

Evaluation and Optimization of Landscape Architecture Design Scheme Using Landscape Visualization Technology: A Case Study of Lumens Model

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1. INTRODUCTION

One of the most crucial challenges for the survival and advancement of humanity in the modern world is environmental conservation. Humans are fully aware of the need to conserve the environment, particularly in light of the modern urbanization's rapid growth, which is reducing green space and increasing air and environmental pollution. The principles of ecology and diversity should guide the design of architecture and landscape architecture, giving people a beautiful and healthy living space. The fields of landscape science and technology, ecology, agricultural science, computer technology, finance, industrial design, and art associated with architectural design and urban planning must all continue to grow in the discipline of landscape architecture.

The fundamental science of sustainable building and bettering human habitation situations is landscape architecture. It is now a part of the national first-class curriculum. To further advance in the areas of fundamental theoretical study and real-world application, however, stronger collaboration between researchers and the entire field is still required. In the field of architecture and landscape building, wisdom creation and consumption have emerged as the "new weather." In the framework of urban landscape construction and urban and rural planning, which are intimately linked to the growth of the landscape architecture sector, the utilisation of contemporary information technology, big data design, data simulation, artificial intelligence, and AI systems can be beneficial in addressing a multitude of intricate issues [1]. The original computer-aided approaches have changed as a result of the gradual penetration of landscape visualisation technology into all facets of the subject matter. The intricate intertwining of aesthetics, ecology, geography, architecture, and other related subjects makes up the broad field of landscape design. The distinct vibrancy of a region's culture has a significant influence on landscape design [2].

While China's landscape architecture specialty still needs to improve its international standing, foreign experts point out that China's domestic specialties are generally the same and that the employment rate for landscape architecture engineers is still far lower than that of architects and planners. The importance of landscape design in urban planning and design has increased with the advent of urban planning and landscape architecture design [3]. Numerous experts and academics have noted that the development of the garden sector would give China's developing urbanization construction process new life and influence and turn it into an essential component [4]. The few design features in Figure 1 are now the primary technological tool for the systematic development of urban space architectural design.



Figure 1: The landscape Architecture design

This study used parametric design software's geographic information system (GIS) technology to optimize the design of a traditional garden setting. Unlike the conventional parametric design approach, GIS technology allows one to investigate and comprehend the logic and internal relationships of the traditional landscape design's seemingly disorganized landscape system. Enhancing landscape architecture's social and economic benefits and fostering its growth while maintaining environmental sustainability are the goals of the research. With the use of virtual reality (VR) technology, people can experience a building virtually and gain information relevant to the intended surroundings [5]. Users can enjoy the most realistic building projects ahead of time due to VR technology. Three key features of VR technology are imagination based on the goal architecture, interaction, and immersion. There is still need for improvement in the technical level of landscape design. Art and technology are typically combined in landscape architecture design, involving numerous disciplines and necessitating a wide range of professional expertise and technological know-how from designers in order to produce a greater variety of landscape design styles with superior quality and efficiency [6]. Nevertheless, designers of today's landscapes lack greater technological and professional know-how, making it impossible to combine art with technology.

Contribution of the study

In order to create a landscape architecture plan, this study makes use of computer landscape visualization technology. In a number of case studies, the Lumens model has been used to assess and improve landscape architecture design plans. In this case study, landscape architects using the Lumens model evaluated various design ideas for a new urban park. Many experts examined elements like water management, vegetation growth patterns, and solar exposure using the Lumens model's modeling capabilities. The Lumens approach was used in this case study to help guarantee that the urban park design satisfied community demands while reducing negative environmental effects and improving the overall standard of the outdoor area. The VR-based ACO-ANN method is the primary geographic information system (GIS) techniques employed in this study. In the task of landscape design, the VR-based ACO-ANN technique primarily extracts and forecasts the spatial elements. The ANN approach primarily extracts and forecasts the landscape design platform's time factor.

The study status of landscape design schemes and the features of affecting elements are studied. The building of the platform, the workflow in Lumens techniques, the analysis of the parametric design in GIS and VR-ACO-ANN methods, and the explanation of ACO-ANN methods are all included. The precision of the Lumens model in forecasting and identifying pertinent elements for landscape design is examined. The research value and practical use of the Lumens model and visualization technologies for landscape architecture design are demonstrated in this study.

2. LITERATURE REVIEW

With the rapid development of AI technology, more artificial intelligence will be applied to landscape research in the future [7]. The discussion of the technology of integrating a variety of AI approaches is not flawless, and the application of AI in landscape architecture is not mature. Parameterized optimization of traditional landscape design can significantly increase its social, environmental, and economic benefits and has good practical value [8]. This was demonstrated by applying parametric software for GIS (geographic information systems) to the optimization of traditional landscape architecture.

Landscape architects' responsibility

- The design, layout, size, and location of new construction
- Storm water management techniques, such as treatment wetlands, green roofs, and rain gardens
- Institutional campus and site design
- Nature preserves, greenways, arboretums, and botanical gardens.
- Recreational amenities such as theme parks, sports complexes, and golf courses.
- Residential communities, business parks, and industrial districts.
- Transit corridors, bridges, transportation structures, and highways
- Town and city squares, waterfronts, pedestrian plans, and parking lots are examples of urban planning.
- Big or small-scale programs for urban renewal.
- Wooded areas, tourist destinations, historic gardens, and conservation research.
- Dams, power plants, reservoirs, applications from the extractive industries, and large-scale industrial projects.

- Landscape and environmental assessments, planning recommendations, and suggestions for land management
- Offshore and coastal development.

+ The practical application quality of this approach was also discussed in the study [9]. In order to implement the research of the intelligent terminal application system of landscape design, the system utilizes AI technology and makes use of component technology [10]. This time, a high level of planning accuracy was achieved in the digital landscape area planning system. This paper presents artificial intelligence, examines the benefits and trends in the development of autonomous data for the landscape design auxiliary system, and then addresses the use of AI technology in this system [11]. At the heart of digital technology are virtual reality (VR) and digital projection technologies, which are crucial to landscape design and presentation [12]. Therefore, in order to support digital technology's new development in landscape design, it is imperative that it be continuously improved and innovated. The use of BIM information models maximizes the expression of the architect's design and increases design efficiency [13]. Although VR collaborative design based on the BIM model offers several benefits over traditional architectural design processes, the development of BIM + VR technology in the field of architecture is now hindered by a number of issues [14]. The parametric model and the functional characteristics model of the Revit family are used to create the Yellow River Bridge BIM model [15]. The issue of insufficient information carriers in the one-dimensional EBS coding system can be more effectively resolved by the two-dimensional EBS coding system. Bridge information may be integrated, interacted with, and stored at every stage due to the 2-D EBS coding scheme. It provides a partial solution to the information island problem. The study demonstrates how the compositions of royal gardens found in the greatest works of Italian Renaissance art employ Fibonacci sequence and geometric proportions rules of the golden division [16]. By utilizing the aforementioned mathematical items, the composition's aesthetic qualities were enhanced and the available space was used to its

