Application of Computer Technology in the Visualized Landscape Design of Modern Urban Garden Environment

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Abstract. The landscape design of the garden environment is closely developed with the combination of aesthetics, environmental science, and planning technology. To solve the dynamic landscape characteristics, this paper relies on computer technology to carry out the visualized landscape design of modern urban gardens, realizes 3D solid modeling and 3D real-time virtual presentation of design scenes, lays a theoretical foundation for garden landscape planning, and discusses in detail the simulation in professional modules process. Finally, an engineering example is used to verify the effectiveness of the system.

Keywords: Computer-Aided Design, Virtual Reality, Simulation, Garden Landscape

1. Introduction
The landscape design of the garden environment is closely developed with aesthetics, environmental science, planning technology, etc [1-2]. Its connotation includes many aspects such as scenic spot planning, road environment, community greening, urban greening, etc. On the one hand, it is necessary to pay attention to the connection between garden landscape and culture, region, and life. On the other hand, it must also promote the sustainable development of ecological vegetation [3]. Design works must not only have visual beauty, but also coordinate with the surrounding environment. It covers urban greening, community greening, square design, road environment, scenic area planning, etc. It not only emphasizes the integration of garden landscape with life, region, and culture, but also considers the sustainable development of ecological vegetation and protects and utilizes natural resources. For landscape architects, in order to make the design concept more accurate, it is particularly important to display the design works in a true, comprehensive and dynamic manner [4-6].

This paper relies on computer technology to carry out the visualized landscape design of modern urban garden environment, laying a theoretical foundation for garden landscape planning, and aims to improve the quality of planning.

2. Visualized landscape design system for garden environment
The visualized landscape design system of garden environment mainly includes:
(1) Editing and modeling module: The system can make arbitrarily complex and detailed
three-dimensional models through the diversified editing methods of this function and richer general modeling methods. Regarding the characteristics of the gardening profession, the modulus of various common garden sketches was summarized, and the parameterization of design techniques was used to quickly establish a three-dimensional landscape model. The system has prepared a file interface that can be directly imported or transferred to an existing 3D model and a library of sketches of a rich variety of 3D gardens.

(2) Terrain design module: The terrain is generated based on contour data and discrete elevation points, and the water flow, orientation, elevation, slope, etc. of the terrain are analyzed, and then the location of the fill and excavation is determined. Carry out reconstruction and calculate earthwork.

(3) Planning design module: This function is used to parameterize, define plots, plan roads, generate steps, fences, ponds, flower ponds, flower stands, ramps, curbs, etc. landscape models and design mountain roads.

(4) Planting design module: This function can provide a rich plant database and pictures, and record the various habits of each plant, and provide various planting methods such as mixed planting, patch planting, row planting, and isolated planting. And modify the number and attributes of some plants that have been planted, and can expand the plants planted on the flat surface to the undulating terrain.

(5) Sprinkler irrigation design module: through the understanding of the design characteristics of my country's sprinkler irrigation industry, a series of professional processes such as professional marking, equipment layout, pipeline drawing, equipment database editing, automatic material statistics and tabulation in sprinkler irrigation design are standardized.

(6) Data statistics module: This function is responsible for the area of green space, water surface, square, road and other plots used in the design of the garden landscape, the length of some structures such as pavilions, flower stands, and the Statistics of the quantity of some garden sketches such as chairs and scenery stones.

(7) Construction drawing drawing: This function can provide many drawing methods, for example, lawn filling, pavilion corridor, water revetment, square, garden road, hedge line, forest edge line, etc. provide a wealth of annotations, and can also be used To label plants, coordinate positioning, elevation, angle, radius and area, etc., the system has also issued a two-dimensional library with filling pattern functions similar to AutoCAD and richer content, and the corresponding renderings can be printed out.

(8) Virtual reality function: This is a function that can display the design process in real time. The technology it uses is OpenGL. It can draw three-dimensional images through some means such as light source camera configuration, scene layout, texture mapping, etc. The real scene is rendered by the simulation effect diagram, and it can also be recorded into a virtual roaming animation image that can be played repeatedly by setting the animation path.

