Available online at www.sciencedirect.com

ScienceDirect

Procedia Computer Science 154 (2019) 556–560

Procedia Computer Science

www.elsevier.com/locate/procedia

8th International Congress of Information and Communication Technology, ICICT 2019

The Development of Hainan Provincial Digital Ocean Environment Parameters Three-dimensional Visualization System

Lei Wang[a,b,*]

[A] *Aerospace Information Research Institute, Chinese Academy of Sciences, Beijing 100094, China*
[b] *Key Laboratory of Earth Observation of Hainan Province, Sanya Institute of Remote Sensing, Sanya, Hainan Province 572029, China*

Abstract

Hainan Province has the largest ocean areas in China. After decades of efforts, it has accumulated abundant marine basic data, and has built various types, different topics and large-scale marine databases. The construction of Hainan provincial digital ocean environment parameters 3D visualization system can effectively integrate, utilize and share these marine information resources, and support marine management and marine ecological environment protection. The multi-dimensional dynamic visualization of information can provide scientific and effective tools for comprehensive marine management and macro-decision-making in a timely and accurate manner.

This paper introduces a digital ocean environment parameters three-dimensional (3D) visualization system based on digital earth sphere model suitable for marine environment parameters three-dimensional visualization display, studies the key technologies of multi-dimensional marine environment parameters visualization based on basic geographic data and remote sensing images, which integrated high-precision Digital Elevation Model (DEM) and satellite images to realize the three-dimensional integration and visualization of marine environmental parameters in the South China Sea, providing data display, multi-temporal dimension comparison and spatial overlay analysis. The functions of statistics and data management provide interactive information services for integrated marine management and decision-making support.

* Corresponding author. Tel.: 86-898-88597739; fax: 86-898-88597739
*E-mail address:*wanglei98@radi.ac.cn

1877-0509
10.1016/j.procs.2019.06.088

*Keywords :*Digital Ocean, 3D visualization

1. Introduction

Since Hainan Province has around 200 square kilometres ocean areas, after decades of efforts, it has accumulated abundant marine basic data, and has built various types, different topics and large-scale marine databases. Hainan provincial digital ocean environment 3D visualization system can effectively integrate, utilize and share marine information resources to support decision-making support and public information services. The multi-dimensional dynamic visualization of information can provide scientific and effective tools for comprehensive marine management and macro-decision-making in a timely and accurate manner.

There are lots of studies on and Digital Ocean (1--9), however, few studies were focus on province or city level. This paper introduces a provincial level digital ocean environment 3D visualization system based on digital earth sphere model suitable for integration of marine environment parameters and three-dimensional visualization display. The key technologies of multi-dimensional marine environment parameters visualization based on basic geographic data and remote sensing images, which integrated high-precision DEM (Digital Elevation Model) and satellite images to realize the three-dimensional integration and visualization of marine environmental parameters in the South China Sea on the digital earth sphere model, providing data display, multi-temporal dimension comparison and spatial overlay analysis. The functions of statistics and data management provide interactive information services for integrated marine management and decision-making support.

2. System Design

2.1. System architecture

The ocean environment parameters 3D visualization system has a multi-tier architecture consisting of presentation, business logic, and data tiers. Fig. 1 provides an overview of system architecture. The presentation tier is the interface for users to submit requests or used as the system client viewer for accessing 3D ocean environment visualization information. The business tier copes with the requests from the presentation tier, which includes ocean information 3D visualization model and ocean information services. The data tier includes basic geographic database, remote sensing image database, ocean basic geographic database and 3D ocean environment parameters database etc.