fullest potential. This study reviews current software solutions that are available for solving 3D city modeling challenges [17]. Additionally, the paper discusses some of the challenges associated with representing the aspects of the urban landscape as they might be viewed using GIS software, and it analyzes the recent history of technology and software techniques related to urban landscape visualization. This study examines the pertinent elements in the landscape design teaching task using artificial intelligence as a digital technology approach [18]. The three aspects of students' design preferences landscape layout, landscape pattern, and landscape design—that are also significant determinants of landscape design are the main topics of this study [19]. By conducting additional research and investigation, it will be possible to make artificial intelligence algorithms more precise and effective in meeting the real-world requirements of teaching landscape design. The integration of research into the landscape architecture design process was investigated in this study [20]. According to the study's findings, the definition and application of research—rather than a sufficient grasp of the design process—is the crucial factor in comprehending the relationship between research and design [21]. According to this research, the lumen approach is a straightforward and effective way to determine interior space illumination based on any kind of sky. This method's main flaw is that it can only calculate in five different locations around the room [22].

The above existing studies didn't provide a clear picture of landscape architecture design using Lumen model. Hence, this study proposed an integration of VR and AI techniques to illustrate the significance of landscape design using visualization technology.

3. Methodology

OPTIMIZATION OF LANDSCAPE ARCHITECTURE DESIGN

Parametric design on Geographic Information System (GIS) Technology

The landscape architecture design was optimized using GIS technology in parametric design, and the quality of the optimization was assessed. With the use of computer hardware and software, GIS technology is a unique kind of spatial information system that can gather, store, organize, and compute pertinent geographic data in all or a portion of the earth's surface area. By converting the design process into a parametric model, parametric design modifies the design effect and has the ability to control or influence the production of a design result. A key component of parametric design is the cooperation and integration of several disciplines. Its inherent complexity, diversity, and inclusivity have significantly altered people's perspectives as well as the conventional design process and method.

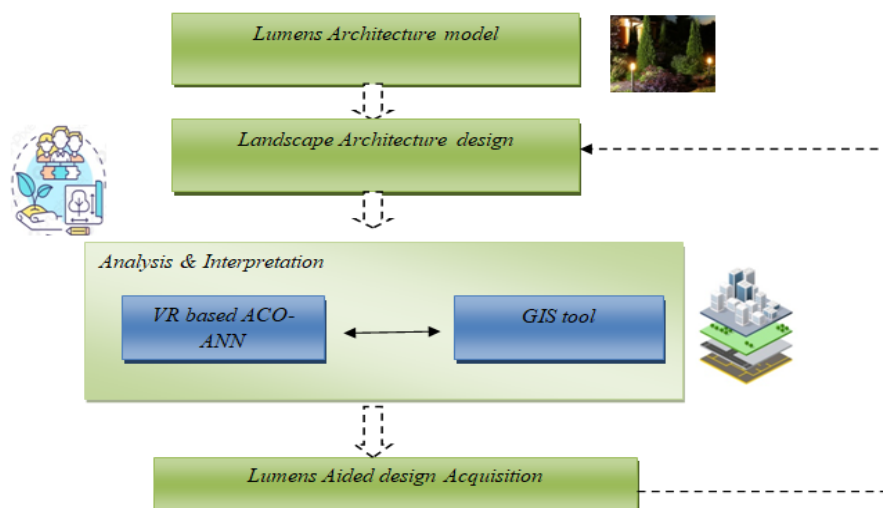


Figure2: Proposed Architecture

Figure 2 represents the proposed model of the study. Computers are used by VR-based ACO-ANN, which is based on geographical databases, to gather, organize, store, process, and analyze data in order to create a geographic model and offer technical assistance for geographic research and decision-making. For landscape architecture planning and design, GIS makes sense because it can do multi-dimensional and multidimensional studies on the project site.

The overall beauty of the landscape architecture can be significantly enhanced by using GIS technology to assess the suitability of the site. The economic indicators of garden project implementation are the primary focus of garden accessibility analysis, as they are useful in assessing the financial gains associated with individual garden projects. Visibility analysis is mostly used to examine the views from the park's roads and the placement of each node in relation to one another in order to create a landscape area and regulate the height of buildings [23]. The visibility of the scenic line and the field of view in a particular area can be analyzed using the GIS technology analysis tool, which offers a solid foundation for route optimization and upgrading as well as the positioning of scenic spots. To improve user immersion and communication, GIS can also be used to convert a two-dimensional landscape-planning map into a three-dimensional temporal map. Lastly, GIS primarily introduces the idea of ecological sustainability, uses the concept of overall development to design the landscape, and applies the principle of landscape ecology in the analysis of the structure and pattern of the landscape.

Fuzzy Evaluation method

The weight of each metric was assessed using the fuzzy comprehensive evaluation approach, with the goal of evaluating the application quality of GIS technology in landscape optimization. Formulas (1) and (2) display the fuzzy comprehensive evaluation's model expression and function expression.

$$F = W \circ R = (w_1, w_2, \dots, w_m) \begin{bmatrix} r_{11} & r_{12} & \dots & r_{1n} \\ r_{21} & r_{22} & \dots & r_{2n} \\ \dots & \dots & \dots & \dots \\ r_{m1} & r_{m2} & \dots & r_{mn} \end{bmatrix} = (f_1, f_2, \dots, f_n) \quad (1)$$

Formula (2) denotes the fuzzy relation matrix R , the weight set W , the evaluation result vector F , and its internal element r

$$A = \sum_{k=1}^m B_k = \sum_{k=1}^m \left(\sum_{j=1}^n C_j D_j \right) E_k \quad (2)$$

In formula (2),

A indicates the overall satisfaction rating for the quality of the landscape;

B_k symbolizes each landscape's score in the first-level indicators;

E_k symbolizes each landscape's weighted value in the first-level indicators;

C_j symbolizes each landscape's score in the secondary indicators;

D_j indicates each landscape's weighted value in the secondary indicators;

m indicates how many evaluation indicators there are in the first-level indicators;

n indicates how many evaluation indicators there are in the secondary indicators.

Simultaneously, matching theoretical models are required for parametric analysis and feature extraction due to the multi-dimensional parametric design of traditional landscape architecture. A multi-dimensional, nonlinear,

geometric, moment-invariant generation model in the traditional garden landscape and its digital expression are demonstrated by formula (3), which is based on the introduction of GIS technology.

$$Dif(F_1, F_2) = \min_{N_i \in F_1, v_j \in F_2, (v_i, v_j)} W[(v_i, v_j) + R_w] \quad (3)$$

Based on this, the multi-dimensional, nonlinear traditional garden landscape's parametric design was created, and the groundwork for the use of GIS technology in the ecological landscape simulation and optimization assessment on Lanshan Mountain was established.

