

# Application Strategies of Spatial Refinement Design in Ancient Cities Supported by Digital Technology—Zhaoyu Ancient City in Qixian County as an Example

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Digital technology provides a method of quantitative investigation and data analysis for contemporary landscape spatial analysis, and related research is moving from image recognition to digital algorithmic analysis, providing a more scientific and macroscopic way of research. The key to refinement design is to refine the spatial design process and the spatial improvement strategy system. Taking the ancient city of Zhaoyu in Qixian County, Shanxi Province as an example, (1) based on obtaining the integrated data of the ancient city through the drone tilt photography, the style and landscape of the ancient city are modeled; (2) the point cloud data with spatial information is imported into the point cloud analysis platform and the data analysis is carried out from the overall macroscopic style of the ancient city to the refinement level, which results in the formation of a more intuitive landscape design scheme, thus improving the precision and practicability of the landscape design; (3) Based on spatial big data, it starts from the spatial aggregation level, spatial distribution characteristics and other evaluation index system to achieve the refinement analysis of the site. Digital technology and methods are used throughout the process to explore the refined design path.

*Keywords:* digital technology, Zhaoyu Ancient City, tilt photography, point cloud data

## Introduction

With the continuous improvement of urban construction requirements for landscape design, the current conditions of landscape design sites are constantly complex. The traditional way of obtaining topographic information has problems such as long periods, high cost and limited information. Nowadays, with the development of digital city technology, a large number of new technologies and new platforms have emerged. In the related fields of architecture and urban and rural planning, the use of digital technology has penetrated into all

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aspects of the disciplinary industry. The level of technical application is constantly expanding. However, compared with architecture, surveying and mapping and other fields, the application of information technology in the field of landscape design is relatively insufficient. In the landscape preliminary planning and design work, must rely on the status quo topography, building features location, space size-related information as the basis, so the accuracy and clarity of the preliminary site information, determines the final design drawings and the degree of organic combination of the site. Digital technology for terrain and landscape research has become the focus of smart city technology research, the landscape industry has an important reference significance. In summary, the existing research on the refinement design path of ancient city space lacks relatively sufficient exploration, therefore, this paper aims at the practicability of refinement design, takes the small and medium scale landscape garden space as the research object, with the help of the current more cutting-edge digital technology methods, through the fusion of multi-methods and multi-platform and collaboration, and comprehensively applies the spatial information collection technology, and the spatial data analysis platform to explore the fine design path of landscape garden space. At the same time, the feasibility of the method is verified with design cases.

### **Overview of Research and Application of Digital Design Tools**

Since the amount of model data constructed based on inclined photography is generally large, the tools that support model browsing and management are mainly based on GIS platforms, such as SuperMap, Citymaker and LiDAR360, which are independently developed by our country, as well as foreign software such as TerraSolid, CloudCompare and ENVI LiDAR, which are based on GIS platforms. software.

Digital means in landscape design are more often used in terrain analysis and large-scale site space pattern analysis, such as Wang Yijing's comprehensive use of spatial information collection technology, spatial data calculation platform, data statistical analysis methods and spatial simulation construction technology, digital technology and methods throughout the whole process, to explore the design path of the refinement of landscape garden space. Wang Liangliang uses digital technology to classify and extract the landscape of traditional villages, and quantitatively analyze them from macro to micro, and summarize the method of a landscape analysis of traditional villages based on digital technology. Fan Yong used multi-source remote sensing data to analyze the process of urban expansion in the Huaihe River Basin during the 16 years from 1998 to 2013.

### **Site Overview**

#### **Presentation of Cases**

Qixian is located in the central part of Shanxi Province, bordering Pingyao and Taigu counties, and is regarded as one of the hometowns of Shanxi merchants. "Qixian" was originally an ancient lake in the Taiyuan Basin, and the word "Qi" means vast waters. Zhaoyu ancient city was built in the Northern Wei Dynasty, more than 1500 years ago, and the Jinzhong Basin remains one of the oldest counties. The ancient city is located in the center of the current main city of Qixian, with a circumference of about 3km and an area of 56.99 hectares, and was listed as a nationally famous historical and cultural city in 1994. The entire ancient city has more than a thousand ancient houses, with more than 20,000 houses of Ming and Qing architectural styles, the most prominent of which are Shanxi merchants' compounds, and more than 170 ancient merchant shops, making it one of the best surviving Ming and Qing ancient cities in China that still has inhabitants.

As an ancient city that still retains its residential function, Zhaoyu Ancient City now has a resident population of more than 5,600. The overall living conditions are backward, with no unified municipal heating and water treatment system, aging sanitation facilities and electrical circuits, and a lack of green space and open space, the historical buildings are in poor condition. Many residents with the means to do so have moved out, and the residents of the ancient city are now mainly low-income tenants and the elderly.

### **Current Issues**

At present, the renewal of the ancient city is mainly point renewal, lack of overall consideration, and part of the design's lack of respect for the architectural style, street texture and continuation, which is easy to causes damage to the established style characteristics of the ancient city. Of the ongoing parts of the renewal project (Figure 1), most of them are for West Street along the street of a building or a few buildings of the single update, the focus is on the house repair rather than the protection of ancient buildings, the field investigation found that along the road after the renewal of the appearance of the house and the original architectural style of the ancient city is incongruous. At the same time, because these cultural relics are widely distributed, transportation is inconvenient, many of these relics are not known, and their value has not been fully embodied.

