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Analysis of Industrial Heritage Skyline in Qingdao Dagang District based on Fractal Theory

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Abstract

Based on fractal theory, this paper introduces it into the design field of industrial heritage skyline by using its characteristics of describing objects with irregular shapes but self-similarity in different hierarchical structures, discusses the fractal characteristics of industrial heritage skyline in Qingdao Dagang District, analyzes the skyline of industrial heritage in Qingdao Dagang District from three levels: long-range, medium-range and close-range from the sea area to the land area, and gives corresponding optimization strategies, which has certain guiding significance for the recycling of industrial heritage in Qingdao Dagang District while making up the research gap in this field.

Keywords

Fractal Theory; Qingdao Dagang District; Industrial Heritage; Skyline.

1. Introduction

Qingdao is a city "prospered by Hong Kong", and the importance of industry to the historical development of Qingdao is self-evident. Qingdao Dagang District has many precious industrial heritages. With the development of Qingdao's urban renewal, Qingdao Dagang District has been upgraded and adjusted in the continuous transformation, so the protection and reuse of its industrial heritages are particularly important. The skyline is an important symbol of the spatial form of industrial heritages, and it is an indispensable part. The protection of Qingdao Dagang District's industrial heritages can't be separated from the research and analysis of its skyline, but the existing evaluation standards lack of industrial heritages.

The elegance of the skyline. The concept of city skyline is the product of the development and practice of modern urban planning and design. The astronomical research contents of skyline mainly have these two development directions. Firstly, the subjective description of the city skyline; The second part is the quantitative analysis process and dynamic control of city skyline. The research of existing systems abroad mainly focuses on the basic analysis model of urban skyline theory and the basic research fields of architectural practice, such as the image of the city in the urban skyline and its recognition in advance, the analysis of the relationship between the main components of the skyline structure system and the main components, the analysis and monitoring methods and defect control of the deviation of building height, size and structure shape in the skyline, the energy-saving building energy-saving policy suggestions and the landscape greening technology of the urban skyline [1].

In 1999, the lack of research on the protection of high-rise buildings also led to the chaos of skylines in some cities. In the 1980s, Wayne attoe (1981) put forward that the landscape function of skyline depends on its own form, the surrounding environment and the viewer's subjective interpretation, which expanded the cognitive theory of skyline. Domestic research mainly focuses on the definition,

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structure and function of skyline. Wang Xiaokai (2004) also divided the four spatial elements that make up the quality of the skyline into the main control point, the sub-general control point and the general control point according to the actual attention of the audience, and emphatically analyzed and expounded the important role of each spatial element point. Bi Wenting (2005) further analyzed and discussed the important determinants of the overall quality of urban space skyline: first, some physical attributes and basic geographical features of urban spatial structure, such as urban mountains, valleys, river landforms, etc. Second, urban construction, planning and control, including urban architectural style, height ratio and organizational form, as well as functional layout forms of various high-rise building structures; The third is the comprehensive dynamic process of the urban environment, including the change process of the city in the plane and vertical direction. Yang Guo (2010) studied the skyline evaluation system and spatial planning control by public survey. Liao Weiwei and Xu Ran (2011) summarized the landscape types of skyline, including skyline outline, skyline facade form and skyline level landscape.

With the advent of the era of scientific intelligence, the research on the skyline of industrial heritage needs more reasonable analysis and more accurate control. However, most of the existing evaluation methods are easily influenced by various subjective factors such as evaluators' aesthetic quality, which leads to the impersonal evaluation results. The fractal theory used in this paper is to describe the geometric shapes of complex irregular figures as the most basic geometric elements, and it is an objective research method to analyze and study the patterns of complex shapes in nature. Fractal dimension in fractal theory is the geometric representation of various complex and irregular plane shapes, and it is the most important applied theory of modern landscape skyline analysis technology. Fractal theory research results have been successfully applied in various fields such as urban and rural planning, architectural design, greening and landscape city design analysis [2]. Using fractal theory to analyze the skyline of Dagang industrial heritage from far, middle and near levels, accurately analyzing the skyline of Dagang industrial heritage, and constructing its analysis and evaluation method are conducive to the overall protection of Dagang industrial heritage, planning and building Dagang industrial heritage, and shaping the unique features of coastal cities.