2.1. Three-dimensional terrain design
The 3D garden landscape design simulation system adopts the regular grid method (RSG) to complete the field simulation and design. The system uses a local interpolation algorithm to use a set of finite digital elevation sampling points or contour data on the terrain surface to model the three-dimensional terrain with triangles, and then convert them into regular grid data, that is, the digital elevation model (DEM). Using the local interpolation algorithm, the digitized elevation sampling points or contour data can be converted into regular grid DEM data. General interpolation algorithms include linear interpolation, inverse distance weighting, finite element method, natural neighboring point method and gram Lijin interpolation and other algorithms, after weighing the calculation complexity and the accuracy of the result, finally use the optimized Inverse Distance Weighted method (Inverse Distance Weighted) for calculation to generate a regular three-dimensional grid terrain. The accuracy of terrain simulation depends on the sampling accuracy of natural terrain. The original terrain is restored to a three-dimensional digital model based on terrain data information, which can effectively provide designers with a basis for data analysis. In order to avoid the impact of sampling point accuracy and range on the simulation results, the system uses manual intervention to calculate the sampling
accuracy and achieve the expected effect. Using DEM model for terrain design can not only simulate site terrain, but also complete site analysis, site leveling and site transformation. The specific terrain design process is shown in Figure 1.

**Figure 1.** Topographic design process flow.

(1) Topographic analysis principle
Slope and aspect analysis: use the DTM grid plane as the basis for calculation.
Aspect: The projection of the vertical foot line (normal) of the plane on the horizontal plane, and the azimuth angle between true north.
Slope: The angle between the plane and the horizontal; or the angle between the normal and the zenith line.
Slope calculation: the slope between two points: the height difference divided by the distance, as shown in equation (1).

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S(\%) = \frac{\text{Height difference between the highest and lowest contours between two points on the surface}(M)}{\text{Horizontal distance between two points on the ground}(H)} \times 100\%
\]  

(1)
(2) Principles and formulas for calculating the terrain elevation of discrete points
The system adopts the principle of height interpolation calculation based on inverse distance weight method to realize the height calculation of discrete point terrain.

2.2. Three-dimensional planting design

2.2.1. Description of planting method
The system can automatically complete planting according to common planting methods, and can form a garden landscape effect through the combination of multiple planting methods. The system associates graphics with data, and not only has the function of assisting drawing, but also the function of assisting design. Apply a plant database suitable for China's climatic conditions as the basis for selecting tree species in planting design. By calling the sub-tables of each region in the plant database, selecting the tree species in the region, setting the specifications of the tree species (including: tree height, crown width and diameter at breast height, etc.), and choosing planting methods: isolated planting, row planting, patch planting, and planting Group planting and mixed planting, etc., choose the plane expression of plants and three-dimensional pictures of plants to complete planting. The expression of the planting plane group should meet the drawing standards of the garden design, according to the plan legend of the plant, or according to the planting point and the outline of the plant. In order to achieve the unity of the two-dimensional and three-dimensional planting design, by switching the view, the plan planting diagram is displayed in the top view, and the plant pictures selected during planting are displayed in the perspective view to express the three-dimensional effect of the planting design.

2.2.2. Representation of plants
In the process of landscape construction, the number of plants used is usually very large. If a three-dimensional model is used to represent plants, the number of patches used by a plant will be large, and the entire project will consume a huge amount of system space. When the number of patches exceeds the system's limit capacity, the system will collapse. Based on the above reasons, the system provides another way of plant representation, using OpenGL bulletin board technology to simulate plants with pictures. Bulletin board technology is a very practical technology, it can use a simple way to achieve many special effects, but its most attractive place is that the system resources used to achieve these effects are extremely low. In this way, for each plant entity, only its location and picture index information need to be stored, and the storage cost of a three-dimensional model is replaced with the storage cost of a photo, thereby greatly saving system space. In terms of display effect, the system has hollowed out the collected pictures of plants in the north and south, and used the OpenGL extension function to achieve the hollowed out texture display effect, and the result is more realistic.

