Research Article
Research on the Key Technology of the Visualization of Food Engineering Electromagnetic Signals

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Abstract: The related theory of GIS, scientific visualization and virtual reality based method used in this study cone approximation signal beam, isosurface and direct volume rendering visualization is realized food engineering electromagnetic signal shape and intensity of itself. In order to allow users to have a feel of the experience, this study also considered a key geographical visualization. With the technique and method of terrain data block scheduling to achieve a rapid indexing terrain blocks and realistic display; using massive image Pyramid block level model to realize the effective organization and management of image data. Finally, the visualization and geographic environment of the food engineering electromagnetic signal fusion, realize the food engineering electromagnetic signal display the result shows practical application value.

Keywords: Food engineering electromagnetic, global subdivision grid, multi-isosurfaces, visualization

INTRODUCTION

With the rapid spread of electronic information technology in society and food enterprise field, the electromagnetic environment is becoming much more complicated, the struggle of electromagnetic space is becoming fierce, which will have a significant impact on the effectiveness of weapon equipment (Ohshita *et al*., 2006). Electromagnetic environment has become the restriction factor of efficiency in the information warfare or electronic warfare. In the electromagnetic space battles, whether you can get the advantage or not, not only depends on the performance of input equipment, but also largely depends on the accurate judgment to the electromagnetic situation and reasonable redeployment towards electronic warfare force. But the complex electromagnetic environment is invisible, only can analy the electromagnetic information in local region through the different detection equipment and only can reflect the electromagnetic distribution characteristics of local region, it is difficult to meet the requirements of the overall command of electromagnetic situation in battlefield, it will restrict the consumer to make the rapid and accurate judgment (Li *et al*., 2012).

In recent years, with the wide application of virtual reality technology and scientific computing visualization technology in food enterprise field, the 3D visualization of electromagnetic information has become possible. It let the consumer understand the invisible electromagnetic environment, has become one of the major concerns of the battlefield environment visualization (Zhou *et al*., 2012). Scientific computing visualization refers to the display of graphics and image using the computer image processing technology. It is a new research field and develops rapidly in recent years, it involves computer image processing, graphics, computer-aided design, visual and human-computer interaction technology and other technologies. Scientific computing visualization can provide a easily understood form with its view image vivid and visual for many abstract, unintelligible, numerical information, discover the rules of the data.

MATERIALS AND METHODS

This study takes the 3D visualization of food engineering electromagnetic signal as the main research contents, focus on the 3D visualization method of food engineering electromagnetic signals, studies the visualization method including food engineering electromagnetic signal shape, food engineering electromagnetic signal strength distribution and fusion method of food engineering electromagnetic signal and geographic environment. In practice, these methods can provide a visual image of the performance of electromagnetic environment for food enterprise command and exercise, so that the officers can quickly

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understand and master of the space electromagnetic situation and provide the decision-making for the radar command, communication and other information equipment and electronic warfare force.

Research on visualization method of food engineering electromagnetic signal shape: The radiation field of the radar antenna has a direction, the radiation field intensity is different in the different direction. We can represent the radiation intensity of the radar antenna in each direction using the vector length from origin to represent, then connect all the vector endpoints to form the antenna pattern. The function of antenna directivity is called pattern function. We can show the relative size of different radiation distance in 3D space with curved surface, which is called stereo directional three-dimensional map.

In this study, the three-dimensional coordinate system is generated in the curved surface equation using two-dimensional polar antenna pattern function. The function of radar antenna pattern using two dimensional polar coordinate often have negative size, this direction curve in polar coordinates is in the opposite direction to the main beam, we call this kind of deviation the back flap. Because of the reflecting surface antenna, the dorsal flap will be reflected to the direction of main beam, the strength of reflection is relevant to the antenna type and material factors. Considering the back flap is not we want to get the beam, so this study does not consider the details of dorsal flap with reflector antenna reflection effect.

OpenGL 3D graphics programming language provides a lot of GLU functions, which can render the surface of the sphere, cylinder and disc equation. In order to create a more complex model, we should arrange these objects with two equations according to a certain order. The drawing function of truncated cone is gluCylinder, using this function, we can specify the frustum of a cone bottom radius (baseRadius), top radius (topRadius) and cone height (height), the parameters slices and stacks respectively expressed truncated cone section and stacking. Because the beam is rotationally symmetric, so you can use a group of truncated cones to simulate the signal beam.