From the ancient city as a whole, (1) Road: there are three levels of cross streets, alleys, paths, and another periphery of a circle of horse road, the road network is similar to a square grid. The streets and lanes are well preserved in terms of style and scale, with local damages. (2) Boundary: the city wall and moat have not survived, the original boundaries and image of the ancient city edge is never found again. The northeastern side of the ancient city is adjacent to the main road, and the billboards are cluttered. Northwest area adjacent to residential areas, the image of the ancient city edge is lost. (3) Area: the ancient city style and pattern are still intact, and the characteristics are still distinctive, but local damage is common, such as the Qixian Hotel, People's Hospital, Qixian Middle School and other serious damage to the pattern of the ancient city.

It can be seen due to the unclear boundaries of the ancient city, the lack of iconic nodes, landscape image is more single (courtyard residential mainly) leading to the overall image of Zhaoyu Ancient City ambiguous, limited development, part of the courtyard is dilapidated, the vitality of the ancient city is no longer. Because of the above problems, this paper makes use of digital technology in the landscape refinement design method, based on the needs of the ancient city protection and organic renewal, analysis of the status quo, and then strengthens the protection of historical and cultural cities, promote the revival of the ancient city, and promote the activation of the use of resources in the ancient city.

## **Research Methodology and Implementation Path**

### **Data Acquisition**

In the updating work of ancient city protection under digital technology, it is necessary to collect a variety of basic data, including topographic maps, spatial data such as the location of historical resources and attribute data such as resource information. Historical heritage protection in the new era requires more refined protection and management than traditional historical conservation planning.

(1) The most basic in the protection of the ancient city is to obtain historical resource data, through the study of relevant literature, from the important historical relics and buildings, the site of the ancient city wall to the historical houses, the location of historical streets and lanes and other information; (2) Built environment data

through the use of unmanned aerial vehicles on the target to shoot, and through digital technology to obtain the remote sensing image map with the accurate coordinates of latitude and longitude. (3) Crawling Baidu heat map data is processed by software to present the population concentration in a certain area with different shades of colors, which largely reflects the use of urban space, and the coordinates of this type of data need to be defined and corrected in the GIS. The coordinates of this type of data need to be defined and corrected in GIS. (4) POI data, which are collected from the Gaode Map developer platform, are point data and need to be projected in GIS and exported to SHP format. These data cover the preliminary analysis of the status quo in the design to the design basis in the design process, which provides a scientific basis and guides the design for the activation of the historic and cultural district.

### **Refinement of the Implementation Path**

Zhaoyu ancient city, as an important cultural heritage concentration area in Qixian County, how to comprehensively protect the appearance of the ancient city, complete continuation of the historical pattern of the ancient city at the same time, to guide its renewal, enhance the quality of the space, and highlight the cultural value, is a topic worthy of discussion. Through the theoretical and practical exploration of quantitative and qualitative analysis, the study explores the design improvement planning and evaluation of the ancient city based on the point cloud spatial data and the real 3D model, and the multifaceted fusion of digital technology, which is a supplement to the study on the enhancement of the vitality of the ancient city with the aid of big data, and also provides a reference to the subsequent research. This paper explores data-based design improvement planning and evaluation from the design level of current spatial characteristics and functional needs. Refinement design needs to be realized with the help of digital technology and spatial big data research methods, but the refined design is different from the quantitative design results of the meticulous, refined design places more emphasis on the design process and ideas, emphasis on the overall cognition of the ancient city landscape and systematic consideration of the refinement of the overall spatial improvement strategy system refinement.

The key to achieving the fine design of landscape garden space, covering the early stage spatial analysis process refinement, the post-existing spatial design improvement strategy system refinement, and the control framework at the macro and micro levels: (1) The spatial analysis process refinement level, including the overall data acquisition and the overall wind appearance of the ancient city, the sunshine analysis, the line-of-sight visual field analysis, and the profiling analysis; and to provide a more targeted approach from the point of view of the digital technology; (2) The fine level of the spatial design improvement strategy system, including the identification of the spatial pattern of the site, the traffic accessibility and the vitality influencing factors such as the degree of aggregation of unique historical resources, to provide a scientific basis for the revival of the vitality of the historical and ancient city and to guide the design.

To address the above issues, the study is to implementation refined spatial design intent through overall spatial data acquisition, spatial point cloud data processing and spatial design guided by graphical data processing respectively (Figure 2).

Firstly, the camera is carried by the drone to obtain raw images of the ground and buildings, conduct aerial triangulation, and then use DasViewer to construct a 3D model, and automatically map the images as textures

onto the surface of the buildings and terrain, generating point cloud models with spatial location information to form a real 3D model.

Secondly, using POI points of interest as basic data, comprehensively applying ArcGIS spatial analysis tools, combining with mathematical and statistical methods, identifying the spatial distribution characteristics from the spatial aggregation level, and realizing the refinement analysis of the site. We analyse the spatial distribution characteristics and spatial vitality of the ancient city and its influencing factors, in order to provide a scientific basis for the revival of the vitality of historical and cultural districts.

Again, PCM (Point Cloud Magic) software is used to import the point cloud model with spatial location information, and then the point cloud processing technology is used to count the point cloud distances, slopes, morphology and other data in each layer. From the macro level, we analyze the landscape zoning, mountain features and overall facade, and at the fine level, we analyze the sunshine and local view.

Finally, the above conclusions are applied to the process of designing practical solutions for early-stage design, testing, and improvement.



Figure 1. Current situation diagram.

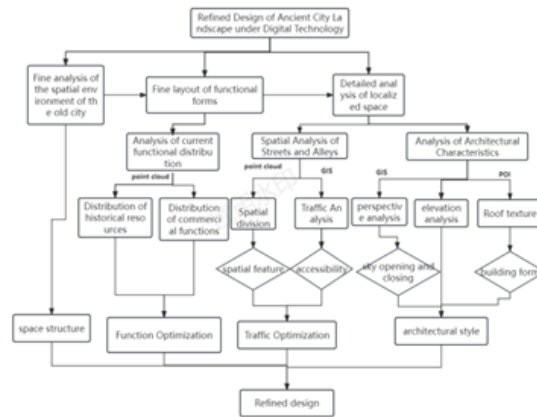


Figure 2. Technical route.