Process Progression of VR-ACO-ANN methods using landscape design

This work has examined the use of ACO method and the VR-ANN method in the landscape architecture design platform. In addition to extracting spatial elements like layout and pattern, the VR-ANN method can minimize the number of parameters that need to be calculated while designing a landscape. In problems involving landscape design, the ACO-ANN approach can anticipate and extract temporal aspects. Time has an impact on the arrangement and patterns in the visual process of landscape design. These influencing elements mostly consist of changes in people's needs for particular landscape patterns and land use policies. Additionally, there is an unavoidable link between these elements and the landscape design plan. It is challenging to determine the relationship between landscape design elements and time when using the manual method. The time features of landscape design elements can be precisely extracted and predicted using the ACO approach. The structure and patterns of landscape design vary depending on the metropolitan area or community. Nonetheless, there is a connection between these outside variables and landscape design considerations. The correlation between the spatial components of landscape design can be effectively extracted and predicted using the VR-ACO approach. Put simply, the 3D landscape design scheme created by computer-aided reality design can have its spatial and temporal properties extracted and predicted by the artificial intelligence approach. In landscape design problems, the spatial and temporal elements can be extracted using VR-ACO algorithms, respectively. In landscape design, they can also be used to map nonlinear data relationships.

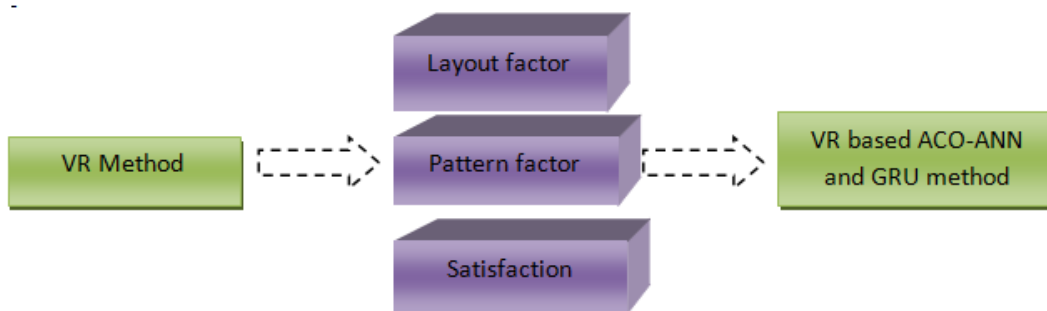


Figure 3: Application of virtual reality in AI method in Landscape design platform

The ACO approach in Figure 3 is capable of extracting the study object's attributes as well as analyzing the correlation between those qualities. It has been effectively used in the domains of medical picture analysis, building facial recognition, and traffic flow control. On the other hand, the conventional ANN approach does rather well on computers. ACO that is excessively deep in its network will demand a lot of processing power and time. ANN algorithms are not often used in landscape design because of their huge computation time, which might be frightening for practical engineering and applications. After being created as a 3D image, landscape design content includes a lot of variables and information. This study investigates the application of the variational Bayesian approach to the ACO-ANN neural network, resulting in the VR-ACO neural network, with the goal of reducing the amount of parameter calculation in the iterative ANN process. The VR-ACO-ANN method's structure and schematic are depicted in Figure 3. While ACO calculates gradients in the form of data values, the

weights in the VR-ACO-ANN structure take the form of probability distributions in both forward and reverse propagation. Because probabilistic forms exist, it considers the interdependence of the data.

The Expressions for Variational Bayesian and ACO Methods

The neural network weights are distributed using a probabilistic approach known as the variational Bayesian method, which can account for the researcher's prior knowledge of the research object. This ensures that predictions made on tiny datasets will be accurate. This work uses ANN as the foundation for the variational Bayesian method derivation process. Small data sets may result from the difficulties of gathering data sets pertaining to landscape design. Since ANN has demonstrated its effectiveness with large datasets, VR based ACO is needed to address the issue of small datasets in landscape design.

The relationship between prior and posterior knowledge of aspects connected to landscape design is established by Equation 4, which allows for the probabilistic presentation of the weights and biases distribution. Equation 4 is hard for a computer to integrate, hence an approximation is needed. The approximate prior knowledge operation method is depicted in Equation 5.

$$P(y^*|x^*, x, y) = \int p(y^*|f^*)p(f^*|x^*, x, y) df^* \quad (4)$$

$$P(y^*|x^*, x, y) = \int p(y^*|f^*)p(f^*|x^*, w)p(w|x, y) df^* dw \quad (5)$$

Equation 5 is integration procedure still faces significant challenges, necessitating further variational approximation processes. The approximate operation approach of the KL divergence method is examined in this paper. Equation 6 illustrates how to operate the KL divergence approximation.

$$l_V = \int q(w)p(F|X, w) \log p(Y|f) dF dw - \text{KL}(q(w)||p(w)) \quad (6)$$

Comparable to the ANN approach, the VR-ACO method likewise necessitates a neural operation that entails figuring out the neural network layer's parameters. Equation 7 illustrates how characteristics like slip step size and filter are calculated.

$$w^1 = \frac{(w+2P-k)}{s} + 1 \quad (7)$$

In order to identify and forecast layout and pattern aspects in landscape design, the VR-ACO approach combines variational Bayesian and Artificial neural networks. The VR-ACO approach improves efficiency over conventional ANN algorithms by reducing computational complexity and training parameters. The VR-ACO approach can be applied to landscape architecture design in order to detect spatial features in landscape design schemes, such as the size and placement of landscape elements, the relationships between the parts, and to gain a deeper understanding of the subject.

ACO-ANN Algorithm

The architecture of the landscape is influenced by ACO-ANN algorithms. In fact, ACO has proven to be a good solution for a number of challenging optimization problems, including the technology used for landscape visualization. The Lumens model comprises basic entities that employ efficient heuristics. Constructively algorithms work on the basis of gradually building solutions, one step at a time, by adding a resolution component to a partial solution, until the final product is realized. Since effective solutions are truly the result of a collaborative interplay of various landscape designs throughout solution development, cooperation is an essential part of ACO-ANN algorithms. ACO has been applied to resolve several challenging problem domains. Challenges are characterized by components as well as phases, which appear to be combinations of constituents. The ACO-ANN Algorithm adds more elements to a condition by developing solution paths in the field of these components in a sequential manner. There are two rules that govern the ACO system:

- When developing responses, the localized signal updating rule was applied.
- The global signal update rule was put into effect when every ACO developed a response.

Additionally, ACO-ANN algorithms are usable: trail vanishing with potential daemon operations. In order to prevent the accumulation of tracks over a small component from becoming an infinite landscape plan, trail vanishing instantly decreases all path values. Disposable activities can also be used to carry out centralized tasks that could be completed by a single landscape architecture design, like using a local optimization method or updating global data to assess if it ought to skew its search strategy from a non-local landscape perspective.

At each phase, each landscape assesses a range of feasible extensions to its current condition and moves toward one in probability. We will now describe the probability density function. The combination of two discrete landscape choices determines the likelihood of having to relocate from county N to system u_0 for ant N_v , the trail level of a move, which indicates how competent it has been in the past and make that landscape-specific move; this indicates a probability indication of an attractiveness of such a relocation. The desirability of such a move, as calculated by some optimization landscape method denoting the priori attractiveness of such a move.

