

## Research Article

# Research on Dynamic Simulation Technology of Urban 3D Art Landscape Based on VR-Platform

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With the rise of some concepts such as “Digital Earth” and “digital city,” how to realize the three-dimensional reconstruction and visualization of the urban art landscape is becoming a current research hotspot. This study takes the VR-Platform as the development platform and combines it with 3dsMax technology to study the dynamic simulation technology of urban 3D art landscapes. Additionally, this study combines the dynamic simulation technology of urban three-dimensional artistic landscape, designs the urban three-dimensional artistic landscape dynamic simulation system from the aspects of landscape modeling, texture mapping, drive integration, and so on, and finally realizes the basic functions such as roaming interaction, map navigation, information measurement, and visual display of the urban three-dimensional artistic landscape dynamic simulation system, which has a certain practical application value.

## 1. Introduction

Virtual reality technology (VR) is a multidisciplinary, interdisciplinary subject and an important direction of the development of simulation technology, which can build a virtual system with real-world shadow and physical effects [1]. With the popularization of virtual reality technology and the concept of the digital city, the application of virtual reality technology in the field of urban planning has been paid more and more attention. Urban 3D art landscape planning is that designers use three-dimensional modeling software to model according to their own landscape planning effects and generate virtual scenes through a virtual simulation platform to show the effect of urban three-dimensional art landscape planning. Applying virtual simulation technology to urban three-dimensional virtual landscape planning can not only realize the real reproduction of an urban landscape but also deeply analyze various types of spatial information by using urban VR, which can provide strong decision support for urban spatial distribution, architectural structure design, landscape

garden planning, space-time positioning, lighting analysis, road design, and other aspects. It is conducive to the realization of more scientific and reasonable urban management, thereby promoting the sustainable development of the city. In addition, virtual simulation technology is applied to the field of urban landscape planning. The current or future cities can be simulated realistically through 3D modeling and presented on a virtual platform so that multiple planning and design schemes can be seen through a virtual platform. This will help users more clearly determine the reasonable planning scheme, make users feel immersive, facilitate the communication between planning decision makers and landscape planning designers, reduce the huge losses caused by unreasonable planning, and make the planning more scientific and reasonable. The main virtual reality software used at home and abroad includes Virtools, Quest 3D, Converse 3D, and VR-Platform [2]. By comparing various 3D modeling technologies and virtual simulation technologies, this study finally chooses the VR-platform for modeling and scene planning of urban 3D art landscapes, aiming at realizing dynamic simulation and display of urban

3D art landscapes and providing reference and guidance for the application of virtual reality technology in urban landscape planning.

## 2. Dynamic Simulation Technology of Urban 3D Art Landscape

*2.1. VR-Platform Virtual Simulation Platform.* The VR-platform is the most widely used virtual reality software in China, which is extensively used in urban planning, interior design, industrial simulation, historic site restoration, bridge and road design, military simulation, and other domains [3]. Compared with other 3D virtual reality software, VR-platform can effectively solve complicated programming problems. It adopts a modular approach in the construction process, which allows visual editing of the interface and enables complex interaction functions with simple sentences [4].

The advantages of the VR-platform virtual simulation platform are prominent, mainly as follows: (1) VR-platform can obtain beautiful, realistic static light and shadow effects through lighting mapping generated by various renderers in 3dsMax and has the real-time material editing function that seamlessly transforms with 3dsMax. (2) VR-platform virtual simulation platform is embedded with script language and has a powerful secondary development interface. More required functions can be developed through the customization function [5]. (3) The display effect of the virtual simulation platform is interactive, and customized browsing is realized by setting up a walking camera, a flight camera, a role control camera, a tracking camera, and so on. (4) The VR-platform virtual simulation platform has a material library, which can be used to simulate materials in real time through simple operations. You can also set material types and adjust material properties, such as dynamic lighting, transparency, and color [6]. (5) A collision detection algorithm is introduced in VR-platform to realize efficient collision detection. (6) The association between the virtual simulation model and the database in VR-platform is also associated with multiple databases. (7) Seamless conversion is achieved with 3ds Max [7].

