A 3D Multimedia Ecological Landscape Environment and Teaching Mode Based on Digital Interactive Experience

Zhigao Xiao, Jinghan Wang, and HanSong Deng

1City University Malaysia, Kuala Lumpur, Malaysia
2Hunan Normal University, Changsha, Hunan, China
3Chang Sha University of Science and Technology, Changsha, China

Correspondence should be addressed to HanSong Deng; 1763931674@qq.com

Received 31 March 2022; Revised 4 June 2022; Accepted 14 June 2022; Published 30 June 2022

1. Introduction

In current information era, digital multimedia has surpassed language, writing, and electronic technology like the most recent information transmitter. Digital multimedia technology combines information processing techniques, computer technology, communications technologies, and other information-related innovations. Digital multimedia knowledge is a type of computer and communication technology that aims to centralize the processing of sound, text, pictures, graphics, and other data so that it may be perceived, interacted with, and managed [1]. In the process of urban gardening work, each garden production unit and planning and design unit have applied the retrieval and inquiry of network information to a great extent, including the release of landscape information, the collection of plans, the evaluation of network plans, and so on. In addition, a geographic information system (GIS) provides an intuitive and rational spatial analysis tool for landscape architecture professionals [2]. It extracts information from various fields of the world through GIS and establishes the required 3D database in landscape evaluation and planning. In addition, it can extract the required data at any time to make statistics of various landscape information, thereby editing and production.

The landscape design comprises landscape operation and landscape planning. In practical work, a large number of performance maps and information materials are usually needed to express the intention of landscape design. It is hoped that the design effect would be seen before the project is completed and maybe improved over time based on functional needs, artistic needs, environmental circumstances, and other considerations. Make modifications so that relevant personnel can make suggestions and decisions on the design plan. In this way, it has solved the difficulty of...
modifying the previous drawings, and the expression is not intuitive after the completion of a lot of regrettable problems. In addition, a three-dimensional model of the stereoscopic effect may be created, which is a type of graphical and graphic expression. It should combine the technology of geographic information systems and global positioning systems to graphical the complex natural landscape. Through the integration with the Internet and Web, it can link the sound and photos to make users dynamic and multidimensional in the three-dimensional virtual landscape architecture. Therefore, to achieve the sensation of being on the scene, angle, omnidirectional, multifaceted browsing and enjoyment of numerous picturesque areas are required.[3]

Digital terrain editing is a modification of terrain data based on terrain visualization, which is an important research field in virtual geographic environments and 3D landscape simulation systems. In the planning and design of digital city and country, with the practice of regional road network, the landscape is often needed for the construction site of flat or excavation, along with the 3D geometric model construction, vegetation, transportation, and other elements of the set after the formation of the region.[4, 5]. Sometimes to meet the requirements of the excavation of the tunnel, bridge erection, filling, and digging earthwork are required to properly edit 3D digital terrain, including terrain elevation, low cut, leveling, and a series of operations, to fully demonstrate the planning and design of the construction project and ultimately achieve the engineering requirements.[6]. The traditional digital terrain visualization is based on the OpenGL graphics standard. OpenGL spatial data organization is relatively simple, but the process is more complex; it is difficult to develop a large-scale three-dimensional scene. Open scene graphics engine has a perfect function, with simple, superior performance advantages, and has a broad application prospect in the simulation system, urban planning, and design engineering. As a result, using a landscape editing module, this research shows a 3D effect of virtual community planning and design. Our scenario contains digital terrain, buildings, and landscape objects such as trees, as well as minor ground trims following terrain texture mapping. All of the tree model’s parameters are controlled using the ParaTree team’s single tree modeling tool. We created our model using third-party software, and the interactive tree and building model are then placed in a 3D digital landscape to create a three-dimensional setting.

1.1. Main Contributions. Firstly, we provide an overview of terrain-making approaches in Computer Graphics, as well as a serious evaluation of them. Secondly, we discussed the interactive editing of digital landscape followed by the software implementation and use of the editing module. Finally, we compare existing methods based on judgment frequency results and judgment accuracy.

