Study and Realization of 3D Visualization System of Power Transmission Grid

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Abstract: With the acceleration of the construction of smart power grid, the power industry has put forward more requirements on the construction, design and operation management of transmission network, and the 3D visualization of transmission grid becomes more and more important. Therefore, in order to show the grid electricity staff such information as the environment and components of transmission grid in a more direct and vivid way, this paper refers to the design of Internet technology and realizes the 3D visualization system of power transmission grid with timeliness and interactivity, which improves the maintenance ability and management of transmission network.

1. Introduction

In recent years, with the rapid development of power grid enterprise in our country, the accelerating of the construction of the transmission line and the implementation of the aerial photography technology by different transmission owners in the country, have higher requirements on the design, construction, and operation management. The 3D visualization technology of power transmission grid combines the design of transmission line with such information as the landform, landscape, weather conditions and other information and expresses in a vivid and direct way in 3D visualization method, so as to make the observers obtain the needed information in a rapid and accurate way. The design of 3D visualization system of power transmission grid is one of the challenging and promising directions on the virtual simulation on real-time scenes.

2. Research on 3D visualization system of power transmission network

2.1 Hardware basis of research

The 3D visualization system of power transmission grid displays technology research and application through the 3D dynamic intelligent technology in real-time and guides the implementation of 3D dynamic technology in grid intelligent display. Through 3D dynamic grid real-time information intelligent displaying technology research and application, the application of 3D display technology, combined with the text, graphics, video, animation, and other forms of power grid dispatching operation data, can conduct the display in a central, dynamic, real-time and themed way.

Through 3D dynamic grid real-time information intelligent display technology research and application, it can resolve such problems as disunity in data, style, dimension, and perspective in different application systems in electric power dispatching control center of Guizhou Power Grid, so as to realize the goal of display integration, panoramic view, and lean management, so as to elevate working efficiency. Table 1. Composition of the graphic processing platform of intelligent display system:

The graphical processing platform of intelligent display system is shown in Table 2:

Hardware equipment working environment conditions: temperature: - 5 ℃ ~ + 40 ℃; relative humidity: no more than 90% (there should be no condensation in the device, or freezing); atmospheric pressure: 70kPa ~ 106kPa.

Table 1. Graphic processing platform of intelligent display system

Items	Index
Model	Think Station P910
Operating system	Windows 7 Professional 64 digits
CPU	2*Intel Xeon E5-2699 v4
Memory	64GB
GPU	ATI FirePro™W8100
Hard disk system	1*1TB SATA,10000rpm
CD-ROM	16X DVD-ROM SATA 1st Drive
Network card	Integration 10/100/1000M Ethernet

Table 2 Database platform of intelligent display system

Item	Index
Model	ThinkServer TS250
Operating system	Windows Server 2008 R2 64 digits (including SQL SERVER2012 database software)
CPU	Intel Core 4 E3-1225 v5 3.3Ghz
Memory	32GB
Hard disk system	2*1TB SATA 7200 Raid 1 Disk Array
CD-ROM	16X DVD-ROM
Network card	Double 10/100/1000M Ethernet

Table 3 Movable touch terminal

Item	Index
Model	Apple iPad Air 2
Operating system	ios system
CPU	A8X chip
DPI	2048 x 1536
Memory capacity	64GB
Endurance	As long as 10 hours
WiFi functions	802.11a/b/g/n WLAN network (802.11n between 2.4GHz and 5GHz)

2.2 System view window design

In the process of realizing the grid system, it needs to change the position of the camera appropriately to observe the grid better; bind the camera with the user's eyes, and the camera's angle is equivalent to the angle of the eyes. The 3D world and screen pixel changes include multiple types of operations that require the implementation of the H process transformation.