*2.2. Technical Process of Dynamic Simulation of Urban 3D Art Landscape.* The core content of using VR-platform software to construct a dynamic simulation system of urban 3D artistic landscape is to construct 3D virtual scenes, and 3D modeling is the foundation [8]. The establishment of urban virtual landscape environments must first be modeled and then form a virtual world according to real-time drawing and stereoscopic display of the virtual environment. The technical process of the dynamic simulation of urban 3D art landscape based on a VR-platform is shown in Figure 1.

First of all, the 3D modeling of the virtual scene of the urban 3D art landscape is carried out to obtain the relevant basic data, and the 3D modeling technology is used to establish the scene 3D model. The production of a virtual 3D landscape model mainly involves the production of terrain,

landscape trees, flowers, plants, and other models, as well as the realization of 3D terrain and landscape model fitting.

Then, the 3D model needs to be further processed. A realistic and smooth 3D virtual scene should have not only a realistic model but also a smooth operation effect, which has strict requirements on the 3D scene model. The model should be optimized as far as possible without affecting the overall effect [9]. Specifically, 3dsmax is used to establish 3D terrain and construct a 3D landscape model to realize the fit between the terrain and the model. Then, texture mapping and painting are carried out to create a realistic 3D scene.

Finally, through the real-time rendering and the three-dimensional display of the three-dimensional interactive simulation platform in the virtual simulation platform, the functions of a dynamic query, interactive roaming, and user-defined browsing of urban art landscapes are realized by designing environmental effects, adding connection database, buttoning trigger events, adding sky boxes, and setting special effects.

## 3. Design of Dynamic Simulation System for Urban 3D Art Landscape

Combined with the technical process of urban 3D art landscape dynamic simulation, VR-platform virtual simulation platform was used to design the simulation system, including the establishment of the 3D art landscape model, texture mapping, and baking of the landscape model, and integrate and drive of virtual scene simulation, and the basic functions of the urban 3D art landscape dynamic simulation system were realized.

*3.1. Establishment of the 3D Art Landscape Model.* Urban 3D art landscape model involves topography, architectural complexes, landscape trees, flowers and plants, architectural sketches, roads and rivers, and other related scenes. Therefore, 3dsMax modeling software was used to establish the scene model of the urban art landscape.

On the basis of DEM data and CAD data of the land use planning map, the topographic model was established, and in particular, DEM data and building elevation information were obtained through field measurement [10]. According to the actual situation, texture data were obtained by digital camera shooting on-site, and then, it was imported into 3DsMax to form a 3D terrain model in line with planning CAD data, as shown in Figure 2.

In urban 3D art landscape planning, exhibition halls, toilets, restaurants, and other large buildings are usually represented by body. Body shape ground objects play a crucial role in 3D modeling. The diversity of body shape, ground objects, and visual appearances add a beautiful scenery line for the city 3D art landscape. Rules are established based on the virtual reality model of 3dsMax to capture vertices or edges to sketch the general outline of the building [11]. In addition, the model is simplified by removing redundant faces and nonvisible and redundant vertices. Figure 3 shows the architectural scene model.