Where

u_0 and N_v be the groups of classes

v is secure online course at that moment, in turn,

Where the number of protected and infected online classes up until time t is represented by the subscripts N . The landscape architecture source s can be calculated at time ' v ' by applying Equation (8), just for notational simplicity.

$$s_m = \sum_{n=0}^s Ex_{s2n}^{\min \text{ } ^{sup}} N(s : u_0; N_t; n^*),$$

$$ACOs = \sum_{n=0}^u Ex_{s2n}^{\min \text{ } ^{sup}} \frac{N(u_0; N_v : s, n^*) N(s, n^*)}{N(u_0; N_v; n^*)}$$

$$Apriori_s = \sum_{s=0}^n Ex_{s2n}^{\min \text{ } ^{sup}} N(u_0; N_v : s, n^*) \cdot N(s, n^*) \quad (8)$$

Whereas $N(u_0; N_v : s, n^*)$ has been the probability that the realizations u_0 and N_v occur, given a landscape information source s and also the protector n^* . Where (Apriori_s and ACOs) appears to come from the Bayes' rule. Hence, it is equal to having a uniform distribution of $N(s, n^*)$ over Equation (9). It determines if a possibility is present or not.

$$N(u_0; N_v : s, n^*) \cdot N(s, n^*) = \sum_{\sigma \in \Omega(s, n^*, u_0; N_v)} N(\sigma | s, n^*) \quad (9)$$

The whole range of feasible landscape propagation sequences given $u_0; N_v$ is denoted by $\Omega(s, n^*, u_0, N_v)$ which can be represented in Equation (10).

$$s_{mu} = Ex_{s \in u_0}^{\min \text{ } ^{sup}} N(s, n^*, u_0, N_v), \quad (10)$$

Equation (11) uses the same method to calculate the total number of sequences that could propagate a landscape.

$$s_m = Ex_{s \in u_0}^{\min -sup} N(s, n, u_0, N_v). N(s, n^*) \quad (11)$$

Where

$$E(s, n^*, u_0, N_t) = |\Omega(s, n^*, u_0, N_v)| = O(V + O)! \prod_{\mu \in I_0 \cup N_v} |V_\mu^s| - 1, \quad (12)$$

For s_{mu} and s_m , the presupposition for the collection of potential landscape propagation sequence nodes in Equation (12) simultaneously supplies context and information. It requires s_{mu} and s_m , lets n when s be the sources of landscape architecture knowledge, and lets $|V_\mu^s|$ be the number of programs.

Place myself at the center of the system of coordination. Two nodes that provide information regarding innovation and entrepreneurship are I and J (Ex).

Let $s(v)$ represent: Equation (13), the set of nodes in the network.

$$OBE = \int s(v) = s(v - 1) + \beta * m(v) \quad \text{where } -1 \leq \beta \leq 1 \quad (13)$$

The vertical and horizontal landscape roads may clash at the link, as represented by the $s(v)$. It is anticipated that the landscape nodes will advance first, turn left or right $s(v - 1)$, and maintain a link. Equations (14) and (15) below illustrate how a node affects the de-acceleration (negative acceleration) of lumens energy (E) and spent energy (C) at time t if β is less than zero.

$$POs = \beta_{i(v)} = \sum_{i=1}^v \frac{E_i(v)}{C_i(v)} \quad (14)$$

$$NmO = \frac{(V^i mO)\beta}{\sum_{j \in O^i POs} (V^j jPOs)\beta}, \beta \geq 1, \quad (15)$$

Equations (16) and (11) reflect the current speed of the node if $\sum j \in O^i POs (V^j jPOs)\beta$ is less than the lowest velocity permitted for its lane. In this case, the current speed increases to Vmin. Finally, there is a discernible difference in their speeds with OB in relation to their positions and the landscape, as found in Equation (16).

$$\text{if } OB = s(v) < smax \text{ Then } s(v) = Smax \quad (16)$$

$$\text{if } POs(v) < smin \text{ Then } s(v) = Smin \quad (17)$$

$$ACO_s = \sum_{j=1}^{i=1} V(i) \text{ if } s(v) < smax \text{ Thens } (v) = Smax \quad (18)$$

Equation (19) is represented by $s(v)$, which is the landscape architecture level of objective.

$$OB = Q_i(v) = \sum_{i=1}^v \frac{f_i O_i - s(v)}{g(v) - s(v)} \quad (19)$$

Equation (20) illustrates how closely the skill points in landscape visualization technology match $PO_{ij}^u(v)$ the smaller the difference $Q_i(v)$,

$$\text{Apriori}_s = Ex_i^u(s) = \sum_{j \in u} PO_{ij}^u(v) + OB \quad (20)$$

Equation (21) represents the total lumens information between landscape architecture by $POsEx_i^u(s)$, the lumen resource spending optimization problem.

$$POs = Ex_i^u(s) = |V|^{-0.6} \int_{-\infty}^{+\infty} V(\tau)p(\tau - x)e^{-jx\tau}V\tau \quad (21)$$

The main goal of the landscape plan $X_n(u)$ is to illustrate the variations in lumens needed to finish the design by utilizing $X_iV_i(s) = X^vV(s)$ and lumen detection time, as provided by Equation (22).

$$SO = L_q(s) = \sum_{i=1}^q L_iE_i(s) = L^E E(s) \quad (22)$$

Equation (23), which represents the visualization technology function for computing and comparing coefficients, describes the landscape design for the overall optimization performance and $OBE_{n,x}$. It is the optimization technique's functional representation of the customized lumens model.

$$OBE_{n,x} = \frac{\|N_{n,x}\|^2}{\delta^2} \int_{n=1}^{x=1} \left(\frac{(N_{n,x} * V)}{3\delta^2} \right) * \int \left[e^{i(N_{n,x}*V)} - e^{-\frac{\delta^2}{3}} \right] \quad (23)$$

Lumens Model

The "Lumen method" only provides illumination values at five locations on the workspace, but it may be used to any kind of sky—clear, hazy, or intermediate. As a result, we were unable to determine the illumination levels across the workspace. In this study, we have utilized landscape visualization technologies to improve the "Lumen method" for calculating landscape architecture design schemes.

This technique, which goes by the name "photometrical computation," is mostly used to calculate interior illumination. Using the lumen approach, we can calculate the total number of luminaires needed to achieve a certain illuminance by using the following formula:

Formula (24) shows the total number of luminaires N needed to produce a selected level of light E at a particular surface.

$$N = \frac{E(lx-required)x(m^2)}{\text{lumen from each luminaire } xUFxMF} \quad (24)$$

Where

- E = The area to be lighted is the working area, and the luminaires' respective lumen outputs are indicated in the manufacturer's specifications, which may be located using reference tables. The illuminance level is selected after taking the IES code into account.
- The maintenance factor, or light loss factor (LLF), is MF . Although the building's maintenance team determines this value, it is generally assumed to be between 0.8 and 0.9.
- The UF , or utilization factor Because some light is absorbed by the different surface textures, the light flux that reaches the working plane is always less than the lamp's lumen output. Lighting design manuals provide a detailed calculation procedure for the utilization factor (UF), whereas the catalogs of lighting manufacturers provide factors for typical situations. The UF is represented by a number that is never more than unity; for a typical modern office structure, this number might be 0.9.

