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Research on Urban Ancient Street Planning and Design Based on Digital Landscape Technology: A Case Study of Rulinli Ancient Street

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Abstract: *As a traditional architectural heritage, urban ancient streets contain profound cultural value. This article is based on the concept of urban modernization development, taking the landscape planning and design of Rulinli Ancient Street in Jizhou District, Ji'an City, Jiangxi Province, China as an example, and combining digital technology to summarize and analyze the common problems in landscape planning of urban ancient streets. Starting from the three elements of building height planning, public service system layout, and green plant system coupling, this paper explores the landscape planning strategy of urban ancient streets under digital technology, in order to provide reference for improving the urban ancient street environmental planning system.*

Keywords: *Digital Landscape Technology; Urban Ancient Streets; Environmental Planning and Design; Space Reconstruction*

1. Introduction

From July 15 to July 18, 2024, the report of the Third Plenary Session of the 20th Central Committee pointed out that all regions need to comprehensively promote the development of the digital economy and promote digital transformation. Applying intelligent and digital technologies to urban infrastructure renovation, architectural planning, and landscape design is an important means of optimizing public services and promoting modernization of urban governance. Based on this, how to achieve organic reconstruction and promote the revitalization of ancient street spaces through digital landscape technology, as urban architectural sites, has become an important issue in the modernization construction of cities in China. Domestic research focuses on using intelligent and digital technologies to achieve spatial reconstruction from a macro perspective, neglecting the social relationship network between ancient streets, micro spaces, and landscape environments. Therefore, innovation should be made in the design perspective of urban architectural sites, and digital landscape design methods should be applied to the planning of urban facilities in detail. Micro design and planning should be carried out in order to truly unleash the value of digital landscape theory and technology in urban ancient street environmental planning and design, and promote the process of smart cities and urban modernization.

This article plans and designs the infrastructure, small landscapes, and micro spaces of urban ancient streets based on micro design concepts from the perspective of innovative digital landscape design. Specific digital landscape technologies are analyzed in order to form a comprehensive method for constructing an urban ancient street environmental planning system.

2. Overview of Digital Landscape Technology

In the context of landscape design research, "digital landscape" is a general term for a type of landscape and spatial concept that utilizes digital technology to perceive environmental changes and promote interaction. Parametric design and responsive design are both digital design methods derived from information technology, which can be used to convey the dynamic meaning of spatial locations to users and deepen their understanding of the ecological connotation of landscapes. Digital landscape technology "uses digital technology as a medium and responsiveness as an important organizational approach. Designers translate complex and difficult to perceive environmental information into tangible physical spaces by completing the translation process from "data" to "landscape". This innovation in urban design concepts and methods can transform the previously passive "meaningless" blank land left by neighborhoods into a cultural landscape system with hydrological and ecological processes, functions,

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and structures [1], as shown in Table 1.

The research on digital landscape theory in urban planning and design abroad mainly starts from the perspective of macro urban planning. With the help of digital landscape design practice, it is confirmed that digital technology can be used as a universal technical means in landscape design, integrating design, architecture, geography, mathematics and other disciplines to carry out urban landscape planning and design. The research methods tend to analyze the application of specific or certain digital technologies in macro urban space. However, domestic regions emphasize the use of diverse digital technologies for macro planning of urban landscapes while ensuring the rationality, ecology, and spatial accessibility of urban landscape planning. The research results mainly focus on the urban landscape planning path and design methodology under the digital landscape theory. There is a lack of research on the micro scale urban digital landscape in both domestic and foreign regions, especially in terms of landscape research on urban architectural sites and old neighborhoods. The digital landscape design system for urban ancient streets is not yet perfect.