1.2. Arrangement of This Paper. Section 2 explains the interactive editing of digital terrain and interactive editing principle along with software implementation, Section 3 is based on multimedia assisted urban landscape design, Section 4 presents our analysis of the value of urban landscape art, and Section 5, which is the last section of this paper, concludes our work.

2. Interactive Editing of Digital Terrain

A digital terrain model is a topographical representation of the bare ground that computer programs may edit. The datasets provide the terrain’s elevation data in a digital format that corresponds to a rectangular grid[7]. Digitized, vegetation, houses, and other cultural characteristics are erased, leaving only the base ground. The digital terrain system consists of a set of locations with defined geodetic locations and a height defining criterion for all additional locations that are not part of the set. Ground control points are sites having established geodetic coordinates (GCP). Geodetic remote sensing and cartometric work may both be used to acquire relief data.

2.1. General Structure of an Interactive System. Figure 1 depicts the general structure of an Interactive System. One notable feature of this approach is the symmetry arranged around a critical component: the conversation controller. At a high degree of abstraction, the functional core and the user have an asymmetric role: both modify task domain notions[8]. The operational core adaptor and the presenting element are the next two interface elements. The multiagent design of the conversation controller is another notable feature of the paradigm. According to this design, the conversation controller is in charge of task-level sequencing. Every user’s job or objective correlates to a thread of discussion. This observation indicates that a multiagent architecture is used. Each thread of the user’s activities can be connected with one agent or a cluster of collaborating agents. Because each agent may save its information, the user can stop and restart any thread at any time. The operational core adapter sends events to the conversation controller, while the presentation element sends events to the user.

Here, we initially explore the model’s two alternative parts, the user and the functional core, then the two connectors, the functioning core adaptor and the presentation element, and finally the important elements, including the conversation controller.

2.1.1. The User Core Module. The user and the functional core generate and receive information through the interface components through the conversation controllers. This is a symmetrical perspective of the overall operation of an interactive environment in which the major component, the conversation controller, is simultaneously controlled by the functional core and the user does not really enforce any model on interaction control. At this level of analysis, the distinction of outside versus internal versus hybrid control[9] is irrelevant. Obviously, the circumstance at hand influences the decision between both options.
2.1. The Functional Core Module. This module acts as a barrier between the conversation module and the functional core’s domain-specific notions. It is intended to reflect the impact of change in its immediate surroundings. It, like any other border, follows a protocol. A protocol is defined by its timing techniques, the type of data transmitted, and some connection techniques [10].

2.1.3. The Presentation Module. This module uses hardware and software to implement physical interaction between the users. It contains a set of presenting components that determine the system’s “picture,” i.e., the tangible behavior of the interactive environment. The presenting element is where low-level multimedia activities like input/output are handled. Presenting objects integrate multimedia interactions into higher-level occurrences in the same way that keyboard and controller actions are now merged into greater abstraction.

2.1.4. Controller of Dialogue. This module serves as the model’s foundation. In contrast to certain user interface approaches, the conversation controller is not a single entity. Instead, it is arranged as a group of cooperative agents that make a connection between both the functional core adapter and the presenting element.

2.2. Interactive Editing Principle. At present, digital terrain organization mainly has the grid structure, triangulated irregular network structure, and contour structure. Triangulated irregular network data structure is commonly used due to its complexity and calculation. Grid data provides the advantages of a simple form, a little quantity of calculation, and easier data organization and maintenance. While data collecting, remote sensing, and grid GIS are all tightly linked and have a high degree of automation, the principal terrain organization method is digital [11]. Digital terrain visualization employs two fundamental implementation methods of triangulated irregular network and grid, namely, digital terrain editing in an irregular grid and grid editing. As a result, they have become the primary method for realizing digital terrain modification. Virtual simulation systems and simulation application engineering have achieved significant advances in digital landscape editing in animation and game platforms during the last 20 years. Furthermore, a huge number of excellent digital terrain editing tools, such as 3D gaming apps, middleware, open-source game engines, and so on, have been developed in the field of geographic analysis and terrain expression [12].

