Journal of Coastal Research	SI	103	530–534	Coconut Creek, Florida	2020

Marine Environmental Monitoring Data Based on Information Visualization

Junhan Li*

School of AI and Big Data
Chongqing College of Electronic Engineering
Chongqing 401331, China

www.cerf-jcr.org

www.JCRonline.org

ABSTRACT

Li, J., 2020. Marine environmental monitoring data based on information visualization. *In*: Yang, Y.; Mi, C.; Zhao, L., and Lam, S. (eds.), *Global Topics and New Trends in Coastal Research: Port, Coastal and Ocean Engineering*. *Journal of Coastal Research*, Special Issue No. 103, pp. 530–534. Coconut Creek (Florida), ISSN 0749-0208.

When the current method was used to analyze the marine environmental monitoring data, it was time-consuming, and the error of analysis results was too large, leading to low efficiency of data collection and low accuracy of data analysis. Therefore, an analysis method of marine environment monitoring data based on information visualization was put forward. The application portal layer, visualization service layer, grid middleware layer and visualization resource layer were used to build the monitoring platform architecture. The monitoring for marine environment data was realized through the grid platform implementation mechanism, information sharing service and visualization service. Through the evaluation equation, thematic map and evaluation report, the marine environmental monitoring data was analyzed. Experimental results show that the proposed method has high efficiency in data acquisition and high accuracy in data analysis.

ADDITIONAL INDEX WORDS: *Information visualization, marine environment, monitoring data, data analysis.*

INTRODUCTION

The coverage rate of global ocean is more than 2/3. The ocean contains rich resources. The development of marine resources is the most important task for all countries (Guo *et al*., 2016). Scientific and rational utilization for marine resources is an effective way to solve the problem of resource scarcity, environmental degradation and population expansion. The marine environment monitoring control methods are very complex. The cost is very high. How to use these marine environmental monitoring data with high value reasonably has become the most important work when people study the marine environment (Liao *et al*., 2016). Digital ocean refers to the information processing method for various marine phenomena, monitoring data and other marine attributes by means of digitalization and information technology according to time and space scales. In above contexts, the analysis method of marine environmental monitoring data has become a research hotspot (Chen and Zhao, 2016). At present, the analysis method of marine environmental monitoring data has the problems about low efficiency of data collection and low accuracy of data analysis, so it is necessary to study the analysis method of marine environmental monitoring data (Li, Chen, and Yang, 2016).

Liu Xueqin, Yuan Shuai and Shi Wenqi put forward the method of analyzing the data of marine environment monitoring based on optical video. This method analyzed the advantages of optical video in the specific small area of sea surface monitoring and preliminarily designed the marine environment monitoring and analysis system, so as to realize the analysis on the marine environment monitoring data. This method had the problem about low efficiency of data collection (Liu *et al*., 2017). Song Lili, Kang Linchong and Wang Yi proposed a method to analyze marine monitoring data based on B/S, which solved the problems of marine environment data organization and management, data service release and visual expression, but the error of data analysis results obtained by this method was large, leading to low accuracy of data analysis (Song *et al*., 2016). Wang Ming, Jing Jianen and Deng Ming put forward the analysis method of marine environmental monitoring data based on VS2012. This method simplified the development difficulty by STL standard template library and introduced multi-threaded technology to improve the processing efficiency, and thus to analyze the marine environmental monitoring data. The analysis results obtained by this method were not accurate (Wang *et al*., 2016b). In order to solve the problems in above methods, a method of analyzing the marine environmental monitoring data based on information visualization was proposed.

MATERIAL AND METHODS

Grid portal is the interface for users to access the grid system. It provides an operation interface for users to customize the services provided by the grid system, submit grid application tasks and obtain the execution results of tasks (Ding, Zhang, and Liu, 2017). It is responsible for building a grid platform to gather massive network resources and thus to realize the management of grid

DOI: 10.2112/SI103-107.1 received 10 July 2019; accepted in revision 16 January 2020.
*Corresponding author: lijunhan84@sina.com

resources and visualization tasks. Finally, the interactive remote visualization service is provided to end users through grid portal (Yu, Li, and Tao, 2016).

Information Sharing Service

The information sharing service realizes the real-time/delay transmission and data format conversion of marine information resources among related nodes in network. Meanwhile, it has the functions of synchronous/asynchronous data update and data flow transmission monitoring control. The information sharing service architecture includes the data transmission, data acquisition/push, data format conversion, data update and data transmission monitoring control module. The data format conversion includes two sub modules: the metadata conversion rule base and conversion service group, and the conversion adapter. The data update includes three services: the data synchronous update service between marine real-time information databases, the data asynchronous update service between marine delay information databases and the data update service between business systems and databases (Liu *et al*., 2018).