## Results and Analyses

### Fine Analysis of the Spatial Environment of the Ancient City

#### Overall pattern analysis

Through tilt photography, point cloud and other digital technology, to provide a fine three-dimensional model (Figure 3-1), the status quo mapping data, planning data, and other core data to sort out the real reproduction of the physical space, and to further surround the end of the ancient city to update the status quo mastery and identification of the problem.

Ancient city space is different from the landscape space and residential space, its building density is much higher than other spaces, in the analysis of the characteristics of the ancient city and space description, specific problems should be analyzed, clear design principles, clear design types and design elements. Using the tilt photography model, the DasViewer 3D Viewer software is used to convert the 3D image model data into a Digital Orthophoto Map and Digital Elevation Model (DEM), and the ground level is called the Digital Elevation

Model (Fig. 3-2), which allows for a more accurate analysis of the relationship between the settlement landscape and the topography. By actively adjusting the color of the Digital Elevation Model to correspond to the height value, cropping out the point cloud of the taller buildings in the site, and highlighting the subtle changes in the ground elevation of the ancient city, the pattern of the ancient city can be clearly reflected.

Visible, Zhaoyu ancient city's overall spatial pattern is more complete, the overall pattern of a slightly longer square city, the city lacks a corner in the southeast, and the entire city is shaped like an ancient official's hat, so there is a "hat city" said. Checkerboard Road is a skeleton, "crossroads" type main street, the main axis of the Ancient City—East, West Street and other road crossings are "crossroads", and its city gate is opposite. The southeast corner of the city is made into a ninety-degree angle. The combination of communities has a centripetal, each lane into its system, temples, streets, shops, and houses forming a magnificent, complete architectural complex.

The ground elevation map shows that Zhaoyu Ancient City is the overall shape of the surrounding low and high in the middle, with wells as a cluster point, to the temple as the center, while considering the height and drainage, the ancient city to the highest cross mouth, and four gates of the drop of about 3 meters, easy to get out of the water.

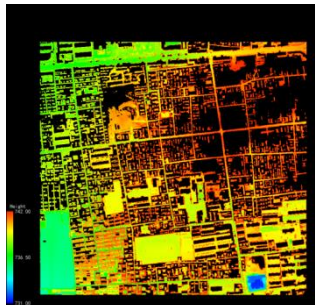


Figure 3-1. Ancient City Texture. Figure 3-2. Elevation map of the ancient city.

### *Spatial refinement*

The research will be the ancient city space from the point cloud data to identify the ground, buildings and other elements. Firstly, the typicality plot samples are selected, and intelligent algorithms building targets and other multiple subsystems of the 3D model are segmented monolithically and given computer image recognition rules for computer learning classification. Ground point classification provides the basis for the construction of the digital elevation model and subsequent point cloud classification of building points, model feature points and other features; the classification of building point clouds is based on the minimum area of the building, the minimum height and other parameters of the statistics and classification of the point cloud collection with the nature of the building of the point cloud is classified out of the whole number of point clouds. After the classification is completed, the point clouds of different categories can be colored separately to enhance the display effect.

Through the above method, we can understand the data characteristics of the point cloud more clearly and explicitly, and visually display the spatial distribution characteristics of the street buildings, to restore the landscape of the settlement on the one hand, and rationally integrate the planning space; on the other hand, we

can sort out the layout pattern within the settlement group, and provide protection suggestions for the construction zoning, functional nodes, road design, etc. of the special topography, to maintain and continue the original landscape characteristics of the traditional ancient city. The original landscape characteristics of the traditional ancient city will be maintained and continued.

According to the ancient city texture and the relationship of the map (Figure 4-1), the overall spatial pattern of the ancient city has the following characteristics:

Firstly, the ancient city part of the map bottom relationship features clearly, with the texture of a typical traditional Chinese city.

Secondly, the traditional pattern, the hierarchical street space system is clear. Zhaoyu Ancient City by the street - street - alley - horse road - path composed of a complete road system, a clearer division of labor, spatial scale decreases the atmosphere of the streets and lanes rich in Chinese classical traditional small town flavor.

In the eastern part of the ancient city, the building density, and population density are high; in the western part the concentrated preservation of a large number of historical remains, and protection is more complete, for the ancient cities of the Ming and Qing styles are most concentrated in the area, the building density is high.

#### *Spatial analysis of streets and alleys*

Streets and lanes in the ancient city are different from general streets and have certain special characteristics, which not only bear the traffic demand of residents traveling to and from the city, but also constitute the most important landscape features and living space in the ancient city, and when designing, not only should we consider its accessibility, but also pay more attention to the protection of the streets and lanes and the improvement of people's livelihoods. Road space and so on is an important carrier of traditional folklore memory and the main object of street shaping. Therefore, it is necessary to do a detailed investigation and research before design, make a comprehensive compilation and judgment on its current conditions in terms of characteristics, traffic, history, and consider the public functions of its community communication space, such as the coordination of parking and access, the living facilities suitable for the elderly and the young and the excavation of the alley culture.

#### (1) Characterisation of streets and lanes

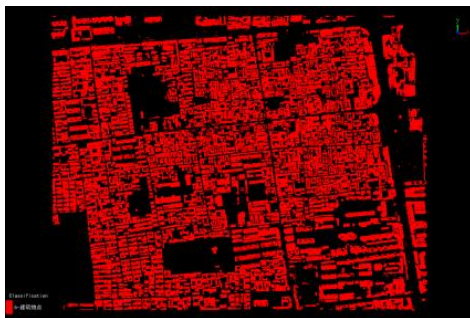


Figure 4-1. Architectural texture map.