EarthSculptor is a realistic terrain editing and painting application with an interactive design created specifically for the quick construction of 3D landscapes for visualization, video, and game design. Terrain rendering in 3D is enhanced by hardware as one of its characteristics due to its automatic lighting and shadow map rendering. Digital terrain editing may not only modify real-world terrain but also construct and plan a wide range of future development or layout programs. The scene editor program may simulate a range of realistic three-dimensional scenarios, providing a person with a strong visual impact and intuitive experience in the future or the emergence of the building and development blueprint. Figure 2 shows digital terrain using WorldBuild software.

The visualization of a landscape is the foundation of digital terrain modification. Its visualization is a significant technology in the building of virtual geographical environments and virtual scenes. Because of the massive scale of the digital landscape, the challenge of real-time rendering has yet to be overcome. The majority of the time, real-time rendering is used here.

Digital landscape levels of details (LOD) are a widely used technique that represents a terrain model at various resolutions to simplify terrain data [13]. The LOD algorithm is a type of adaptive mesh (ROAM) method and a view-dependent progressive mesh rendering approach. In recent years, the terrain rendering technology, which is according to the data of massive terrain, cannot be a one-time loading computer memory put forward. Many academics have proposed core scheduling based on terrain rendering technology because the terrain data is kept on the hard drive when drawing out data exchange inside the technique of scheduling implementation. Tang was introduced based on pertinent perspectives of the basic methodology of drawing method of big-scale landscape rendering technology. Similarly, Goswami developed large-scale terrain-based parallel memory approaches. Terrain paging technology can successfully address the issues of data management and dynamic scheduling. The essential premise is as follows: first, the terrain is separated by size. Next, the terrain page is
divided into layers and blocks. Lastly, the multiresolution tile pyramid data structure is constructed. According to the construction of the four forks, the top level of the pyramid has the hardest terrain data, and the succeeding layers are divided into four subblocks. The loading and unloading of the landscape page are appraised during a real-time tour by estimating the distance between distinct detail layers. It is loaded and unloaded in the view range to accomplish real-time loading and unloading of topographical data.

2.3. Software Implementation and Application of Editing Module. The editing module is based on the author’s research team’s virtual forest scene visualization technology. This system employs the VisualStudio2008 development environment, which employs the open-source OSG3.0 and ArcEnging 2D graphics engine [14]. The created GIS development kit is a standard two- or three-dimensional integration of a virtual forest scene visualization system. In computer visual reproduction, not only can the real forest environment, vegetation, artificial structures, and other elements of the landscape be realized, but also the help of three-dimensional design for regional landscape planning. In this study, the digital terrain editing module is embedded into the VisForest system, which can be used as an assistant tool for forest ecological planning, urban and landscape plans, road traffic planning, and other engineering applications. Figure 3 explains the terrain editing flowchart model. According to this figure, this model works in the following 6 phases.

2.3.1. Prepare Data. This is the first phase on terrain editing model. Here the data is collected and prepared to provide for publish services.

2.3.2. Publish Service. This is the second phase, which is concerned with the production and sharing of 3D printer
material. The potential of 3D publication is a business for the
development and dissemination of documents for the
manufacturing of 3D objects. A 3D publisher is any person
or company who creates files for 3D printers. It collects
prepared data and sends it to map authors for downloading.

2.3.3. Author Maps. The author’s maps are crucial in the
third phase because they represent the maker’s point of view
on the material. The creator of the map obtains his infor-
mation from the map’s source. This is a distributed storage
system that saves the gathered data with the assistance of a
publishing service and makes it available to the user upon
request.

2.3.4. Downloading Phase. This is the fourth and most
crucial phase, in which smart devices such as cellphones,
PCs, and other devices may access saved maps on authors’
maps. The requested device must be connected to the In-
ternet to download data from the cloud.

