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Research article

Design of an automatic landscape design system in smart cities based on vision computing

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Abstract: In future smart cities, automatic landscape design can be viewed as a promising intelligent application to reduce the reliance on expert labors. As it is a kind of visual sensing activity, it is expected to develop a robust interaction platform with strong ability of visual information fusion. To deal with this issue, this paper integrates vision computing, and designs an automatic landscape design system in smart cities. The whole design framework can be attributed as three aspects of works: function analysis, structure design and implementation. Among, the visual information processing runs through the three aspects. Then, the generation process of landscape design is simulated in detail via a systematic case study. To prove the significance of visual information processing in our proposal, this article uses a model analysis method to compare the effects of traditional data processing technology and visual data processing technology. The analysis results show that vision computing technology provides technical support for landscape design. We also carry out some performance testing towards the designed automatic landscape design system, and evaluation results are demonstrated via visualization format. The designed automatic system is a proper prototype that can be developed to realistic engineering systems by some following completion.

Keywords: Intelligent systems; smart cities; automatic landscape design; vision computing

1. Introduction

Since entering the 21st century, the concept of sustainable development has become the most important theme of this century. People have been doing their best for the natural ecology. With the continuous development of science and technology, people use computer means to help society enter the ”information society” and ”digital society”. At the same time, research directions such as ”Digital Earth”, ”Digital Economy” and ”Digital City” are also emerging. These characteristics all mark a rapid increase in human productivity. These characteristics are also a major new turning point in the development of human civilization. Since the mid-20th century, the wave of the information revolution has developed rapidly. The development of information technology has a more lasting and far-reaching impact on the entire society [1, 2]. This round of information revolution is caused by the rapid development of information technology. The information revolution has brought about the adjustment and innovation of different industrial structures, and this technology has also profoundly changed the material environment and information environment on which human beings live [3, 4]. Similar to the previous revolutions of the times, the information revolution also relies on its enormous impact to change the social structure around us. Information technology affects our way of life and the social culture of the public in many ways. All aspects of our life, work, study, entertainment, transportation and social life will be completely changed with the introduction of information technology [5, 6].

With the continuous development of digital technology, the role of this technology has changed from computer-aided design to parametric co-design [7, 8]. Digital technology is playing an increasingly important role in landscape practice, which puts forward new requirements for the concept, content and method of landscape design. The core of digital design is to realize the optimal design scheme through calculation rules and parameter settings. This technology can better improve the efficiency and accuracy of the design [9, 10]. The introduction of digital methods in landscape design breaks through the excessive reliance on experience and vision in the conventional design process. This method reduces the disadvantages of the creator's subjectivity and randomness, and makes the design results more rational and scientific [11, 12]. At present, the application of digital technology to landscape design is mainly reflected in the following aspects [13]. First of all, in terms of expression, digitalization and landscape design are integrated with each other, adding a variety of artistic expressions. Secondly, in terms of media materials, digital technology provides a new method for the creation of landscape works [14, 15]. The technology integrates digital media such as computers, projectors, monitors, sensors, voice-activated devices, and communication equipment. Finally, from the perspective of technical means, in the process of digital landscape design, a variety of technical means have been introduced simultaneously in the creation and generation of works. These contents include computer technology, imaging technology [16, 17], virtual reality technology, holographic imaging technology, interactive sensing technology, remote sensing technology, network multimedia technology, etc. The expression of the design scheme of landscape architecture is divided into two parts: the expression of design drawings and the expression of construction drawings. After the design results enter the feedback stage, they will quickly enter the final expression stage of the scheme.

The use of intangible media by digital technology is gradually changing the traditional landscape design concepts and methods [18, 19]. Digital technology will be applied to the creative process as a new method, which brings a new artistic form to landscape works. This method breaks the boundaries of the original three-dimensional angle, allowing art to truly involve multi-dimensional space. This method is also a great revolution in the history of landscape design. In recent years, computer technology, remote sensing technology, geographic information technology and global satellite positioning technology have been continuously developed. In the professional field of landscape architecture, digital landscape technology (digital landscape architecture technology) has been developed for nearly half a century [20, 21]. The development of information technology can more and more reflect its core productivity and main competitiveness. With the development of digital technology, people's way of life, social economic production situation and even social spatial organization have undergone tremendous changes. Digital computer models are commonly used in landscape architecture, planning and design, and other related disciplines [22, 23]. The technology is used in areas such as visualizing proposals, evaluating alternatives, and modeling impacts. Numerical models refer to those modeling methods in the computer's memory. These methods only present changes in form or appearance at render time.

In general, the validity of model conclusions depends on the quality and characteristics of the model. In many cases, GIS systems are capable of creating representations of landscape suitability and visualization. CAD systems are mainly used to make 3D renderings of pavement geometry or to estimate cut fill volumes. Landscape ecologists use differential equations and particle systems to describe dynamic developmental processes such as vegetation succession. Generally speaking, visualization methods are mainly used for the details of the development of things as perceived by humans. Designers need to consider the overall structure and details of the design scheme. On the one hand, the results of the scheme need to fully express the design details. The project team should use exquisite renderings to show the design content to the outside world. Over the past 30 years, this technology has been extensively developed and explored, and it can provide unexpected information. The digital collection technology of landscape information is also developing continuously [24, 25].

