



Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

Research on construction technology of 3D simulation platform of radiowave environment based on OpenGL

Wang hong-ming^{1,2} and Dong Jun¹

¹The State Key Laboratory of Complex Electromagnetic Environment Effects on Electronics and Information System (CEMEE), Luoyang, China

²National Key Laboratory of Electromagnetic Environment, China Research Institute of Radiowave Propagation, Qingdao, China

ABSTRACT

Based on the visualization contents of radiowave environment, this paper achieved the coloring, rendering and illumination processing for the earth's surface using the powerful function of the OpenGL 3D graphics programming tools, which can realize the function including modeling, color processing, light treatment and texture mapping. We built a radiowave environment three-dimensional spherical bottom scene, used the LOD terrain technology to achieve the realistic terrain expression. We used isosurface extraction and ray casting volume rendering algorithm to achieve the drawing for the radiowave environment data. We also carried out the target modeling with the 3DMAX modeling software, finally, all of the above visual contents were integrated in the visual simulation platform of radiowave environment. Research has some practical value.

Keywords: OpenGL; visualization; simulation platform; radiowave environment; modeling

INTRODUCTION

Radiowave environment refers to the various environment which has the ability to influence radio wave propagation, it is an important part of the complex electromagnetic environment. The spatial extent of radiowave environments ranging from ground (sea), the ground (sea) surface, the troposphere, stratosphere, ionosphere, magnetosphere and the outer space. Under the conditions of information warfare, Radiowave environment information has become the battlefield environment protection information, which is as important to meteorological, hydrological and geographical information. The commanders can timely access to battlefield radiowave environment information through the visual simulation platform, it can provide intuitive information and decision support for space combat or even joint operations

Presentation of traditional radiowave environment information is mainly in the form of overlying radiowave environment information distribution diagram in two-dimension GIS platform, which go against the auto-visual image of three-dimensional space radiowave environment information and cannot fully reveal the general view of radiowave environment. With the rapid development of computer technology and network technology, computer simulation and virtual reality simulation technology has been widely applied in all walks of life, These technology provides the conditions for the development of radiowave environment visual simulation platform.

OpenGL is a three-dimensional graphics library developed by the US advanced graphics and high-performance computer systems company (SGI), which is a software interface to the graphics hardware, can be implemented in many different hardware platform. Because OpenGL has a lot of powerful graphics functions which can be performed on the entire three-dimensional graphics rendering of light and color, it is convenient to map out the objective world

realistic three-dimensional scene. In this paper, we build the visual simulation platform for radiowave environment using the powerful OpenGL graphics package with the VC platform.

OPENGL TECHNOLOGY BASE

A. Key Features

As an open, high-performance graphics and interactive visual treatment standards, OpenGL has the Features as follows:

- Function rich: OpenGL library provides a rich graphics, image processing functions, including: all kinds of graphics rendering, lighting transformation, scene change, coordinate transformation, texture mapping, polygon division, and exchanging between the pixel storage format and double buffer etc.
- Hardware independence: OpenGL is a graphics hardware-independent application interface. The user must begin to construct their own three-dimensional model from a point, line, surface and other basic graphic elements and perform three-dimensional real-time interactive operation.
- Operation simple: OpenGL provides a lot of graphical functions which are Easy to understand. beginners can also use its powerful graphics capabilities to quickly build a three-dimensional graphics and interaction.
- Can run on the network, OpenGL is a client / server type. On the C/S architecture, the client sends OpenGL drawing commands, the server receives the command and executes a drawing by agreement.

B. main functions

- Modeling: OpenGL graphics library provides the basic point, line, polygon drawing function, it also provides a complex three-dimensional objects, such as balls, cones, polyhedrons, teapots and complex curves and surfaces (such as Bezier, Nurbs curves, etc) drawing functions.
- Transformation: The transformation function of OpenGL graphics library consists of two parts: basic transformation and projection transformation. Basic transformations Includes translation, rotation, ratio and mirror, projection transformation Includes parallel projection (orthographic projection) and perspective projection transformation.
- Color mode setting: OpenGL color mode Includes RGBA mode and color index.
- Light and material settings: OpenGL light has Emitted Light, Ambient Light, Diffuse Light and Specular Light. The material is represented as the light reflectance.
- Texture Mapping: The realistic surface details of an object can be expressed by the function of OpenGL texture mapping.
- Bitmap display and image enhancement: OpenGL provides the basic image features pixel Copying and Reading, in addition, it also provides special image effects processing including blending, antialiasing and fog, which can enhance the graphics display effect
- Double Buffering: OpenGL uses the front buffer and back buffer alternate scene technology, in short, back buffer computing scenarios, generate screen display, front buffer display picture which has been painted in the back buffer.
- Special effects: OpenGL can achieve special effects such as Depth Cue, Motion Blur and other special effects.