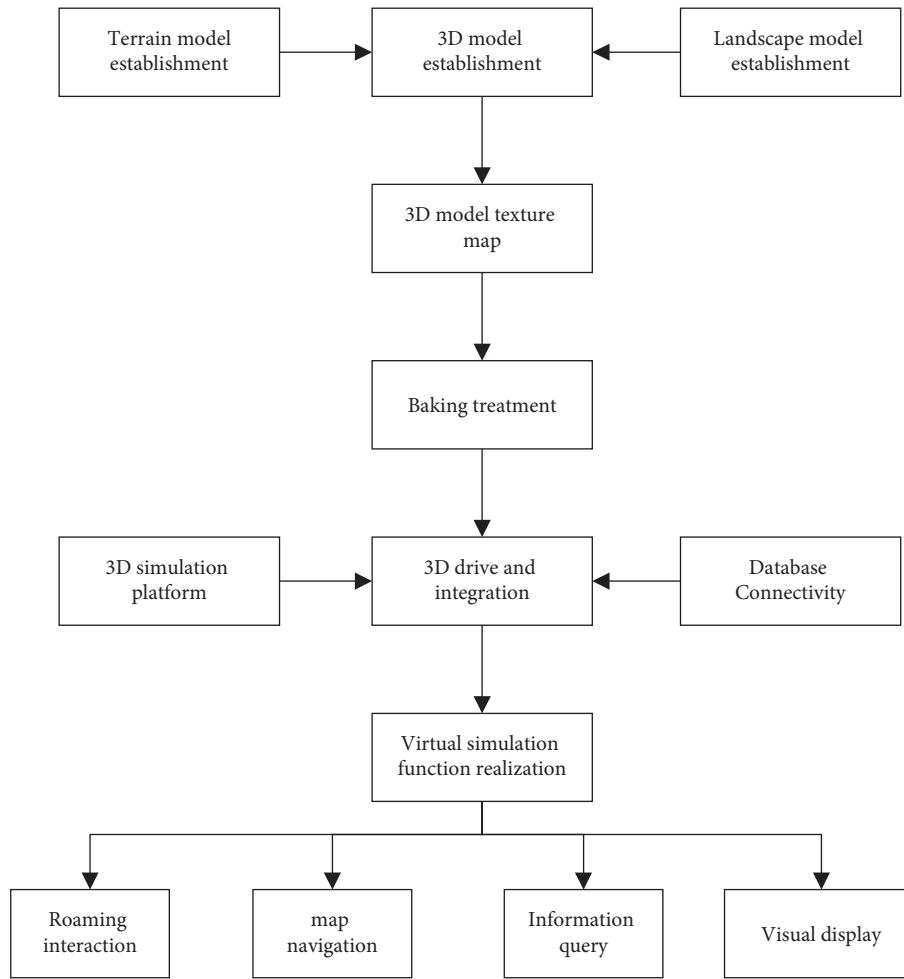


FIGURE 1: Dynamic simulation technology flowchart of the urban 3D art landscape.

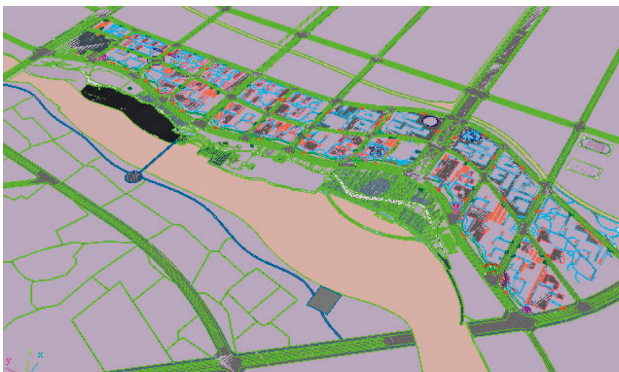


FIGURE 2: Terrain scenario model.

When making outdoor virtual reality scenes, not only buildings should be considered but also a large number of auxiliary models such as roads and green belts should be considered. Therefore, environmental scenes need to be added. For example, trees and flowers are all represented by models, which lead to a large number of model faces in VR scenes, bringing a lot of difficulties to editing and scene operation. Therefore, the green model is expressed with ten literal objects or hollow stickers. For the landscape of flowers

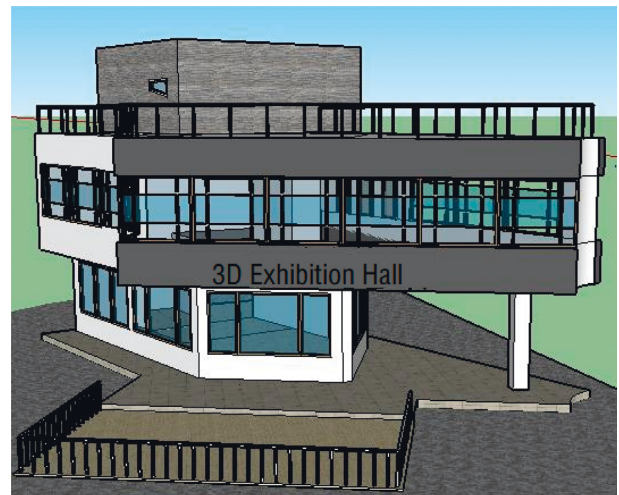


FIGURE 3: Exhibition hall scene model.

and trees, the “cross-plane” modeling method combining image and model is adopted to establish the corresponding entity model [12]. That is to say, attaching one side of the tree to two intersecting planes and then copy the same tree model by instance copy. At the same time, street lamps, rivers, and

other models of similar size in the scene are copied by instance, which improves efficiency and saves system resources. The plant scene model is shown in Figure 4.