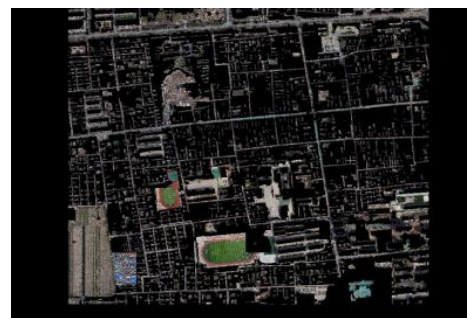


Figure 4-2. Street texture.

Firstly, the distance data between buildings can be counted by batch calculating the point cloud distance of street and alley buildings (Figure 4-2), and data visualization and analysis is carried out based on the data. Based on the separated ground layer point cloud measurement calculation, it is concluded that the width of the

main street is basically in the range of 7~8m, while the traditional street is in the range of 3~6m, and the alleyway (path) is in the range of 1.3~2m.

It can be seen, among them, the east-west and north-south streets, Zhenglian Street, Xiao Dong Street, Chenghuangmiao Street, Fire Temple Street, Xindao Street, Coal Market Street, Northwest Horse Road, Southeast Horse Road for the availability of motor vehicles. At present, the traffic in the ancient city is chaotic, motor vehicles without a specific driving road, motor vehicles in the ancient city streets and lanes between the free movement of the streets and lanes of the ground damage is serious, at the same time to the traffic in the ancient city caused by congestion. Improve the traffic condition of the ancient city on the one hand, taking into account the traffic accessibility, on the other hand, also need to protect the ancient city landscape and texture. Redistribute the traffic flow and pedestrian flow on the original roads, and improve traffic efficiency while visiting the historical buildings and alleys.

#### (2) Traffic analysis of the streets and lanes

Traffic accessibility is used to calculate the sum of the shortest topological paths of the target streets between any roads in the system and from the roads to the historic buildings, measuring the potential of the space to pass through the whole area. This is used as a reference for the delineation of traffic flow.

Since the ancient city has been integrated with the surrounding land in the long-term development and did not leave the city wall (hard boundary) on behalf of the city, the main roads and land boundaries of the city are used as the limiting factors. According to the planning drawings combined with the point cloud ground element extraction, the roads in the ancient city are divided into four types: main roads (east-west and north-south avenues), secondary roads (major streets and alleys), side roads (minor streets and alleys), and lanes (path). The street CAD is imported into GIS for accessibility assignment. The three elements of “center”, “connection” and “node” are set. The “center” represents the location of the important protected historical buildings, the “connection” is used to simulate the network structure of different levels of roads; the “node” is the meeting point of the roads. The walking speed for all roads is set at 1.5m/s, i.e. 90m/min.

① **Road accessibility calculation (Figure 5-1):** the average minimum impedance from the point of demand to all destination points is used as the accessibility evaluation index; the purpose of traveling is not taken into account, and only a general evaluation of the road network is done so that the distance is the shortest, the time is the shortest, and the cost is the least, etc.

$$A = \frac{1}{n-1} \sum_{j=1, j \neq i}^n (d_{ij})$$

$A$  denotes the accessibility of the entire road network, and  $d_{ij}$  denotes the node  $ij$  minimum impedance between them, which can be shortest distance, shortest time, least cost, etc.

② **Node Accessibility Calculation (Figure 5-2):** The average weighted travelling time from the demand point to the destination point is used as the accessibility evaluation index of the point, which takes into account the attractiveness of the destination point, and is more able to respond to the consideration of the destination situation in the actual travel. According to whether an important historical building is a cultural protection unit



as the basis for evaluation of the value of the building, the higher the level of control and protection means that the historical value of the building is higher.

Travel Potential:  $[\text{Travel Potential}] = [\text{Value Assigned}] / [\text{Total Distance Travelled}]^{\text{Attenuation coefficient}}$

Probability of travelling:  $[\text{Probability of travelling}] = [\text{Potential energy for travelling}] / [\text{Total potential energy for travelling}]$

Weighted travelling time:  $[\text{Weighted travelling time}] = [\text{probability of travelling}] * [\text{total person travelling time}]$

Accessibility:  $[\text{Accessibility}] = \text{average} [\text{weighted travel time}]$

The topological analysis converts the validated axial model into a line segment model, with a total sample size of 193. According to the results of the analysis of the accessibility index of the residential area, the darker the color of the area, the lower the accessibility index, and vice versa, the lighter the color, the lighter the accessibility, so it can be seen that the Cross Street in the Ancient City and the two main roads around Youyi Street and Xinjian Road show high accessibility, and the cross-shaped vertical and horizontal tangent spatial structure of the Ancient City of Zhaoyu is identified. The cross-shaped spatial structure of Zhaoyu Ancient City is identified, while the color gradation from Cross Street to the internal streets and lanes shows a gradual change from light to dark, which is consistent with the change of the grade of the streets and lanes.