(1) Viewpoints changes of power transmission grid: the grid model library function called gluLookAt () changes the viewpoint, transforming the scene from the world coordinate system to the camera coordinate system; the function uses H parameters, viewpoints, reference point locations and the upper location of the point of view to show the camera position. In the world coordinate system, we use 3 score vectors of n, u, and v to represent the coordinate basis, and the score vector W is from the reference point center to the vector of the view eye, which is equivalent to the z-axis of the world coordinate system; u is the cross product of up and n in the direction of the view, equivalent to the X axis; the score vector V is the cross product of n and u, which is equivalent to the Y-axis. The mathematical expressions are:

$$n = \frac{eye - center}{|eye - center|}, \quad u = \frac{up \times n}{|up \times n|}$$

The basis vectors of the world coordinate system are X (1,0, 0), Y(0,1, 0), Z(0,0,1), from which we can get an outline excessive matrix A:

$$A = \begin{bmatrix} \mu & \nu & n & 0 \\ \mu & \nu & n & 0 \\ \varpi & \nu & n & 0 \\ -e & -e & -e & 1 \end{bmatrix}$$

(2) Projection: change the scene which has transformed into camera coordinate system to the projected coordinate system again to get the vector usually under the standard coordinates, in which all the coordinates are mapped to - 1-1, and the value from screen to the far plane Z is 1, with the close screen coordinate of 1.

(3) Viewport transformation: this step is to show the projection transformation to the screen, which is similar to printing out the photos. This transformation means that the scene is eventually shifted to the window coordinate system, where the X/Y direction of the X/Y axis is based on the range of (0,0)- (width, height). The z-axis is going along the screen, and the value scope is [0, 1]. Realizing these features requires the camera node Camera category, image device object, GraphicsContext class, and the viewfinder osgViewer class provided by OSG. The view finder can organize and manage the nodes in the scene camera, and meanwhile, in combination with the variables and updating of the scene nodes, each frame stored in the camera can be played to complete and show an integrated 3D simulation scenario. The camera node is used to realize the change of view point in the camera, which is mainly through matrix change. The graphic device object defines the device platform in the scene, determines the corresponding relationship between rendering effect and pixel cache, and has many operational functions.

2.3 The realization of weather effect

In the 3D visualization system of power transmission grid, the simulation of the weather effects of rain and snow can improve the real sense of the system. In order to realize this function, OSG provides the particle system osgParticl. The effect of particle motion with natural physical characteristics can be simulated effectively. Particle system is a certain number of smile particle collection with simple shape into an irregular fuzzy objects; each particle has size, position, shape, color and other properties, the corresponding methods in the particle system are also provided to achieve it. Through establishing the steps of the particle system, and the basic properties of the self-defined snow particles can be set as shown in table 4 below according to the predefined particle system of OSG:

Table 4 Snow effect data parameter setting

Parameters	Attribute description	Setting values
Life Time	Particle life cycle	3
Size Range	Particle size	(15000,30000)
Alpha Range	Particle transparency	(0.6f, 1.0f)
Color Range	Particle color	(1.0f,0.5f)
Radius	Particle radius	0.05f
Mass	Particle quantity	0.lf
Texture file	Particle material	snow.rgb
emissive-particles	Radial pattern	false
lighting	Added light	false
RateRange	Speed range	Maxvalue 1
ToGravity	Gravitational acceleration	scale=1.0f
F1uidToAir	Air attribute	void

The process of the weather effect construction in this system is determined according to the steps of the creation of the particle system, it is mainly the simulation operation of the weather snow effect and the rain effect.

3. Realization of 3D visualization system of power transmission network

3.1 Realization of model loading function

Load the processed model which is constructed and handled by 3 d Max to the scene, and load the terrain, transmission tower, insulator, and transmission line in accordance with the order into the scene through the VISA Read read Node File () of OSG according to such information as location, size, and direction stored in the database. By default, the right window operation bar control is not selected, and the effect diagram after the successful load is shown in Figure 1, 2.