Generally speaking, the traditional methods of describing landscape information include language, topographical maps, hand-drawn drawings or photographic pictures and so on [26, 27]. There are various types of media that can be recorded in these methods, usually paper or film. The digital collection forms of landscape information can be roughly divided into two categories: one is to record the existing data on the storage medium, the other is to use modern scientific and technological equipment to quantify the landscape information data, and then record it in the form of data in the storage medium. The existing planning and design drawings include various aspects, such as general plan, renderings, aerial views, perspective views, photos or models, architectural sketches, section views, etc. These contents can represent the digital landscape information at different times, including a large amount of qualitative information, and resume the landscape database according to a certain mapping method, and can extract and query various information, and count, edit, extract and output various general and official elements. On this basis, the landscape design unit can carry out a concrete analysis of the landscape environment through mathematical models.

2. Application of visual data processing technology in different stages of landscape architecture design

2.1. Application of visualization technology in the pre-analysis stage of the scheme

Generally speaking, experts and scholars can carry out field research on design sites together with designers. Among them, the scheme designer collects and organizes the preliminary data of the scheme. Designers have a preliminary understanding of the design site by means of photography and field measurements. Based on the original materials given by the client, the designer understands the client's subjective and objective needs for the design. In addition, the designers further analyze and grasp the main ideas of the design work based on the data obtained from the previous research [28, 29]. The designer further selects the objects and goals of the design, and further conceives the overall design scheme [30].

Designers need to systematically analyze the rationality of the project. In the early stage of design, experts give targeted guidance and suggestions to the design team through visual data processing methods. The design team further analyzes the favorable factors and unfavorable factors in the site, and gives opinions and analysis on repairing or avoiding. The basic information of the site that the design team usually needs to master includes several aspects. First, the design team needs to sort out and analyze the general situation of the project location. These include atmospheric conditions, light, temperature, wind speed, wind direction, geological and hydrological information. In addition, the design team needs to analyze the surrounding environment of the design site. The specific content includes the basic situation of the traffic conditions around the design site and the distribution of facilities in the surrounding area. Finally, the design team needs to further analyze the environmental data in the site. The specific content includes topography, vegetation distribution, water system trend and so on. Generally speaking, designers can conduct preliminary analysis of the design site by combining the image data of field research and visualization software such as Google earth.

Visualization technology can provide a new way of expression. This visual expression is different from the traditional expression in the past. With the continuous development of visualization technology, the technical process of landscape garden design has also undergone great changes. Generally speaking, designers complete the gap between traditional design methods and design ideas through BIM technology. In addition, designers can also conduct preliminary spatial analysis of the site environment through GIS or CAD files. Through these methods, designers can understand the land use, planting density and other conditions of the site. These work contents help designers to have a more comprehensive understanding of the resource allocation in the design site. The application of these visualization tools can provide a good foundation for scheme design, and can provide designers with more systematic scientific judgments. In addition, the pre-analysis of the design scheme is very important, and this stage directly affects the quality of the final design results. Designers use visualization technology to communicate, express and directional planning of projects. The work at this stage also plays a catalytic role in the connection and series work of the subsequent design stages.

The framework of landscape design research method based on visual data processing technology as shown in Figure 1. It can be seen from Figure 1 that visualization technology is a comprehensive technology that is widely used today. The process of using landscape architecture design involves a series of latest research results in high-tech fields, from computer hardware facilities to software development research. As a graduate student majoring in landscape architecture, the author tries to start from the process and needs of landscape architecture design, sort out the software tools and their functions that can be used in landscape architecture design, list the technical methods for the establishment of landscape models, and demonstrate the application of BIM concepts to landscape architecture. The necessity and feasibility of gardening profession. The focus of the research is on "the application of visual landscape information model to the planning and design of landscape sites as a scientific and convenient auxiliary design tool". The project team needs to use structural construction drawings for technical evaluation. The project team can perform real-time switching from renderings to construction drawings through visualization software such as Vector works. The visual data analysis method is conducive to the scientific expression of the design scheme.

Combining both theoretical and practical application levels to conduct research on process and operability. At the theoretical level, the design process of BIM, the sustainable development needs of the site and the development level of visualization technology are discussed to pave the way for a reasonable process in the process of landscape architecture design; at the practical level, the existing developed software is used. The technical support that can be provided is mainly based on the application practice in landscape planning and design. Equation 1 respectively express the logical composition of