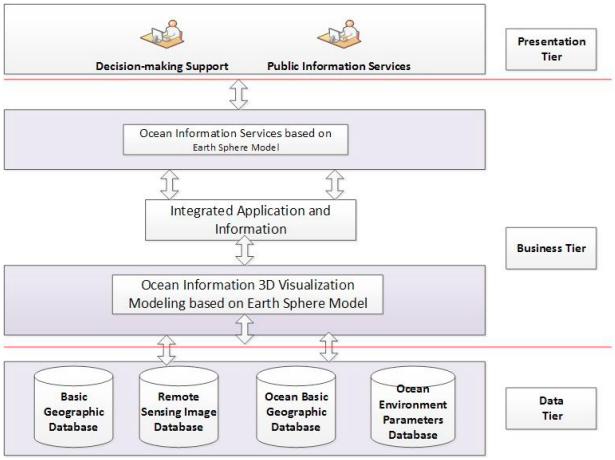

Fig. 1. System architecture

2.2. System software architecture

The system has a C/S architecture. The logical analysis layer of the system consists of GIS function module, terrain field module, 3D modeling and integration module and data publication module. Each module is interdependent and closely related. The system software architecture is shown in Fig.2.

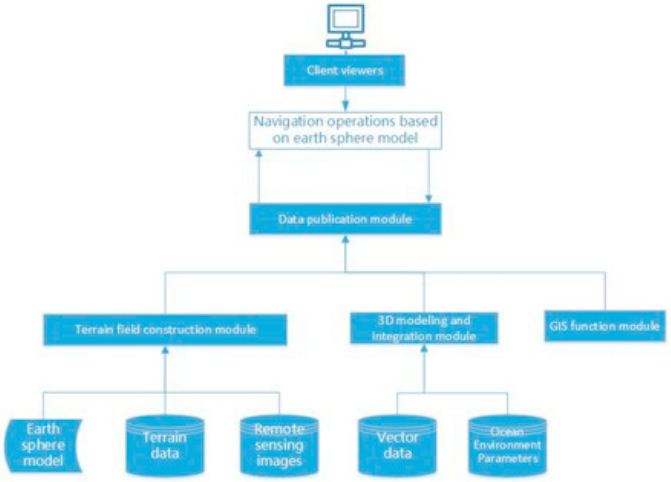

Fig. 2. System software architecture

2.3. System Functionality

Monthly average and yearly average of 6 ocean environment parameters such as sea surface chlorophyll concentration, sea surface current field (vector), sea surface salinity, sea surface temperature, sea surface wind field (vector) and effective wave height, were showed on the 3D visualization model based on earth sphere model with the help of the key techniques developed such as 3-D visualization and multi-layer, multi-time information visualization (Fig. 3.). With the help of navigation operations such as rotation, pan, zoom in and zoom out, spatial query and attribute query, the 3D visualization system will be a very useful tool to support marine management, marine ecological environment protection and governance, marine use and marine function zoning, providing data display, multi-temporal dimension comparison and spatial overlay analysis. The functions of statistics and data management provide interactive information services for integrated marine management and decision-making support.

3. System Development

The Skyline software is used to implement the Hainan provincial digital ocean environment parameters 3D visualization system. The technical realizations are explained as followings: firstly, the earth sphere model is established; secondly, the Digital Orthophoto Maps (DOM) is fused with DEM to create real 3D terrain model by project transformation, geometric transformation (including pan, rotation, zoom in and zoom out etc.) and texture mapping using DirectX; then through the overlay of vector data with DEM and integration of ocean environment parameters models with terrain model to implement 3D visualization model. Fourthly, navigation operations such as rotation, pan, zoom in and zoom out, and spatial query are implemented by using free Active X in client side. Finally, a tool is developed to publish the terrain field data for client view.

The construction of 3D visualization system includes the following 5 steps,

(1)The modeling of earth sphere

The modeling of earth sphere includes 3 steps, including the establishment of earth sphere model, the calculation of sphere parameter, and sphere surface grid generation.

(2)The construction of terrain field

The data used in this system include terrain data, remote sensing images, and texture data etc. The construction of terrain field means integration, merging, and overlay of remote sensing images, texture and DEM data to implement 3D visualization model based on earth sphere model and exporting to terrain field files.

(3)Vector data overlay and visualization.