2. Research Objects

Qingdao Dagang District is located at the west end of the central area of Qingdao, on the east bank of Jiaozhou Bay, from Cruise Port Road near Pier 6 at the south end to Hangzhou Branch Road near Pier 8 at the north end, east of Jiaoji Railway, west of Jiaozhou Bay, south of China and Hong Kong, and north of Haibo River, with a total area of about 4.2 square kilometers. The coastline of Dagang is 15.4(17.57) km from the west end of Pier 6 to the south of Haibo estuary. As Pier 3 and Pier 5 in Qingdao Dagang District belong to military wharves, this study will not study Pier 3 and Pier 5 for the time being. Therefore, the scope of this study is defined as six wharves 1, 2, 4, 6, 7 and 8 and the whole land area of Dagang District (as shown in Figure 1, 2).

Figure 1. current situation of Qingdao Dagang District (picture source: https://henan.china.com/）

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As we all know, Qingdao beer or China's "Brand Capital" beer has many beer industrial brands from domestic and many famous beverage manufacturers all over the world, such as "Qingdao Beer, Haier, Hisense and Aucma Home Appliances, Double Star Sporting Goods" and so on. However, the only symbol that can represent Qingdao is the sculpture of "The Wind in May" located in May 4th Square, so there is a lack of "city card" that belongs exclusively to Qingdao. As the origin and origin of Qingdao, Qingdao Dagang District is not only the witness of Qingdao's history, but also the owner of its unique shoreline form, which is the first choice to represent Qingdao's urban features. Analyzing its skyline based on fractal theory can not only enrich the diversity of Qingdao's skyline, adjust the relationship between Qingdao Dagang District's industrial heritage skyline and its surrounding environment, but also enhance its identifiability with that of similar cities. International first-tier metropolises such as Beijing, Shanghai and Guangzhou all have unique and highly recognizable skylines. Therefore, the introduction of fractal theory into the study of industrial heritage skyline of Qingdao Dagang District can guide the improvement of industrial heritage skyline of Qingdao Dagang District, provide accurate design reference for its protection strategy, and even benefit the future urban development of Qingdao.

Figure 2. Location map of Qingdao Dagang District (Source: self-drawn by the author)

3. Analysis of the Skyline of Industrial Heritage in Qingdao Dagang District

3.1 Fractal Theory

Fractal theory is a theory that describes the complex patterns with irregular geometry as elements in nature. Among them, fractal dimension is an important parameter to describe irregular shape changes such as skyline. The larger the fractal dimension, the more complex and rich the shape change of the object; On the contrary, the smaller the fractal dimension, the less the change of the outer contour of the object. Fractal is often used to describe some objects with extremely abstract and irregular shapes, such as mountains with changing heights, coastlines with winding shapes, scattered shapes and even fragmented sunset clouds. Although their shapes are different, they are "self-similar" at different levels [3]. Usually these shapes are difficult to describe in traditional Euclidean geometry. Fractal

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theory means that all the infinite levels have fine structures, and all the levels have strictly similar structures or self-similarity.

3.2 Skyline

The skyline is the undulating line between the outer contour lines of buildings and other objects and the plant landscape and natural objects such as mountains. At present, skyline is mainly divided into two forms: one is naturally formed due to special terrain or plant landscape, and the other is consciously shaped by human intervention such as buildings and structures. The skyline map is a basic contour map of the sky, which takes the blue sky as the basic background and consists of a major building or a group of important buildings and a series of other complex objects. It is mainly a two-dimensional projection composed of various three-dimensional image forms. The skyline has obvious fractal characteristics. Astronomical observation systems on the same skyline at many different latitudes have highly similar self-similarity and fine observation structures. A large number of skyline dimension calculations and high correlation coefficient calculations in the data have further proved that it does have extremely significant fractal characteristics.

It is proved that it does have extremely significant fractal characteristics.