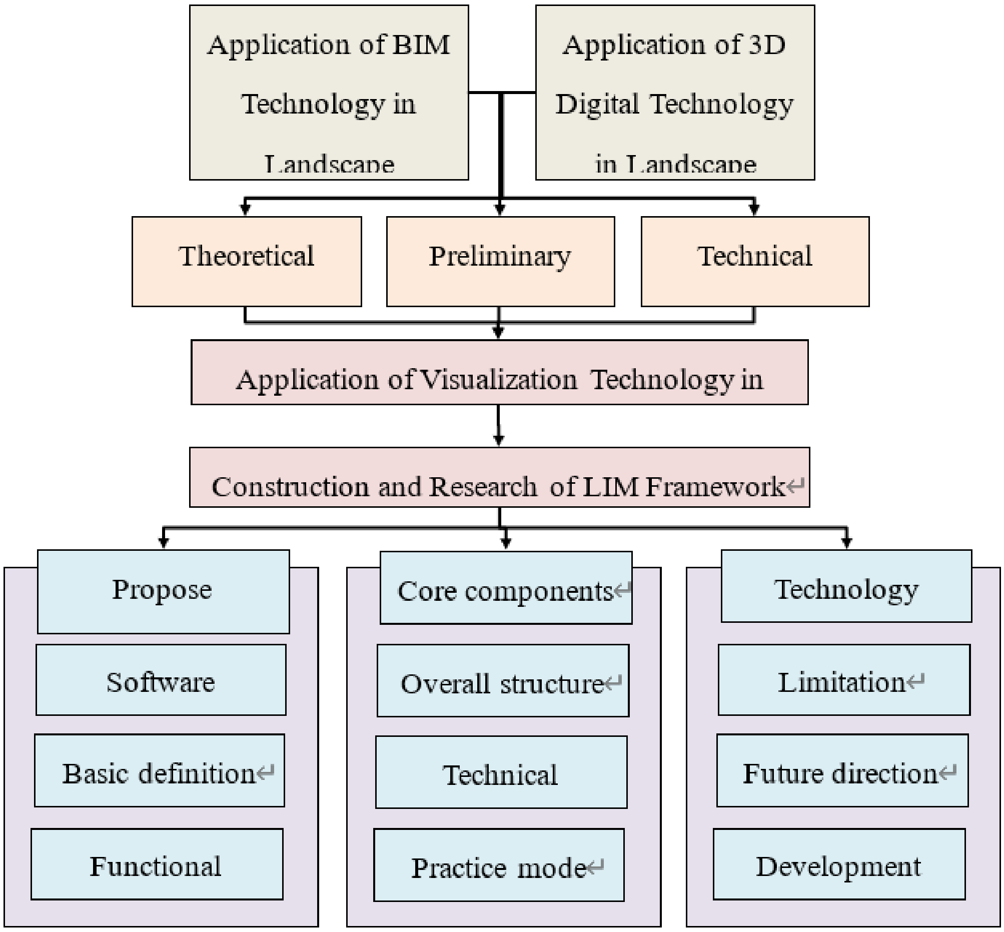

Figure 1. The framework of landscape design research method based on visual data processing technology.

the visualized data processing model. Linear regression mainly reflects the linear relationship between predictive variables and independent variables, which can be expressed as:

$$E(Y) = a + \beta_1 X_1 + \beta_2 X_2 + \mathrm{K} + \beta_n X_n \tag{2.1}$$

Equation 2 and Equation 3 respectively express refinement analysis formula of visual data processing technology. The extra relative risk (ER) is used to reflect the effect of environmental factors on sports health risks. The ER value is based on the relationship coefficient in the regression model β. The calculation formula is:

$$RR = \exp(\beta x) \tag{2.2}$$

$$ER = (RR - 1) * 100 \tag{2.3}$$

$$ER(95\%CI) = [\exp[(\beta \pm 1.96 se)x] - 1] * 100 \tag{2.4}$$

Equation 4, Equation 5 and Equation 6 respectively express the calculation formulas of the teaching effect of landscape design and the visual data processing model. Among them, B_i is used as the scale element corresponding to the i-th evaluation in the data set B. Through the data set B, the data membership vector representing the injury of the athlete can be effectively integrated into a scalar. The formula is expressed as:

$$V = r_j \times B \tag{2.5}$$

Shape the general functional relationship between the output y of the injury model and the input $x_1, x_2, \ldots, x_n$. The Kolmogorov-Gabor polynomial is as follows:

$$y = f(x_1, x_2) = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_1^2 + a_4 x_2^2 + a_5 x_1 x_2 \tag{2.6}$$

2.2. Application of visualization technology in the design stage

After sorting out the preliminary data of the design project, the project team further carries out the overall planning and conception of the site according to the current situation of the environment and the design goals. On this basis, the design team will further clarify the overall positioning of the region, the design style and the corresponding technical and economic control methods. From the perspective of sustainable development, the design team takes into account the historical context and social and economic benefits of the site. Designers can fine-tune photos taken in the field through hand-drawn sketches or using drawing software such as Photoshop. The design team can then graphically express the design intent at the beginning of the project. On this basis, the project team can use visualization methods such as spatial 3D models to conduct in-depth analysis of the design effect. The design method has also been continuously developed from the traditional sketch design and the expression form of static images to the display method of visual animation.

The application mode of visual data processing model in landscape change analysis as shown in Figure 2. As shown in Figure 2, this model is the Steinitz Landscape Change Model. The model can divide the design process into three parts and six levels at different stages. The whole design process includes a total of six models, namely: representative model, process model, evaluation model, change model, image model and decision model. The real process simulated by the model is similar to the mathematical chart model of the system. The model contains many simplified and abstract elements. A common representation of a model is a flowchart or process tree, showing a series of process steps and feedback loops. The results of the model can express the designer's decision-making process and thinking path for the design scheme.

American scholars have used GIS software to practice the process of landscape analysis and urban planning methods. Generally speaking, the process framework is a linear system, and the six models can form three full process loops. It can be seen from Figure 2 that the model first confirms the context of the project, and then establishes the research object and question. On this basis, we specifically analyze the specific content that the model can make decisions. In the process, we need to refine the research method of the project. We need to deeply analyze specific problems and find specific countermeasures to solve them. Finally, we need to further analyze the overall architecture of the model and draw a final conclusion. The entire process has one or more starting points. The decision content of the model is directly related to the complexity of the model. This model provides a good argumentation process for site design for landscape architecture design.