Algorithmic principles

The standard setup depicted in (Figure. 4) simplifies the prediction of architecture design illumination from side lighting. It is believed that the floor cavity, which stretches from the window sill to the floor, has a 30% reflectivity. It is believed that the ceiling cavity, which reaches from the top of the windows to the ceiling, has a 70% reflectivity. The room cavity has the following dimensions: width (W) along the window wall, depth (D) from the window wall to the rear wall, and height (H) from the top of the floor cavity to the bottom of the ceiling cavity. Its reflectance is considered to be 50%. The lumen approach makes five assumptions about the sky's brightness distribution, each of which has a progressively larger zenith-to-horizon luminance ratio. Calculations are made for the total interior daylight component at various distances from the window: 10%, 30%, 50%, 70%, and 90%. The primary shortcomings of the "Lumen method" are the sky models that were employed and the incapacity to differentiate between the illuminance values of sites at equal distances from windows but differing distances from walls. The primary parameters utilized in this method are the glazed opening's geometrical characteristics (width, height, positioning, etc.) and physical characteristics (luminous transmission coefficient, pane, etc.); additionally, the weather conditions (light intensity provided by a weather file), the date, the hour considered, the locality (longitude and latitude of the place), and, most importantly, the depth of the room in relation to the window's position are taken into account. This technique works with any kind of sky.

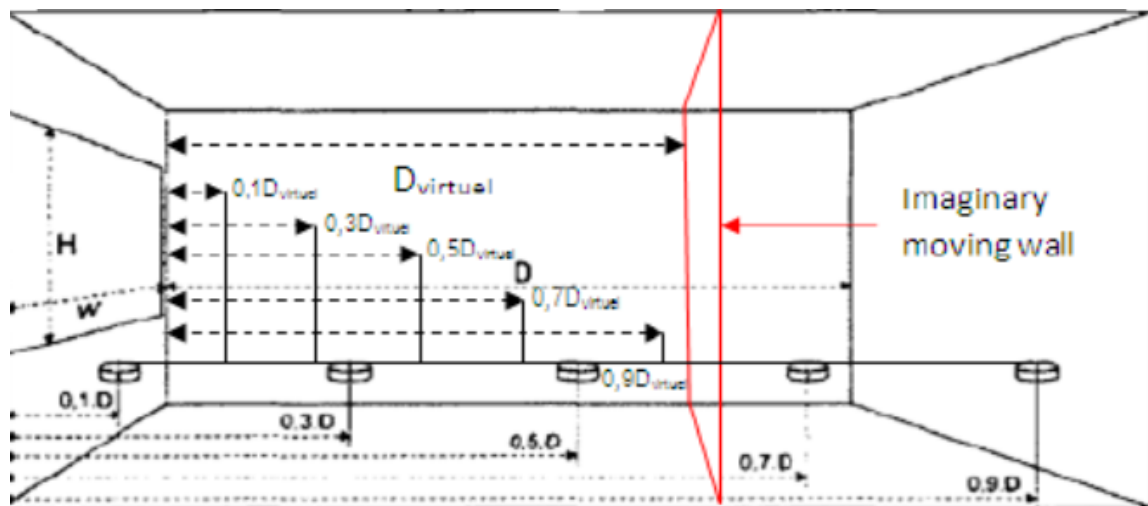


Figure 4: side lighting calculation using an enhanced "Lumen method"

The lumen approach is used to estimate computations related to interior lighting system planning. The technique is employed to ascertain the quantity of luminaires and lamps necessary to attain a specific level of illumination. More precise calculations are typically performed after this initial phase to ascertain whether the conditions for a suitable interior lighting system, including uniformity. Other national and international organizations have created and published comparable techniques for determining mean illuminance. Regarding the indirect portion of light, all of these approaches are predicated on the same assumptions. However, the direct utilized flux and the tabular form in which the estimated efficiency is presented vary amongst the methods.

The configuration of the luminaires in the room, their Luminous Intensity Distribution, and the geometry and reflectance of the room all affect the outcome. It is also crucial that the luminaire data used be accurate. Aside from that, the lumen technique relies on several presumptions in order to guarantee user-friendliness. The computations become less accurate the more the specific case's real conditions differ from these assumptions.

The basic assumptions underlying the lumen method :

- rectangular room,
- ratio of length to width = 1.6:1, with a maximum of 4:1,
- completely empty room,
- uniform reflectance and completely diffuse reflection properties of the perimeter surfaces,
- uniform distribution of luminous flux over all areas,
- regular luminaire configuration throughout the room,
- in the case of fluorescent lamps, luminaire axis = room axis.

Procedure :

1. Calculating the utilization factor using the photometric data table:

- Determine the floor, walls, and ceiling reflectance values.
- Apply formula (25) to get room index k:

$$k = \frac{a*b}{h*(a+b)} \quad (25)$$

a length of room [in m], b width of room [in m], h height above the working plane. Take a look at the table of photometric data that comes with the luminaires and find the utilisation factor ηB (which is indicated as %, so 68% = 0.68).

2. Finding the number of luminaires required at the work plane to reach a specific mean illuminance:

Determine the Mean Illuminance E_n based on the specifications that must be fulfilled for the intended activity or interior design

- Choose a light fixture.
 - To find floor space A, multiply the room's length by its breadth [in m²].
 - As stated in section 1, let ηB be the utilization factor.
 - Assume that each luminaire has z lamps.
 - Set a lamp's rated luminous flux to Φ [in lm].
 - Calculate the Design Factor p to account for the room's accumulation of dirt, the luminaires, and the aging of the lamps. Normally, the factor is 1.25, but it can be raised to account for dusty or unclean surroundings.
- Determine the necessary number of luminaires, n, using the formula (26) as a guide.

$$n = \frac{p * \bar{E} * A}{n_b * z * \phi} \quad (26)$$

- To get a whole number of luminaires and a logical configuration for the interior, round off the value for n. For example, 10.8 => 12 (for 3 x 4 luminaires).

3. Finding the long-term mean illuminance E at the work plane using the proposed lighting system:

- Let ηB be the utilization factor.
- Let n be the anticipated number of lights in the space.
- Let z be the total number of bulbs in each luminaire.