Visualization Service

The visualization service on grid platform can effectively utilize massive resource in network, and realize the visualization of large-scale datasets through parallel mechanism (Sun, 2017). According to the application requirements of marine environment information visualization, it is necessary to obtain the visualization resources and divide the visualization tasks, so as to complete the parallel visualization tasks and remote access.

Execution process of visualization task: the message transmission and data transmission in parallel visualization is realized by customizing the underlying network communication mechanism, with high efficiency (Wang *et al*., 2016a). In the parallel visualization algorithm, aiming at the visualization of ocean flow field, a parallel topological simplification algorithm of plane flow field based on physical features is proposed, which has high efficiency and strong scalability. New volume rendering algorithms and parallel volume rendering strategies can be easily added to the framework.

Task management module is responsible for grid resource matching, visual task scheduling, visual task segmentation and task merging, so it is the workflow engine of visual services. The processing flow is shown in Figure 1.

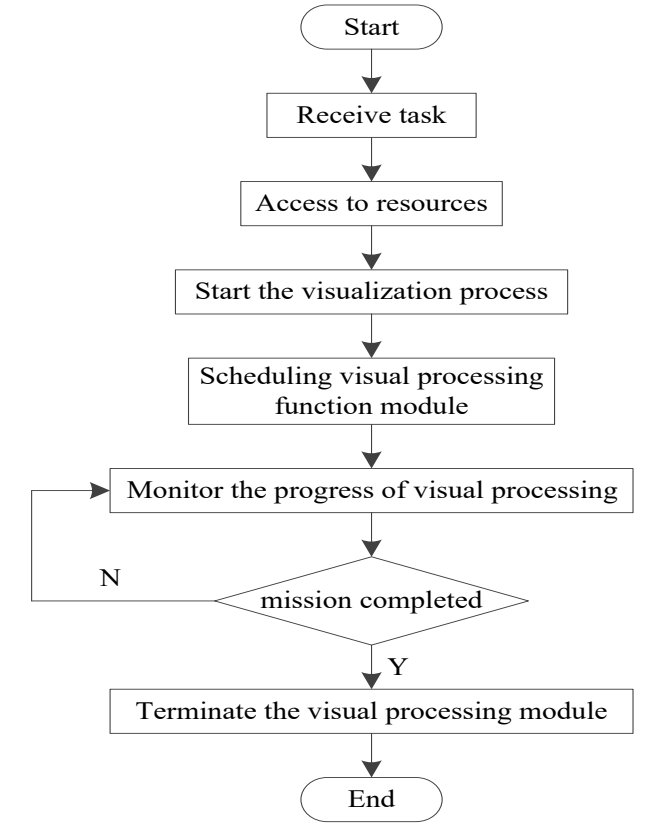

Figure 1. Flowchart of task management module.

RESULTS AND DISCUSSION

Evaluation Equation

The evaluation equation is the core of marine environment analysis and evaluation, whose input is generally the monitoring data and evaluation criteria, and output is the evaluation result. However, there are many cases of nested calling equation in the calculation. For example, the input of comprehensive evaluation method of sewage outfall is not the monitoring data, but it is the calculation result depending on other evaluation methods. In order to obtain the comprehensive evaluation result, it is necessary to substitute the calculation results of other evaluation methods as input into the equation of comprehensive evaluation. The proposed method defines these kinds of equations as the nested equations, which defines such calls as the nested call. All these things need the automatization.

The single factor evaluation method is to evaluate the pollutants one by one through the off-shore sewage outfall, and get the pollution index of each pollutant, and then obtain the excessive pollutants in sewage.

The equation of calculating pollution index is:

$$P_i = \frac{C_i}{S_i} \tag{1}$$

In the Equation (1), P_i is the pollution index of pollutant i; C_i is the concentration of pollutant i; S_i is the emission standard of pollutant i.

The equation of calculating pH pollution index is:

$$P_{pH} = \frac{pH}{pH_{sd}} \tag{2}$$

$$P_{pH} = \frac{pH - 7.0}{pH_{su} - 7.0} \tag{3}$$

In the Equation (2), P_{pH} is the pollution index of pH; pH_{sd} is the lower limit of pH standard value; pH_{su} is the upper limit of pH standard value.

It mainly depends on the relationship between pollution index and 1. If it is greater than 1, this pollution factor is considered as the excessive pollutant at the current outlet.

Thematic Map and Description of Evaluation Report

(1) Thematic Map

According to data and analysis evaluation results, the thematic map contains two types: thematic maps based on map and thematic maps not based on map. Finally, the generated map will be imported into the analysis and evaluation report based on the monitoring.