2.3.5. View, Edit, and Query Phase. This is the most crucial
stage in the terrain modification model. The requester can
query any type of information from the author’s map phase,
as well as requesting changing and viewing the data con-
tained on the author’s maps.

2.3.6. Synchronize Change Phase. The catalogue database is
refreshed during the synchronization process with any
modifications to primary endpoint sections, RAD 3D
characters, visual basic icons, or other visuals.

The model has been synchronized to include the follow-
ing:

(i) Any changes to attributes that were bulk imported
into the catalogue are recalculated in the appropriate
model occurrence.

(ii) To boost efficiency, any sections produced using the
copy to catalogue command in the model can be
transformed from noncached to cached form.

Terrain start editing module and set the edit parameters
edit mode (including elevation, leveling, reduced), editing
area (square, circle, polygon mode), and editing design el-
evation by mouse interactive operation, select the series of
coordinate points in the terrain and for the construction of
the editing area. Among them is the height of the target area
of the editing area, which you may adjust by dragging and
dropping the mouse to meet the height of the planning and
design requirements. Figure 4 shows the effect of edit terrain
area.

Because in the park, road, residential construction area,
there are often ground floor tiles, to reflect the reality, in the
terrain editing processing, there is a need for texture mapping
on the editing area, with the more realistic display. It has
become an important application field of virtual reality and
geographic information systems to assist the planning and
design of landscapes utilizing 3D digital terrain analysis and
editing. This paper presents a 3D effect of virtual community
planning and design based on a terrain editing module.
Among them, the scene includes digital terrain, buildings,
and landscape elements such as trees and small ground
trimmed on the ground after the terrain texture mapping. All
parameters of the tree model are through the team developed
the single tree modeling tool developed by ParaTree. Third-
party software creates the building model, and the interactive
tree and building model are then put in a 3D digital land-
scape, making a three-dimensional environment.

3. Multimedia Assisted Urban
Landscape Design

3.1. Computer Simulation of Garden Design. Landscape,
architectural design, and urban design are based on existing
topographic maps, databases, and information research. The
current states of information collection, which include the
surrounding environment, historical relic status informa-
tion, collecting of historic sites, and scenic beauty, all
contribute to the creation of a drawing library. The status
quo of information collection is usually by a camera and
then transmitted to the computer by scanning. Now, a digital
camera may shoot the current scenario, which is instantly
visible, and if not satisfying, it can be recreated (without
wasting film). The acquired photos are saved in data and can
be directly communicated to a computer, reducing data loss.
It can also be captured using digital cameras to capture the
scene, after which the computer can recognize the infor-
mation data provided to it and convert it to animation in the
form of true reproduction using the EasyCD software
burning program.

Any architectural design must satisfy the function’s
material and spiritual demands and the usage of certain
materials implies organizing a specific environment. The use
of natural landscape and the change of landscape or man-
made landscape, as well as the planting of plants and the
layout of the building for people living and observing the
recreational environment, are all included in the scope of the
design. As a result, we gathered information and converted it
into computer data as a background or reference map,
developed by the original program’s creator. It specifies the
basic design goal based on the requirement for function, art,
environmental circumstances, and other aspects. Figure 5
shows landscape design of our proposed mode.

According to the design intent, the digital production
personnel converts the 2D graphic layout from format of
AutoCAD into the format of normal data file for the present enhanced three-dimensional modeling program such as 3DS or 3dsMAX software [15]. It creates a 3D rough initial model to pursue the distribution relationship between the environment and space, to choose a design based on the concepts of logic, agreement, scale, modification, contrast, and proportion in creative procedures.