C. working process

For many geometry, OpenGL mainly describes them through their vertices which are treated one by one. The processor will perform complex computing operations, all the calculations are performed for each vertex. At the same time, the processor will rasterize the graphics vertex, the purpose is to form a series of graphics fragments. In contrast, some data such as pixel type, stores the results obtained after running processing in a corresponding flash memory. These flash memory is texture assembled, for geometric vertex operations, grating effect also applies, the purpose is to form a series of graphics fragment. The last phase of the program is to put all the graphics fragment into frame buffer for displaying.

OpenGL working procedures according to the following steps:

- First, construct geometric elements, these elements are composed of point, line, surface and bitmap, create the mathematical description of the object.
- Then, determine the color of the calculation model, meanwhile, determine the lighting and texture.
- Finally, raster operation, translate the mathematical description and color information of the object to the pixels of screen.

II. CONSTRUCTING METHOD OF RADIOWAVE ENVIRONMENT VISUAL SIMULATION PLATFORM

A. scene rendering

When draw the scene using OpenGL, we must carry out the initialization work, such as setting the pixel format, setting the light source, setting the viewport and so on. We should also add windows event handler, such as OnCreate, OnSize, OnPaint etc. Then we enter the phase of models Rendering, based on the existing data format, we can create a mathematical model using the triangle construction function, place the object in three-dimensional space, and select

the vantage observation point, acquire the color information according to the texture map or result calculated by lighting conditions and color value. The next step is to raster, convert the geometric data and pixel data objects into pieces, execute mixing, jitter and other operations. Finally, convert the segment to screen pixel.

Draw a series of image files textures used in the scene from the resulting conversion tools, programs written using his picture to read the data, including the Alpha value of RGB values, and part of the picture formats, the use of OpenGL texture mapping these textures mapped to the surface of the model. Texture mapping values in addition to the surface can be directly used to draw coloring, you can also call the function to complete OpenGL pixel mixing operation, so as to achieve the desired effect.

Complete scene painting class in the scene rendering, Earth control category, camera control class preparation. Including the realization of generating earth background, change the viewport. Complete the function of the mouse interactive operation including the mouse generates, viewport change, left mouse button, middle mouse button, right button and move; the Earth control operation including drag on the Earth rotation, tilt operation, around the central axis of rotation, scaling, moving up and down, etc. The visual basic platform is shown in Figure 1.

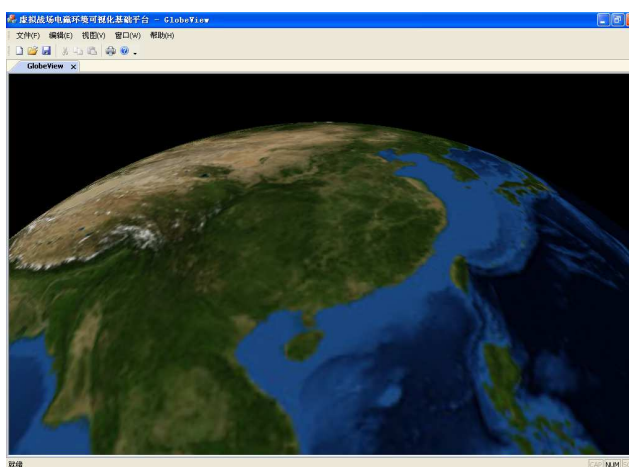


Fig.1: the visual basic platform

B. terrain expression

When we draw a large terrain scene, we must use the grid method to deal with large amounts of data, it can not meet the real needs. Terrain LOD technology is a relatively simple method for large-scale terrain rendering. LOD technology is to reduce the geometric complexity of the scene by progressively simplifying terrain detail in order to improve the efficiency of rendering algorithm. For the terrain scene, the level of detail selected Mainly take the following factors into consideration: the distance between the viewpoint and the terrain, gaze direction, surface features and terrain undulating features. There are common LOD terrain rendering methods: quadtree, GeoMipmapping, ROAM and other methods.