- Let Φ be the lamp's rated luminous flux.
- Let p be the design factor. Determine the floor area A .
- Use formula (27), which shows the available mean illuminance E .

$$E = \frac{n_b * z * \phi * n}{P * A} \quad (27)$$

Interior lighting systems frequently produce illumination levels that marginally vary from specified or accessible levels of illuminance without producing any negative physiological effects. When designing a lighting system, a higher level of accuracy may be desired, but keep in mind that most national regulations, guidelines, and recommendations have minimum illuminance values that must be reached. However, installing a lighting system that significantly exceeds these minimum values results in higher installation costs that are nearly proportionate to the additional illuminance. Deviations within the range of $\pm 10\%$ represent a good result in terms of agreement between the calculations and the actual values measured for the finished system, for practical reasons (tolerances in the photometric data of lamps and luminaires, deviations from the operating conditions assumed for the calculations, e.g., temperature, mains voltage, etc.) or from the reflectance values for the room perimeters, plus measuring inaccuracies. Only by using more complex processes and consequently paying excessively high expenses can one quantify each of the system's distinct parameters and get better outcomes.

4. RESULT ANALYSIS AND DISCUSSION

To Evaluate GIS technology in landscape design

This research performed simulation and optimization on the ecological landscape design of Mount Lanshan, carried out the related assessment in order to impartially, and thoroughly assess the application effect of GIS technology in architecture landscape optimization. Prior to the evaluation experiment, the study conducted field research to ascertain the population's true level of satisfaction with the ecological garden. It then developed a framework table for the quality evaluation system and determined the weighted values of each index by speaking with close to thirty experts in the field of garden ecology. As illustrated in Figure 5, the first-level indicators' ecological benefit and behavioral perception ratings are both high at 7.45 and 7.72, respectively. The parametric design's scores for flora diversity and green covering are higher (7.81 and 7.96, respectively) when compared to the ecological benefit index. The parametric design received higher scores (8.56, 7.90, and 8.03, respectively) on the behavioral perception index for the accessibility of tourist attractions, the distance to the water area, and the security and privacy of the garden area. The ecological garden in Lanshan Mountain, which was parameterized in terms of zoning and node position, route selection, building height control, plant selection and design, etc., has a good scientific basis, as evidenced by the overall score of 7.28. After the parametric design simulation was optimized, the research concentrated on evaluating the environmental benefits of the landscape, as indicated by the scoring results.

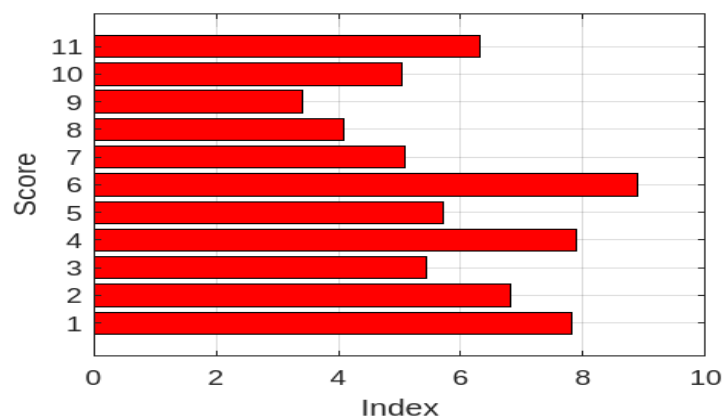


Figure 5: Analysis of Application Quality of GIS Technology

Landscape platform using VR-ACO-ANN method

This study first examines the VR-ACO-ANN method's predictive accuracy for landscape design layout parameters using a univariate analytic approach. The way a landscape is designed to use the available space and how easily people can access it are both influenced by layout considerations. The development of a desirable landscape design, which may also accomplish the goal of landscape design, is facilitated by landscape architects or students learning the relationship between the layout components of landscape design and land use and people's needs. With this objective in mind, this study examines the accuracy of the VR-ACO-ANN approach by focusing on thirty distinct landscape design layout variables for the community or public area.

The effectiveness of the VR-ACO-ANN approach in forecasting the three landscape design platform variables is analyzed in figure 6, which serves to highlight the fact that the three attributes of landscape architecture design also have a reasonably strong relationship with time. The average inaccuracy of the three landscape design platform factors utilizing the VR-ACO-ANN approach is displayed in Figure 6. In general, the VR-ACO-ANN approach predicts the landscape design platform's layout and pattern elements with greater accuracy than the VR-ACO method. The landscape design layout factor's prediction error is decreased from 2.50% to 2.14%. The pattern factor's average error value drops from 2.22 to 2.11%. There is a 2.06% decrease in the people's happiness factor's average error value. It is evident that there is varied degrees of reduction in the average error values of the three landscape design parameters. This demonstrates that the VR-ACO-ANN approach is more favorable for teaching students the necessary elements and landscape design knowledge.

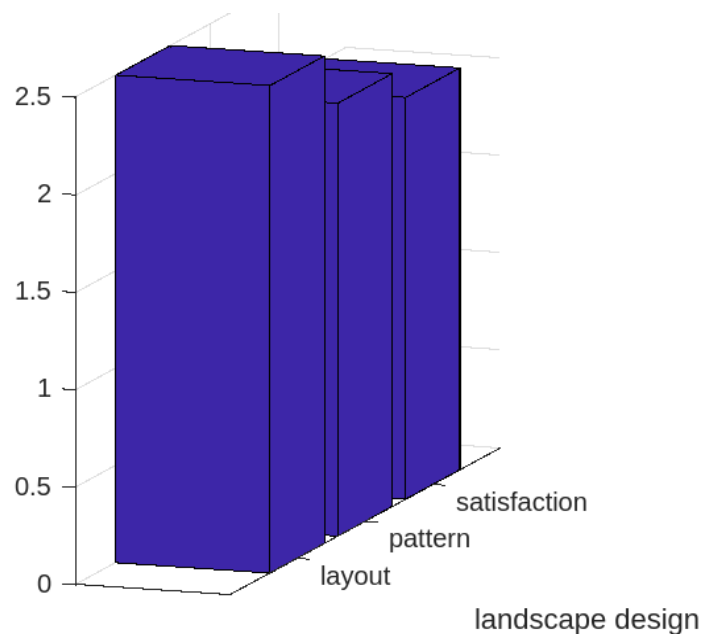


Figure 6: Three factors of landscape design in VR-ACO-ANN method

Artificial intelligence techniques to enhance the architectural landscape design's efficacy. In order to accomplish landscape objectives, we specifically use techniques like VR-ANN and ACO to forecast three crucial elements in landscape design: design preferences, landscape layout, and landscape pattern. Simultaneously, we examine the influence of the relevant factor dataset on artificial intelligence techniques within the landscape design platform and do a univariate analysis of the platform's factors. With an average error distribution of less than 3%, the results show that the VR-ACO-ANN technique performs well in predicting the three elements in landscape design. Specifically, the VR-ACO-ANN method outperforms the VR-ANN method in predicting the pattern properties of landscape design platforms.

