Hindawi
Scientific Programming
Volume 2022, Article ID 7664803, 8 pages
https://doi.org/10.1155/2022/7664803

Research Article

Design of Commercial Building Complex Based on 3D Landscape Interaction

Hongfei Wang

Art College, Sandong Jianzhu University, Jinan 10430, China

Correspondence should be addressed to Hongfei Wang; 13434@sdjzu.edu.cn

Received 4 December 2021; Revised 25 December 2021; Accepted 27 December 2021; Published 17 January 2022

Academic Editor: Tongguang Ni

The needs of visualization of multidimensional information of the earth, 3D virtual construction, and engineering design are driving research into some technologies of 3D landscape interactive design. The function and availability of the 3D landscape interactive system are largely determined by an efficient interactive algorithm, which is an essential part of the interactive design system of commercial architecture landscape. This paper investigates and evaluates the current state of 3D landscape intersection in landscape design, compares and evaluates existing 3D landscape modeling methods, and proposes some recommendations for the feasibility of a 3D commercial building performance scheme that will serve as a model for future large-scale urban commercial building landscape modeling. When the landscape is represented by objective substances like visual images, people are more likely to actively engage with nature and make automatic decisions based on physiological responses. The introduction of 3D technology has given people's lives a new lease on life, and it is critical to optimize urban planning and management.

1. Introduction

Today's society is rapidly entering a digital world, thanks to advances in global informatization and the development of digital technology, computer software and hardware, database technology, network information industry, database technology, computing graphics and images, virtual reality technology, and so on [1]. The city provides the necessary space for human production and life, that is, urban space, as a relatively concentrated area of human life on the earth [2]. Everything has its own three-dimensional spatial information in reality, which is a true three-dimensional geometric space. It is necessary to create a three-dimensional landscape model of the city in order to express and process the three-dimensional data of urban space [3]. Commercial complexes can provide more convenient centralized living areas based on the needs of users to adapt to the fast-paced urban development [4]. Diversified retail businesses that are closely related to life disrupt the traditional residential business environment model and create a brand new integrated business model of urban agglomeration based on life, pleasure, and a variety of choices [5]. Urban complex is the product of urbanization. It is composed of social living spaces with different properties and uses in the city. Through the introduction of urban public space, it comprehensively combines various scattered spaces, gives full play to the coordination of architectural space and the complementary role of architectural functions, and shows great vitality and abundant development potential [6].

As the social economy has grown, a new commercial format has been introduced from abroad, as evidenced by its name. The urban commercial complex is a significant commercial center in a city, and its significance has outstripped the general concept of structures [7, 8]. There will be a variety of feature models as well as complex and changeable geomorphic models throughout the city. To improve modeling efficiency and quality, we must choose appropriate modeling methods for various features and geomorphology. In this paper, the performance of 3D architecture in landscape design is taken as the main starting point, and the information obtained from field investigation is taken as the main source of thesis materials, and analysis and suggestions are made in the form of investigation report. This paper studies and analyzes the performance status of 3D

landscape intersection in landscape design, and puts forward some suggestions on the feasibility of 3D commercial building performance scheme. The existing three-dimensional landscape modeling methods are compared and analyzed, and their respective characteristics are summarized, so as to provide reference for future large-scale urban commercial building landscape modeling.

Commercial complex itself has many characteristics such as intensification and unity. At present, it is favored by many consumer groups. It is under this background that urban commercial complex architecture has developed rapidly in China in recent years [9]. With the development of commercial architecture performance technology, it not only produces new things, but also makes outstanding contributions to social reform [10]. The performance art of commercial architecture is particularly important [11]. The three-dimensional landscape interactive design method gives the three-dimensional virtual scene of urban landscape, so that designers can deal with the virtual environment flexibly and creatively, establish effective information exchange and interaction between information map and human vision, and carry out knowledge mining [12].

2. Related Work

In literature [11], based on the principle and classification of landscape model expression in urban 3D geographic information system, a batch 3D model construction method of symbol matching and triangulation was proposed for abstract point, line, and area objects, and a set of rapid 3D model construction tools was developed based on this method. Literature [13] points out that the performance of landscape images needs a deeper definition to show them, which is the process that can finally realize the whole view. Literature [14] points out that urban commercial animation is not only a work of art with originality, aesthetics, image, and emotion, but also a commodity and a special cultural product. In literature [15], based on 2DGIS, a 3D city map was developed, and the building model within the city was built with simple geometry. Literature [16] puts forward the idea of establishing the 3D model base of urban landscape to realize the rapid reconstruction of urban 3D landscape. Literature [17] mentioned in the research that, in the process of urban construction, we should maintain the existing urban history and culture, do a good job in the publicity and popularization of urban history and culture, and create a strong urban cultural atmosphere and noble urban humanistic spirit.