At the same time, landscape architecture and landscape are more general than other architectural designs because they possess time and space, visible colorful sound, and the sense of three-dimensional space shape. In addition, garden art lies in the creativity and the artistic expression of this n-multimedia computer technology. Because there is an urgent need to design the effect of predictability, we can observe the design effect and timely modifications and promptly correct the clearly defined aim of landscape design to design reference design personnel. The rapid development of information technology, powerful three-dimensional modeling, rendering entities, animation, and landscape design creates a good environment for creativity. Our landscape architecture can be seen in Figure 6.

3.2. Environmental Design. The purpose of any design process is to fulfill a demand for material and intellectual purposes, and the use of specific materials means arranging the space. The construction, usage, and modification of native landforms landscape finally unlocked the landscape terrain, along with the building of vegetation established and organized to make a recreational environment which people utilize, live in, and appreciate. We acquire position details and convert it into computer data as a backdrop for the original program written by the architect, based on the efficient demands, artistic criteria, conditions of environment, and a basic layout purpose. Subsequently, as per the design intent, the digital production staff converts the 2D graphic designer’s layout format of AutoCAD into a standardized format of data file that can be sent through current and innovative 3D modeling software 3DS. A prototype 3D model in the form of a rudimentary embryo is created to investigate environment dispersion connections and spatial patterns connections. The goal of this prototype is to see if the design is possible in terms of art composition techniques, as well as to look at consistency, motion, scale, proportion, balancing, contrasting, and other elements. Figure 7 shows our three-dimensional modeling environment.

The color laser printer will produce perspectives by utilizing the sophisticated processing of image capacity of the PhotoShop program for picture postprocessing. A detailed examination of the artistic impact and on-time modification of its creative effect is performed using a range
of specific filter function of computer program. The landscape layout is not only to explore the location but also to enhance the urban climate circumstances. Furthermore, it has partial regional temperature, moisture, and airflow adjustments to safeguard the surroundings, green sight, clean urban air, decreasing urban sound, water, and soil contamination suppression, and fulfilling the system which is necessary. Architects decide the influence of design, as well as design standards and electronic information and designing law, such that the program is not only creative with benefits but also legal and acceptable.

4. Analysis on the Value of Urban Landscape Art

4.1. The Present Situation of Landscape Art Design

(i) The advantages and disadvantages of urban landscape design have a great influence on the construction of the urban environment. The flexible use of landscape art design in the urban landscape design can make the city's natural environment more beautiful and improve the urban grade. In the process of urban landscape design, we should fully understand the purpose of the landscape art design, grasp the connotation of landscape design, and integrate landscape design into urban landscape design.

(ii) Landscape art design of a single: planting a garden might result in the cultivation of lower-quality tree species. On the other hand, the urban landscape is complete, diverse, and rich in design. As a result, forestation necessitates a diverse range of native trees. The conventional landscape design idea is basic and straightforward, and it cannot compete with the notion of urban landscape design. Because conventional city landscape design necessitates relatively simple planting seedlings, the development of the city chain is at a disadvantage and will result in poor plant growth. After garden art design is completely incorporated into urban landscape design, landscape design will take into account the various elements of green cultivation for the development of the city's landscape.

(iii) Concept of garden art design: In the traditional urban landscape design process, the requirements of the urban landscape, such as the share of green, scenic spots, and other factors, are ignored. City landscape design of the traditional mountain often chooses stout trees or old age long design. This common practice ignores the aesthetic attractions but also does not meet the requirements of ecological landscape garden design. Modern landscape design must be holistic with overall consideration, not only to meet the needs of beauty but also to be conducive to the coordination of urban landscape design.

4.2. Landscape Art Design to Promote the Development of Urban Landscape Design

Urban landscape design necessitates the cohabitation of decorative and urban landscape art. Urban landscape designers effectively integrated the concept of landscape design as well as the local peculiarities of rare species into the design of the urban environment. Landscape art design should follow the principle of local conditions, which is fully combined with the local natural environment of different elements, to improve the degree of urban landscape greening and landscape structure. Flexible use of landscape art design can change the original city to city landscape construction in microcirculation. It also improves the resistance stability of the ecological system and can better improve the local environment of the city, and the ecological balance can better protect the city environment. Garden art design focuses on the cultivation of rare species and can be good preservation and breeding of precious plants and can be a good way to improve the sound development of the ecological environment. The city landscape design may create an optimal living habitat for rare plants, can boost protection, is favorable to sustaining local species variety, and can better improve the city's local environment. Many parts of urban landscape design can benefit from this garden art design. Garden art in the city may help people feel more at ease and give more leisure and high-quality visual enjoyment.