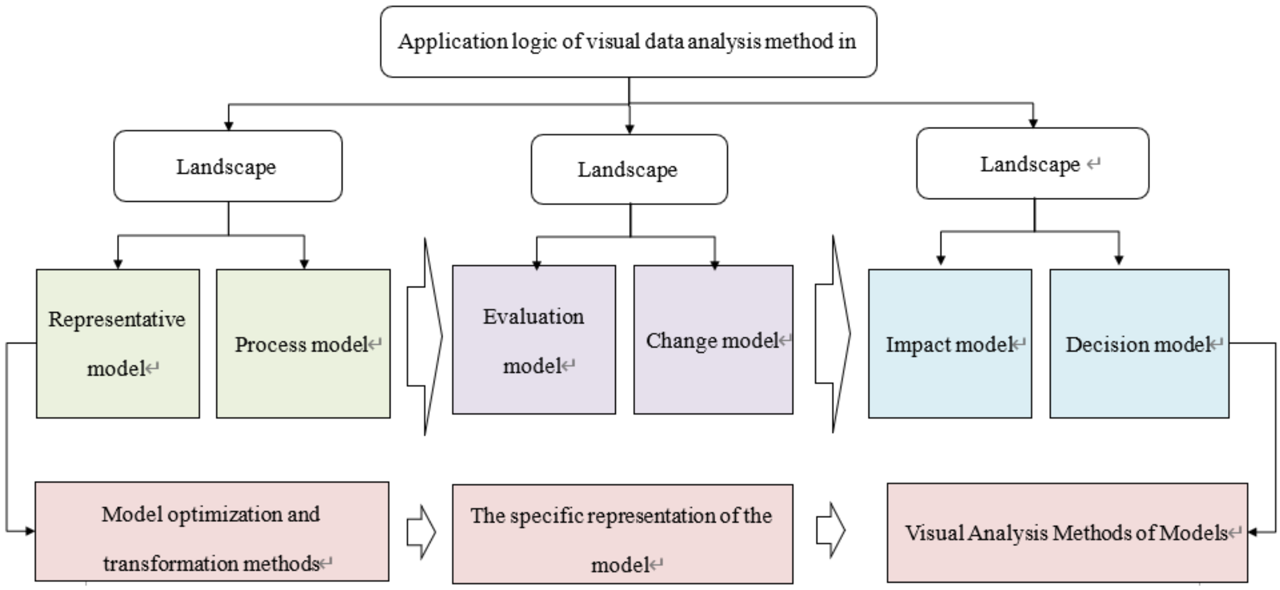

Figure 2. The Application Mode of Visual Data Processing Model in Landscape Change Analysis.

2.3. *Application of visualization technology in the feedback stage of plan implementation*

In general, designers visualize models of landscape design proposals. After the model is generated, there are multiple "feedback and modification" procedures. The program requires the joint participation of designers and project management departments. First of all, the designer needs to clarify the matching degree of the model architecture and the original scheme design idea. Designers need to analyze the specific areas that need to be adjusted and improved. The design team conducts in-depth analysis and discussion on the scheme model, and the designers need to clarify the new framework of the scheme and the ideas for scheme improvement. In addition, the designer adopts the visual data analysis method to further clarify the rationality of the landscape design scheme. On this basis, we discuss the accuracy of the design scheme. Through in-depth discussions, the design team further clarified the key content that the scheme needs to focus on at different stages. In addition, based on these opinions, the designer will refine, supplement, modify and improve the design scheme.

In this process, designers need to gradually and deeply discuss the rationality and integrity of the project content. Generally speaking, the common design method is to output the solution model in the form of pictures. The design scheme is supplemented by relevant text descriptions. Design proposals need to be expressed in commonly used electronic formats such as PDF or PPT. Furthermore, there are many types of visualization methods in the field of landscape architecture. Visual landscape architecture design requires the participation of many institutions. The planning and design of landscape architecture also involves many municipal engineering projects, and there will also be public participation. Therefore, the garden design plan needs to comprehensively consider the different opinions of people from all walks of life. During the interactive process of the design process, the project team goes through multiple stages of feedback. The project team needs to continuously optimize and complete the project design under the guidance of various opinions. With the rapid development of visual