The astronomical research content of the skyline mainly has these two development directions. Firstly, the subjective description of urban skyline; The second part is the quantitative analysis process and dynamic control of urban skyline. With the continuous innovation, improvement and application progress of scientific research means and technology, the research on dynamic quantitative analysis and quality control in urban skyline has gradually become the focus of common attention and discussion [4]. In 2010, Zhang Jianhua and pan Lei divided the city's skyline into three levels: prospect, media and background, which laid a very important and solid scientific foundation for my long-term academic research path in the future. Based on GIS method, this paper makes a quantitative comparative analysis on the spatial stereoscopic difference between urban contour and urban skyline, and points out the influence of skyline and skyline on urban contour. In 2013, fractal theory was first introduced into Cao Yingchun and Zhang Yukun to accurately describe and quantify the skyline of the city. In 2016, Yan Jun and Jing Zhangpeng pointed out that fractal dimension can be directly used as another most important reference and index for the evaluation of a region or the elevation design level of the overall waterfront landscape buildings in a Chinese city, and it is the first time to change it from the overall architectural form of the city This paper comprehensively studies the configuration and quantitative characteristics of plant varieties and the overall style characteristics of landscape buildings, and puts forward several problems and suggestions on how to shape a complete urban waterfront architectural landscape system and the overall facade architectural image design specialty of a city with Chinese characteristics. In 2017, Yan Jun and others took the East Bank of Xuanwu Lake in Nanjing as an example to calculate the segmented and layered fractal dimensions of its skyline. The fractal theory proposed can also continue to provide a quantitative evaluation tool for the evaluation and analysis of urban waterfront landscape quality. Plant spatial fractal dimension is the two leading factors that determine the control of landscape skyline. The architectural structure has a great impact on the implementation of urban landscape skyline control. Han Yezi and Yuan Hang respectively summarized and proposed the relevant index system and technical methods of building control affecting the urban skyline landscape for the first time, and have established a corresponding scientific comprehensive evaluation model system. In 2019, based on the fractal theory, Yan Jun, Qiu Bei and Mao Jian conducted a quantitative and comprehensive evaluation of the skyline model of the waterfront facade of Yushan Lake in Ma'anshan. Through simulation and calculation, they proposed the fractal dimension of the skyline model of the waterfront facade of Yushan city determined after the improved design, and suggested that the fractal dimension should be improved and controlled within its reasonable range through optimization, This paper makes some meaningful planning choices and control assumptions for China's future urban spatial development model, and further puts forward urban transformation suggestions. In 2020, taking the urban skyline in the core area of Qianjiang New Town in Hangzhou as an example, Wang Qianhua and others quantitatively evaluated

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its morphological characteristics and put forward relevant suggestions by using fractal theory and relevant mathematical methods.

4. Research Methods

The skyline analysis of Qingdao Dagang District is mainly influenced by three factors: observation direction, observation height and observation angle. It is different from the skyline of inland cities. The skyline of Qingdao Dagang District has a very clear visual boundary-the sea. In the vertical and horizontal sense of the whole city, marine landscape architecture plays an important basic role in supporting the development of urban floating shore architecture system and urban waterfront landscape system. Similarly, in the sense of a city's horizontal direction, the broad and flat urban sea surface buildings in turn define the city skyline in the sense of the whole city's horizontal direction. At the same time, the sea level has also opened up one extremely open space for viewing the skyline. Viewpoint, coastline display angle and observation height will affect the observation direction of coastline. According to the relevant research, when the viewpoint is located in the height range from the third of all buildings in the visual range to the human viewpoint, a more objective fractal dimension value and a better visual effect can be obtained. In terms of sight distance, according to the analysis, when the distance between the collection point and the main body of the viewing area (the area with more high-rise buildings) reaches the following conditions: when the horizontal line of sight in the vertical direction forms an angle of view of about 10 with the upper boundary of the line of sight, which just covers most buildings (the tallest landmark building is not included), the distance is a good viewing distance, and a relatively objective fractal dimension of the skyline can be obtained. Therefore, this paper chooses the visual direction from the sea area to the land area and the height of all buildings in the visual range, which is close to one third of the minimum end to the human viewpoint, to analyze and study the industrial heritage skyline of Qingdao Dagang Port Area from three levels: long-range, medium-range and close-range. Among them, the description and analysis at the perspective level mainly studies the relationship and influence of existing plants and buildings in Qingdao Dagang District on the overall large Qingdao urban background; At the middle level, the skyline of industrial heritage in Qingdao Dagang District is refined in different levels, and the trend changes of each level and the corresponding influencing factors are studied. On the close-up level, the skyline of each section of industrial heritage in Qingdao Dagang District is extracted in sections, and the trend changes of each section and the corresponding influencing factors are analyzed in detail [5]. (Figure 3)

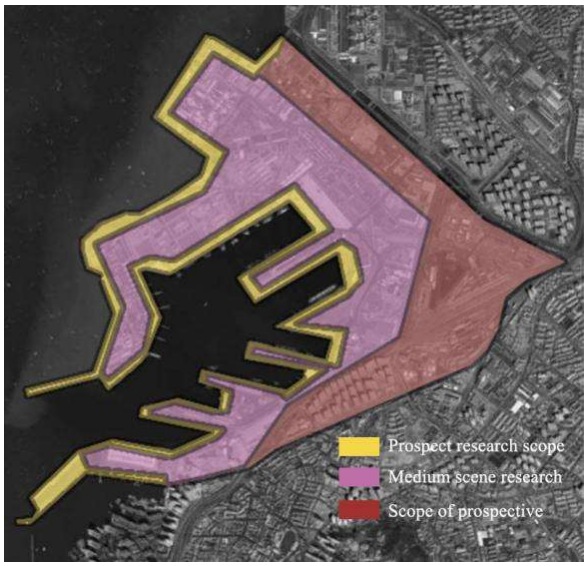

Figure 3. Schematic diagram of the research level of the skyline in Qingdao Dagang District (Source: self-drawn by the author)

