planning layout, area and flow relationship of public space in the community; *B.* research the topological relationship of public space of residents in the community, visually describe the configuration of space, through the network topology, reflect the current situation of public space accessibility in the settlement; *C.* for the community public, To further construct a spatial network for the accessibility elements of the community public space, the spatial sentence method is chosen here to simulate the spatial integration of the parameter data of the behavioral network, and to quantitatively evaluate the accessibility of the public square in Wanggang community by using the line segment model method after the verification of the axial model; *4)* Based on the results of this fitting analysis, the public space with poor accessibility under the influence of the distance of the road network is screened, and the corresponding optimization design strategy is proposed. Since the description is rather abstract, the following case of Guangzhou Jiahe Wanggang Community Public Square is selected for detailed analysis.

3.1 Case Space Network Construction

In this paper, the Wanggang community square is investigated as shown in Fig. 2. The general plan consists of each node around 1 public community square, and only the stopping spaces mainly used for residents' activities related to the research content are counted in the paper. The main body of the residential building does not belong to the category of community public space (except for the overhead floor), and since the behavioral path of residents usually starts or ends at the residential building, it is numbered in the network and included in the network of residents' behaviors together, without analyzing its network parameters. Most of the community public spaces analyzed in the study are stopping spaces, so residents who produce effective stays within the limited space during the research process are counted in the scope of the study, and the effective stay length is defined as 10 min based on the preliminary research, and using the stopping space $\geq$1 times is considered as an effective stay [2] (Table 1).

Table 1. Statistical table of the number of public squares and surrounding residences in Wanggang Community

Community space constitutes a unit	*Public space name*	*Amount*	*Remarks*
public square	Fitness facilities area	One, number A1	Fitness facilities, seats
	Pond	One, number A2	
	Rest space	Two, numbered A3 and A4	Seat (near pond)
	Residential building	4 houses, numbered A1, A2, A3 and A4	
	Ancestral hall	Three, numbered A5, A6 and A7	

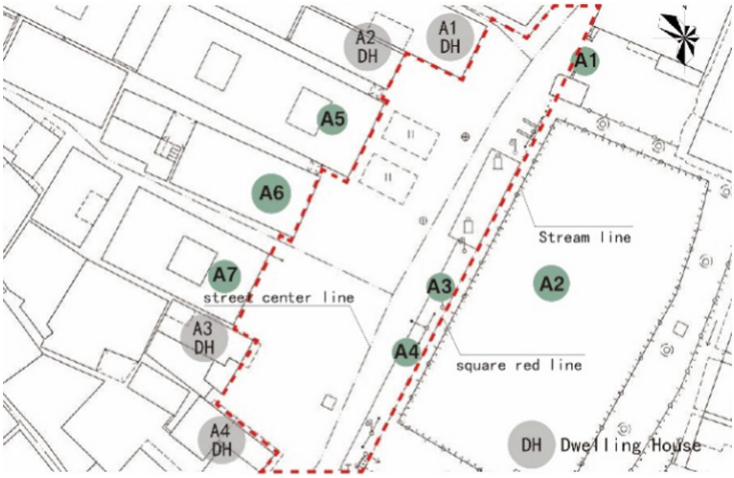

Fig. 2. Distribution of public space and housing in Wanggang Community Square.

3.2 Node and Connection Pattern Study

Topological relations of space are a way to study the nature of space. Drawing on the method of mathematical topology, the conformation of space is visually described in the form of a relational diagram. The conformation diagram represents the relationship between convex space and path axes without the need to represent the actual form of buildings or landscape structures. Therefore, it is necessary to further optimize the CAD planes of community public squares [5]. This study reduces the dimensionality, simplifies the node classification, and summarizes four types of nodes from the diagram itself. Public squares do not exist independently of the urban environment, and their structure is constrained by a combination of urban resources, spatial vision, and other factors: the first step of the study is to analyze the history and traffic of the site from

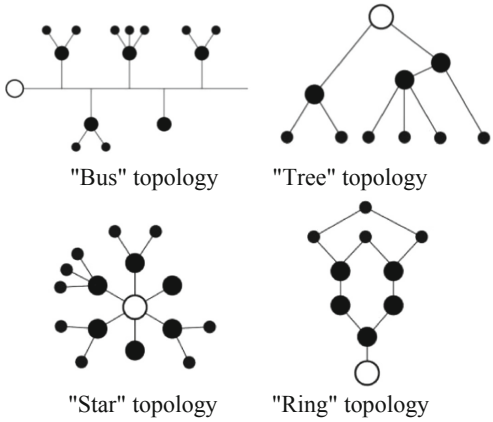

Fig. 3. Node connection structure.

a landscape perspective, and to clarify its interface nodes with the external urban and internal reserved building nodes. In order to delineate the spatial hierarchy of the site and form a clear spatial structure, it is necessary to analyze and classify the new landscape nodes as the basic elements of the physical space, and divide them into structural element nodes and filler element nodes [3] (as in Fig. 3).