Literature [18] discusses the scientific and technological expression methods of landscape design. In order to meet the requirements of the new world and people's fast-paced lifestyle, the three-dimensional landscape design has become increasingly prominent, allowing people to place themselves in the digital three-dimensional and experience the unique visual and auditory feelings that virtually brings to people. Literature [19] shows the realistic animation of urban outlook landscape, which can intuitively reflect the development process of the city, make the performance of urban context and image more prominent, and show people's life forms in the city. Literature [20] shows that the three elements of space, path, and visual threshold give full play to the interaction and show multimeaning space. Its organizational mode causes overall environmental participants to increase their autonomous activities, improve their sense of self-satisfaction, provide positive feedback to the environment, affect the interactive experience between the environment and participants once more, and effectively realize interactive media interaction and communication. The combination of various formats, complementary interests among formats, close relationship with cities, and other characteristics of urban complexes are mentioned in literature [21]. Many factors contribute to the operation's success. Although external open space landscape design is one of them, its function is indispensable. The rules of urban design may be reversed, interrupted, or even abandoned for different people under different circumstances. It examines the city's construction from a different perspective, and it also aids my search for a new learning angle in this topic's research. The construction of a virtual city landscape, the use of three-dimensional landscape intersection, and the method of three-dimensional landscape modeling are all examined in this paper.

3. Methodology

3.1. Virtual City Landscape Construction. For a large-scale complex scene, the establishment and optimization of the model are extremely important. Interactivity and realization intention need to be considered. Compared with animation model, there are usually fewer details to improve the real-time effect. On the existing basis, people can only sacrifice the perfect and accurate visual art, achieve a higher level of realism through the balance with real time, and construct a virtual environment that can realistically simulate the real world [22]. With the rapid development of software technology, the computing speed of microcomputer exceeds one billion times. The new technology of computer graphics display card greatly accelerates the computing and processing of landscape data and makes the visual development system of landscape reach a new level of rapid interaction. Three-dimensional landscape visualization equipment has also been greatly developed, and a large amount of production is also slowly carried out. The development of software has mushroomed, and a series of 3D landscape visualization software has been developed [23].

Natural topography and human landscape are included in three-dimensional landscape, which includes complex three-dimensional topography, simple matchbox-shaped houses with regular shapes, trees, waters, and even moving cars and pedestrians, among other things. The foundation of the entire virtual scene and one of the most important research fields in the virtual geographical environment is urban landscape modeling. For a long time, computer scientists have been attempting to replicate a real three-dimensional scene in the real world in the computer [24]. Computers can now draw various complex and realistic 3D scenes in real time, thanks to advances in 3D visualization technology, virtual reality, and real-time realistic graphics,

and this ideal is becoming a reality. Drawing based on graphics or geometry, which is actually the simulation of the light interaction process of objects in real scenes, is the traditional method of 3D representation of real objects. The brightness of each visible point on the screen is calculated by the drawing algorithm. Figure 1 depicts the procedure.

People have an insatiable desire for city life in order to survive and develop in the city and to live better in the city. Currently, the urban commercial complex has established itself as a significant commercial center of the city, gradually replacing the previous single architectural model by appearing in the form of a building complex, combining the contents of urban living spaces such as office, business, and residence in the city, and establishing a dynamic relationship of mutual benefit and interdependence on this basis. We can establish an object behavior model independent of user input, in addition to mathematical modeling of the direct response of object motion and physical characteristics to user behavior, as the embodiment of virtual reality's autonomy. The research of a new generation of modeling methods represented by behavior modeling is on the rise, and its application prospects are very promising [25]. With the continued development of virtual reality technology and the expansion of the application field of virtual reality technology, the research of a new generation of modeling methods represented by behavior modeling is on the rise, and its application prospects are very impressive. Determine the spatial position and geometric shape of each building object using the urban basic geographic information database, then get its basic three-dimensional shape using height information, and then map according to the texture of each facade to get the building's basic model.

The building viewpoint data model mainly applies the storage method of point data in vector data; that is, the coordinate points of the building are stored. The attribute data model in the system can be designed into several attribute information tables by applying the design principle of general relational database. The object hierarchy in the vector data model is shown in Figure 2.

The modeling environment provides interactive, multidisplay, and user-defined 3D graphic viewer and a two-dimensional hierarchical structure diagram. All the displays are interactive and fully related, and this flexible combination accelerates the organization of database, model generation, modification and editing, and the definition of structural relationship. In general, there are two types of virtual scene model object representation, specifically representing the outline and shape of primitives in the objects, which can save calculation time during generation but requires a lot of time and space to store and access, and specifically representing the outline and shape of primitives in the objects, which can save calculation time during generation but requires a lot of time and space to store and access. It is beneficial to storage in principle, but it must be recalculated each time it is used. When drawing graphics, it switches among these detail models based on the distance of viewpoint or other standards and automatically selects the corresponding display level, allowing the scene's complexity to be changed in real time without affecting the visual effect. However, the primary goal of using examples is to save memory; as a result, the display speed will be accelerated; however, because the geometric position of objects must be obtained through geometric transformation, the amount of calculation required by the system will obviously increase as the number of example objects increases.