Table 1: Overview of Digital Landscape Theory Research

esearch field	time	author	subject	research contents
Digital Landscape	1998	Tomasula	Bytes and Zeitgeist: Digitizing the Cultural Landscape	Explored how digital transformation affects cultural and artistic expression in interactive environments.
Electronic Landscape	2000	Pettifer	Exploring electronic landscapes: technology and methodology	Studied the concept of electronic landscape as a virtual environment that integrates information and social dimensions.
Digital Landscape Technology	2007	Shinozaki	Digital Platform for Collaborative Urban Landscape Design	Google Earth as a tool for collaborative city design
GIS digital landscape technology	2014	STEFFEN NIJHUIS	Applications of GIS in landscape design research	The Application of GIS in Landscape Management
Digital Design	2017	Yangliu	Preliminary Exploration of Landscape Space Installation Design Method Based on Digital Tools	Examine the integration of digital software tools in various stages of landscape design.
The Value of Urban Digital Landscape	2018	Ginzarly	Mapping historic urban landscape values through social media	Emphasis was placed on spatial data mining techniques for analyzing digital landscapes, with a focus on automation and model construction.
Digital Creative Design	2019	Bruno	CREATIVITY 4.0. EMPOWERING CREATIVITY IN THE DIGITAL ERA	Explore how to integrate digital media into landscape design education to enhance creativity.
Parametric design	2023	Liu Zhe	Research on Parameterized Design of Spatial Structure of Near Natural Forest Landscape	Emphasis was placed on the application of parametric design in optimizing building performance and functionality.

3. Landscape Planning Issues of Urban Ancient Streets

3.1 Driving problem of landscape facilities in ancient streets

3.1.1 Building height control issues

In urban environments, the combination of spatial symbols and spatial arrangement forms a unique regional spatial context and architectural style of a city, reflected in three major levels: urban pattern, architectural clusters, and landmark landscapes. These spatial elements are closely related to building height [2]. The phenomenon of high-density development of urban buildings is quite common. Although the existing layout of urban buildings has little impact on the functionality of building clusters or open spaces, there are still issues with the height design of some urban building clusters in terms of facade layout. Due to the excessive density of high-rise buildings and imbalanced building proportions, it seriously affects the lighting, ventilation, and landscape effects of low rise buildings [3]. As a standard low rise urban building, the architectural function of urban ancient streets is also influenced by high-rise buildings, as shown in Figure 1. The layout of urban buildings in the figure is a typical embracing layout,

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where high-rise buildings form enclosed spaces around the low rise buildings, which destroys the landscape sharing of the enclosed low rise buildings (i.e. the central ancient street building). The viewing line between the peripheral space and the central low rise buildings is severely obstructed, which is not conducive to showcasing the unique architectural landscape of urban ancient streets.

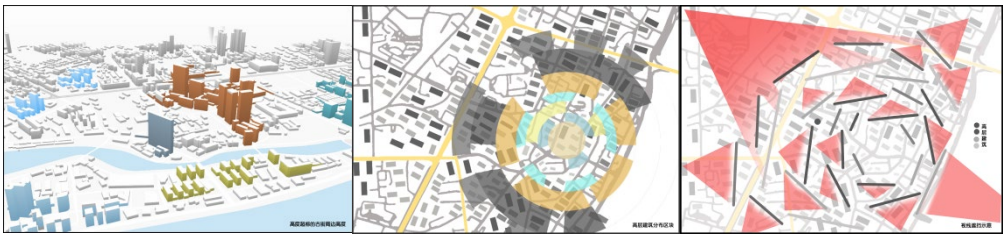
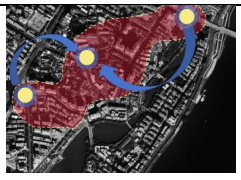


Figure 1: The height conflict between ancient streets and urban buildings (Image source: self-made by the author)

3.1.2 Conflicts in the operation of public service systems

From the perspective of the architectural properties of urban ancient streets, due to the fact that most cultural ancient buildings belong to reconstructed buildings (i.e. modern architectural complexes that have undergone significant renovations and updates while preserving the basic structure of the buildings), the adaptability of the buildings themselves to the public service system is insufficient, resulting in functional conflicts between some public service facilities during operation [4]. For example, the environmental protection system and the public transportation system are the two core systems of the public service system, and there are functional conflicts between the greening engineering and waste treatment facilities in the environmental protection system and the traffic arteries and models in the public transportation system. As shown in Table 2, the data in the table are conflict indices based on the MDCA model and statistics around the environmental protection system and public transportation system of Rulinli Ancient Street. The data in the table shows that there are functional conflicts between multiple environmental protection systems and their operating facilities distributed in the area, and each conflict index is in the index range of "4-6 points". The measured performance difference between the environmental protection system and the public transportation system is very significant, reflecting significant conflicts in the operation of public service systems.