3.3 Accessibility Integration of Space

People travel in a certain line when they are enjoying a tour, and the accessibility of the space during the tour allows us to interconnect the different nodes in the complex spatial structure, where the crowd or business arrives to be able to carry out the activities that are more important to them. In the line segment model of spatial syntax, integration (I) is considered to be the most effective metric for quantifying accessibility. Integration is the degree of dispersion of a unit space from other spaces in the system under a certain radius. A larger value of integration means that the space has a higher potential to be reached in the system, reflecting that the space is in a more convenient location in the system; on the contrary, it has less potential and is in an inconvenient location. By calculating the constructed line segment model in DepthmapX, the brighter the color of the line segment, the higher the integration degree and the stronger its accessibility. Based on the aforementioned, we import the geometric model of Wanggang community public square into Depthmap to calculate the graphical results as Fig. 4 and Fig. 5. Figure 4 is the line segment illustration of the feasible layer. The yellow and green lines represent the area with better accessibility, while the blue and cyan lines represent the area with weaker accessibility, i.e. the center of the site with better accessibility. Figure 3 is the illustration of visual layer, yellow, yellow-green and orange areas indicate that these areas have good spatial accessibility, so the results calculated by Depthmap show that the spatial accessibility of the public area in front of the Li Ancestral Hall and the south side near the pond is better to attract tourists to visit the end of the square through the pond, which is also a reasonable way to show that the square is a major node in the

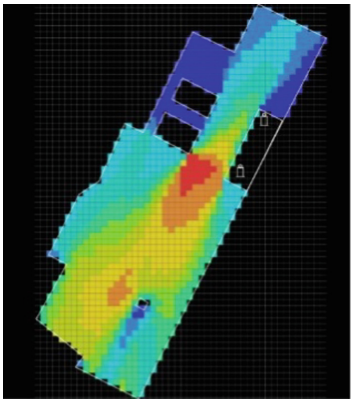

Fig. 4. Illustration of line segment of visual layer.

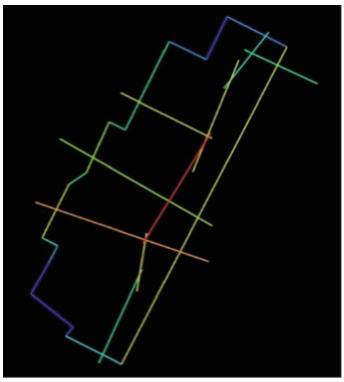

Fig. 5. Illustration of line segment of feasible layer.

overall plot of Wanggang community. This treatment enhances the visitors' perception of the depth of space and stimulates their interest in exploring the ancestral hall.

3.4 Optimization of Design Strategies

Based on the above discussion, corresponding design strategies should be adopted in the transformation of public spaces with low accessibility to residents' behavioral networks:

3.4.1 The Newly Designed Public Spaces are Specifically Integrated Between the Spaces

Specific integration of the newly designed public space between spaces as a pause or buffer effectively shortens the path distance between nodes. For example, adding nodes Z1, Z2 and Z3 (as in Fig. 6) to the plaza can significantly shorten the path distance between nodes A5, A6, A7 and node Z1, thus increasing the accessibility of the plaza public space and bringing vitality to the site.

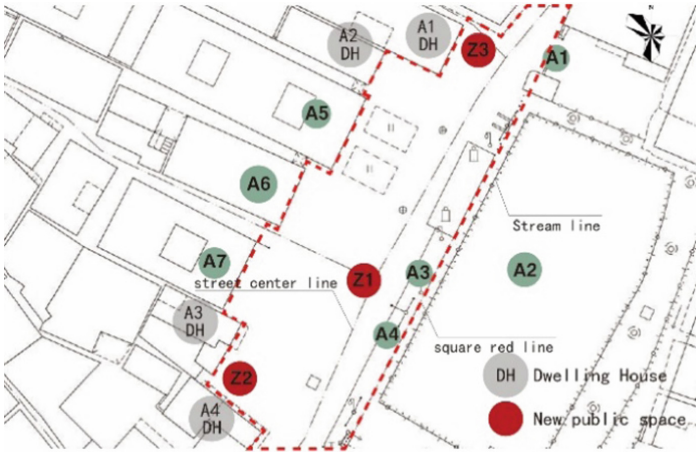

Fig. 6. Schematic diagram of public space optimization design of Wanggang Community Plaza.