3.2. Application of 3D Landscape Intersection in Commercial Building Complex. Landscape visualization emerges when information technology has progressed to a certain point. The three-dimensional landscape has become the main stage as a result of the advancement of electronic technology. Despite the fact that China is late in developing landscape visualization, many advances have been made in recent years, including research and development of 3D technology for urban landscape visualization, interactive operation of 3D scene models, 3D dynamic interactive visualization models, and visualization technology and its application in geological exploration. Communication expresses the superiority of three-dimensional architectural design, and traditional renderings based on artificial modification contain some misleading elements. However, by presenting the real estate to the developer in the form of a 3D animation, the developer can make an accurate assessment of the scheme's characteristics and quality based on personal experience, allowing the developer to select the best strategy, maximize land utilization and construction project development rates, and significantly increase the cost. By displaying large-scale projects with vivid 3D technology, a vivid 3D model can be built, which can meet the requirements of the masses from multiple angles, levels, and directions, and make reasonable distribution for each key point and channel of the building itself, which resonates with people's design ideas [26]. According to the requirements of the planning scheme, various 3D building models are arranged on it, the simulated digital terrain is generated according to the contour lines of the actual terrain, and with the help of 3D animation software, an animated tour path is created, and finally a section of building roaming with the help of 3D software is completed. Later, text description, music background, graphic materials, and so on can be added to it by software, and some simple query functions can also be realized.

We can show the exterior and interior of the building in detail, as well as the surrounding environment, using 3D representation technology, as if we were on the spot. As a result, first, the workload of the building created using 3D representation technology is reduced, and second, people can more easily feel the information they require. Finally, thanks to advances in 3D technology, people can now modify their dissatisfaction at any time and from any location, greatly reducing time and improving quality. Virtual modeling using geometric models is based on computer graphics, which abstracts the real scene and creates a 3D geometric model of a virtual landscape using polygons. After that, texture mapping and control parameter setting takes place. Finally, using software control, real-time rendering and drawing of the visual picture on

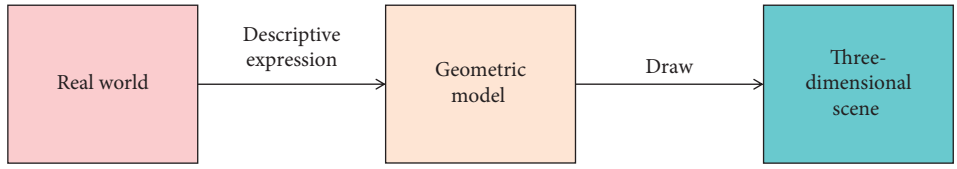

Figure 1: 3D scene construction process.

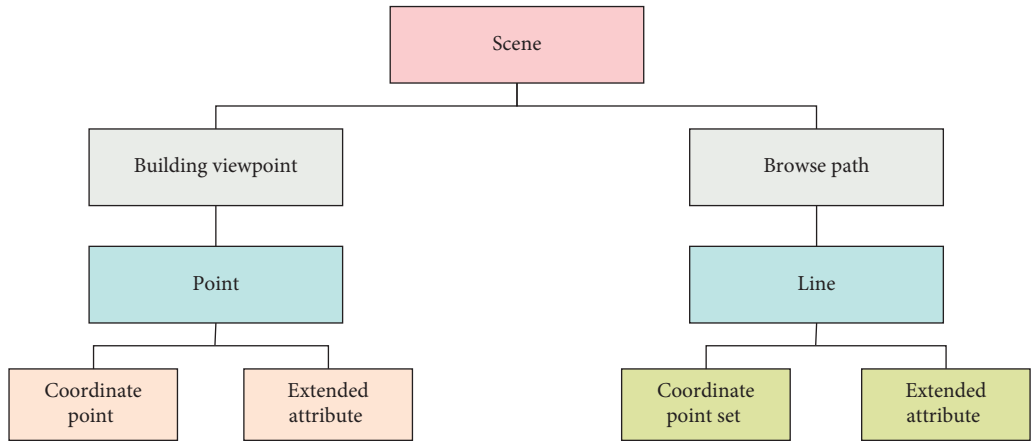

Figure 2: Object hierarchy in the vector data model.

the output device are carried out based on the observer's position, illumination, and blanking information, completing the roaming of the entire scene. Figure 3 depicts the modeling process.

With the appearance of 3D technology, the requirements of computer software and hardware are also improved. The improvement of computer hardware is not difficult, but the improvement of software technology is an arduous task, and there are always unsolvable problems. However, thanks to today's rapid advancements in science and technology, computer software and hardware technology have vastly improved, laying the hardware foundation for 3D landscape intersection technology and expanding its application field. The use of 3D landscape intersection technology in virtual reality, architectural performance, and film and television scenes reflects its importance as a display medium in the field of architecture. It deviates from previous plane renderings' simple plane layouts, combining high-tech animation techniques with gorgeous film and television special effects, vividly and concretely depicting the style of architectural buildings or unique urban buildings, and integrating people's rich life plots, the geographical location of buildings, and the beautiful environment. The rapid growth of China's economy has increased demand for real estate, and the continuous development of urban planning has given architectural animation significant market power. Its outstanding qualities make it a highly sought-after golden occupation field in the twenty-first century.