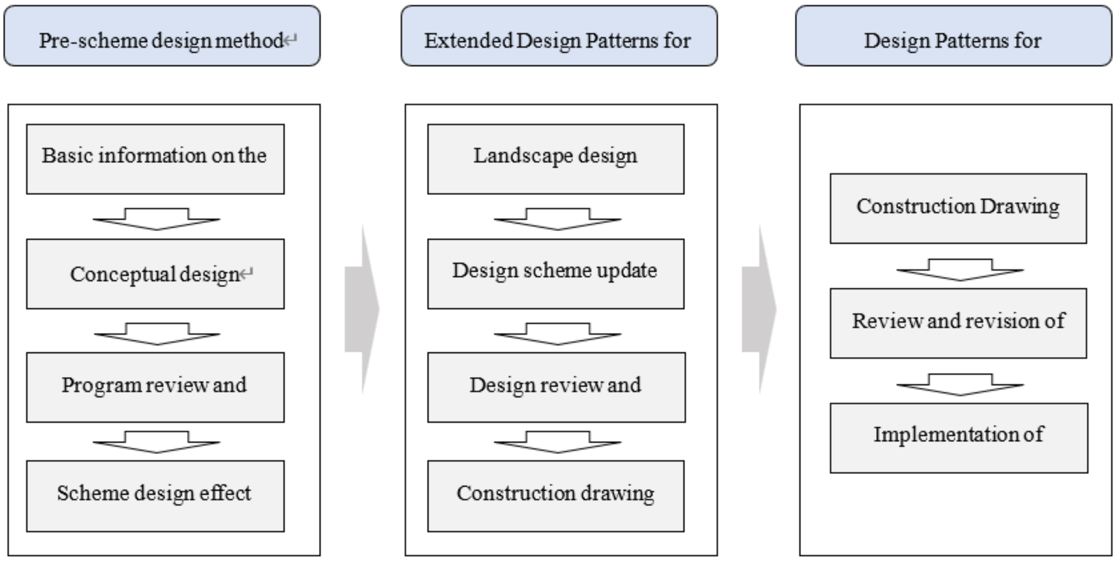

Figure 3. The design process of landscape architecture scheme.

expression technology, the workload of project visual design has been shortened to the greatest extent. The public and the client can better understand the project content. Experts will evaluate the design content of the scheme from the perspective of non-professionals. Designers can fully understand the important process of landscape design system. The computer system can process complex computing data and reduce the time for manual data processing. At the same time, the continuous advancement of digital manufacturing technology has changed the design method on the one hand, and accelerated the entire design process on the other hand.

The design process of landscape architecture scheme is shown in the Figure 3. As it can be seen from Figure 3 that the sequence of the design process for a landscape architecture consists of multiple stages. According to the time axis, the design process can be divided into multiple stages such as the preliminary survey and investigation stage of the scheme, the initial stage of method design, and the scheme reporting stage. In addition, the design process also includes the scheme deepening stage, the scheme construction stage, the scheme use stage and the scheme maintenance stage. These stages can be subdivided into different operation steps, among which landscape architects are most involved in the design stage. It can be further divided into the pre-design analysis stage, the scheme design stage, the scheme feedback stage and the scheme expression stage. Designers play an important role in landscape architecture design work through visualization technology. This technology can be better combined with digital technology, which is conducive to the organization of work in different aspects of landscape architecture design.

Equation 7, Equation 8 and Equation 9 respectively express the calculation formulas for the data processing flow and data visualization processing effect. The function of forgetting gate is to determine the part discarded from the input information h_{t-1} and x_t, and output a value between $0-1$. The larger the value, the more information is retained. The output of forgetting gate is calculated as follows:

$$f_t = \sigma\left(W_f\,\{h_{t-1}, x_t] + b_f\right) \tag{2.7}$$

$$i_t = \sigma\left(W_i\left\{h_{t-1}, x_t\right] + b_i\right) \tag{2.8}$$

$$C_t' = \tanh\left(W_C\left\{h_{t-1}, x_t\right] + b_C\right) \tag{2.9}$$

Equation 10, Equation 11 and Equation 12 respectively express the calculation formulas of the influence of different data modes on landscape design. Suppose the index evaluation set is represented by A, r_j is represented by the membership degree vector, and the data set is represented as:

$$r_j = \left(r_{j1}, r_{j2}, r_{j3}, r_{j4}, r_{j5}\right) \tag{2.10}$$

In the formula, r_j represents the membership degree vector corresponding to the index evaluation set A. Assumptions:

$$B = (B_1, B_2, B_3, B_4, B_5) \tag{2.11}$$

Self-organizing process adaptively forms the first-level intermediate model:

$$z_k = f_k\left(v_i, v_j\right), i, = 1, 2, \ldots, 6 \tag{2.12}$$

3. Application methods of visualization technology in the field of landscape architecture design

3.1. Application ideas of visualization model

The scene construction method combining virtual environment and real environment is very effective. This method of scene design will bring strong sensory stimulation to people. Rich visual analysis methods are beneficial to improve people's cognitive ability to the environment and deepen people's ability to understand the environment. Visual methods facilitate the updating of design patterns, which facilitate designers' representation of design scenarios. In addition, technologies and design tools for landscape visualization have also developed rapidly. However, the design results at the current stage are only a simple impression of the landscape. People's various cognitive effects of landscape environment come from various types of design patterns and methods. These landscape design patterns are helpful for people to understand the changing trend of the landscape environment and the characteristics of the landscape environment. Each parameter represents a corresponding characteristic including structure, capacity, cost and even some physical properties. The various features and movement structures of landscape design have diverse forms of expression. There is an interactive relationship between design ideas and design methods, and these design models become the basic form of landscape design.

As can be seen from the above Figure 4, it can be seen through model analysis results that visual data processing technology is constantly optimizing and innovation. The practical effects of landscape garden planning and design have also been continuously optimized, and the planning and design effects have maintained long -term stable development level in the early stage of digital processing technology. The technical methods required for landscape design at different stages are not exactly the same, and the practical effects of the technical methods of visualized data processing are also different. When data processing technology develops to version 2.0, the landscape design planning effect is linear correlation. Data visual processing technology has a linear relationship with landscape design models, and visualized data processing effects and landscape planning effects also have a linear association.