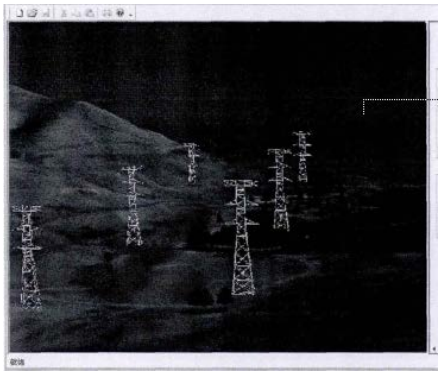

Figure 1 Figure of successful load model

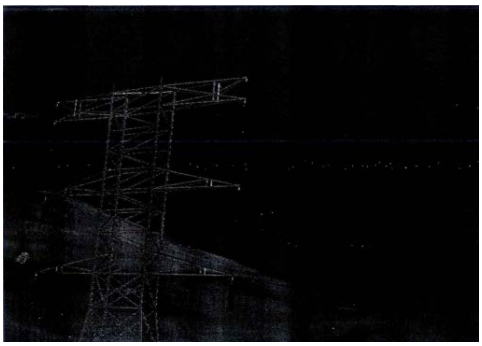

Figure 2 Figure of successful load model

3.2 The effect of the weather

(1) The realization of snow effect. In the process of realizing the design of system snow effect, it often combines with fog effect so as to make the scene more realistic; during the operation realization of the snow effect in this system, it is necessary to set the parameters of snow effect in the settings of the menu bar to realize the rendering of snow effect after successful saving. (2) Realization of rain effect. In the implementation process of rain effect, it is similar to the snow effect that particle system is taken to set the corresponding parameters, and the specific operations are the same as the snow effect; the main difference lies in that the material is different. The implementation of rain effect is also accompanied with fog effect. The effect of rain effect is shown in Figure 4 below:

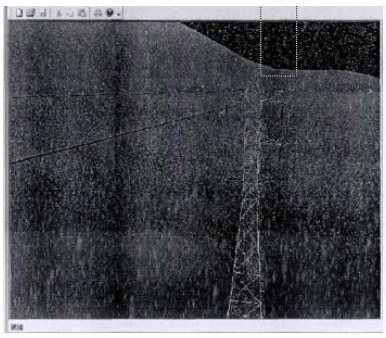

Figure 3 Figure 1 of snow effect realization

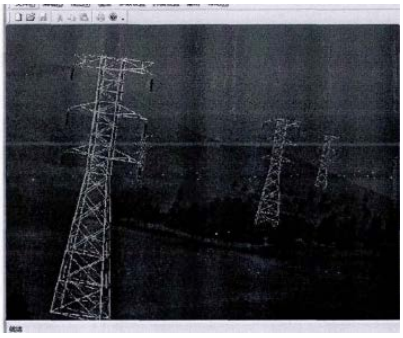

Figure 4 Figure 2 of snow effect realization

3.3 The realization of roaming

Roaming has a variety of ways roaming such as scene roaming and path roaming; in the system implementation, the simulation roaming is mainly for roaming roaming and path roaming; the implementation of the bots is realized through smooth and accurate transformation of the observer to the designated position; the view settings of action box of the right child windows of the operating system provides the functions of scene roaming; the observer can realize the results as is

shown in Figure 5 through moving the button left to right, up and down, front to back to adjust the position:

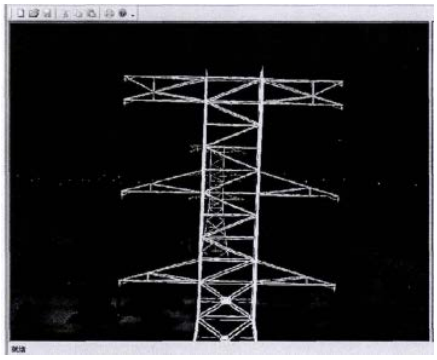

Figure 5 Scene roaming roaming

4. Conclusions

With the acceleration of the construction of smart power grid, the research of transmission grid has become more and more, and the 3D visualization of transmission network has become an important subject for the research of power personnel. Therefore, in accordance with the current research trend and in order to display such information as the environment and components of power transmission grid to the electricity staff, this paper designs and realizes the 3D visualization system of power transmission grid; the system has timeliness and interactivity, which can improve the ability of the maintenance of the grid and the management level. The implementation of OSG 3D image rendering engine and MFC interface technology, can realize the 3D visualization system of transmission network.

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