To Go Where we Have Never Been to: 3D Real-Time Visualizatuion of Terrain Database

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Abstract. 3D visualization is important content of digital terrain information space performance. Based on high-precision bathymetric data by NOAA and high-resolution satellite image data, this paper construct the seafloor at the Mariana Trench and the lake Superior scene data model, which roaming anywhere at any angle of view in the 3D terrain scene are interactively obtained and dynamically presented the nature looking in real-time truly and intuitively using Vega-Prime system. As the benefit with using 3-D visualization technology, we can go to visit places where we have never been to.

Introduction

In recent years, with the rapid development of computer technology, especially computer graphics 3D visualization technology and virtual reality technology, the intuitive and vivid 3D terrain visualization system has become a research hot spot[1]. Compared with the characteristic 2D terrain which is monotonous and lack of intuition [2], 3D terrain can transform geographic data and its analysis results into direct visible information[3-5]. As a result, roaming anywhere at any angle of view in the 3D terrain scene are interactively obtained and dynamically presented the nature looking in real-time truly and intuitively[4, 6, 7].

Using 3D visualization technology, we can go to visit places we have never been to[8]. In this paper, we use 3D simulation technology to observe the oceanic trenches that are several kilometers deep and the terrain scenes on the beautiful Lake Superior.

Data Acquisition and Processing

Data Acquisition

Obtaining high-precision underwater terrain data is the key to constructing a high-fidelity seafloor model. The multi-beam detection technology can acquire high-precision and high-density underwater topographic point cloud data, which can accurately reflect the detailed features of underwater terrain. The bathymetric data of the Mariana Trench have be obtained by National Centers for Environmental Information (NOAA) Office of Ocean Exploration and Research (OER) using Kongsberg EM302 multi-beam survey system in May 2016. The accuracy of the constructed Grid DEM data is 0.16 arc-second (~45 meter cell size) grid.
The Great Lake Superior bathymetric data have been obtained by the program which was managed by NCEI and relied on the cooperation of NOAA/Great Lakes Environmental Research Laboratory, NOAA/National Ocean Service, the Canadian Hydrographic Service. The accuracy of the constructed Grid DEM data is 3 arc-second (~90 meter cell size) grid.

Data Processing

The visual images of seafloor and terrestrial 3D topography include two parts: underwater geomorphic image and terrestrial remote sensing image. The underwater geomorphological image can be used to represent the detailed features of the underwater targets information. The underwater DEM data can be colored according to the different depth values, and the colored texture rendering seafloor information can be used to represent the underwater geomorphic information effectively. The landform high-resolution satellite imagery have been obtained by Google-Earth (January 2019).
Construction of 3D Terrain Database

3D terrain database is constructed using the commercial modeling software Terra Vista (by Presagis Corporation), which Real-time 3D complex terrain database generation tool system software based on Windows platform, specially designed to process high-precision large-area terrain data, support multiple data format import and output in multiple database formats.

The DEM format terrain files and texture images are converted into the virtual simulation standard format Open-Flight format database model. The real-time visual simulation software Vega Prime (by MPI Corporation) is used to realize the visualization and roaming of 3D terrain scene. The workflow is as follows:

Key Technologies

The key to constructing the database of 3D terrain scenes is how to rationally optimize the terrain model and data organization structure and reduce the complexity of the scene. The geometric model with different approximation accuracy is built for each original polyhedral model based on the distance between the viewpoint and the object. Smooth transition technology automatically selects the detailed level model to be displayed based on distance and reduces the geometric complexity of the scene. In real-time roaming of terrain scenes, virtual texture mapping techniques are used to select the appropriate exact virtual texture to map to the corresponding terrain grid based on the location of the viewpoint.
Terrain Blocks and LOD Setting

Firstly a suitable grid structure and terrain block design should be developed. Secondly setting different levels of LOD, and improving the terrain height by optimizing different levels of LOD. When processing texture data, the virtual texture data set is cut and generated according to different LOD levels, and a virtual texture grid stack with different hierarchical resolutions are generated to ensure a visual seamless transition of different resolution images in the virtual scene display.

![Image](image1.png)

Figure 6. Construction of Grid blocks and LOD setting of 3D terrain scene Database.

Real-time View Display of Terrain Scene

The scene management of the terrain scene database was realized by importing the database model of the Open-Flight format into the real-time visual simulation software Vega Prime.

Real-time control roaming can be realized by the VP Motion module. Controlling the changes of environmental elements such as illumination, cloud layer and wind speed over time can be realized by the ENV module. The water surface effect can be realized by the VP Marine module, and the interactive display of illumination and water objects can be realized to present natural looking of the environment.

Now we have the opportunity to see the 3D scene of oceanic trench seafloor and the beautiful Lake Superior.

![Image](image2.png)

Figure 7. 3D terrain Visualization of the lake Superior.
Conclusion

Based on high-precision bathymetric data and terrestrial high-resolution satellite image data, this paper construct the seafloor at the Mariana Trench and the lake Superior scene data model. Roaming anywhere at any angle of view in the 3D terrain scene are interactively obtained and dynamically presented the nature looking in real-time truly and intuitively using Vega-Prime system. Using 3-D visualization technology, we can go to visit places where we have never been to. The system is a useful attempt to apply virtual reality technology to landscape tourism.

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