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3D Model Optimization and Roaming of Large Data Volume Virtual Landscape

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Due to the huge data in a 3D model of a large-area virtual landscape, the optimization method of the modeling process is well worth studying. We examine it from three aspects: selecting modeling tools, reducing model redundancy and complexity, and reducing model file size. The architecture of the virtual scene roaming system used in the modelling is given.
The realization process of the roaming system is examined from three aspects: 3D model data transformation, roaming path and perspective design and finally, roaming system integration.
A data compression and conversion algorithm is provided in this paper. Finally, a virtual campus roaming system with a large data volume is implemented on the Visual C++ software platform. The system has good real-time interaction and scalability.
The Internet age today means that data includes every input into a search engine, as well as every transaction on shopping websites. The term for the huge data sets that have resulted is called Big Data. Those data sets are so large they cannot be collected, managed and processed in reasonable time by the software tools that are currently part of the mainstream of tools.
Harvard Social Professor Gary King describes the Big Data Age as "a revolution in which huge data resources have led to quantification in all areas, whether academia, business, or government." However, Big Data has not yet popularized landscape design. For this reason, one emerging research topic has been to promote the development of the creative park landscape using the resources and favorable information provided by Big Data.

Keywords: Large data, optimization, 3D model, virtual landscape; large data volume; 3D model optimization; data conversion; roaming.

1. INTRODUCTION

As of 2012, the world's data volume has jumped from TB to PB, EB and even ZB levels. According to the IBM study, 90% of the total data available for human civilization came from the past two years. By 2020[1−2], the world's data will be 44 times the size of today's data. With the emergence of new technologies such as social networks, mobile computing and sensors, large data applications have expanded to network logs, social media, perceptual data, covering audio, pictures, video, geographic location information, analog signals, and so on, truly interpreting the diversity of data.

Big data can break through the existing technical framework and route, efficiently deal with massive data volumes, collect huge information through real-time processing, and provide feedback to users[3−4].

Shanghai Ferroalloy Factory was the predecessor of the Post-Industrial Eco-Park. The pollution caused by the factory was significant. The Chinese government is using its resources to rebuild the post-industrial eco-park from the original industrial wasteland creating the eco-creative park. The term "industrial wasteland" refers to the areas that were once used for industrial production, transportation and storage related to industry there. Many of these areas were later abandoned and they include mines, quarries, factories, railway stations, docks, industrial waste dumping sites and so on. Almost all industrial wasteland has caused varying degrees of damage to the environment and changed the original habitat. The original factory left a lot of industrial plant equipment and had a negative impact on the environment to some extent. To improve and restore the environment we can use intelligent technology with big data. The inadequate cultivation of plants in the park is manifested by insufficient dynamic monitoring of plants, data collection and analysis. Other factors contributing to problems in cultivation include greenhouse environmental regulation, scientific fertilization, rational irrigation, illumination, soil acidity and alkalinity[5−8]. Intelligent centralized management in the park is lacking with plants enduring extended periods in the hot sun. They endure significant water loss and are often on the verge of wilting. Therefore, we urgently need to use the intelligent technology in the era of big data to carry out meticulous and centralized management of plants.

In addition to this, the consumption of electricity in landscape lighting is high, resulting in a significant waste of energy. According to statistics, street and landscape lighting account for about 15% of the city's total electricity consumption. At present, the landscape lighting in the park lacks reasonable transformation and accurate control, resulting in landscape lighting being inefficient. This is not conducive for the purpose of the energy conservation and cost control in the park. Therefore, we urgently need to use the intelligent technology in the era of big data to carry out scientific management of the park's energy usage. Sculpture and landscape sketches are the main landscape representations in the external space environment of the building. The landscape sketches of creative parks built on industrial waste sites are mostly part of a building, structure, facility structure or structure that preserves the abandoned industrial landscape, such as walls, foundations, frames, dismantling frames and other components.