3.4.2 The Space with Lower Centrality is Transformed and Integrated with the Surrounding Space with Higher Centrality

Transform and integrate the spaces with low centrality with the peripheral spaces with high centrality to clarify their spatial functions and serve as an effective supplement to the spaces with high centrality, making them more in line with the behavioral habits and usage needs of the surrounding residents. Or install recreational facilities in spaces with low accessibility to increase the possibility of outdoor recreation for residents. For example, Wanggang community recreation facilities are highly concentrated and belong to the public space of "demand exceeds supply". The space with low centrality and ambiguous surrounding functions can be transformed into ornamental recreation space or cultural display area. For example, A3 and A4 can be integrated into Z1 leisure and viewing area, and A1 can be integrated into Z3 cultural display area, so as to achieve efficient use of space through functional conversion.

3.4.3 Strengthen the Connection Between the Group and the Space Inside the Group

No nodes were set in the original plaza site due to cost saving of Wanggang community, which weakened the accessibility of the space within the group to connect with the external shrine. Consideration can be given to opening Z1, Z2 and Z3 (as in Fig. 6) to improve the accessibility of public spaces within the group and avoid the problem of long paths from certain spaces within the group to other spaces outside.

3.5 Generating Design Practice

The design is divided into the following levels: plot block division, public square layout configuration generation within the block, building block generation, block road system establishment, and landscape design along the lake. This paper explores the practical nature of the design by starting from the topological configuration of the landscape layout of the divided community-scale plots, so as to form a well-connected spatial form and achieve a good degree of internal access to the neighbourhood [7].

3.5.1 Block Node Setting

The reserved landscape nodes are determined by the designer according to the style of the square and the current situation of the site. The entrance node of the shrine is the focal point of communication between the neighborhood and the external spatial environment. The central node of the public plaza helps to enhance the overall vitality of the Wanggang community and attracts people in transit. It can be seen not only as a regional interchange hub, but also as a "first impression" of the neighborhood's spatial perception and a turning point that connects the experience of the Wanggang community. The new node in the rest area can also activate site-specific functions and bring life to the plaza.

3.5.2 Landscape Layout Topological Configuration Generation

Before the program starts, a global total depth value target for the mapping should be preset, which comes from the designer's understanding of urban space and depth value theory. The program is constantly refreshed and traversed, so that the overall depth value of the square tends to decrease continuously. If the pre-set global total depth value target is reached, the system will pause. If the target is not reached, each intelligent body will continue to move according to the rules, and after a continuous cycle, its value will eventually stabilize within the preset range, thus achieving a better topological configuration [3].

3.5.3 Final Plaza Design Results

Based on the topology of the landscape layout, the public space is formed by combining the nature of the neighborhood and the view of the plaza with the corresponding landscape elements. How to map the "lines" in the landscape topology to the relationship between specific buildings? The study adopts the following specific practices as examples (Paradigm) (as in Fig. 7), including the guidance of traffic connection between community plots, accessibility of plazas, interconnection of landscape nodes, etc. Based on the examples, further deformation and optimization can be done, combining the accessibility of space, retaining the reasonable landscape patterns in the original site after analysis, and adding new landscape patterns to the design. The existence of the example ensures the coexistence of the overall organic and local richness (as in Fig. 8).