Through the two-dimensional beam equation, we can calculate a series of values in equal interval sampling points, then we can use the adjacent value as a round table on the bottom surface radius, use the sampling interval as a round table high. We can finally generate the main lobe beam by drawing a series of circular truncated cones. The drawing effect of round table approaching the signal beam is shown in Fig. 1.

Isosurface extraction methods of food engineering electromagnetic signal strength distribution: 3D data can be regarded as a collection of sampling points in a spatial region, these sampling points have the same physical properties. The data value in the region of non-


(a)   (b)
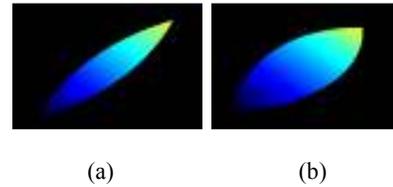
Fig. 1: The drawing effect of round table approaching the signal beam; (a): Field value is 80 dB; (b): Field value is 60 dB

(a)   (b)
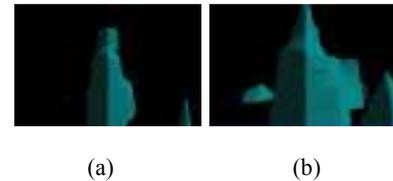
Fig. 2: The drawing effect of MC isosurfaces extraction algorithm; (a): Field value is 40 dB; (b): Field value is 20 dB

sampling points can be calculated by the interpolation points near the sampling data. All points in the region with one of the same data value will be composed of one or more surfaces, called isosurface. The marching cubes algorithm provides a simple and effective method for extracting the surface, each vertex is labeled and categorized according to the different vertices state combination (Hu *et al*., 2011; Lorensen and Cline, 1987), the equivalence point on the edge of each strip cube can be obtained by linear interpolation methods, then fit the isosurface with a series of triangles. MC algorithm uses triangular facets as the basic elements of geometric primitives (Montani *et al*., 1994). The current graphics cards support hardware accelerated rendering for triangular patches and MC algorithm itself is simple, easy to implement, so it has been widely used (Congote *et al*., 2010), is considered as one of the most popular isosurface extraction algorithm.

The basic idea of Marching Cubes algorithm is as follow: Process the voxel one by one in the field, classify those voxels which have the intersection with the isosurface and then calculate the point of intersection with the iso-surface voxel edge using the interpolation method, next connect these points to generate one or more triangular mesh (Nielson *et al*., 2008), then calculate the vector of each triangle mesh using interpolation method. Finally, draw the isosurface using common graphics software packages or hardware (Yang and Wu, 2002). The drawing effect of MC isosurfaces extraction algorithm is shown in Fig. 2.

The food engineering electromagnetic signal strength distribution of volume rendering algorithm: How to convert a three-dimensional space of discrete sample values to a two-dimensional image on the screen? This is a technical problem to be solved in volume rendering. It can reproduce the original 3D data and allow the users to intuitively feel the

(a)   (b)
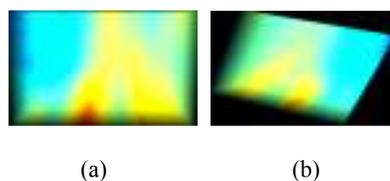
Fig. 3: The drawing effect of GPU-accelerated ray-casting algorithm; (a): Front view; (b): Side view

distribution and changes in the three-dimensional data field. The principle of ray casting volume rendering algorithm is as follows (Song *et al*., 2005; Gobbetti *et al*., 2008). First, emits light into the voxel space along the line of sight direction, then resamples the selected points on the light, calculates the data values of resampling points by interpolation algorithm (Na and Jung, 2008), next, determine its opacity and color values for each sample point through the transfer function. Finally, achieve the image synthesis for each resampling points (Lux and Fröhlich, 2009). In the ray casting method, because of a huge amount of computation in operatting on each body, it limit the rendering speed, the purpose of real-time rendering can not be achieved (Zhu *et al*., 2011). Based on GPU-accelerated ray-casting algorithm can take full advantage of the ability of software and hardware image processing, realize the real-time rendering of volume data, solve the contradiction between the image rendering speed and rendering quality in real-time rendering phase. The drawing effect of GPU-accelerated ray-casting algorithm is shown in Fig. 3.