When multi-resolution terrain data for view-dependent rendering, usually in line with user needs to check the accuracy of the data requirements from the top layer by layer. If the terrain data range is large, you can build a terrain tile quadtree block the entire terrain. Establish tree hierarchy quad dynamic LOD terrain consists of modules responsible for the completion. LOD module build according to the digital terrain elevation data grid, each square of terrain tiles can be regarded as a quadtree nodes, each node holds the altitude information center point, and then based on the characteristics of the terrain topography of the terrain recursively continue to be divided into four regions equal, the greater the depth of division higher the resolution of the terrain, terrain display until production to meet the needs of the terrain quadtree. Before drawing each frame is updated each chunked LOD, LOD terrain center module based on block distance from the observer's point of view to determine the level of detail of the terrain.

The visual effect of terrain expression using LOD technology is shown in Figure 2.

C. The moving target Modeling and Movement Planning

OpenGL provides multiple functions for drawing three-dimensional solid model, we can draw a simple model such as the spheres, cubes and vertebrae using these functions. However, these functions are difficult to draw complex solid models. So we consider the use of other modeling tools to assist the establishment of a three-dimensional object model. Therefore, we can establish the target model using the 3DMAX modeling software, OpenGL can use the

model data file and achieve the control of object model, so as to realize the seamless integration of three-dimensional simulation system and its application environment.

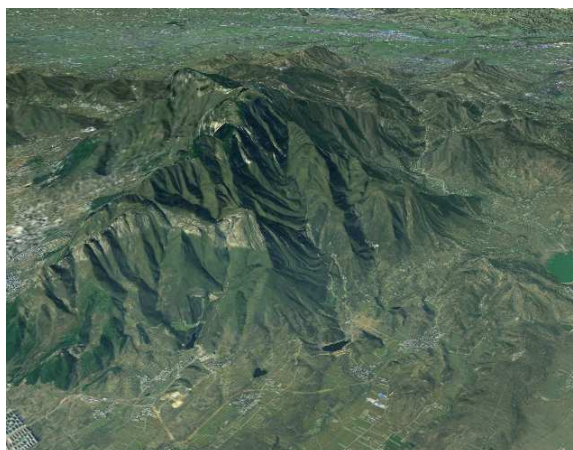


Fig.2: the visual effect of terrain expression using LOD technology

We can convert 3DS model format to C\C ++ files format which can be used in the OpenGL program using the 3D Exploration, Wcvt2pov software, we can also load 3DS models directly in the OpenGL program. After loading the 3DS model in the OpenGL program, we need to control the models for scaling, rotating, moving and other operation. The visual effect of target Modeling is shown in Figure 3.

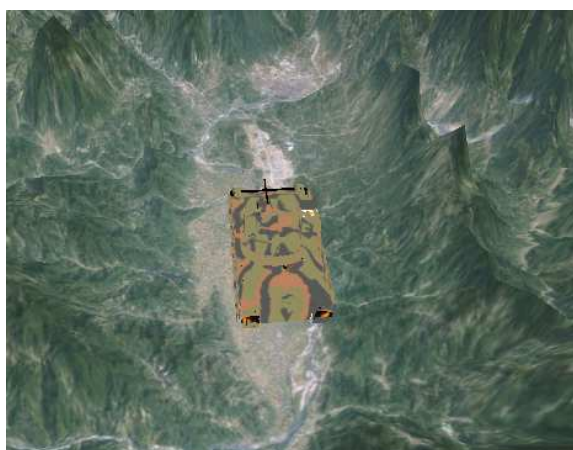


Fig.3: the visual effect of target Modeling

III. THE APPLICATION OF RADIOWAVE ENVIRONMENT VISUAL SIMULATION PLATFORM

OTH radar detection in complex radio environment is always carried out its radar detection performance and performance parameters, target characteristics, movement and specific radio environment, must take full account of these factors, in order for the OTH radar detection efficiency for proper evaluation. The current assessment of the effectiveness of radar technology and platform environment is still relatively scarce. Computer simulation technology is an important means of dynamic, complex large system evaluation.

Using this simulation system can develop microwave OTH radar simulation system, the detection system using atmospheric waveguide propagation models consider the effect of anomalous atmospheric and irregular terrain. According to the radar equation for different objectives, microwave-horizon radar detection area ducting simulation environment, detection probability, if we find the goal to give the alarm information.

An example of radiowave environment visual simulation platform application is shown in Figure 4.