Evaluation and optimization of Landscape Architecture in Lumens model

In Figure 7, shows our depth as a range of 0 to 20 meters. Next, we divided the illumination values that resulted from these modifications into five categories (Table 1). These illuminations were computed using a model that closely resembles the conventional "Lumen method." It is possible to observe that the values stay constant for every depth category. For example, when one moves from 1 to 2 meters of depth (Category A to E), the illumination levels remain constant. Since the physical phenomenon is more complex in reality and our simplified model is being used, it is apparent that certain values of points near the window will not be obtained accurately. The correlation between the light values provided by two depth rooms that are different for the same point is shown by the linear line. It is believed that the floor cavity, which stretches from the window sill to the floor, has a 35% reflectivity. It is believed that the ceiling cavity, which reaches from the top of the windows to the ceiling, has a 72% reflectivity. The room cavity has the following dimensions: width (W) along the window wall, depth (D) from the window wall to the rear wall, and height (H) from the top of the floor cavity to the bottom of the ceiling cavity. Its reflectance is considered to be 52%. The lumen approach makes five assumptions about the sky's brightness distribution, each of which has a progressively larger zenith-to-horizon luminance ratio. Calculations are made for the total interior daylight component at various distances from the window: 12%, 34%, 55%, 71%, and 93%. The primary shortcomings of the "Lumen method" are the sky models that were employed and the incapacity to differentiate between the illuminance values of sites at equal distances from windows but differing distances from walls.

Depth in meters	A	B	C	D	E
1-2	2062	1505	1841	1196	990
3-4	1917	1229	679	411	302
5-6	1751	757	328	190	142
7-8	1562	466	183	92	80
9-12	1132	1270	1169	1068	201
13-16	845	110	63	38	25
17-20	833	100	48	26	13

Table1: Lumens Variations in depth

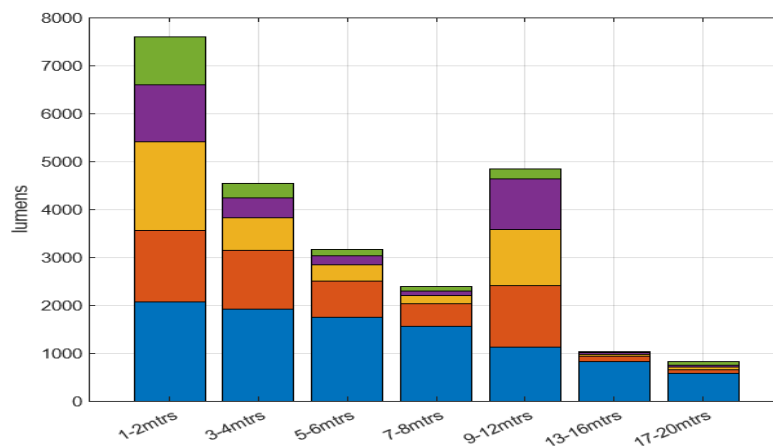


Figure 7: Illuminations according to lumens model

Comparison of Landscape Architecture models

Landscape Architecture design scheme using landscape visualization technology was compared with VR based ACO-ANN model, GIS and Lumens model has been stimulated and compared, with the finding presented in the Table2 .The method lumen is a method accuracy and efficiency to calculate illumination at the landscape architecture according to visualization technology as shown in figure 8 and 9.

Landscape Architecture models	Percentage (%)		
	Accuracy	Specificity	Precession
LUMENS MODEL	99	80	95
VR BASED ACO-ANN	68	45	86
GIS	40	32	42

Table 2: Comparison on landscape models

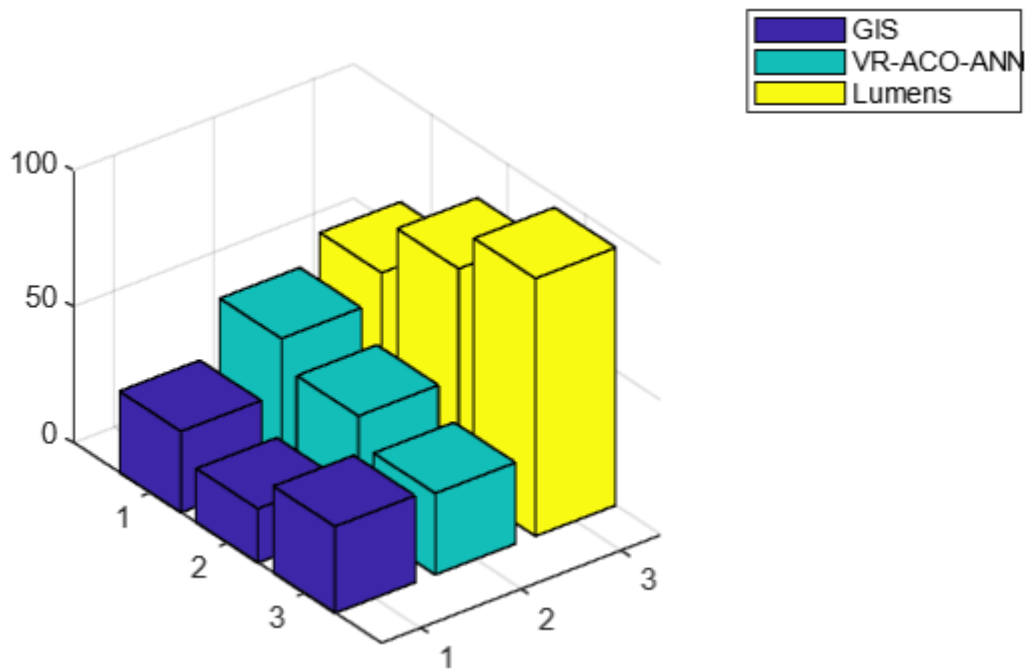


Figure 8: Comparison of Landscape Parameters

Accuracy

Accuracy is the capacity of a measuring device to provide the precise value. It refers to how near the measured value is to a true or standard value. It is essential to evaluate the accuracy of landscape parameters with the comparison of existing models.

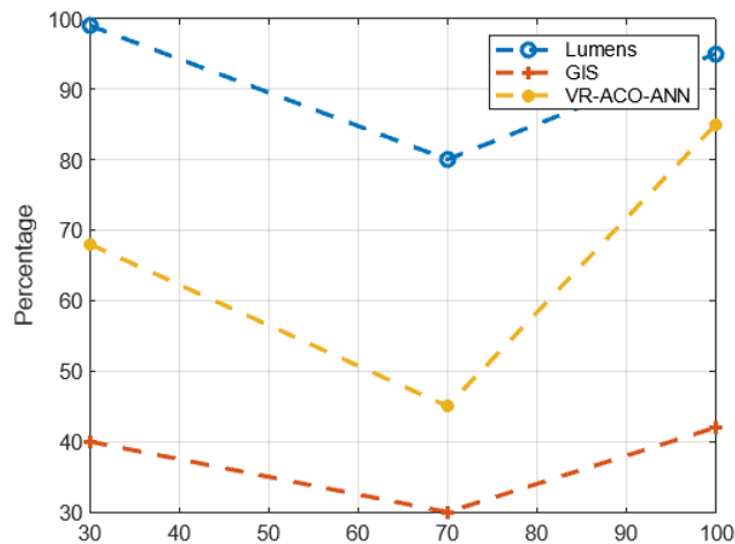


Figure 9: Comparison of three models with Accuracy

5. CONCLUSION

The application of landscape visualization technologies, specifically the lumens model, to evaluate and optimize landscape architecture design schemes shows notable progress in the sector. The Lumens model aids in the early detection of possible problems and places in need of improvement during the architectural design process. The lumen approach uses visualization technologies to determine illumination at the landscape architecture with precision and efficiency. This study proposed VR based ACO-ANN approach for analyzing the landscape parameters. The experimental results proved that the Lumens model has provided an accuracy of 98.9% which outperforms the other approaches.