The relationship between urban status evolution and influencing factors is as follows:

$$Y = F(A, X). \tag{1}$$

Y is the change level of urban state, X is the influencing condition, A is the effect of the influencing condition, and F is the action function. Let us assume that there are n city states that have not been evaluated, the relative change of city states is y, and there are m influencing factors x. Among them, each influencing factor is X, the urban planning factor is x_p, the influence degree of each influencing factor is A, and the influence degree of urban planning factor is a_p. The formula can be expressed as,

$$y_n = f_n\left(a_1, a_2, \ldots, a_p, \ldots, a_m, x_1, x_2, \ldots, x_p, \ldots, x_m\right). \tag{2}$$

Taking into account the spatial and temporal dimensions, this relationship can be expressed as,

$$Y_k^t = F\left(A_k^t, X_k^t\right), \tag{3}$$

where k is the area ID and t is the time period. The area k has the city state $s_k^{t_s}$ at the start time of the time period t and the state $s_k^{t_e}$ at the end time, and then the city state changes $y_k^t = s_k^{t_e} - s_k^{t_s}$ of the area k at the time period t.

The inconvenient expression of architectural language and the designer's poor expression of perspective make it difficult for the masses to communicate and understand the design significance, and traditional architectural expression has significant limitations. We must mention the urban simulation system in the field of urban planning. Its significance lies in the application of virtual reality technology to urban landscape planning and design, with the goal of establishing a real model to reflect the urban environment and then realizing the real model through on-the-spot investigation and data capture into the computer. As a result, using 3D virtual technology and designers' creative ideas, we can fully express a single building, its material color, and our

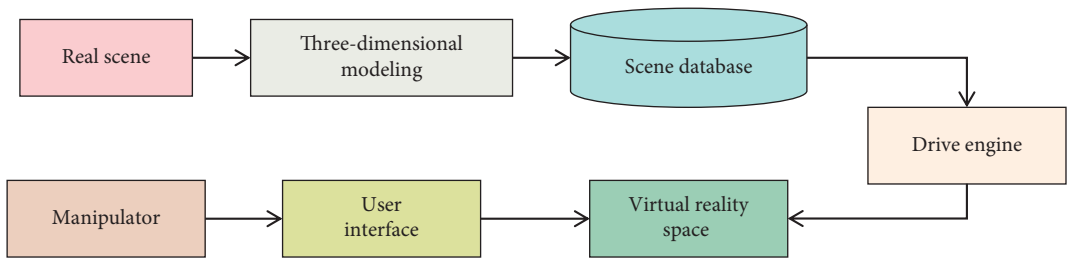

Figure 3: Flowchart of the modeling method.

own cultural information when we want to express all-round architectural information. People require more direct visual expression, and the intersection of three-dimensional landscapes has unquestionably become a necessary tool for people to enjoy the best visual experience. As a result, it is critical to incorporate 3D landscape intersection technology into the user participation design system, as traditional architectural performance is unmatched. It will be more widely used if 3D landscape intersection technology is applied to it.

4. Result Analysis and Discussion

4.1. Three-Dimensional Representation of Urban Landscape Commerce. Through the technical means of three-dimensional animation, artworks that show the vividness, aesthetics, creativity, and emotion of three-dimensional dynamic images from all angles [27]. The prospect of urban three-dimensional commercial performance in practical commercial application is still very broad. With the development of computer technology and technology, there will be more and more mature methods for building urban 3D landscape models, with higher modeling efficiency and better model quality. An important part of the three-dimensional landscape interaction is the three-dimensional animation of urban prospect landscape, which is essentially different from other kinds of animation. It mainly focuses on the prospect of future urban development and teaches intuitive three-dimensional deduction of future cities, showing the expression methods of urban development, urban rhythm, and urban image color. It can intuitively interpret the state of people's lives and the features of the city.

The physical attributes of objects are considered in the modeling of commercial complex. Fractal technology and particle system are typical physical modeling methods. Fractal technology can describe data sets with self-similar characteristics. Figure 4 shows the comparison results of algorithm performance before and after storage optimization.

Cultural Preservation in the City Landscape architecture performance is a form of cultural protection for urban landscapes based on the display of visible and intangible, static, and dynamic virtual reality technology. Today's cities are rapidly developing, but this rapid development has severely weakened the cities' original cultural atmosphere as well as their historical and cultural heritage. We should make a strong appeal to our people to protect our traditional urban culture and historical culture, using urban culture to protect landscape architecture animation, raise societal awareness, and deeply love our own urban history and culture; history is irreversible, so how can we strengthen awareness of inheriting our own history and culture, maximize protection, and make the city where we live have a good cultural atmosphere?