2.3. Dynamic browsing and rendering technology
After the system finishes creating a 3D model, assigning materials to entities, setting light sources, and viewpoints (cameras), it can dynamically browse at any time, make 3D realistic renderings or animations, and use rendering renderings to reflect light and shadow effects and textures. The difficulty of 3D CAD lies in the problem of large-volume and large-volume shuttle-type real-time dynamic 3D browsing. The system uses low-cost, high-performance graphics cards, and its mature interface languages such as OpenGL and Direct3D based on hardware acceleration, and through the use of complex 3D entities. The rapid triangulation processing can better solve the problem of fast dynamic display of large-capacity entities. At the same time, the use of smoothing processing for specific three-dimensional meshes also greatly reduces data processing. The system reasonably uses the triangle belt and triangle fan methods provided by OpenGL to reduce the recording on repeated nodes and greatly reduce the nodes that express the stereotyped objects. At the same time, the use of smoothing processing of specific three-dimensional meshes also greatly reduces data processing,
which has a significant effect in practical applications. The three-dimensional garden sketches in
garden design are of various forms and body shapes, and the requirements for texture mapping are also
different. The types of texture mapping include: plane, cuboid, sphere, circle, cylindrical triangle
surface and adaptive mapping, etc. The system is based on a variety of mapping Method to calculate
the texture coordinates, use bitmap texture materials to realize real-time display of entities. Since
OpenGL is a lower-level language directly driven on the graphics card, the size of the texture must be
2 scenes, so it needs to be sorted when it is passed to OpenGL. Taking into account the characteristics
of garden landscape design, it is not possible to use simple planting and subtraction methods, but to
integrate color compression, color merging and softening techniques to achieve the desired effect. By
reading the transparent channel information of the 32-bit color bitmap, combined with the OpenGL
template application, the hollow-out texture display technology is realized, and the effect that cannot
be achieved in the past is achieved in the performance of the environment and scenery. The tree picture
uses a hollow texture map, and the tree picture size is set to 2 times to improve the display accuracy. In
terms of graphics rendering algorithms for photorealistic rendering and dyeing, by comparing the three
algorithms of depth buffering, ray tracing, and radiosity, the system uses an improved and more
accurate radiosity algorithm to solve the problem of slow rendering calculation speed and make The
degree of practicality. The system provides ray tracing and radiance rendering modes, which are
suitable for outdoor and indoor realistic rendering. The unique hollow-out texture background entity
can directly complete the layout of various backgrounds in the scene. The system can create multiple
cameras (viewpoints), and select one of them as the current camera. You can drag and modify the
position of the camera. During the dragging process, the position and angle of view of the camera are
displayed in each view in real time, and the observation range of the camera is displayed in the camera
view to achieve the WYSIWYG effect. At the same time, the system also supports six types of light
sources such as light source, cone light source, parallel light, cylindrical light source, surface light, and
sunlight. The sunlight automatically calculates the light direction according to the latitude and
longitude and the local time. Each light source can be set and modified interactively. The system
provides three display modes: wireframe, OpenGL, and highly realistic. Highly realistic graphics
display mode supports five graphics rendering algorithms: depth buffer, ray tracing, radiance, depth
buffer + ray tracing, ray tracing + radiance, etc. The time cost of various algorithms and the effect of
graphics reality are different. It can meet the needs of various applications. The system's rendering
algorithm uses anti-aliasing technology to support natural environments such as fog and background.
At the same time, it uses a variety of graphics acceleration algorithms such as space segmentation,
which can quickly produce high-quality rendering graphics. In terms of animation production, the
system adopts a multi-window interactive mode, setting a polyline or Bezier curve as the camera path,
and setting the parameters of each key point of the path to complete more complex camera animation
and scene switching effects. Provide OpenGL and rendering animation for scene browsing simulation,
adopt MPEG compression algorithm and expand MPEG graphics standard, can complete higher
resolution animation, and play it through the player program.

3. Results analysis
The system fully integrates three-dimensional modeling, three-dimensional terrain design,
three-dimensional planning and design, three-dimensional planting design, three-dimensional scene
real-time simulation, garden professional construction drawing and rendering, simulation animation
and other simulation functions. After repeated testing and display in all aspects, the system is proved It
has strong stability and security reliability under various complex operations, and has fast execution
speed for various operations between large-capacity entities, and its compatibility, scalability and
resource occupancy and other indicators Have reached the corresponding requirements.

4. Conclusion
This paper relies on computer technology to carry out visualized landscape design of modern urban
garden environment, and lays a theoretical foundation for garden landscape planning, and realizes 3D
modeling, 3D terrain design, 3D planning and design, 3D planting design, professional garden construction drawing, 3D scene real-time simulation And effective integration of various functional modules such as post-rendering and simulation animation production.

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