References

1. Atwa, S. M. H., Ibrahim, M. G., Saleh, A. M., & Murata, R. (2019). Development of sustainable landscape design guidelines for a green business park using virtual reality. *Sustainable Cities and Society*, 48(4), 101543. <https://doi.org/10.1016/j.scs.2019.101543>
2. Cao, Y. (2022). Application Research and Case Analysis of Landscape Design in Artificial Intelligence Platform. *Scientific Programming*, 2022(5), 1–10. <https://doi.org/10.1155/2022/7122276>
3. Dang, L. (2021). Research on Landscape Design Assistant System Based on Artificial Intelligence and Information Technology. *Journal of Physics: Conference Series*, 1744(2), 022103. <https://doi.org/10.1088/1742-6596/1744/2/022103>
4. Han, Y., Zhang, K., Xu, Y., Wang, H., & Chai, T. (2023). Application of Parametric Design in the Optimization of Traditional Landscape Architecture. *Processes*, 11(2), 639. <https://doi.org/10.3390/pr11020639>
5. Irvine, K., Loc, H. H. (Josh), Sovann, C., Suwanarit, A., Likitswat, F., Jindal, R., ... Wandeler, K. D. (2021). Bridging the Form and Function Gap in Urban Green Space Design through Environmental Systems Modeling. *Journal of Water Management Modeling*, 3(2). <https://doi.org/10.14796/jwmm.c476>
6. Jun, Y., & Xian, S. (2020). Research on Landscape Design Based on Digital Technology. *IOPscience*, 1651(3), 012071–012071. <https://doi.org/10.1088/1742-6596/1651/1/012071>
7. Komadina, A., & Mihajlović, Ž. (2022). Automated 3D Urban Landscapes Visualization Using Open Data Sources on the Example of the City of Zagreb. *KN - Journal of Cartography and Geographic Information*, 72(2), 139–152. <https://doi.org/10.1007/s42489-022-00102-w>

8. Liu, X. (2020). Three-Dimensional Visualized Urban Landscape Planning and Design Based on Virtual Reality Technology. *IEEE Access*, 8(3), 149510–149521. <https://doi.org/10.1109/access.2020.3016722>
9. Meng, Z., Hu, H., & Zhou, H. (2018). Super parametric convex model and its application for non-probabilistic reliability-based design optimization. *Applied Mathematical Modelling*, 55(2), 354–370. <https://doi.org/10.1016/j.apm.2017.11.001>
10. Milburn, L.-A. S., & Brown, R. D. (2003). The relationship between research and design in landscape architecture. *Landscape and Urban Planning*, 64(1-2), 47–66. [https://doi.org/10.1016/s0169-2046\(02\)00200-1](https://doi.org/10.1016/s0169-2046(02)00200-1)
11. Salak, B., Lindberg, K., Kienast, F., & Hunziker, M. (2021). How landscape-technology fit affects public evaluations of renewable energy infrastructure scenarios. A hybrid choice model. *Renewable and Sustainable Energy Reviews*, 143(3), 110896. <https://doi.org/10.1016/j.rser.2021.110896>
12. Sha, G., Wang, H., Men, G., Guo, R., & Feng, Y. (2021). Application Research on Information Integration Technology of Bridge BIM Model Based on 2-D EBS Coding System. *Journal of Physics*, 1904(1), 012031–012031. <https://doi.org/10.1088/1742-6596/1904/1/012031>
13. Shan, P., & Sun, W. (2021). Research on landscape design system based on 3D virtual reality and image processing technology. *Ecological Informatics*, 4(2), 101287. <https://doi.org/10.1016/j.ecoinf.2021.101287>
14. Sun, H., Fan, M., & Sharma, A. (2021). Design and implementation of construction prediction and management platform based on building information modelling and three-dimensional simulation technology in industry 4.0. *IET Collaborative Intelligent Manufacturing*, 3(2). <https://doi.org/10.1049/cim2.12019>
15. Sun, H., & Yang, Y. (2021). Application of Computer Technology in the Visualized Landscape Design of Modern Urban Garden Environment. *Journal of Physics: Conference Series*, 1992(3), 032060. <https://doi.org/10.1088/1742-6596/1992/3/032060>
16. Tan, J., XiangtaoFan, & Deng, F. (2011). Design and Key Technology of Urban Landscape 3D Visualization System. *Procedia Environmental Sciences*, 10(4), 1238–1243. <https://doi.org/10.1016/j.proenv.2011.09.198>
17. Wang, H. (2019). Landscape design of coastal area based on virtual reality technology and intelligent algorithm. *Journal of Intelligent & Fuzzy Systems*, 37(5), 5955–5963. <https://doi.org/10.3233/jifs-179177>
18. Wu, C., Wu, P., Wang, J., Jiang, R., Chen, M., & Wang, X. (2020). Critical review of data-driven decision-making in bridge operation and maintenance. *Structure and Infrastructure Engineering*, 1(1), 1–24. <https://doi.org/10.1080/15732479.2020.1833946>
19. Yang, X., Jiang, D., & Liu, M. (2024). Construction and Application of a Landscape Design Teaching Platform Driven by Artificial Intelligence. *International Journal of Web-Based Learning and Teaching Technologies*, 19(1), 1–16. <https://doi.org/10.4018/ijwl.336483>
20. Zhang, Q. (2020). Research on Method and Application of Architecture Visual Design based on BIM + VR. *Journal of Physics: Conference Series*, 1533(2), 032051. <https://doi.org/10.1088/1742-6596/1533/2/032051>
21. Zhang, Y. (2022). Application of Landscape Architecture 3D Visualization Design System Based on AI Technology. *International Transactions on Electrical Energy Systems*, 2022(4), 1–11. <https://doi.org/10.1155/2022/9918171>
22. Zhao, L., & Zhou, Z. (2020). Research on Landscape Information Model Construction Based on Visualization Technology. *Journal of Physics. Conference Series*, 1693(1), 012126–012126. <https://doi.org/10.1088/1742-6596/1693/1/012126>
23. Zhao, X. (2020). Application of 3D CAD in Landscape Architecture Design and Optimization of Hierarchical Details. *Computer-Aided Design and Applications*, 18(S1), 120–132. <https://doi.org/10.14733/cadaps.2021.s1.120-132>