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5. Result

5.1 Qingdao Dagang District Industrial Heritage Skyline Vision

The existing buildings (such as grain silos, silos, etc.) on the wharf of Qingdao Dagang District are combined with the background environment from the sea area to the land area in the study area to form the overall shape of the skyline vision. Under the influence of large urban background factors (such as mountains and overpasses), the skyline changes rhythmically. Therefore, controlling the skyline in the future can not only enrich the skyline level of Dagang District, but also have certain reference significance for the planning of Qingdao's skyline.

There are various types of industrial heritage in Dagang District, ranging from silos and gantry cranes with a height of tens of meters to mooring posts and mooring rings with a size of tens of centimeters. Through the analysis of the prospective skyline of Dagang District, it is concluded that the focus of skyline vision control and guidance lies in the smooth display of skyline, and the height of buildings and structures in this area should be coordinated with each other, and the buffer and transition should be designed with emphasis under the mutual influence factors. At the same time, the height and volume of buildings and structures in front and middle skyline should be coordinated with those in the future, and a certain distance and height difference should be kept to improve the overall coordination of the skyline hierarchy.

5.2 Mid-view of Qingdao Dagang District Heritage Skyline

As the part of buildings and structures between the foreground and the distant horizon of the skyline, the middle view plays a connecting role and is the main component of the skyline. To a great extent, it can feel the overall situation and volume of the skyline, so its trend changes can affect the overall visual effect of the skyline. Although the skyline of buildings and structures in Dagang District is necessarily related to their height, it is not that the higher the skyline is, the more obvious its characteristics are. On the contrary, it is the height difference between the buildings and structures in the port area that has a more obvious influence on the trend of the skyline at the middle level. According to relevant research, the higher the folding degree of the outer contour of the skyline, the higher the observer's perception of the skyline.

The focus of the skyline design at the middle level of Dagang District is to give full play to its transitional role of connecting the preceding and the following and the main role of visual C position. In the design, the height of buildings and structures in this area should be appropriately increased, and the volume of some buildings and structures should be appropriately increased to form the transition and folding degree of height difference between buildings and structures. In the design, attention should be paid to coordinating the transition relationship between high and low rhythms of buildings and skyline vision.

5.3 Close-up of the Heritage Skyline of Qingdao Dagang District

The skyline close-up mainly shows the detailed nodes of the skyline, which can reflect the interactive relationship between the skyline and the environment in Dagang District. The landscape of the skyline of Dagang District is mainly composed of water surface and coastal buildings distributed in strips, with specific forms such as water body, dam edge, vegetation, close-up small-scale buildings, landscape structures and sculptures, etc., with various colors and rich levels.

The focus of skyline design in Dagang District lies in the control of skyline visual permeability and the shaping of skyline details. The coastal area should retain a relatively open visual corridor that can reflect the characteristics of the port area, mainly buildings and structures with small height and volume and linear distribution, so as to minimize the interference of some abrupt landscape objects (such as some buildings and structures with exaggerated shapes and colors) on the vision of the coastal skyline.

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6. Conclusion

In this paper, the skyline of industrial heritage in Qingdao Dagang District is analyzed, and the skyline can be optimized on this basis, which is helpful for a more comprehensive understanding of the coexistence relationship of the external space of industrial heritage in Qingdao Dagang District and better driving its protection and reuse, forming a certain radiation range to drive the urban renewal and planning and design of Qingdao coastal area, and making the "production shoreline" of Qingdao Dagang District become a "living shoreline" and the "industrial rust belt" become a "living show belt". At the same time, the research and design of the industrial heritage skyline of Qingdao Dagang District can make use of the "brand capital" effect of Qingdao to create an iconic industrial heritage skyline with Qingdao's urban heritage, enrich the diversity of skyline, adjust the relationship between Dagang industrial heritage skyline and the surrounding environment, and enhance its identifiability with skylines of similar cities, so that it can become another business card of Qingdao after the "May Wind".

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