As can be seen from some of the included pictures, these landscape sketches consist of components that tend to emphasize visual symbols, but do not signify their functional use. In addition, there is insufficient information to introduce the landscape in sketches. Tourists often do not know the origin and materials of many landscape sketches. Therefore, we urgently need to use the intelligent technology in the era of big data to transform the landscape sketches of the park. At present, most creative industrial parks are transformed from abandoned old factories, and the parking system in the park is backward, which does not take into account the parking difficulties when the park is heavy traffic, resulting in disorderly parking of vehicles, causing interference and intrusion to the pedestrian environment and external public space. At the same time, the phenomenon of random parking also has a negative impact on the beautiful road landscape, and has an impact on the overall image of the Creative Industry Park. Therefore, we urgently need to use intelligent technology in the era of big data to ensure the park system facilitates orderly management of the park. At present, most creative industrial parks are transformed from abandoned old factories, and the parking system in the park is backward, which does not take into account the parking difficulties when the vehicle is in heavy traffic. This results in the disorderly parking of vehicles, causing a lot of interference and intrusion to the pedestrian environment and external public space. At the same time, the phenomenon of random parking also has a negative impact on the beautiful road landscape, and has a great impact on the overall image of Creative Industry Park. Therefore, we urgently need to use our technology for the orderly management of the parking system.

Virtual reality technology is a new technology that uses a computer to generate a realistic three-dimensional virtual environment and permits user interaction with it through sensing devices. It is widely used in simulation, visual simulation, 3D visualization, virtual product design and virtual agricultural robot operations. Applications exist in area's such as the natural environment, virtual war environment and virtual city roaming.

Virtual environment modeling is an important research field of virtual reality technology and the foundation of the entire virtual reality system. In order to create an environment that is immersive and realistic for people, software must create models and virtual scenes that are as realistic as possible. However, if the models and scenes are too detailed and the amount of data is too large, it will cause the virtual reality application system to fail. This is especially the case for more complex scenes, such as virtual scenic spots. Therefore, in the modeling of virtual reality systems, the amount of model data should be as small as possible to ensure the operational efficiency of the virtual reality application system.

The large-data-quantity virtual landscape roaming mainly uses the panning, rotation, push-pull, pan, zoom, and combined transformation of the camera lens to display the scene and the object in different directions. The basic elements include: virtual camera settings, motion speed control, and simulation of various actions of virtual observers (walking, rotation, and other actions). The virtual roaming system studied in this paper is based on the most currently advanced virtual reality software. The second development will eventually create a virtual landscape with realistic visual and auditory integration.

2. 3D MODEL OPTIMIZATION METHOD

The large-volume virtual landscape involves a large number of irregular terrains, a variety of irregular patterns such as trees, flowers, houses and the like. The problems of large data volume and low rendering speed naturally become a bottleneck for the development of virtual landscape models. Therefore, in the process of building a model, it is necessary to develop good work habits, establish a model optimization consciousness, scientifically organize the structure of the model and reduce redundancy of the model. At the same time, it is necessary to select modeling tools and try to compress the model data without affecting the model fidelity.

2.1 Reasonable selection of modeling tools

A reasonable selection of modeling tools based on the scenario of the virtual landscape is extremely important for the entire modeling process. Currently, MultiGen Creator and

3DSMAX are representative in several common visual simulation modeling tools. The MultiGen Creator family of products is the world's leading real-time 3D database generation system for generating, editing and viewing visual databases in battlefield simulation, entertainment, urban simulation and computational visualization, with automated large terrain and 3D Powerful functions such as human landscape generators and road generators. Therefore, it is ideal to use the MultiGen Creator to build the terrain and roads of the virtual landscape. 3DSMAX is the world's most widely used 3D modeling, animation, and rendering software and can make almost any model you need. In the modeling process of large data volume virtual landscape, 3DSMAX can be used to build more complex models, such as houses, kiosks, odd-shaped stones, humans, animals, etc., and then import the model created by 3DSMAX into MultiGen Creator. We can then generate a scene hierarchy database that makes it easy to build high-quality virtual landscapes.

2.2 Reduce model redundancy and complexity

During the modeling process, when the model created by 3DS MAX is imported into MultiGen Creator, MultiGen Creator converts the original non-triangular patches in the model into triangular patches, thus increasing the number of polygons. Some adjacent triangular patches merge into one large polygon, which effectively simplifies the model and reduces the number of polygons. Using Combine Faces under the Edit menu, MultiGen Creator automatically merges adjacent triangles in the same plane, reducing the number of triangular faces by more than 50%.