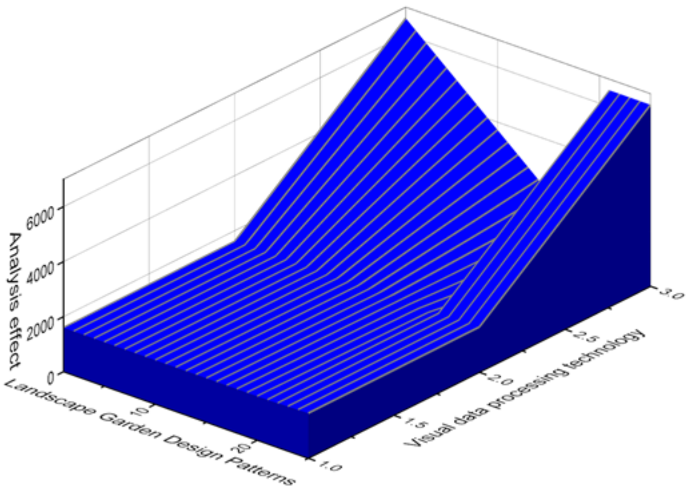

Figure 4. The application effect of visual data processing technology in landscape garden design.

3.2. Expression of visual model

However, existing landscape design methods do not fully express the specific ways in which people experience the real world. People rarely have the opportunity to deeply understand the landscape environment and landscape design results. Furthermore, the design effect of the landscape environment is not static. The design results will be affected by changes in the external environment at any time. For non-industry people, it is difficult for people to understand and choose the expression of this abstract mixture. Specifically, a visual design method is generally used to express a certain design concept and design thinking. In addition, this visual design method has various manifestations in the curriculum design of landscape architecture. This representative visualization method can be applied to a variety of scenarios. This design method is helpful for people to understand the rationality and scientific of the design effect. The traditional design patterns and design concepts are reflected in the design methods of virtual place design and visual scene expression. Definition, parameter operation, and parameter model and fine-tuning. This design process is a computer-aided design based on parametric design. Designers can continuously revise the calculation program system to further optimize the design results of the scheme. Designers will look for the best landscape design among feasible solutions.

The comparison of different data processing methods on the effect of landscape design affects the effect are shown in Figure 5. Different data processing methods will have different effects on the effect of landscape design. Specifically, traditional data processing technology will classify all data content required for landscape design work. During the process of data processing, the designer cannot intuitively visualize the data processing content at each stage. The designer cannot intuitively understand the data processing difference between data processing and data processing effects. In addition, it is difficult for designers to process data processing methods at different stages. The visual data processing method has a better sense of experience and display. The designer can better understand the advantages and disadvantages of the landscape design effect of each stage through visual data analysis methods. The designer further optimizes the performance effect and design accuracy of landscape design schemes through in -depth analysis of the advantages and disadvantages of each stage of design

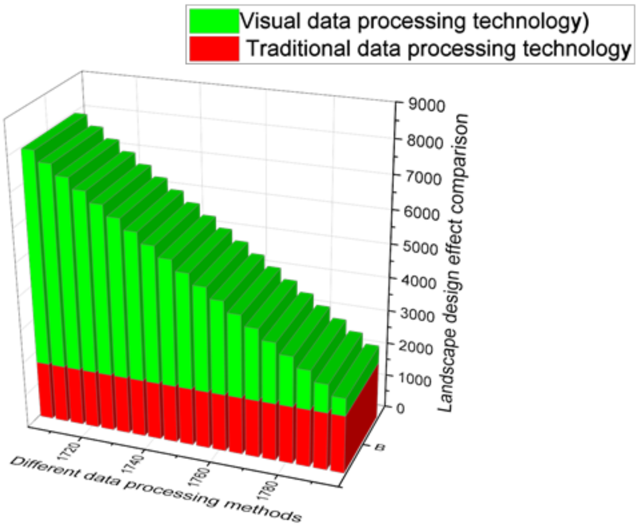

Figure 5. The comparison of different data processing methods on the effect of landscape design affects the effect.

schemes.

Designers use production software to scrutinize the design scheme, and comprehensively analyze the rationality of land use function organization in landscape design. On this basis, the project team will comprehensively determine the organization of various elements in the site. The project team will start from various perspectives and further simulate and analyze the movement trajectories of different elements in space and time. Designers need to focus on the rationality of the spatial scale of the scene. In addition, designers need to consider the direction of sight in the site and what kind of psychological feelings different groups of people will have after using the site. Designers analyze the rationality of different design schemes through visualization technology, and after adjustment, a preliminary model of the design scheme can be generated. Landscape architects often use this method to design projects, and different visualization techniques can enrich the expressiveness of design works. Through the visual model, the designer can feel the information of the site in real time in the virtual scene, making the result work more scientific and accurate. The number of research literature and constructed the corresponding landscape element model. We believe that different types of software platforms have different features. We need to combine the landscape information platform, and we further build the landscape design software model. This model is worthy of further study in technical, software development and theoretical aspects.

The results above expressed the actual performance effect of different visual analysis models. The results of the different visual data processing models in the practice of landscape design work analysis are shown in Figure 6. Generally speaking, we use the traditional data analysis method as the control group of the model. We carry out model analysis of the differences between data parameters and data types in different visual methods. Specifically, we arrange different data parameters to analyze the effects of different visual data model combination conditions on the landscape design scheme. As a result, the visual data analysis method can effectively improve the fluency and accuracy of landscape design effect expression. The landscape design work requires a comprehensive support of multiple data