In 3D scene, the fitting of 3D model and terrain is an important part of urban 3D art landscape planning and design. Therefore, the surface leveling tool [13] is used to place the three-dimensional model on the terrain so that the urban architectural elements are truly integrated into the irregular terrain. The fitting effect of the 3D model and the terrain is shown in Figure 5.

**3.2. Landscape Model Texture Mapping and Baking.** In order to make the 3D scene closer to the real environment of the urban art landscape, it is necessary to enhance the texture of the 3D model and improve the modeling of the 3D model through mapping. Specifically, the method of bitmap pasting can be applied to 3D urban art landscape model mapping. Firstly, select the required texture model and select a picture in the Material Editor. Then, select the bitmap in the diffuse channel and select the drawing to specify the material to a sphere model [14]. Finally, click to assign the material to the selected object and display the standard map in the viewport. When using a bitmap, 3ds Max will automatically pop up the parameter setting panel of the bitmap after the bitmap is loaded, and the relevant values of the bitmap can be set, such as offset value and angle value. Taking steps as an example, the texture mapping effect is shown in Figure 6.

At the same time, select the baking model in 3dsMax for rendering processing and rendering, and select the baked object to fill and assign the corresponding value [15]. Select Lighting Map from the output options and add relevant elements to create a new baking object. Click “Render” to complete the baking operation of the model.

**3.3. Virtual Scene Simulation Drivers and Special Effects.** The VR-platform 3D interactive simulation platform is used as the driving engine for the dynamic simulation system of the urban 3D art landscape. Firstly, the modeling is converted to 3dsMax for texture mapping and rendering, and the VR-platform export plug-in is installed to export the scenario model to VR-Platform format [16]. Click the VR-platform editor to import, edit, set, and browse on the VR-platform. Additionally, skyboxes, particle effects, water effects, smoke, collision settings, and cameras can also be added to achieve virtual scene simulation integration and drive, as shown in Figure 7.

- (1) Create a skybox. When planning a city 3D art landscape, adding a skybox to the virtual scene can make the virtual scene and skybox fusion, forming a more realistic effect. There are two ways to the add skyboxes. One is to directly add skyboxes in VR-platform [17]. The second is use 3dsMax to make skyboxes and then add skyboxes directly to the VR-platform [18]. Therefore, add the skybox to the VR-platform editor, set the sky color and display type, and add it to the 3D scene environment. The skybox



FIGURE 4: Plant scene model.



FIGURE 5: Effect of a 3D model and terrain fitting.

can also be modified by right-clicking “Modify,” as shown in Figure 8.

- (2) Set the water surface material. Only static models are not enough for the real-time virtual reality scenes. In order to create light and shadow effects, dynamic mapping technology is adopted in this study [19] to create a light and shadow effect. Specifically, adjust it into Fresnel water surface material, edit the water surface refraction group and reflection group model, and adjust water wave parameters.
- (3) Enable collision detection. Due to the change of model position and posture, it may collide with static