As a new business model, commercial complexes have not been in China for a long time, and there are basically no successful examples in China for reference. In fact, urban commercial landscape is to display the characteristics of the original architectural style in urban commercial complexes from the perspective of landscape designers and, at the same time, make these commercial buildings bring people a warm, comfortable, and relaxed shopping and leisure environment. Commercial landscape design should be combined with urban design, so that the landscape can reflect the humanistic and three-dimensional characteristics and better integrate with the city, thus providing important guidance for urban development. Landscape design can humanize the architectural space, at the same time, increase more added value of fine products, and also have a great impact on the lifestyle of residents. On the whole, the construction of business environment has certain forward-looking characteristics. Landscape ecology places special emphasis on maintaining and restoring the continuity and integrity of landscape ecological process and pattern, that is to say, maintaining the spatial relationship between residual green patches in cities and natural patches in wetlands.

The commercial building complex model created based on the task of three-dimensional landscape interaction can solve the possible design problems and quality problems of the project in advance through collision detection and other forms. Figure 5 shows the comparison of simulation of commercial building topology reliability optimization before and after optimization.

Three-dimensional landscape interaction measurement relationship is also widely used in planning results in the area statistics of planning land, the calculation of floor area ratio of different land types, the height and density of buildings, and the minimum distance between buildings with different heights. The approximate relationship between road width and building area is shown in Figure 6.

As a public place to provide consumption and leisure for urban residents, the landscape design of urban complex must strictly follow the principle of publicity. To a great extent, it has replaced urban public spaces such as city

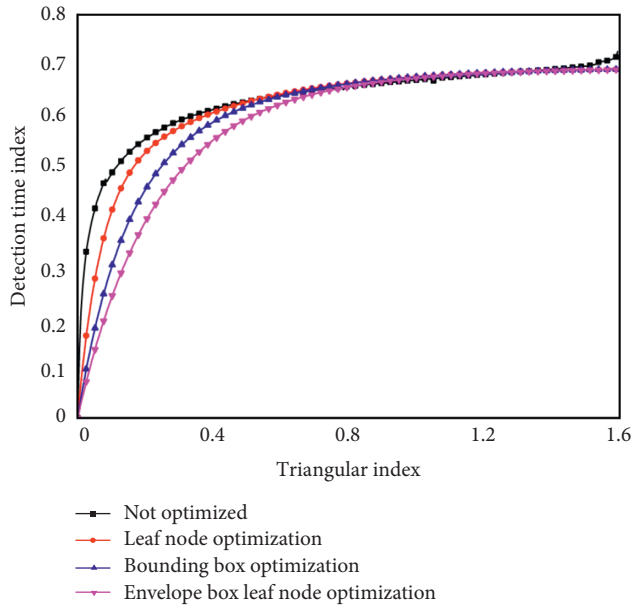

Figure 4: Comparison of algorithm performance before and after storage optimization.

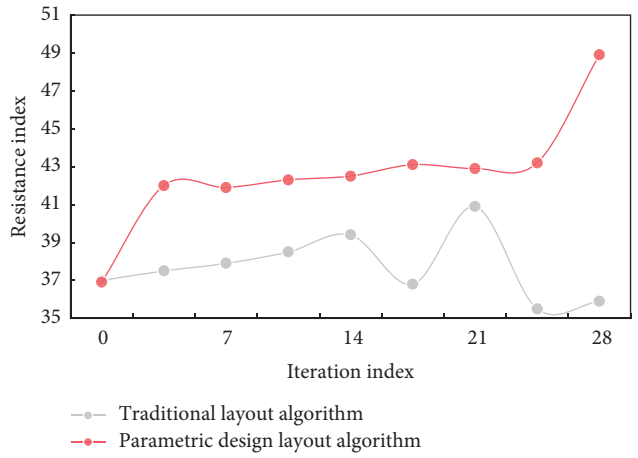

Figure 5: Simulation comparison of commercial building layout optimization.

streets and squares, and now urban commercial complexes have evolved into a main carrier of urban public activities. In the commercial landscape design of urban complex, the whole city should be regarded as a whole, and the construction should be based on it. In this case, the boundary between the city and the building becomes increasingly blurred. At the same time, designers should pay full attention to local historical and cultural traditions and pay attention to issues such as national personality, cultural customs, and religious beliefs, so as to show local characteristics by using various expression techniques in the design process.