Study on fusion method of food engineering electromagnetic signal visualization and geographic environment: It is lack of expressiveness for showing the distribution of the electromagnetic environment in isolation. The electromagnetic environment computing and visualization system must be based on the geographical environment as the background, the stations related with the electromagnetic field must be added to the geographical environment in order to give the user an immersive feelings.

Virtual signal environment scene generation and real time display technology: The large-scale 3D terrain scene is a very important part in the 3D virtual environment, the Fidelity of terrain and rendering efficiency will directly affect the performance and visual effects of the entire system. In the terrain environment simulation, in ordere to achieve the purpose of real-time rendering, the technical method of terrain data block scheduling is usually adopted. We can divide the terrain into several smaller terrain blocks using this method, judge the visibility of small terrain according to the viewpoint of the position and size of cone, involve the terrain blocks into memory in image rendering and clear the terrain blocks which are not

possible to see in current from memory. So we can achieve the following goals: control the amount of data involved in the image rendering, reduce memory overhead and reduce the graphics rendering time.

We can realize fast indexing terrain block using a quad-tree indexing technology, if you want to schedule a terrain data from a file or database, you should calculate its position in the file according to the global number of the block or find the database tables and table record number. If it is real-time rendering, you need to know the number of the block in the cache and calculate its corresponding global number. How to design the serial number? This is a problem with index code related, while the index code in the indexing process is a key part, the encoding type and encoding length will directly affect the effectiveness of the index.

With the increasing data processing level, the amount of data will grow exponentially, but not all regions are required to show the same accuracy in practical application. So the multi-resolution remote sensing images display on the Earth's surface that is the requirement of visualization of the virtual environment.

Pyramid model in image processing, compression, management and display area has a very wide range of applications, this study also uses the pyramid model to manage multi-resolution pyramid image. First, we define the initial image as the bottom of the pyramid model, namely Tier 0 and carry on the block, form a layer 0 tile matrix. On the basis of the 0 layer, then generate a first layer according to a standard method, the standard method is each of the 2*2 pixels for the synthesis of 1 pixels, carries on the block, form a first layer of tile matrix. Finally, under such circumstances, constitute the entire tile pyramid model. Tile size generally use 2n×2n, n is a positive integer.

RESULTS AND DISCUSSION

Fusion visualization and geographic environment of the food engineering electromagnetic signal: The deterministic propagation prediction method could consider the geographic information and radio environment information. It analyses the different propagation mechanism in propagation path through the terrain profile analysis and atmospheric refractivity profile analysis, such as scattering, refraction, diffraction, multipath propagation effects, etc. Then carry on organic synthesis, predict and evaluate the system performance. The conventional field strength results only can display a certain antenna height of field intensity distribution. This method generates the raster data for display in the form of a spherical surface, can not exhibit the change trends for the spatial field strength in different antenna height. This study establishes a sphere shell space grid model which is suitable to describe the grid data of radio wave environment information. Using this grid model, we can split the different antenna height to a 3D space. Then we can integrate the visualization of food engineering electromagnetic signal into geographical

environment through the GPU-accelerated ray-casting algorithm.

We use VC ++ language and OpenGL 3D tools to achieve the dynamic effects of radar beam scanning. The use of the machine parameter is as follows, Intel 3.0 GHz, 4GB RAM, GeForce G100 graphics card, Windows XP operating system, Microsoft Visual Studio 2008 programming environment. The scene display smoothly, beam shape and scanning effect are realistic. It can meet the needs of the warfighter command in a certain extent.

CONCLUSION

The 3D visualization of electromagnetic field is a hot research topic. With the development of high performance computing, people will be able to solve the model more complex, more precise calculation problem, produce more large-scale data sets, which brings great challenges to visualization research. On the other hand, with the development of computer graphics technology, people require for visualization is more and more high, fast, accurate, realistic hope of visualization. The 3D visualization of electromagnetic field mainly includes the source of electromagnetic radiation of geographical environment, meteorological environment, electromagnetic environment itself. This study from the visualization of food engineering electromagnetic signal shape and intensity of the round table, using the method of approximation signal beam, isosurface and direct volume rendering visualization is realized food engineering electromagnetic signal shape and intensity of itself. In order to complex electromagnetic environment simulation is close to the practical, realistic, to combat and command staff have a sense of "immersion", this study also considered a key geographical visualization and visualization and geographical environment factors such as the food engineering electromagnetic signal fusion. A picture of the real electromagnetic environment for the relevant researchers show.

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