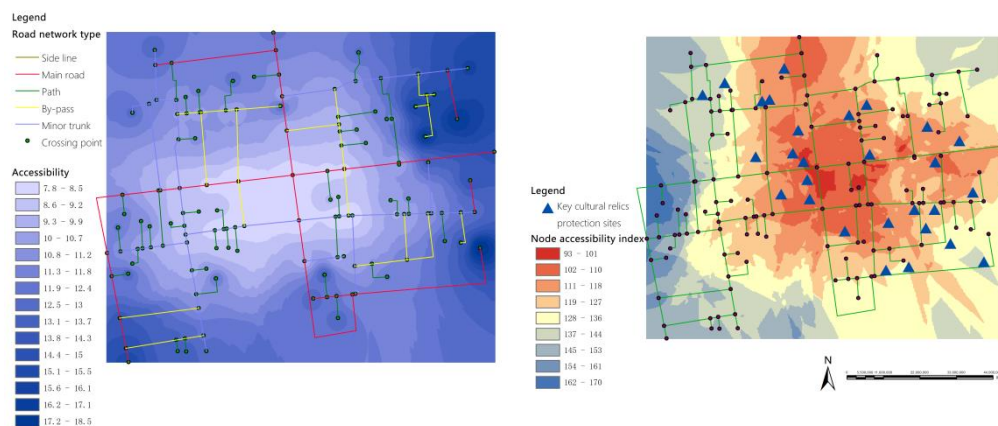


Figure 5-1. Road Accessibility Figure 5-2 Node Accessibility.

### *Building space analysis*

The traditional wooden structure, brick gray tiles and oriented angle doorways still maintain the architectural style of Jinzhong workshops and Jinzhong dwellings since the Ming and Qing dynasties, and these elements have long been important features representing the architectural culture of Shanxi. In the shaping of the ancient city, architecture is the element that can best reflect the cultural value and sense of historical identity, and the analysis of the overall facade and texture pattern of the shops along the street and the historical houses reflects the continuation and protection of the traditional culture.

#### (1) Elevation analysis

From the three-dimensional space, Zhaoyu ancient city of the fifth elevation is more unified, mainly slope roof. However, in some areas mixed with flat roofs, form and color are not coordinated, and the unified pattern of more than one place with multi-story buildings broken, communication towers, water towers, and chimneys on

the skyline of the Ancient City has a serious impact. First of all, I would like to explain that discussed in the paper is mostly the street storefronts, mainly for the analysis of historical buildings in the Ancient City, from a historical perspective, to strengthen the protection of the historical elements of the Ancient City, and to promote the revitalization of the use of resources in the Ancient City, the mastery of the status quo situation of the Ancient City and the identification of the problem is the basis of the protection and updating work. The digital surface model of the target is obtained by using the DasViewer live 3D viewer software, which can clearly obtain the morphological characteristics of the buildings.

① Classification of the facade: the specific analysis of the model of West Street in the three-dimensional model, the form of the building facade you are divided into three types: front porch, no porch and protruding type (Figure 6). Front porch has always been an important part of commercial buildings. Its main function is to shade the sun and rain and expand the make space and so on. No porch-type storefronts in the Ancient City are more like a combination of shops and residential products, shops to the outside into the open street surface and residential closed to the inside into the towering courtyard wall. In the form of no-porch type, it has the characteristics of both, and shows a kind of heavy shop characteristics.

② Facade Height: In the application, the building height distribution is roughly determined by the number of point cloud heights from the ground, such as shown in Figure 7-3, the height of the building point cloud is concentrated in 6~8m, and reaches a peak around 7m, which shows that the height of the building is mostly around 7m, and less than 8m, indicating that most of the new buildings are in the range of 1~3 floors. According to the point cloud analysis of building height, the current situation of building height can be summarized comprehensively, most of the new buildings in the ancient city are in line with the requirements of the wind appearance, but there are still a small number of buildings that affect the wind appearance due to excessive height.



Figure 6-1. Front Porch Style Figure 6-2 No Porch Style Figure 6-3 Projecting Style.

③ Local visual field analysis: the main purpose is to ensure that the sight lines between important viewpoints and landscapes are smooth, and that appropriate spatial scales are maintained between buildings. The open space visual point is selected for landscape visual field analysis, and the visual field effect of the target point is obtained through line-of-sight calculation (Figure 7-2), which shows the damage to the landscape visual field caused by some of the buildings and cluttered structures, and assists in judging the buildings that need to

be demolished or remediated so that after remediation the visual field can be directed to the historical buildings more often to enhance the guidance of the line of sight in the public space.



Figure 7-1. Line-of-sight analysis diagram.

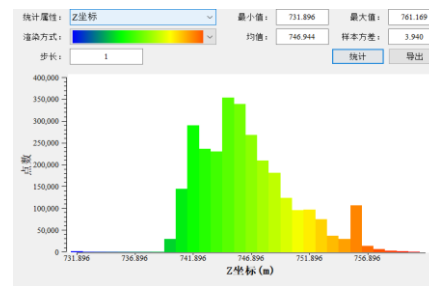


Figure 7-2. Roof Point Cloud Height Map.

## (2) Architectural texture and roof form

Zhaoyu ancient city of commercial buildings in the form of roofs are mainly single-slope roofs (Figure 8-4) and double-slope roofs (Figure 8-5) two kinds of double-slope roofs are divided into pointed mountain roofs and Chinese round-ridge roofs. No difference in the roof style of traditional Chinese buildings, but alternating the Ancient City, and commercial buildings and streets in different combinations, is a major feature of the roof of commercial buildings in Qixian (most of the commercial buildings in the region for a unified roof style).

In the building layer analysis, the lack of control of new buildings in most traditional villages makes the old and new buildings mixed with each other, which makes it difficult to determine the historical landscape area. Therefore, the study takes advantage of the fact that most of the historical buildings in the ancient city have double-slope roofs and low heights, and separates the building layers according to the point cloud of the 3D reality model, calculates the slope value of the point cloud and the height value of the distance from the ground, and divides the buildings of Zhaoyu ancient city into two categories: historical buildings (sloped roofs) and newly-built buildings (flat roofs). Combined with the aerial view panoramic map of the special building data correction, to obtain the distribution map of the two types of buildings. This is used as a reference basis for the delineation of the core area of historical features.