Data describing the surface of a solid model is often redundant, and redundant polygons here mainly refer to parts that are not visible when the model is viewed outside the entity. Therefore, deleting the back, interior, or occluded polygons of the model while building the model database can reduce the rendering time of the system. For example, the secondary house only needs to draw the exterior of the house. The bottom and inner walls of the house do not need to be rendered, so they can be deleted directly in the model. Since they are invisible when the scene is viewed, removing them does not affect the visual effects of the entities, and eliminating these redundant polygons can greatly reduce the complexity of the entire scene.

We can use the Level of Detail (LOD) model to describe different objects in the same scene. When drawing, if an object is far away from the viewpoint, or if the object is small, you can use a thicker LOD. This is the way the model is drawn. Conversely, if the object is closer to the viewpoint or the object is larger, it is drawn with a finer LOD model. The LOD model is usually generated by the mesh simplification algorithm. The current mesh simplification algorithm is the triangular mesh simplification algorithm proposed by Schroeder. The basic idea of this method is to classify the vertices in the triangle mesh first, using the distance error respectively. Calculate the importance of vertices, remove unimportant vertices, and triangulate the voids left after the vertices are removed.

In height field data, the importance of a point can be defined as:

$$H(x, y) - (aS)(x, y)$$

Where $H(x, y)$ is the height value at the (x, y) point in the original model, and $(aS)(x, y)$ is the height value at the (x, y) point in the approximate model. The smaller the local error, the higher the quality of the resulting model.

The global error metric is:

$$\sum_{x,y} |H(x, y) - (aS)(x, y)|$$

The global error metric is the sum of the approximation errors at all points. There must be as little global error as possible at all deleted vertices.

2.3 Reduce model file size

The size of the model file reflects the complexity of the model to a certain extent. By using texture mapping, texture compression and examples, the size of the model file can be reduced, and the speed of the system for the purpose of storage, loading and drawing can be improved. Real-time interactivity of the roaming system will be prompt.

The texture mapping technique "fits" the texture image on the surface of the polygon at the corresponding location to replace the detailed model details. This processing can reduce the number and complexity of polygons in the model and improves the display speed when the image is drawn. Texture mapping does not reduce the fidelity of the scene as long as the viewpoint is not too close to the entity. In addition, from the perspective of contrast, it is highly desirable to use this method.

Texture compression refers to the necessary compression processing of texture images without affecting the fidelity of the scene, reducing the size of the image file, thereby reducing the size of the model file. Texture compression is achieved by reducing the size of the texture image, but the image length and width pixel values of the texture should be an integer power of 2, otherwise the texture may be distorted during real-time roaming. Combining 3D modeling software can be used to properly select the format of texture image. For textures with only grayscale changes, try to use reasonable data format to save space. Other formats such as .jpg can also reduce the size of texture files.

An instance technique is a reference to an object in the model database, and multiple instances of the object can be created at different locations by transformations such as translation, rotation, and scaling. Unlike copying, they just point to a pointer to the original object, so the size of the model file does not increase. For a model that repeats multiple occurrences in a scene or a model with symmetrical structural features, example techniques can be used, such as a tree planted at different locations or the same pavilion built on different mountain waists. The virtual environment is shown in Figure 1.

2.4 Fractal Algorithm Application

In the design of the virtual landscape model, the fractal algorithm can be used to construct the model to optimize the natural landscape model of the scene. Fractal algorithm based on

Figure 1 Virtual environment.

fractal geometry theory is one of the promising big data scene modeling techniques. Fractal Brownian model simulates in a variety of ways including shear displacement method, inverse Fourier transform method, heavy line subdivision method and the random midpoint displacement method (Random Midpoint Displacement). The plant model construction algorithms are: L-system, Iterated Function System (IFS), Diffusion Limited Aggregation (DLA) model and particle system. The L-system can quickly generate plant graphics with small data volume.