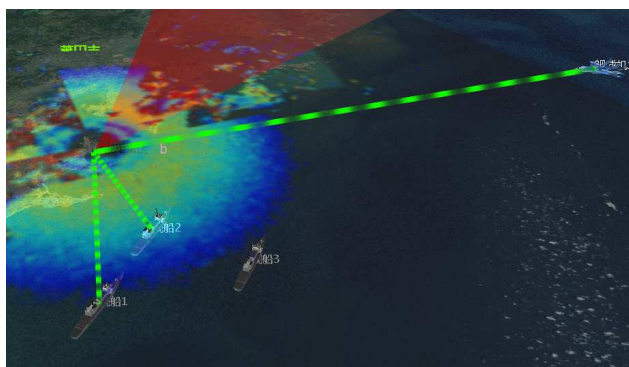


Fig.4: A example of radiowave environment visual simulation platform application

CONCLUSION

The purpose of the radio environment for simulation and visualization in order to assist users to analysis and decision making, which requires the dimension of a two-dimensional, three-dimensional space on the radio environment for visualization, and provides an intuitive visual form secondary user insight into spatial electromagnetic field distribution and other situation, the direction of wave propagation and the strength rule.

Radio environment information is an important part of the battlefield environment protection information, involving a wide range of spatial regions, how to effectively carry out massive data management and visualization has been worthy of further study. In this paper, the use of OpenGL 3D graphics programming tools were achieved scene rendering, realistic terrain expression, integration and visualization of three-dimensional modeling of moving objects and situational planning function wave of environmental data, set up radio environment visual simulation platform. On this basis, to achieve the development of microwave-the-horizon radar simulation system.

Nevertheless, the paper realized radio environment visual simulation platform has yet to be perfected. In terms of display means, should be combined with surface rendering, volume rendering and vector drawing, and other forms of drawing way to richer, intuitive display radio environment information in the sphere.

REFERENCES

- [1] Wei-wei Gan, Xi-tang Tan, Study on Simulation of Sandstorm Based on OpenGL[J], *Recent Advances in Computer Science and Information Engineering*, **2012**, Lecture Notes in Electrical Engineering Volume 125: 811-816.
- [2] Bo Peng, Chuanwen Luo, Wangyang Jiang, *Information Engineering and Applications*, **2012**, Lecture Notes in Electrical Engineering Volume 154: 1722-1727.
- [3] Xiuli Gong, Youqing Guan, *Recent Advances in Computer Science and Information Engineering*, **2012**, Lecture Notes in Electrical Engineering Volume 125: 747-753.
- [4] Fangjie Tao, Fuyan Liu, Gang Liu, *Proceedings of the International Conference on Information Engineering and Applications*, **2013**, Lecture Notes in Electrical Engineering Volume 218: 789-795.
- [5] Miao Song, Peter Grogono, *Innovations and Advances in Computer Sciences and Engineering*, **2010**, 539-543.
- [6] Yang Chao, Research on electromagnetic environment modeling and rendering three-dimensional method of virtual battlefield [D], Changsha: National University of Defense Technology, **2010**.
- [7] Liu Fang, Huang Mengcheng, Liu Xuehui, etc., *Computer Aided Design and Computer Graphics*, **2010**, 22 (3): 382-387.
- [8] Yang Chao, Xu Jiangbin, Zhao Jian, etc., *Systems Engineering and Electronics*, **2009**, 11 (5): 2767-2772.
- [9] Hu Huaquan, Yang Chao, Wu Lingda, etc. *Computer Engineering and Applications*, **2011**, 35 (5): 206-209.
- [10] Imma Boada, Isabel Navazo, Roberto Scopigno, *The Visual Computer*, **2001**, 17 (3): 185-197.
- [11] Enrico Gobbetti, Fabio Marton, José Antonio Iglesias Guitián, *The Visual Computer*, vol. 24, no. 7-9, pp. 797-806, **2008**.
- [12] Kyung-Gun Na, Moon-Ryul Jung, *Advances in Multimedia Modeling*, vol. 49, no.3, pp. 348-357, **2008**.
- [13] Gert-Ludwig Ingold, Petra Wyrowski, Hermann Grabert. *Zeitschrift für Physik B Condensed Matter*, 85(3), pp. 443-449, **1991**.
- [14] Shyh-Kuang Ueng, Yang Fu-Sheng. *Advances in Visual Computing Lecture Notes in Computer Science*, 5876, pp. 899-908, **2009**.
- [15] Joanna Porter-Sobieraj, Maciej Swiechowski, *Computer Vision and Graphics*, **2010**, 6375: 276-283.