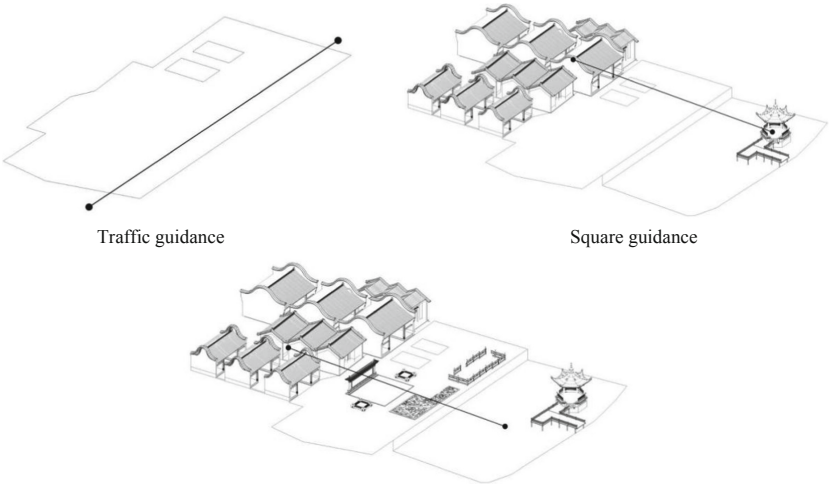

Fig. 7. Operation Paradigm.

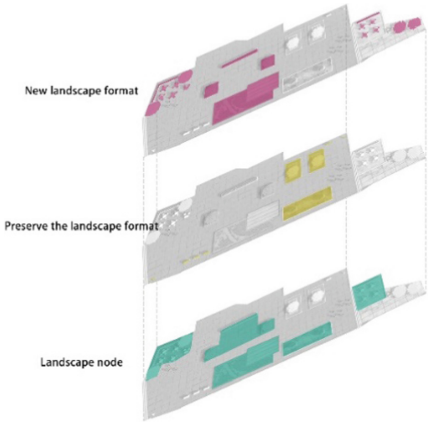

Fig. 8. Axonometric design results

4 Conclusions

This paper analyzes the correlation between the two on the basis of residents' behavior and transcreation of spatial accessibility with topological structure and spatial syntax, explores the layout design reasons that lead to the differentiation of community public space use, provides design basis for community optimization and transformation, makes the environment closer to the actual needs of residents, makes community public space continuously improve and develop benignly in the process of use, and promotes harmonious with high-quality living space The high quality of living space promotes harmonious social interaction and active social activities, and guides residents to develop

a healthy and sustainable lifestyle. There are many factors that affect the accessibility of space, and a comprehensive consideration is needed to present its objective laws in a more scientific way. [4] The study shows that the accessibility of crowds is higher at the center of public squares, and the setting of central nodes provides the necessary conditions for the reasonable use of spatial depth in relatively small public spaces, reflecting the reasonable use of accessibility; the spatial topological relationship between buildings and nodes explains the influence of the hierarchy of spatial sequence of landscape layout on spatial depth, and indicates the behavioral, perceptual cueing, and guiding role of landscape layout arrangement in touring; the results calculated by Depthmap further show that the spatial accessibility of public plazas is not only the most important factor, but also the most important factor. The results calculated by Depthmap further prove the correlation basis of spatial accessibility integration and daily activity behavior, reflecting the design approach of "space at hand" [5]. The quantitative fitting analysis of the planned spatial layout and residents' behavior provides a scientific method to improve the accessibility of community public space, which can promote the positive development of space in the process of use and provide conditions for residents to develop a healthy lifestyle.

References

1. Chen, Y X. Li, Q. Liu, XZ, Lin, SN. Lian, XX. (2021) Accessibility of campus Public space based on space syntax: A case study of Fujian Agriculture and Forestry University. Sichuan construction, 41(03):49-53.
2. Guo, Y. Zheng, W.(2016)An association model between intelligent landscape network topology and ornamental efficiency. Journal of Shenyang University of Technology,38(06):686-691.
3. Li, JY. Tang, F. (2021). Research on generation method of architectural layout based on Accessibility optimization: A case study of urban design of Huai'an Li Canal[C].Wisdom Building the Future -- The 2021 National Architecture Department architecture digital Technology Teaching and Research Symposium proceedings,2021:246–255.
4. Mo, SJ. (2019)Large community neighborhood space landscape design. Building science, 35(09):149-150.
5. Yang, XJ. Liu, XY. Ye, J. (2021) Research and practice of landscape Architecture from the perspective of topology. Urban construction,18(14):157–160.
6. Yang, XL. Wang, XF. (2021) Accessibility of community Public Space based on behavioral network and road network distance fitting analysis: A case study of Xinghewan Community in Guangzhou. Modern Urban Studies,2021(04):11-17.
7. Zhang, YY. Sun, YT. Yao, CH. (2019) Application of spatial syntax in accessibility of urban parks: A case study of urban parks in Wuhan's Third Ring Road, Chinese garden,35(11):92–96.