The vector data used in this system include basic geographic data (administrative boundary, river, water course and road) consisting of line and polygon, all of these data need to be integrated in this system. Vector data overlay and visualization mean the overlay of these vector data into 3D terrain field based on earth sphere model and exporting to vector field files.

(4) Ocean environment parameters 3D modeling and integration

The ocean environment parameters 3D models consist of monthly average and yearly average of 6 ocean environment parameters models such as sea surface chlorophyll concentration, sea surface current field (vector), sea surface salinity, sea surface temperature, sea surface wind field (vector) and effective wave height. 3D modeling and integration mean ocean environment parameters modeling and overlay these models into vector data and 3D terrain field to implement 3D visualization model. There are two ways of modeling: one is modeling using 3D modeling software such as 3dMax, another is modeling in vector and terrain fields based on earth sphere model.

(5) Navigation operations based on earth sphere model

The navigation operations based on earth sphere model include rolling, zoom in, zoom out, pan, attribute queries, length and area measure etc., which are the base of sphere operation.

(6) Publishing of field data

The publishing of field data includes publishing of terrain field, vector field and model field data. When these field data are published, users in the client side could select any of vector field and model field data and load them into terrain field. Among them, a tool need to be developed to publish the terrain field data and Internet Information Services (IIS) could be used to publish the vector field and model field data.

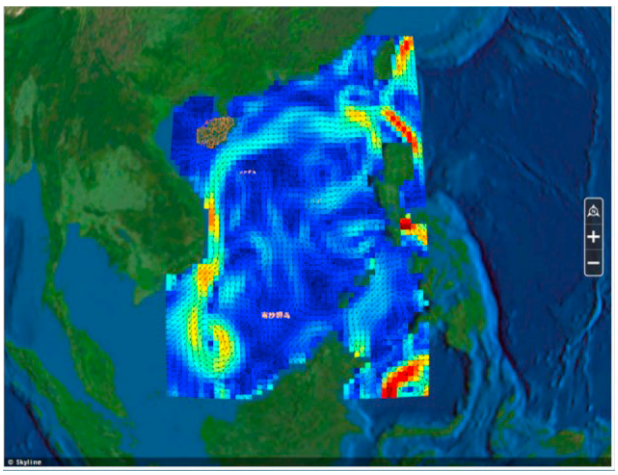

Fig. 3. Sea surface current field (vector) 3D visualization on digital earth sphere model .

Acknowledgement

The author expresses the appreciation of funds supported by Hainan Provincial major science and technology projects (#ZDKJ2017009&#ZDKJ2016015)

References

1. Chen S P and Genderen J 2008 Digital earth in support of global change research. International Journal of Digital Earth, 1(1): 43–65
2. Goodchild M F 2008 The use cases of digital earth. International Journal of Digital Earth, 1(1): 31–42
3. Guo H D, Liu Z and Zhu L W 2010 Digital Earth: decadal experiences and some thoughts. International Journal of Digital Earth, 3(1): 31–46
4. Hou W F 1999 Tentative idea for development of "Digital Ocean". Aviso of Ocean, 18(6): 1–10
5. Su F Z, Du Y Y and Pei X B 2006 Constructing digital sea of China with the datum of coastal line. Geo-Information Science, 8(1): 12–15
6. Zhang X, Dong W, Li S, Luo J, Chi T 2011 China Digital Ocean Prototype System. International Journal of Digital Earth 4 (3):211-222
7. Dong W, Zhang X, Jiang, B 2010 "Service-based distributed data management and application in China Digital Ocean", Geoscience and Remote Sensing Symposium (IGARSS) 2010 IEEE International, pp. 425-428
8. Patrikalakis N M, Abrams S L, Bellingham J G, Cho W, Mihanetzis K P, Robinson A R, Schmidt, H and Wariyapola P C H 2000 The Digital Ocean. In Proceedings of Computer Graphics International GCI '2000 IEEE Computer Society Press Los Alamitos
9.Zhang X, Wang L, Jiang X, Zhu C (eds) 2017 Modeling with Digital Ocean and Digital Coast. Coastal Research Library, vol 18. Springer, Cham