Table 2: Internal Conflicts in the Public Service System of Ancient Streets

classification	Functional area	Impact conditions of public transportation system	Conflict index
landscape engineering		Public transportation facilities occupy urban green space and damage existing ecological habitats; Generate noise and air pollution; Soil disturbance leads to soil erosion and vegetation degradation.	6.525
Waste treatment facilities		Traffic congestion or inadequate transportation network leading to delays in waste transportation; Poor coverage of public transportation routes and insufficient accessibility of waste disposal facilities.	5.175
Ecological restoration facilities		Large scale transportation facilities divide ecological restoration areas into small blocks, leading to habitat fragmentation; Transportation facilities such as roads and rails have damaged the connectivity of ecological restoration areas.	4.65

3.1.3 Lack of rationality in the placement of green plant systems

The green plants along the ancient street in Rulin are mainly camphor trees, followed by subtropical vegetation such as ginkgo trees, red maple trees, oleander trees, and banyan trees. The green plants in this area are mainly distributed along the Houhe River, Zhongshan Road, and both sides of Houhe Road. The coverage of green plants in the ancient street is relatively small, with few low and short shrubs such as

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forsythia and paulownia trees, and few large green plants such as broad-leaved trees in the entire area. On the one hand, the placement of green plants in the ancient street lacks rationality, and there is a phenomenon of artificial crossing of multiple shrub belts in the leisure area, indicating that the layout of shrub belts to some extent affects the normal passage of pedestrians. On the other hand, although the ancient street buildings in Rulin are low rise buildings, their heights are generally between 6m and 17m, which has a certain impact on the lighting of the green plants in the space. For example, the solar altitude angle in the region is 39.45 °~86.33 °. From December to May, some plants with an altitude below 3m cannot receive effective light; However, from June to October, the sun elevation angle in the ancient street area is relatively high, and small green plants cannot be used to block sunlight, which is not conducive to realizing the value of the green plant system.

3.1.4 Application of Digital Landscape Technology in Ancient Street Landscape Planning and Design

The landscape planning of urban ancient streets now needs to address issues such as complex surrounding buildings, lack of systematic public service facilities, and fragmented layout of green plant systems. Digital landscape technology can calculate the height of buildings, analyze the relationship between landscape viewpoints and the line of sight of ancient street buildings, clarify the location of high-rise buildings with line of sight obstruction, and determine the optimal design height of high-rise buildings within the line of sight [5]; By analyzing the concentration of the population and the impact range of the public service system, the optimal design points for various public service facilities can be calculated based on meeting the needs of the population for the use of the public service system; By using digital modeling technology, analyze the landscape benefit coefficient corresponding to the location of green plants, select the green plant location scheme with the highest landscape benefit coefficient for planning and design, and ensure the functionality of the green plant system.

3.2 Plot analysis

Rulinli Ancient Street is located in Cangkou Community, Wenshan Street, Jizhou District, covering an area of about 20000 square meters. Under the influence of the Cangkou shantytown renovation and Rulinli characteristic ancient street project in July 2012, Rulinli Ancient Street has transformed from a cultural and historical block to a block that integrates commerce, leisure, and sightseeing. Based on the concept of digital landscape, the landscape renovation of Rulinli Ancient Street needs to address the current problems of low efficiency in the use of environmental infrastructure and insufficient urban resilience, as well as the practical problem of insufficient environmental services in the ancient street.

3.3 Building height planning and design

Table 3: Building Height Design for Each Visual Area

Viewpoint position	Sight distance (m)	latitude	longitude	Average visual line height (m)	Maximum building height (m)
riverside promenade	1284.68	27°0601"N	114°5955"E	45.59	48.32
Xinhe New City	159.94	27°0608"N	114°5911"E	41.97	46.51
Yonggu Lane	925.09	27°0553"N	114°5905"E	40.36	46.51
Jinggangshan Avenue	1201.37	27°0630"N	114°5854"E	45.37	52.82
Renshanping Park	456.71	27°0626"N	114°5905"E	42.88	54.44
Baohua New City	418.01	27°0630"N	114°5912"E	40.05	47.28
Yangming East Road	624.91	27°0639"N	114°5912"E	43.67	53.27

The theory of landscape patching holds that the layout of old city buildings and streets has the characteristics of freedom, looseness, and broken texture. Urban architectural development should strive to organically combine historical and cultural elements with historical value, so that material and non-material elements with cultural and historical value can better reflect their own characteristics [6]. In the construction of urban ancient streets, it is necessary to reasonably regulate the height of ancient street buildings to maximize the expression of the street's style, in order to stimulate the vitality of the urban