3. ARCHITECTURE DESIGN OF ROAMING SYSTEM

The roaming system is mainly divided into two parts: some optimization reduction methods through 3D scene modeling to realize 3D scene modeling and roaming engine implementation. Secondly, implementing flexible roaming in the scene also requires some software and programming. The roaming system designed in this paper is based on the EON platform, and uses VBScript and JavaScript language to develop viewpoint tracking and view switching, as well as camera behaviors such as autonomous roaming. Visual C++6.0 can be used as the development platform, can call Eonx4.0.1 control for system integration development, and finally generate a virtual roaming system with visual operation interface [8]. The architecture of the roaming system is shown in Figure 2:

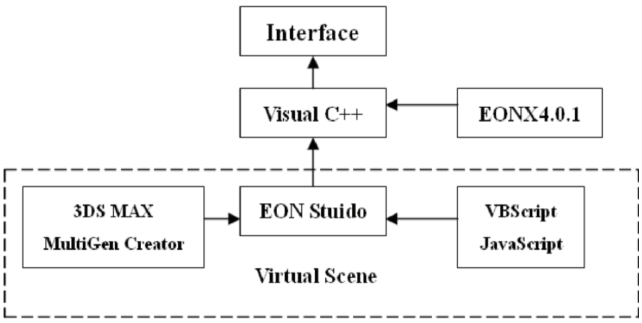


Figure 2 Roaming system architecture.

3.1 Conversion of model data

3D data (usually referred to as 3D graphics and models as 3D data) is often described by a polygonal mesh. The set of vertices and faces is a 3D mesh. The position (or pose) of the point in the 3-dimensional space can be represented by a Cartesian coordinate system, and the face is composed of a series of points in a prescribed order. The simple principle of 3D information acquisition is based on a polygon mesh and for the transformation processing of various 3D model formats [5], the instantaneous pose of 3D solids (model) is:

$$P_{ijk} = \int\int\int f(x, y, z)x^i y^j z^k dxdydz$$

in the formula, $f(x, y, z)$ is used to describe the (x, y, z) coordinate function of the entity. By rotating the coordinates, let the rotated matrix be R, and the inference can get the affine map, which is represented by $\alpha(v)$:

$$\alpha(v) = S^{-1} \cdot F \cdot R \cdot (v - g)$$

S: the area of the polygon;

v: represents a point within the area;

$F(x, y, z)$: The implicit equation represents an arbitrary polygonal surface, the light reflection is invariant, and the matrix is represented by F;

g: the center of gravity of the polygon.

Using the above principles, we can convert the 3D data raw file format to a format suitable for EON. Various file formats have different loaders, and both 3D Studio and LightWave files are loaded using the plug-in converter and inserted into the simulation tree structure. The loading is divided into two steps: the first step is to load and convert the file into the internal database, and the second step is to establish the EON hierarchical relationship in the database by the plug-in conversion program, and establish an EON simulation tree structure, including all the geometry. The structure will be converted to a polygon mesh, and all materials will be converted to the format used by EON. These objects will be placed under the parent frame node to form a tree-like hierarchical relationship between the frame and the grid function nodes.

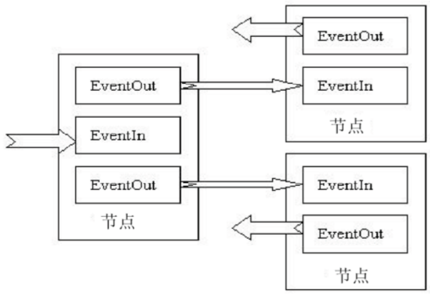
3.2 Design of roaming paths and perspectives

The roaming path is generally divided into autonomous roaming and automatic roaming of a fixed path. The autonomous roaming can be implemented by the walk node, and the motion state of the camera is controlled by setting the forward speed of the walk node and the rotational speed of the corner, thereby achieving autonomous roaming. Automated roaming of fixed paths enables fixed path roaming by setting a fixed set of XYZHPR coordinates in the virtual scene and letting the trajectory of the camera fit along the discrete points of the set.