4.2. Analysis of Building Characteristics. The method of building model includes the plane data and height data of the building. With the development of computer technology

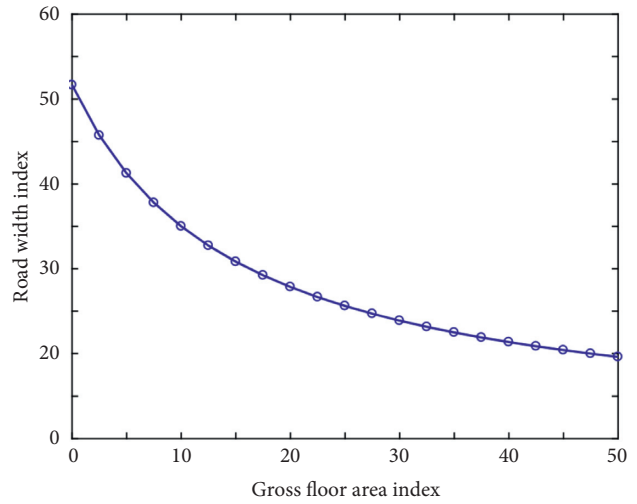

Figure 6: Relationship between road width and building area.

and graphics technology, some modeling software can be used to achieve finer and finer modeling to meet the basic visualization requirements into the three-dimensional modeling software and then directly stretch to the corresponding height to get the basic external surface model of the building. Through texture mapping, a complete building model can be obtained. Geometric modeling is the first development in the three-dimensional landscape interaction of commercial building complex layout. Analyze its path density, number of nodes, and central potential. The relationship between path density and node path is shown in Figure 7.

In terms of function, the close overlap between necessary space and auxiliary space improves the utilization rate of commercial landscape space and the vitality of space, thus strengthening space communication and strengthening commercial functional space. In terms of form, polysemy space revolves around the theme of complex landscape, and multidirectional guiding space is used in landscape nodes such as scenic spot transformation, so as to transform the space into nature, coordinate and strengthen the landscape theme as a whole, and promote the accessibility of the theme. Following the characteristics of people's public activities, the route layout considers the various route requirements of various formats in commercial complexes, and vertical traffic such as inevitable routes, horizontal passages, and landscape continuous routes is organized in a network to ensure high accessibility of major activity areas. Building texture is an important part of the 3D landscape. The majority of texture data comes from field photographs and is directly related to 3D scenes. As a result, texture data quality determines whether a more realistic expression effect can be achieved. Roads and their appendages, vegetation, the water system, independent features, and so on are examples of surface appendages. The 3D expression of plants such as flowers, trees, and other objects is an important part of the 3D landscape during the construction of the entire city 3D landscape, and it is also directly related to the fidelity of the 3D landscape expression.

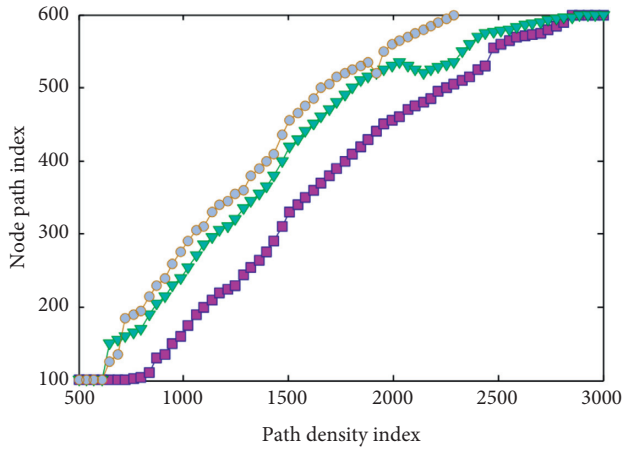

Figure 7: Path density and node path relationship.

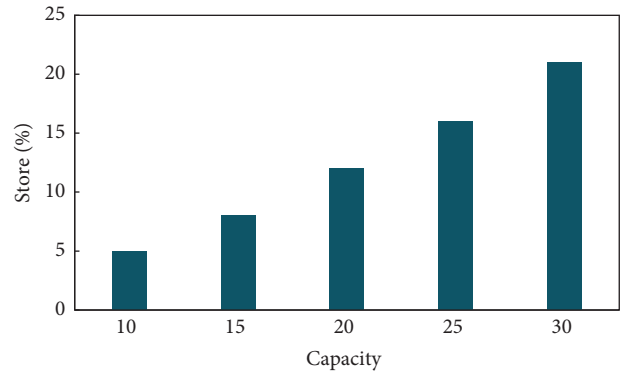

Figure 8: Excess cost ratio of single domain strategy.

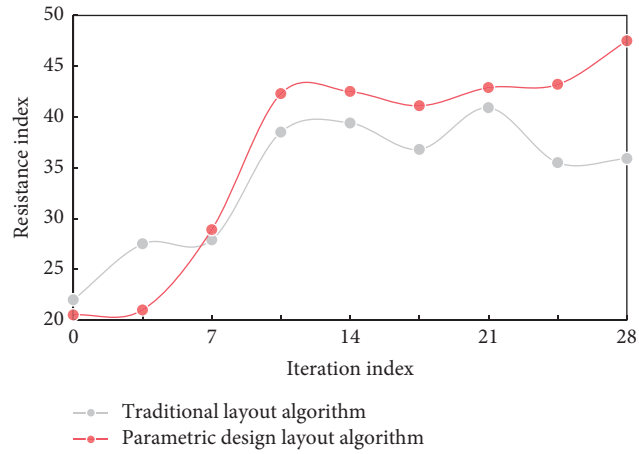

Figure 9: Simulation comparison.