Firstly, the image map is segmented (Figure 8-1), and some typical block samples are selected. According to the architectural layers separated from the point cloud of the 3D live model, the ground layer can more clearly reflect the layout of its streets, alleys and public spaces, and the architectural layer embodies the architectural density, and the active adjustment of the digital elevation model's colors corresponds to the height values, emphasizing the slight changes in the architectural elevation (Fig. 8-2), which can reflect the architectural heights, slopes and other characteristics. As a result, the slope of the roofs of historical buildings is mostly concentrated at about 20 degrees (Figure 8-3).

Obtain an overall analysis of the architectural texture and use it as a reference value to control the architectural form. This method can accurately and efficiently grasp the overall characteristics of the

architectural form of traditional villages, and provide data support such as building volume and building spacing for subsequent remediation and construction.

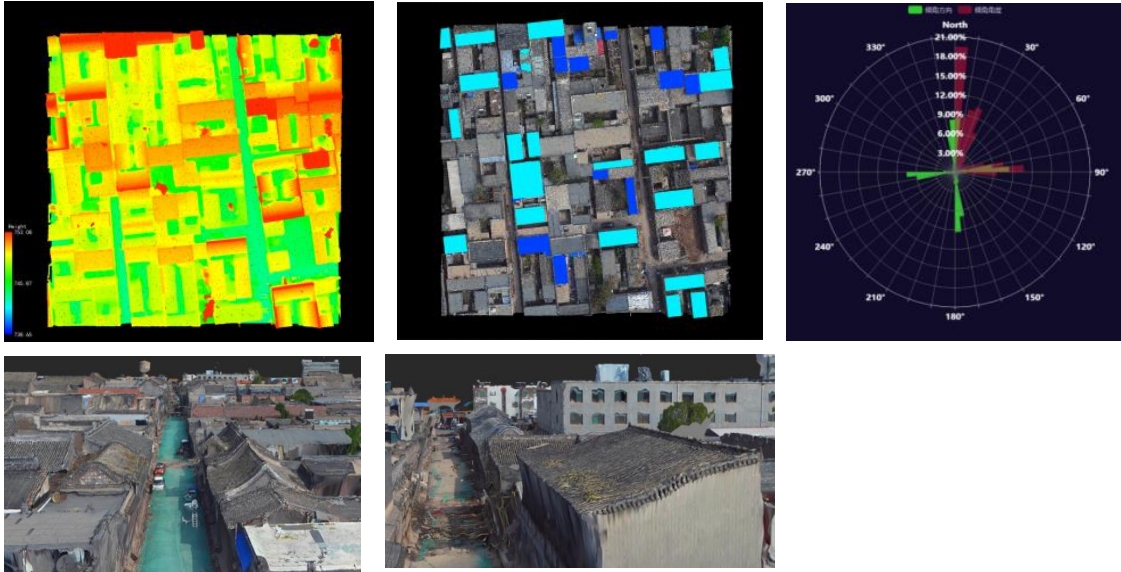


Figure 8-1. Localised Roof Elevation Diagram.  
Figure 8-3. Roof Slope Angle Rose Diagram.

Figure 8-2. Localised Roof Classification Diagram.  
Figure 8-4. Double Slope Top Figure 8-5 Single Slope Top.

### (3) Building color and material analysis

As a historical and cultural heritage, it is especially important to analyze the overall appearance of the main streets and alleys. In the past, it was very difficult to obtain a detailed aerial view, but now it can be derived accurately and quickly by using an oblique photographic model. As shown in the figure, an aerial view of Zhaoyu Ancient City from the east can be used to visualize the overall appearance of the streets and their surroundings. Color analysis(Fig. 9-2) of the buildings and environment in the aerial view is performed to extract the main colors of the street. It is found that the traditional buildings are dominated by dark grey, light grey and earth colors, which come from the colors of the building materials of the ancient city itself, such as green bricks, (Fig. 9-1) grey tiles, earth walls, while the environment is dominated by green plants, and the roofs and walls of some newly built buildings in the ancient city are dominated by red and blue, which appear to be more abrupt. It can be seen that the environmental landscape of the Ancient City is relatively intact, but the height and color of some new buildings do not match the original landscape, which has caused some damage to the overall facade landscape, and should be followed up with protection and remediation strategies.

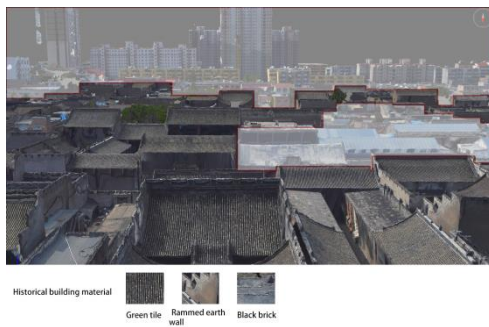


Figure 9-1. Material analysis diagram.

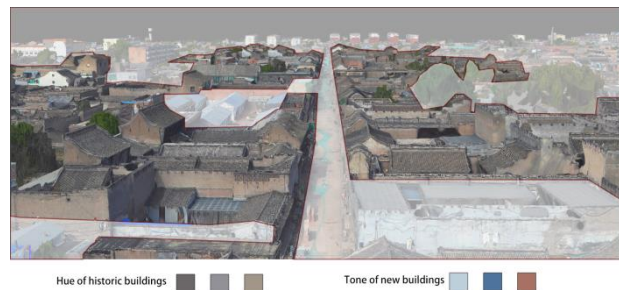


Figure 9-2. Color analysis diagram.

### Feature Analysis of Functional Status

Function, as a social representation of a place, is an attribute attached to a space by the people who move in it, and the reason why a physical space can be used by people is largely dependent on the various functions carried in the space. The “function” discussed in this paper refers to the physical function of the building, the common commercial, residential, and cultural functions.