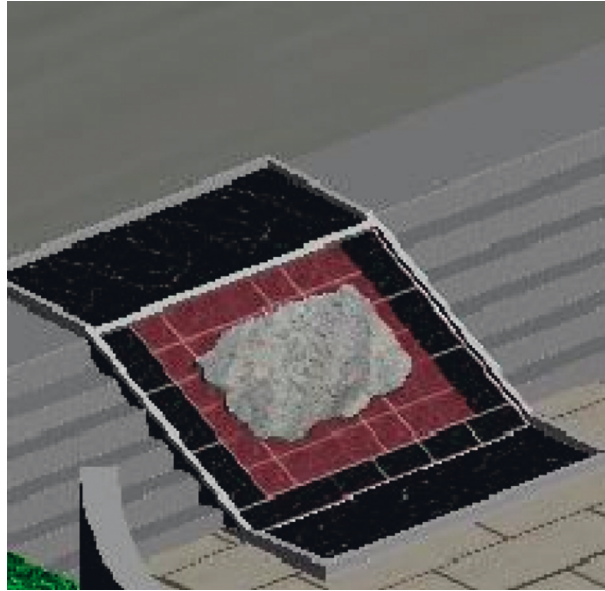


FIGURE 6: Map effect for the step scene.

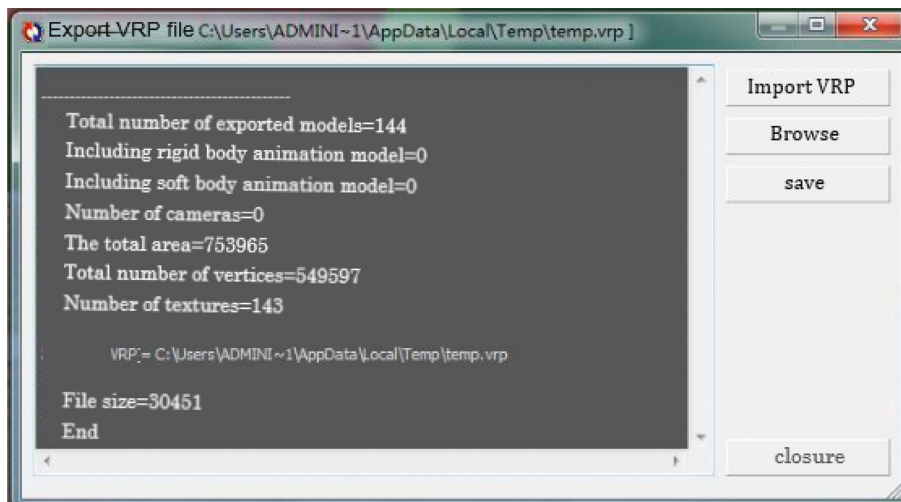


FIGURE 7: Integration and driver of virtual scene simulation.

- or dynamic models in the scene [20] during the urban 3D art landscape roaming. Collision detection is added to main models such as the ground and main structure, which can effectively improve the authenticity of roaming in virtual scenes. VR-platform has designed an efficient and accurate collision algorithm. Open the “Physical Collision” panel in the VR-Platform editor, select the model to which collision detection effects need to be added, and add collision attributes [21], and then, hide the model so that visitors cannot cross when they use the angle of view of the collision detection camera to roam. Finally, browsing is prohibited in some places in the scene, as shown in Figure 9.
- (4) Simulate different weather effects. In order to simulate the different weather conditions of the city so that visitors can browse the virtual art landscape of

the city under different weather conditions, a variety of weather effects for the current virtual scene can be added, such as fog and cloudy [22].

- (5) Add background music. In order to make the urban virtual art landscape not only visually realistic but also auditory appealing, a music background can be added to the virtual scene. Select the music file you want to add and set it as background music; the music can also be repeated [23].
- (6) Set up the camera. In order to let visitors know where they are browsing in the virtual art landscape of the city, a timely navigation map can be used to help visitors locate. Custom browsing is also possible by setting up walking, rotating, and flying cameras [24]. On the VR-platform editor interface, interactive production is used to realize the interactive functions of virtual scenes.