The top texture of 3D building model cannot be directly obtained by field photography, so it can only be collected from orthographic images with original resolution, which can reduce workload and difficulty, and at the same time ensure the quality of texture data. Assume that the capacity of intradomain links is the capacity of interdomain links. The performance is illustrated by three different scenarios, as shown in Figure 8.

Fully consider the psychological factors of the active crowd, follow the changes of space and path, set the viewpoint, consider the attraction and guidance of the crowd's sight within the scope of sight, and consider the intensity and density of the sight direction and each attraction point within the visual threshold scale when arranging the landscape nodes. From the viewpoint, according to the sight demand of the active crowd, the scenic spots with different intensities and spaciousness are displayed in different sight scales, such as intimacy scale, etiquette scale, and public scale, so as to influence the diversified choices of user paths and make the experience interaction between each scenic spot and users. The simulation comparison of topology stability optimization is shown in Figure 9.

From the beginning of people's participation in the landscape experience, they have been actively or passively playing the role of interactive experiencer in the landscape, and their interaction mode is mainly direct expression, that is, active and direct participation in the landscape. Usually, when the landscape is represented by objective substances such as visual images, people tend to get close to nature actively and make automatic choices based on physiological reactions. The typicality of scenic spots and synaptic settings are the direct choice of human-landscape interaction. Effective arrangement of facilities and landscape nodes play a leading role in people's sense of participation and experience. Second, when the overall artistic conception of the environment is coordinated with the theme, the crowd's freedom will change the way they experience the world with the change of the path, be attracted by sound and shadow, be attracted by the gathered crowd, be attracted by unexpected events that have not been planned, and so on, all of which will have an impact on the interactive subject. The study of the interaction of commercial complexes and 3D landscape design can help to boost the economic benefits and vitality of urban commercial areas, as well as promoting the organic coexistence and development of people and the urban commercial landscape.

5. Conclusions

The development of history and civilization is not fast, and it will not have a long span, due to the city's constant expansion and construction. In general, once a city has reached a certain level of development, it is relatively stable. Modern cities have a large population, a large scale, and a complex functional structure, making commercial building complexes difficult to define and shape. This paper systematically examines related theories and methods in the construction of virtual cities, with a focus on comprehensive virtual city modeling, three-dimensional visual browsing and query, and so on. It has quickly spread throughout the city as a dynamic factor that can best promote urban economic development due to its development mode of maximizing land use. It is difficult for a single commercial structure to become a business gathering place. As a result, the commercial building complex has become an advantageous commercial carrier, allowing for increased attention to

outdoor open space landscape design. The external space of an urban complex is systematically planned using modern landscape design knowledge, creating a landscape environment with intensive functions, high identification, and reasonable spatial combination, and jointly acting on a region to bring economic benefits. With the rapid advancement of science and technology, we must not only preserve our cultural heritage, but also begin to learn and receive new knowledge, as well as arming ourselves with new science and technology, in order to construct a better city and achieve faster development.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] D. Yu, "Discussion on the landscape design trend of the interior space of commercial building complexes," *Western Leather*, vol. 38, no. 20, 1 page, 2016.

[2] R. Lu and Z. Lu, "Urban landscape design works. Research on interactive landscape design of urban commercial complexes," *Shanghai Textile Technology*, vol. 6, no. 6, pp. 69–71, 2019.

[3] R. Lu and Z. Lu, "Research on interactive landscape design of urban commercial complex," *Shanghai Textile Technology*, vol. 47, no. 6, 3 pages, 2019.

[4] N. Peng, "Analysis of commercial landscape design in urban complex," *Urbanism and Architecture*, vol. 4, no. 6, 1 page, 2017.

[5] Y. Zhang, "Research on the application of landscape elements in the interior space of urban commercial complex," *Modern Horticulture*, vol. 18, no. 18, 1 page, 2016.

[6] R. R. Morajkar, R. L. Klomparens, W. E. Eagle, J. Driscoll, M. Gamba, and J. Benek, "Relationship between intermittent separation and vortex structure in a three-dimensional shock/boundary-layer interaction," *AIAA Journal*, vol. 2, pp. 1–19, 2016.

[7] F. Jian, Y. Yao, A. A. Zheltovodov, and L. Lu, "Investigation of three-dimensional shock wave/turbulent-boundary-layer interaction initiated by a single fin," *AIAA Journal*, vol. 55, no. 22, pp. 509–523, 2016.

[8] M. Sessarego, N. Ramos-García, H. Yang, and W. Z. Shen, "Aerodynamic wind-turbine rotor design using surrogate modeling and three-dimensional viscous-inviscid interaction technique," *Renewable Energy*, vol. 93, no. 8, pp. 620–635, 2016.

