3D visual analysis of seabed on smartphone

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1 Introduction

'Digital Seabed', as a hotspot of the marine information technology, has become a hot subject in the field of marine exploration for various tools for research or commerce. Besides, with the development of marine information technology, multi-dimensional dynamic visualization of the water environment data becomes a hotspot in marine research, which is mainly reflected in simulation and emulation of the information on water environmental elements including sea temperature, ocean current salinity and seawater density. An exploratory research about 3D ocean current model rendering and multi-touch interaction [3] was conducted early. The visualized analysis based on the time-space characteristic of marine environment data has been already implemented on web context [12]. The integrated virtual reality system of marine environment has been utilized for geospatial analysis on high-performance computer [5]. However, all of current related systems are dependent on the high performance computer, since they are using complexity algorithms to realize a realistic virtual-seabed.

2 Approach and Results

Our aim, instead of just building a virtual environment replicating the seabed, is to create a ubiquitous platform which can collect data of the variance of strata beneath the seabed, and then find efficient approaches (i.e. analysis and visualization) to use and display that information for various phenomena. The core data structure is so-called 'section-drilling' model, which is based on the features of the comprehensive data from multiple sources under the seabed. The complete description of 'section-drilling' model is introduced at [11]. Based on the core algorithm, a component is extended to smartphone ubiquitous context, the mobile prototype has been presented at Siggraph Asia 2014 [9]. Our cooperative network architecture supports the data flow [8], which is based on WebVR engine [10].

On smartphone browser, an application based on the 'section-drilling' model demonstrate its omnipresent feature. The consequent '3D Seabed' is applied to fields like simulation, visualization, and analysis; a set of interlinked, real-time layers that capture the information about the 3D Seabed, as well as its analysis result, help to accomplish that. Comparing to our previous work, this paper extends the seabed terrain to water body and water temperature visualization.

The grid-like figure in Figure 2 is built by delaunay triangulation algorithm. The converted coordinate sequence has hierarchical information. The fence diagram is obtained by hierarchical rendering of strata according to the survey line. The horizon diagram is obtained by triangular processing of discrete peaks in the same stratum. The sidescan sonar image and multibeam fusion renderings function employed the undersea canyon area data to present, as shown in Figure 3. The oil spilling dynamic visualization in Figure 5 right is implemented by 3D dynamic particle system.

In addition, some visual analysis methods have been implemented and worked on desktop computer smoothly, but haven’t...
has been ported to mobile device yet. Nonetheless, all the algorithms are designed taking into account computational efficiency on ubiquitous context. As shown in Figure 4 left, the sectional temperature map and marine water temperature field internal profile are visualized by volume rendering based on 3D texture. The transparency of invalid data point is set as 0 by adding judgment identification. Moreover, the internal section of parameter rendering volume is rendered through setting volume. The marine water environmental temperature Isosurface in Figure 4 right is rendered by improved Marching Cubes algorithm. To improve the drawing quality, the normal vector of triangular mesh on the contour surface is obtained based on the estimation method of the gradient normal vector, so as to realize the smoothness of the contour surface.

The client is wrapped into a component extending to smartphone ubiquitous context. The component is implemented in C++, Java with Android SDK/NDK, the 3D rendering tasks were realized using OpenGL ES.

3 CONCLUSIONS

Agreed as being both directly useful and generally extendable for future applications, the mature criterion application is a beneficial tool for the scientists and public for browsing and analyzing the information from the seabed intuitively. Three-dimensional or multi-dimensional visualization of spatial information is a popular and tough topic. The spatial model and criterion application, the topic of this paper, are still under discussion and remain a primary research. Many key problems, for example, the visualization of dynamic data reflecting the particular geological phenomenon indicating faults and folds, still need to be researched and worked out in the future. We believe there remains more value for a broader field, especially in a utility seabed monitoring device that provides unremitting multi-source and multi-dimensional synthesis of virtual and ubiquitous applications. In our future work, in order to improve the system performance, abstract visualization approach [14] is considered to represent the ocean current data. To enhance the flexibility of user-and-system interaction, a novel touch-less technology is considered as the input method [6]. Beside scientific field, we plan to perform a virtual seabed community project based on this framework [7] in civil field, as a rich mobile application [13], to provide a intuitive and usable communication tool for ocean field experts.

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