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ancient street's architectural landscape. Therefore, at present, based on the layout position of the main viewpoints around the ancient street in Rulin, a network of viewpoint axes should be established between the landscape viewpoints and the buildings in the ancient street, to control the individual buildings between the viewpoint points and the landscape viewpoints from crossing the landscape viewpoint axis, in order to protect the landscape sharing of the ancient street in Rulin. Regarding the viewpoint area covered by the Rulinli Ancient Street viewpoint circle, the study focuses on Binjiang Avenue (viewpoint angle 0 °~120 °), Xinhe New City (viewpoint angle 120 °~157 °), Yonggu Lane (viewpoint angle 157 °~184 °), Gunan Avenue (viewpoint angle 184 °~197 °), Jinggangshan Avenue (viewpoint angle 197 °~248 °), Renshanping Park (viewpoint angle 248 °~265 °), Baohua New City (viewpoint angle 265 °~300 °), and Yangming East Road (viewpoint angle 300 °~360 °). Based on low impact development design, the building height planning data is designed as shown in Table 3.

3.4 Design of Ancient Street Public Service System

The development vision of the community public service system is to build an ideal community that is fair, democratic, diverse, inclusive, and sustainable. In order to ensure the applicability of the urban ancient street public service system, the service system should adopt systematic design, relying on the 15-minute urban design theory, organically integrating the residential system, leisure system, learning system, and elderly care system in the public service system, and constructing a complete public service system unit. As shown in Figure 2, the transformation form of the public service system in Rulinli Ancient Street is depicted. The functions of the (medical and health, education services), cultural and leisure service system, and environmental protection service system in the ancient street can cover the entire area, enabling residents or tourists in the ancient street to receive the basic public services they need within 15 minutes, ensuring that the functional community of the ancient street is fully functional.

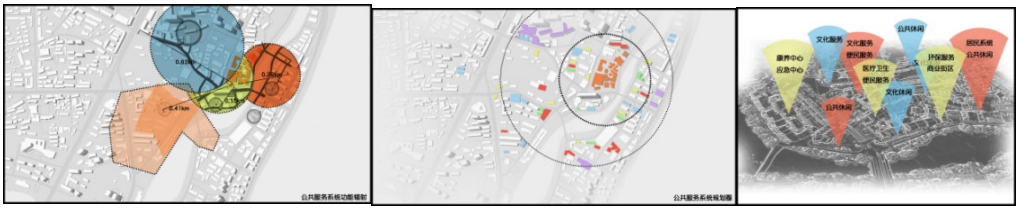

Figure 2: Layout design of public service system

3.5 Green plant system design

In the vertical greening follow-up design of Rulinli Ancient Street, the greening configuration needs to consider ecological benefits, aesthetics, and maintenance costs [7]. In the study, "vertical greening planting height" was used as the independent variable, and the ANOVA statistical model under digital landscape technology was used to calculate and analyze the landscape benefit index *Eh* corresponding to different design heights of vertical greening in Rulinli Ancient Street. The model experiment results showed that when the design height of vertical greening was 3.2m, the landscape benefits were most prominent, and when the vertical greening height was 2.0m, the ecological benefits of green plants were better. Therefore, As shown in Figure 3，the landscape greening system of Rulin Li Ancient Street can adopt vertical greening to follow the original spatial conditions, and based on the optimal greening design height, adopt a multi distributed greening layout to optimize the operation effect of the greening system.

Figure 3: Placement strategy of green plant system

4. Conclusion

This article takes Rulinli Ancient Street in Jizhou District, Ji'an City, Jiangxi Province, China as an example. Through case analysis and theoretical research, a digital landscape theory based urban ancient

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street landscape planning path is constructed, providing innovative guidance methods for the utilization of public environmental resources and the standardized governance of community landscapes. The renovation design of the ancient street landscape in this article is influenced by factors such as the accuracy of literature and the number of design samples. The sociality and adaptability of design theories and strategies will also be affected to some extent. Therefore, future research will further explore landscape space design methods based on optimizing public services and promoting modernization of urban governance, combining digital landscape technology, responsive design technology, and parametric design technology to create a more comprehensive environmental planning system.

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