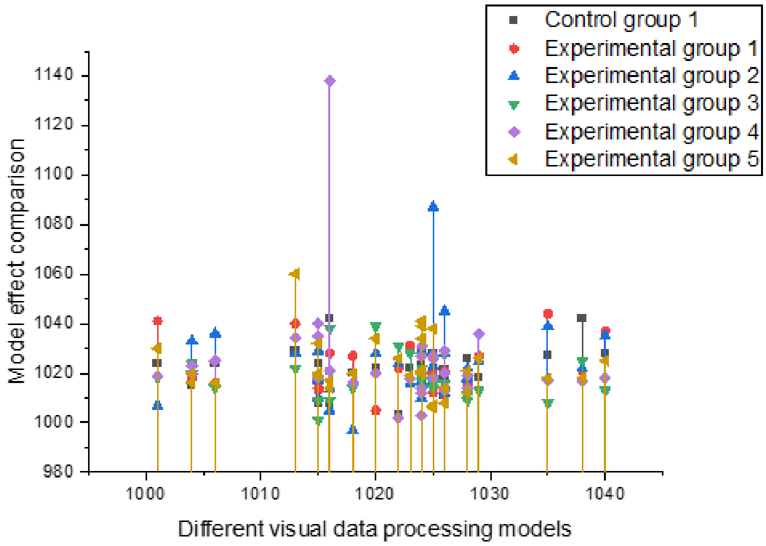

Figure 6. Different visual data processing models in the practice of landscape design work analysis.

processing models. On the one hand, the landscape design work needs to prepare the research data and integrate the data structure and data mode. On the other hand, landscape design also needs to sort out the internal associations of the data, sort out the link relationship between different data content, and strengthen the accuracy and practicality of the data link.

3.3. Carrier types of visual models

Visual design patterns reflect different development characteristics in different historical periods. With the development of the times, the carrier of knowledge inheritance in the field of landscape architecture has also undergone rapid changes. The traditional landscape architecture design method mainly adopts the expression form of paper drawings. With the rapid development of the times, the expressions of landscape architecture have become more abundant. Generally speaking, it includes various forms such as graphic symbols, text and text. These forms of expression have been continuously developed and improved, mainly including virtual reality and other expression methods. The traditional way of design expression is paper printing. With the continuous development of time, the way of design expression is gradually updated to the way of digital multimedia technology. Landscape design patterns correspond to visual expressions. To the theme of the era of landscape architecture planning, this paper puts forward the construction ideas and framework of visual landscape information model. This model is helpful to know the landscape design, fill the gap of existing research, and broaden the ideas of landscape design and construction. Through the guidance of theory, we elevate digital landscape design technology to a higher level.

The results of the timeliness of visual data processing effect are shown in Figure 7. In Figure 7, we detailed analysis of visual data processing processes. The timeliness of the data processing model of this article is classified and compared. In the early stage of the data processing process, the analysis effect of the data model shows a stable development trend. The model analysis effect shows a steady rise. The application scale and application effect of visualized data processing models in landscape

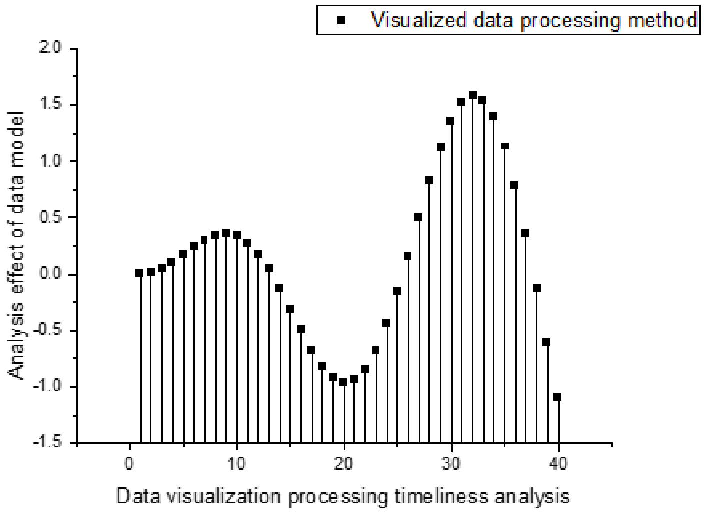

Figure 7. The analysis of the timeliness of visual data processing effect.

design work are not significant. With the continuation of visual data processing time, data analysis processing effects are constantly changing. In the mid -term phase of visual data processing, the model analysis effect presentation continues to decline first, and then continuously improves the development trend. With the continuous and in -depth application of visual data processing models, the analysis effect of the model shows a straight -line upward trend in the later stage of the application. The visual data analysis effect can well support the dynamic interaction and real -time optimization adjustment of landscape design work. However, we can also see from the model analysis results that the model analysis effect does not show linear change characteristics over time. The effect of visual analysis of the model and the time of the model application show the relationship between fluctuations.

The results of the diffusion effect analysis of visual data processing are shown in Figure 8. It can be seen from the diffusion of model analysis results in Figure 8. From the model results, we can see that the visual analysis effect shows the radiation distribution trend of the circle. The landscape design effect of the inner circle is the most obvious. The landscape design effect and visual data analysis model show a significant relationship. The more to the outer layer, the correlation between the landscape analysis effect and the visual data processing model. In addition, the visual data analysis effect also has the difference in radiation radius. Traditional data processing methods generally do not produce great changes in landscape design effects. The visual data processing effect will change accordingly according to the data processing mode used and the data tissue structure. Visual data processing methods have multiple characteristics such as accuracy, integrity, and availability. The application effect of different visual data processing models and the actual diffusion effect of the model presents linear direct related features. We use this model as an auxiliary tool to design landscape places with more scientific basis. This paper deeply analyzes the domestic and foreign landscape architecture design research related content.