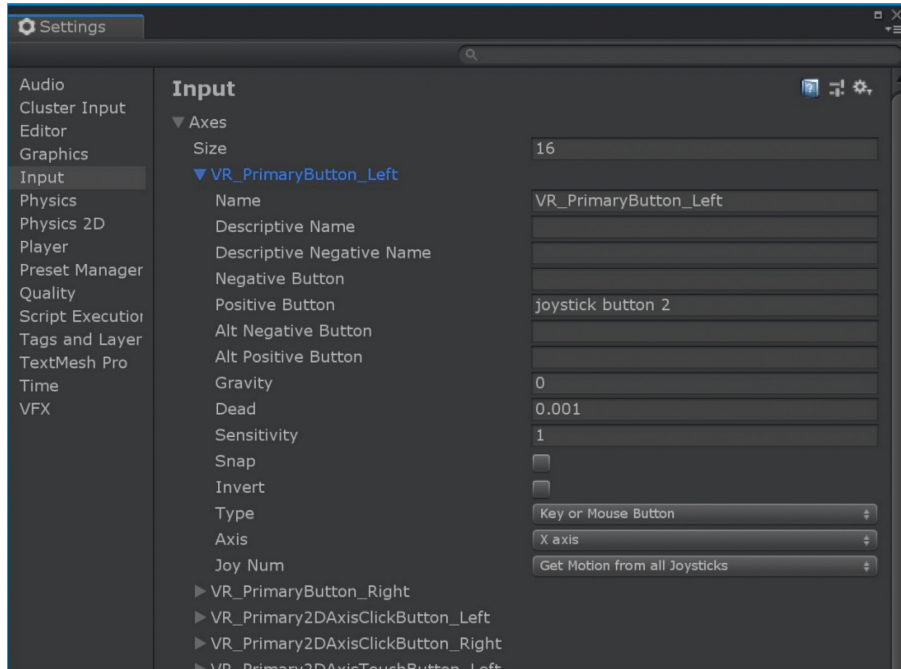


FIGURE 8: Create a skybox.



FIGURE 9: 3D renderings of urban virtual art landscape.

Based on the above design scheme, the 3D renderings of the urban virtual art landscape were obtained, as shown in Figure 9.

**3.4. Function Realization of Urban Landscape Dynamic Simulation System.** VR-platform virtual simulation platform has a powerful interface design module, a database module, a script interaction module, and a secondary development function module [25]. These functional modules are applied to the functional development of the dynamic simulation system of urban 3D art landscapes, and the following basic functions can be achieved.

- (1) Roaming interactive function: the dynamic simulation system of urban 3D art landscape realizes three

kinds of roaming functions: fixed-point roaming, path roaming, and avatar roaming [26]. The preset state is fixed-point roaming, which can directly switch to the starting point of each fixed-point camera [27]. The camera's movement can be controlled by WSDA four-letter keys or up, down, left, and right arrow keys to reach the user's desired location. Path roaming is to let the camera walk along the preset path to automatically view the scene [28]. When the user clicks "Path Roam," the window switches to a series of default path windows. Users can choose from four paths, and they can choose their favorite viewing path. The avatar tour is to create avatar characters in the scene, which allows

you to roam the scene as an avatar, roaming and browsing the scene from the avatar's perspective [29].

- (2) Map navigation function: dynamic navigation is a basic function of the dynamic simulation system of urban 3D art landscapes [30]. Roaming through virtual scenes, users mostly focus on the details of the scene, and it is difficult to fully understand the overall situation of the scene. After roaming, users often do not know which road they have taken in the scene. Therefore, it is necessary to add position and navigation functions in the system. Users can see the location of roaming on the navigation map and quickly roam to the desired place using the navigation map. Figure 10 shows the map navigation function.
- (3) Information query function: the information query function can be used to query information about buildings and planned plots in a scenario, including building name, height, area, and design concept [31]. Click the information query button on the interface, and the dynamic simulation system of the urban 3D art landscape will switch to the information query function. At this time, as long as users click on the building or plot that they want to query, the system will query relevant data from the database, and the relevant information window will pop up.
- (4) Visual display: the visual presentation function can output what is currently displayed in the scene in JPG format [32]. This feature can be used when the user needs an output screen in the current scene. By changing the parameters, the user can modify the output effect picture.