POI points of interest can be used to measure the density of street business types in the ancient city, and measure the spatial service potential. In this paper, we mainly process the data from the Gaode map development platform and obtain all kinds of POI information in Qixian County through crawler technology, and the original data is in CSV format, containing the name and coordinate information of the points of interest, which needs to be projected in GIS and exported to the format. Referring to the land use status quo and Gaode map POI data, the land use status quo is the basic reference, but the timeliness is poor; the field research results are more timeliness, to ensure that the data are not missed, so the land use status quo data and the Gaode map POI data which are updated more frequently are chosen as the reference.

This paper focuses on analyzing whether the functional diversity and density meet the demand. Functional richness includes the nature of the site, the type of business and so on, and the domestic Gaode map POI has covered almost all kinds of facilities related to residents’ lives in recent years. Considering the characteristics of the ancient city, it is necessary to subdivide the nature of the site and classify the functional types in the area into commercial, cultural and residential.

As shown in Figure 10-1 (1) Commercial Function: From the functional dimension, the POI categories in Zhaoyu Ancient City are more complete, and the four commercial old streets preserve the characteristics of the commercial street market in the Ming and Qing Dynasties, especially the existing silver houses and former residences of ticket houses in West Main Street, which reproduces the prosperity and heyday of the ticket houses and other commercial and financial business in the history of the Shanxi merchants, and it is the first market reflecting the Ming and Qing Dynasties market of the Shanxi merchants. POI data under this dimension are concentrated in East Street and West Street of Cross Street and partly located in North Street and South Street. All four streets are commercial-type streets, but they have been downgraded from the main commercial centre of the whole county in the past to the centre of the residential area with the ancient city as the main focus, mainly focusing on garments, daily-use department stores and services, with a small number of shops for tourism

services. East Gate near the square and antique commercial buildings defines the edge of the Ancient City, the north side was occupied by Qixian Hotel a shop business type of miscellaneous, communication equipment, hardware and plumbing equipment, aquatic tea, restaurants and other miscellaneous stocks. (2) cultural function: the main design of the ancient city around the historical buildings to carry out planning and design, and through the analysis of the historical buildings of the nuclear density, derived from the historical resources within the ancient city of the aggregation of the degree of nuclear density analysis (Figure 10-2) (historical value of the building whether the cultural heritage unit as the basis for evaluation, the higher the level of control and protection of the building of the higher the value of the historical value of the building. Classify the building as a provincial or higher-level protection unit.) From the cultural function distribution kernel density map, the eastern part of the ancient city, with the Qu's Family Compound, Changyu Chuan and other classic residences of Shanxi merchants as the main body, has formed the starting area of the ancient city's tourism and services; the western part, with the Da De Cheng Tea House, Da De Heng Ticket House and the Temple of Literature. (3) Residential function: Zhaoyu's ancient city courtyard is its essence, there are currently more than a thousand various types of courtyards, due to the destruction of the city wall, the city's new areas and the boundaries of the ancient city are gradually blurred, especially in the ancient city on the west side and the south side of the newly built areas of residential and the ancient city has been mixed, the west side of the northern section of the ancient city boundaries are mainly for the people's hospital of Qixian broken, the southern section of the low-rise residential and the ancient city mixed; the ancient city of the south side and the school, factories, low-rise residential houses junction, the boundary is blurred.

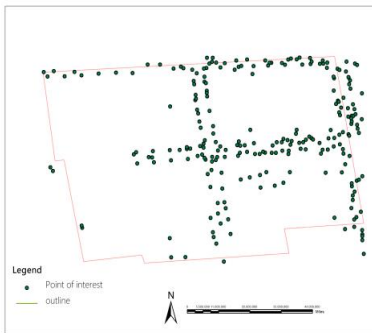


Figure 10-1. poi point map.

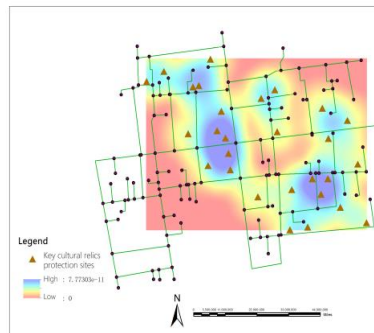
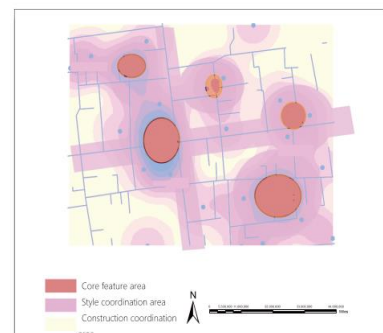


Figure 10-2. Kernel density analysis map. Figure 10-3 Architectural Style Control Map.



## Improvement Recommendations

### Improvement of Spatial Layout

In terms of traffic and function, according to the study, it is clear that the east side of the Ancient City and the east and west streets are the key areas for renovation and development. On the one hand, there are two national cultural relics protection units here—Dui Family Courtyard and Changyu Chuan Tea House, and other cultural relics protection units at all levels are densely scattered throughout the city, with rich architectural heritage resources. On the other hand, the northeastern part of the Ancient City is closer to the main development axis of the city and is easily accessible, making it the main entrance and exit point for tourists. By

overlapping the nuclear density map with the current situation map, the dark-colored area and the east-west street are designated as the core landscape area, the orange part with traditional buildings as the center of influence outwards is set as the landscape coordination area, and the light-colored area as the residential part is set as the construction coordination area, which ultimately forms the architectural landscape control map shown in the figure (Fig. 10-3). At the same time, the public space system is planned, combining the residential dominant area division and ground level analysis, retaining the larger surface area, superimposed on the analysis of traffic and road connectivity, and appropriately improving the public function of the community communication space without destroying the characteristics of agglomeration development.