[9] B. H. Smith, S. R. Arwade, B. W. Schafer, and C. D. Moen, "Design component and system reliability in a low-rise cold formed steel framed commercial building," *Engineering Structures*, vol. 127, no. 11, pp. 434–446, 2016.

[10] F. L. Sun and C. Y. Dong, "Three-dimensional crack propagation and inclusion-crack interaction based on IGABEM," *Engineering Analysis with Boundary Elements*, vol. 131, pp. 1–14, 2021.

[11] L. Xu, Y. Zhao, Z. Li, C. Shi, and Z. Yu, "Three-dimensional vehicle-ballasted track-subgrade interaction: model construction and numerical analysis-ScienceDirect," *Applied Mathematical Modelling*, vol. 86, pp. 424–445, 2020.

[12] Z. Zheng, G. Duan, N. Mitsume, S. Chen, and S. Yoshimura, "An explicit MPS/FEM coupling algorithm for three-dimensional fluid-structure interaction analysis," *Engineering Analysis with Boundary Elements*, vol. 121, pp. 192–206, 2020.

[13] T. V. Buren, M. Beyar, C. M. Leong, and M. Amitay, "Three-dimensional interaction of a finite-span synthetic jet in a crossflow," *Physics of Fluids*, vol. 28, no. 3, pp. 2394–2402, 2016.

[14] A. Winzen, B. Roidl, and W. Schröder, "Combined particle-image velocimetry and force analysis of the three-dimensional fluid-structure interaction of a natural owl wing," *Bioinspiration & Biomimetics*, vol. 11, no. 2, Article ID 026005, 2016.

[15] K. Jong-Young, K. Tae-Eon, K. C. Gun et al., "Three-dimensional culture and interaction of cancer cells and dendritic cells in an electrospun nano-submicron hybrid fibrous scaffold," *International Journal of Nanomedicine*, vol. 11, pp. 823–835, 2016.

[16] W. Parasil and N. Watanabe, "Nonlinear dynamical analysis of interaction between a three-dimensional rubberlike membrane and liquid in a rectangular tank," *International Journal of Non-linear Mechanics*, vol. 87, pp. 64–84, 2016.

[17] C. Curró, N. Manganaro, and M. V. Pavlov, "Nonlinear wave interaction problems in the three-dimensional case," *Nonlinearity*, vol. 30, no. 1, pp. 207–224, 2017.

[18] H. Cho, N. Lee, J. Y. Kwak, S. J. Shin, and S. Lee, "Three-dimensional fluid–structure interaction analysis of a flexible flapping wing under the simultaneous pitching and plunging motion," *Nonlinear Dynamics*, vol. 86, no. 3, pp. 1951–1966, 2016.

[19] N. Zhang and J. Lian, "Interactive architectural garden landscape roaming design based on 3DMAX," *Modern Electronic Technology*, vol. 43, no. 3, 5 pages, 2020.

[20] N. Liu, Y. Guan, and X. Bai, "Research on the design of three-dimensional parking space in commercial complex based on AHP," *New Building Materials*, vol. 46, no. 8, 6 pages, 2019.

[21] F. Fu, Z. Liu, and Q. Huang, "Three-dimensional urban landscape pattern change characteristics in Futian District, Shenzhen," *Acta Ecologica Sinica*, vol. 39, no. 12, 10 pages, 2019.

[22] W. Wang, "Discussion on the fire protection design of the large-scale commercial complex building atrium," *Fire Science and Technology*, vol. 037, no. 008, pp. 1098–1100, 2018.

[23] L. Ning, "Discussion on the fire protection design of a large commercial complex," *Fire Science and Technology*, vol. 36, no. 9, 2 pages, 2017.

[24] K. Zhao, D. Stead, H. Kang, F. Gao, and D. Donati, "Three-dimensional numerical investigation of the interaction between multiple hydraulic fractures in horizontal wells," *Engineering Fracture Mechanics*, vol. 246, no. 2, Article ID 107620, 2021.

[25] S. Nikolai, S. Claire, V. Jonathan, and L. Stéphane, "Simulation of three-dimensional nanoscale light interaction with spatially dispersive metals using a high order curvilinear DGTD method," *Journal of Computational Physics*, vol. 373, pp. 210–229, 2018.

[26] K. B. Lua, Y. J. Lee, T. T. Lim, and K. S. Yeo, "Wing–wake interaction of three-dimensional flapping wings," *AIAA Journal*, vol. 55, no. 3, pp. 1–11, 2016.

[27] M. Z. Baykara, H. Moenig, T. C. Schwendemann, Ö. Ünverdi, E. Altman, and U. Schwarz, "Three-dimensional interaction force and tunneling current spectroscopy of point defects on rutile TiO2(110)," *Applied Physics Letters*, vol. 108, no. 7, Article ID 9384, 2016.