The development history of city landscape design, landscape art design, modern city landscape design, and landscape design is nearly racing together from the beginning. The two have had a tight friendship since their childhood experiences. However, in today's economic and social development, landscape art and urban landscape design has begun to show some differences and gradually formed different fields. It is crucial to remember that landscape design is still an important aspect of urban landscape design and support. How to make the garden art design better serve the urban landscape design, which increases the quality and efficiency of urban landscape design, will remain an important concern in the future phase of development. We work hard to increase the use of landscape design in urban landscape design, as well as the quality of usage, so that garden art design may genuinely serve urban landscape design.

4.3. Analysis of Comparison of Accuracy and Judgment Frequency

This section describes the data we acquired in the landscape environment, as well as our judgment of the frequency analyses of the conventional procedure and our proposed method. Figure 8 compares the judgment frequency results of the conventional procedure and our proposed method.

As shown in the preceding figure, when the duration is in the range of 0–10, the traditional procedure's judgment frequency
frequency progressively increases, but it is always less than that of the 3D simulation approach. Whenever the time is between 10 and 15, the traditional procedure’s judgment frequency begins to decline. The traditional approach has shown an up-and-down tendency over time, with the fastest frequency being only about half of the highest frequency of the 3D picture simulation. As can be observed, the speed and frequency are sluggish and poor while using the conventional process to assess the acceptability of the landscape; however, the frequency is quicker when utilizing the 3D image simulation judgment technique.

Figure 9 depicts the comparison of judgment accuracy results. As shown in this figure, whenever the judgment range is within 20%, the accuracy of the conventional procedure and the technique described in this study are not significantly different. Furthermore, the accuracy of conventional procedures is greater than that of this paper’s method. When the judgment range is 20% to 45%, the accuracy of the traditional processes is much greater than the method described in this study. However, if the range is steadily expanded, the accuracy of the three-dimensional picture simulation judgment approach employed in this research improves. Therefore, the accuracy of the conventional technique is usually kept at around 40%. As can be shown, the 3D picture simulation judgment approach is more accurate than the traditional way of analyzing the rationality of landscape design.

As shown above, the number of matching feature points and matching frequency of the landscape generated by the convolutional judgment approach are lower than those obtained by the 3D image simulation method utilized in this research. When assessing the rationality of the terrain, the pace is slower and the frequency is lower. While employing the 3D picture simulation approach, there is a greater matching frequency of feature points and a faster judgment frequency, proving the reliability of this judgment method.

5. Conclusions

The emergence of strong performance technology has been facilitated by the use of digital landscape design technology in recent years. Computer information processing technology, landscape art analysis, and digital design are the primary directions of today’s society design. Because of the direction of information technology development, designers simply need to take personal notebook computer multimedia, from input, voice input, design specification, design of intelligent
judgment thinking, and completely automatic compatible data format. The design assignment may be accomplished and the desired impact attained in a short amount of time. At the same time, ecological and land use data may be archived and managed in the geographic data database. The contemporary garden idea encompasses the majority of people’s activities. It is used to enhance the climate, temperature, humidity, and airflow of the local region, as well as to safeguard the environment, water, and soil pollution reduction. As a result, the scope of modern landscape design is wider than ever before, with richer content and more complicated facilities, as well as the requirement for multimedia computer information management and design.

**Data Availability**

The datasets used and analyzed during the current study are available from the corresponding author upon reasonable request.

**Conflicts of Interest**

The authors declare that they have no conflicts of interest.

**References**