Taking into account the line of sight, topography and other factors of different conservation areas, screening and remediation requirements for buildings affecting the windscape will be made. Subsequently, the peak height of 7m of historical buildings should be used as a reference element to set the height control requirements for the core landscape area. It can be seen that the comprehensive statistics and analysis of the point cloud data of the oblique photography model is an effective means to set the parameter threshold and quantitatively analyze the feature control requirements, and has a high reference value element to formulate the height control requirements of the core feature area.

### **Improvement Street Traffic**

Through the above analysis, it can be seen that the diversity of functions and density do not meet the needs of tourism in the ancient city. Combined with the distribution of cultural heritage buildings and other factors such as the distribution of non-heritage culture, and based on the building distribution map, to determine the ancient building area that is the core area of the historical landscape, and the new building area, for different types of alleys, for residential-led streets, focusing on the update of the function of the old and the young, and retaining the atmosphere of life; for multi-functional alleys, compared with the residential-led its commercial atmosphere is stronger, and should pay more attention to whether the style is coordinated or not. For multi-functional alleys, which are more commercial than residential-led ones, more attention should be paid to the coordination of style and traffic.

### **Promoting Functional Upgrading**

According to the above analysis and the accessibility calculation map, the accessibility indicators of the streets and nodes of the ancient city can be obtained more scientifically and systematically, which can provide the basis for the subsequent improvement of the spatial layout. On the one hand, update the traffic management mode of the ancient city. Relying only on road construction to improve the traffic in the ancient city has a limited effect. Traffic in the ancient city should be improved by combining the organization of the transport system and traffic demand management. On the other hand, improves the spatial layout and promotes quality improvement. Firstly, set up core historical style areas in highly accessible areas, add service and tourism function facilities to enhance the experience of tourists, pay attention to the areas where the supply of service intensity is less than the demand, and prioritize their quality improvement. Through the construction of the open space green space itself, the service quality will be upgraded and the problem of overuse will be alleviated. Secondly, focus on areas with low accessibility, add functions that meet the demand for recreation in the vicinity, eliminate service blind zones, and optimize spatial layout to improve accessibility and fairness.

## Applications and Outlook

### Practical Applications

This paper takes Zhaoyu ancient city as an example, introduces the use of digital technology in the landscape refinement design method, based on the needs of the ancient city protection and organic renewal, strengthens the protection of historical and cultural cities, promotes the revival of the ancient city, and further promote the revitalization of the use of resources within the ancient city, the key to the refinement design lies in the spatial design process, the spatial optimization strategy system refinement relative to the traditional analysis method, has the following points Advantage.

At the level of refinement of the spatial analysis process, including overall data acquisition and the overall landscape of the ancient city, sunshine analysis, line-of-sight visual field analysis, and profile analysis; a more targeted and systematic design principle is provided from the perspective of digital technology. The digital surface model is obtained through tilt photography, and digital technologies such as image processing, point cloud segmentation and artificial intelligence can be used to quickly obtain vectoring landscape information such as orthographic projection, overall elevation, and local field of view of the settlement. Compared with the traditional analysis method based on two-dimensional mapping diagrams, digital technology can not only quickly complete the data acquisition, but also provide a more intuitive and comprehensive three-dimensional model.

At the fine level of the spatial design improvement strategy system, including the identification and characterization of the spatial pattern of the site, the accessibility of the traffic and the unique gathering of historical resources and other vitality influencing factors, we can show the ancient city in all aspects of “time and space” dimension, spanning the history, the present and the future of the three-time domains, and spatially, including the lanes of the ancient city, the community, Spatially, it includes different elements such as lanes, communities, plots, buildings, houses, etc. Based on the technology of “three-dimensional live model, Geographic Information System (GIS)” and other technologies, it integrates the data of information model, and through digital technologies such as tilt photography, point cloud, etc., it provides a fine three-dimensional model to truly show the physical space of the ancient city, and further integrates the data around the multi-dimensional data to carry out a refined analysis at the three-dimensional spatial level; it provides a good opportunity for the designers to design and develop the city’s future. The level of multiple data integration, from the three-dimensional spatial level of refinement analysis; for the design work to provide more scientific technical support, and further guide the allocation of resource elements, especially the rational adjustment of spatial layout, traffic functions, etc., to break through the dilemma of coexistence of the ancient city of protection and renewal, hoping to ultimately form a refined model of the renewal of the ancient city of planning and practice, and to achieve a closed loop of the wisdom system. It is hoped that a refined ancient city renewal planning and practice model can be formed to achieve the closed loop of the wisdom system, provide a scientific basis and guide the design for the revival of the vitality of ancient city

### Outlook

UAV tilting photography has its advantages, but it also has disadvantages, UAV tilting photography has a certain perspective blindness and can not obtain internal information. In the mapping of ancient buildings, not



only do we need to obtain information about the exterior of the building, but also information about the internal structure of the building, while ancient buildings usually have rich texture patterns and patterns and complex structures. For the ancient building mapping both in accuracy and detail put forward higher requirements. The two techniques have obvious deficiencies in ancient building mapping. Aiming at the characteristics of tilt photography technology, combined with three-dimensional laser scanning, the two technical means are combined. The use of UAV tilt photography for external data acquisition. Three-dimensional laser for ground and internal structure data acquisition, in order to form a complementary advantage, the establishment of air-ground integration of three-dimensional data acquisition methods. At the same time, with the help of the current more cutting-edge digital technology methods, through the integration and collaboration of multi-methods and multi-platforms, the comprehensive use of spatial information acquisition technology, and spatial data analysis platform, to achieve a refined landscape garden spatial design path.

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