#### 4. Application Prospect of Urban 3D Art Landscape Dynamic Simulation System

With the continuous development of landscape planning, virtual simulation technology, and 3D modeling technology, the combination of these three technologies has broad application prospects [33]. With the help of virtual simulation technology and 3D modeling technology, the dynamic simulation of urban 3D art landscapes is also an objective requirement of landscape planning and development. The development and application of the dynamic simulation system of urban 3D art landscape can simulate a full three-dimensional, life-like urban landscape environment, which provides a three-dimensional and intuitive three-dimensional spatial information system for urban landscape planning, construction, and operation management and improves the level of urban landscape planning and management. Urban 3D art landscape dynamic simulation system can be widely used in all aspects of planning and bring considerable benefits. The details are as follows:

One is to show a life-like urban landscape planning scheme. Current urban landscape planning is mainly based on static or animation effects, most of which are two-

dimensional planes, lacking three-dimensional, dynamic, and immersion. It is not conducive to the overall evaluation of planning schemes. The landscape planning is designed as a 3D model, and custom browsing can be realized through virtual simulation technology so that any position in the scene can be observed, giving people an immersive feeling. In industrial augmented reality and other aspects, VR glasses, gloves, and other applications in this industry can enable the audience to experience planning and design from all aspects of vision, hearing, touch, and so on. The dynamic simulation system of urban 3D art landscape can bring realistic visual effects to users and give them an immersive experience by displaying the results of planning schemes in three dimensions. It can also obtain the data of planning projects through the database to facilitate the organization and management of projects.

The second is to avoid design risks and make the planning scheme reasonable and scientific. At present, urban art landscape planning and design are mainly based on the professional knowledge and materials mastered by planners and designers [34]. Using AD and other software to make planar graph and 3D animation effect drawing cannot reflect the rationality of planning and layout, and it is not easy to modify.

Using virtual simulation technology to generate virtual landscape planning scenes is helpful for planning designers or users to browse all angles of planning layout, find deficiencies, and modify timely. For example, you only need to set the corresponding parameters to change the height of the building, building color, green density, and so on. To some extent, it speeds up the speed and quality of planning scheme design, improves work efficiency, and saves a lot of manpower and material resources. In view of the advantages of virtual simulation technology, if it is introduced into urban landscape planning and design, it can find out whether the planning layout is reasonable without actual planning implementation. The virtual environment established by the dynamic simulation system of urban 3D art landscape is based on real and scientific data and digital models, and the landscape planning and design can be reproduced truly according to the specifications and requirements of the planning project design. Through roaming and interactive experience, users can easily find some design defects that are not easy to detect, which can reduce the loss caused by incomplete plans and greatly improve the quality of urban landscape planning.

The third is to facilitate the promotion of the urban landscape. With the development of the Internet, virtual tourism has gradually become a hot topic. After the completion of the urban art landscape planning results, the use of network technology to upload the design of a three-dimensional landscape scheme to the Internet can not only provide tourists with a realistic scene of the city's tourism scene but also provide consumers with detailed information. Let the tourists who are thousands of miles away can wander freely and customize their browsing experience, so as to facilitate the tourists to understand the overall situation of the urban landscape and find places to attract their own. At the same time, it is also convenient for tourists to increase



FIGURE 10: Map navigation function.

the publicity of popular science knowledge of urban art landscape protection.

## 5. Conclusions

At present, the application of 3D modeling and virtual simulation technology is becoming more and more extensive, and its application in urban landscape planning can make urban landscape planning scientific, reasonable, and refined. Through the research on the dynamic simulation technology of urban 3D art landscape based on VR-platform, the 3D scene modeling of urban art landscape is completed. The terrain modeling and building modeling are completed by using the 3dsMax geometric modeling method, and the environmental modeling of trees, flowers, roads, and so on is completed by means of example replication. Through virtual scene simulation integration and drive, the basic functions of the dynamic simulation system of urban 3D art landscape are finally realized, including roaming interaction, map navigation, information query, visual display, and so on. The development of a dynamic simulation system of urban 3D art landscapes has broad application prospects. It not only demonstrates the realistic urban landscape planning scheme, avoids design risk, and makes the planning scheme reasonable and scientific but also facilitates the publicity and promotion of urban landscape, which is conducive to the realization of the digital city.

## Data Availability

The dataset can be obtained from the corresponding author upon request.

## Conflicts of Interest

The authors declare that there are no conflicts of interest.

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