The traditional visual expression of design mainly adopts the medium of text and drawing. With the continuous evolution of expression methods, electronic media have gradually replaced the drawing media and become the main way of visual expression of landscape architecture design. Landscape architecture design patterns will be displayed entirely through digital media. There are many forms

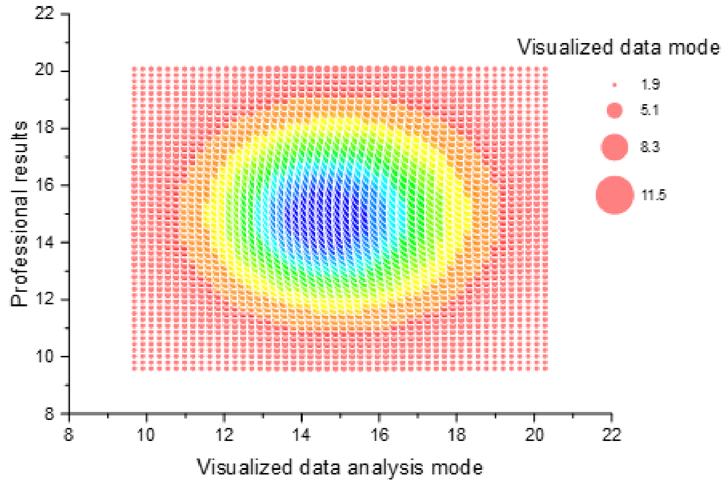

Figure 8. The diffusion effect analysis of visual data processing.

of expression of landscape architecture design thinking. Generally speaking, visual design expression is the main means of expression. Visualization is a more intuitive form of expression than written words or sound. The visual expression can provide a spatial organization mode that is more suitable for the actual scene. Complex spatial organization patterns can be expressed and displayed through a clear visual medium. However, each media medium has its own unique characteristics. Various visual expressions have their own advantages and limitations.

3.4. The expression process of the visual model

Generally speaking, various visualization techniques have corresponding forms in the field of landscape design. As the visualization of landscape expression technology becomes more and more common, the application scenarios of landscape architecture visualization technology become more and more extensive. Generally speaking, the manifestations of these visualization techniques mainly include four types, including sensory cognition, emotional expression, behavior management and comprehensive expression.

In addition, the landscape design work goes through multiple stages of design consulting work. These visualization techniques may vary greatly in the application process. Visualizing technical details can have different sensory effects on designers. People have different degrees of visual perception of the same design work. In addition, different visualization techniques can express landscape design effects in different forms. Diverse types of visualization techniques result in different decision-making scenarios. Therefore, the content of the visualized data must conform to the rules. The information content conveyed by visualization technology must be accurate. This real demand of designers also proves the importance of visualization technology of landscape architecture from another aspect. In addition, landscape architecture design has also shifted from visual visualization thinking to digital visualization thinking. With the technical support of computer science, we will be able to construct three-dimensional visualization models in the virtual world. Due to the various constraints in the development of software and hardware, the traditional thinking mode of designers needs to be updated.

4. Conclusion

Visualization technology is a complex and changeable computer technology, which has changed the way of human daily life. The technology has also gradually replaced many jobs. At the same time, the technology has also created new ways of working. With the continuous maturity and development of visualization technology, the role of this technology in landscape architecture design is becoming more and more important. At the same time, the concept, content and method of landscape design are constantly developing, and the application of new technologies in landscape design is becoming more and more extensive. The development of new technologies also puts forward new requirements for landscape design work. The core content of visualization technology is to make a design scheme by setting calculation rules and parameters. The generation, development and regulation of design schemes all need the help of visualization technology.

In addition, visualization techniques help to optimize the design. This technology can improve the efficiency and accuracy of the design. The research focus of this paper on digital landscape design focuses on the interactive performance of design content. In general, future landscape design work needs to strengthen the application of interactive forms of landscape design methods. Interactive landscape design will be the dominant direction in the future. The designer will take the interactive concept as the leading factor to carry out the landscape design. From the preliminary design to the final work presentation, the designer applies interactive thinking throughout the entire landscape design work. In the existing work, designers have not directly applied visualization technology to interactive design work. The designer only reflects the interactive design idea in the final design work. With the introduction of visualization technology, designers can maximize the interactivity of landscape art through appropriate computer manipulation.

This technology enables both the designer and the audience to become the creator of the work. With the continuous introduction of visual interaction technology, contemporary landscape design works have significant interaction, experience and innovation. This change is not limited to its artistic expression. This technology enables the audience to connect more directly with the work in an interactive way. Visualization technology is conducive to the expression of inner emotions in landscape design works. This technology establishes an effective connection mechanism between the author and the audience. Interactivity becomes the most prominent feature of landscape works, and this characteristic also enriches the expressive forms of the works.

This paper mentions centralized interaction methods, including mechanical interaction, experiential interaction, virtual interaction, and innovative interaction methods. This new form of artistic expression provides a better expression channel for landscape design works. We use an interactive design approach that produces effects that change in real time. This design method offers more possibilities for artistic creation. This method of visual expression also enables landscape artwork to be integrated into the daily life of the general public. Based on the theme of visualizing interactive landscapes, we also further explore different forms of interactive expression. These methods include inductive interaction, mechanical interaction, and interactive landscape interaction. In addition, digital programming can realize the interaction effect between different subjects.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Conflict of interest

The authors declare there is no conflict of interest.

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