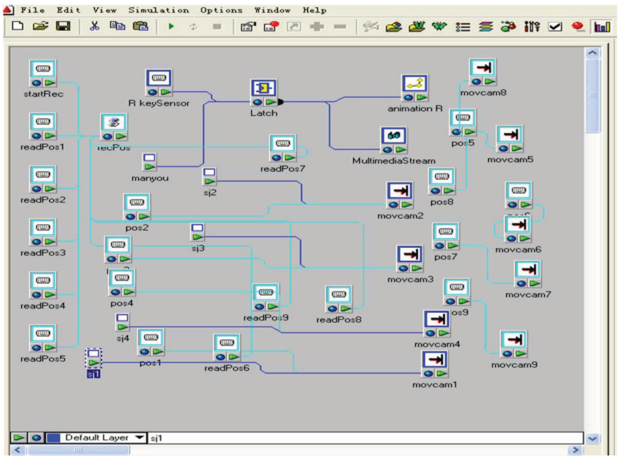
The angle of view roaming is a set of observation points that are specifically set for quick browsing of iconic scenic spots. You can quickly switch to a specific attraction by clicking the mouse or pressing a preset button.

The development of the roaming path and viewpoint switching adopts the node routing driving mechanism (as shown in

Figure 3). Real-time interaction between human and virtual scenes is realized through a series of nodes such as sensors, script nodes and switch nodes. As a result, the user feels as though they are there at the actual place depicted by the virtual reality scene.



(a) Node routing mechanism



(b) Node routing for roaming paths

Figure 3 Node routing mechanism and roaming path.

3.3 Roaming System Integration

After the camera actions such as roaming path and viewpoint switching are developed in the virtual reality platform, the InEvent and OutEvent nodes are set for signal transmission. Using Visual C++6.0 as the software integration development platform, we first create a single document MFC program, then create an EON object by calling the Creat() function, and load the edz file developed by EON to realize the VC interface and the edz file. This is for the purpose of intercommunication. Finally, a virtual landscape roaming system with a visual operation interface was developed.

Virtual BOOL Create (LPCTSTR lpszClassName, / / class name of the associated class, long pointer type

LPCTSTR lpszWindowName, / / parent window name

……

CWnd* pParentWnd, / / pointer to the parent class

……

CCreateContext* pContext = NULL { return CreateControl(GetClsid(), lpszWindowName, dwStyle, rect, pParentWnd, nID); }

4. INSTANCE VERIFICATION

Taking the campus of South China Agricultural University as a model, the virtual campus roaming was realized on Visual C++ with EON virtual reality development software. As shown in Figure 4, the user can browse the scene in all directions, or automatically roam according to the predetermined path, and select different perspectives for observation. The system design and development method has a good application value.

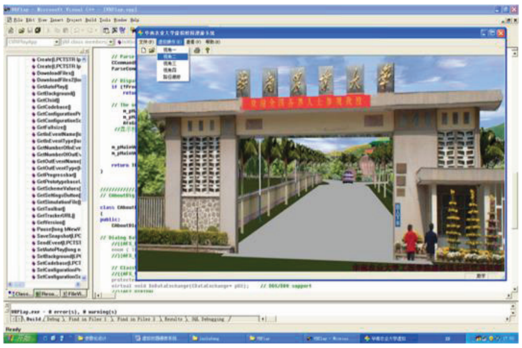


Figure 4 Virtual South China Agricultural University Campus.

5. CONCLUSION

In order to realize the virtual landscape simulation of a large-dimensional three-dimensional complex environment, this paper optimizes the three-dimensional model in the modeling process in three distinct steps: the rational selection of modeling tools, reduction of model redundancy and complexity, and reduction of model file size. These things were studied in detail. The architecture of the roaming system is constructed. The realization of the roaming system is studied from the aspect of data transformation, roaming path and perspective design, as well as roaming system integration. The data compression and conversion algorithm was given, and the virtual data volume realized. The campus roaming system with good real-time interactivity and scalability. With the development of data mining and analysis technology, we have entered the era of intelligence based on large data. The application of Big Data has gradually penetrated into people's daily life. In the context of today's big data era, the landscape development of creative parks is still in its infancy, and intellectualization has not been widely used. Therefore, we should comply with the new demand for intellectualization, take sustainable development as the design guiding ideology, and combine the advantages of resources brought by the Internet of Things technology to further promote the landscape development of creative parks. I believe that the trends identified in this paper are irreversible.

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