(2) Evaluation Report

Generally, the evaluation report is in word format. It summarizes the conclusions obtained by a series of analysis and evaluation methods into an evaluation report. The content of report can be divided into three categories: thematic map, table and descriptive text (Wang *et al*., 2019). From the content source, it can also be divided into dynamic content and static content. The static content is also called template content, and dynamic content needs to be analyzed and calculated. The evaluation report can be divided into monthly report, quarterly report and annual report according to the frequency. The number of pages varies from several to dozens.

Research on Automatic Spatiotemporal Analysis and Evaluation

(1) Storage and Call of Evaluation Standards

Through the above analysis on evaluation criteria, after considering the common and special conditions of evaluation criteria, the storage structure of evaluation criteria is designed based on five attributes of evaluation criteria, namely, the standard name, standard classification, element name, element unit and element value.

According to the actual analysis of evaluation business, the evaluation standard is called based on monitoring station or sewage outfall. Therefore, the standard configuration fields of monitoring station and sewage outfall information are designed. If it is not modified, the standard of the last configuration will be used automatically next time. The standard of sewage outfall can be configured by the name of sewage outfall. In general, the monitoring region is determined at first, and the unified evaluation standard is adopted in a certain area.

(2) Storage and Driving of Evaluation Equation

The evaluation equation is called by the evaluation method. According to its corresponding relationship, the storage structure is designed by three levels: evaluation method, analysis item and evaluation equation. For example, the single factor evaluation method is based on single factor, and the analysis item is the single factor evaluation of one pollutant, and evaluation equation is an abstract logical expression. The logical variables can be combined with the actual business variables through the evaluation equation configuration.

According to the storage design of evaluation equation, before executing the evaluation equation, the user needs to select the evaluation method and then input the monitoring data and evaluation criteria. The system automatically calls out all the analysis items under the evaluation method (Gu *et al*., 2019). After the evaluation equation drives the process, the system begins to analyze and calculate the analysis items one by one. If the nested call is encountered, the recursion will be adopted until all the analysis items are calculated. Finally, the calculation of evaluation method is completed.

(3) Automatic Production of Thematic Map

The thematic map making is completed through the interaction of front end and back end. The data required for thematic map is calculated in the back end of server, and the rendering and generation of thematic map are completed in the front end of browser. The thematic map making is generally carried out in two links. The first link is carried out when the single evaluation method calls. The second link is carried put in the process of evaluation report generation.

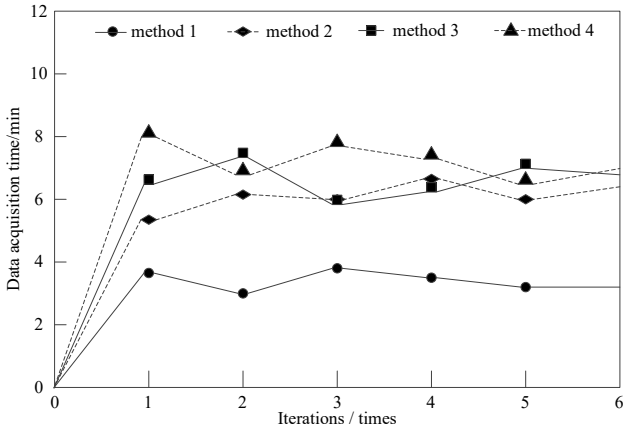

Figure 2. Data acquisition time of different methods.

(4) Automatic and Dynamic Generation of Evaluation Report

The evaluation report needs to be generated in the browser front end and the server background respectively. The purpose of generating the evaluation report in the front end is to achieve the dynamic effect of evaluation report, so that the user can watch the real-time status of the evaluation report generation. The purpose of generating the evaluation report in the background is to generate the evaluation report with Word format, so that the user can edit or publish the evaluation report. The most important data needed for evaluation report is calculated in the background and stored in the database according to the structure of key value pairs. After the background generation is completed, the front end can obtain the key value of data and generate the analysis and evaluation report dynamically.

In order to verify the effectiveness of the method of analyzing marine environmental monitoring data based on information visualization, it is necessary to test the method. The operating system is Windows, and the software environment is NET FRAMEWORK 3.5. The analysis method of marine environmental monitoring data based on information visualization (Gu *et al*., 2017a), the analysis method of marine environmental monitoring data based on optical video, the analysis method of marine monitoring data based on B/S and the analysis method of marine environmental monitoring data based on metadata were adopted to compare the time taken by different methods. The test results are shown in Figure 2.

Figure 2 shows that the data acquisition time of the method based on information visualization is less than that of the method based on optical video, the method based on B/S and the method based on metadata. Because the analysis method of marine environmental monitoring data based on information visualization realized the information sharing service through four modules: sharing service module, data acquisition module, metadata management module and basic module, which shortened the time of acquiring marine environmental monitoring data (Gu *et al*., 2017b). Thus, the data collection efficiency of the marine environment monitoring data analysis method based on information visualization was improved.

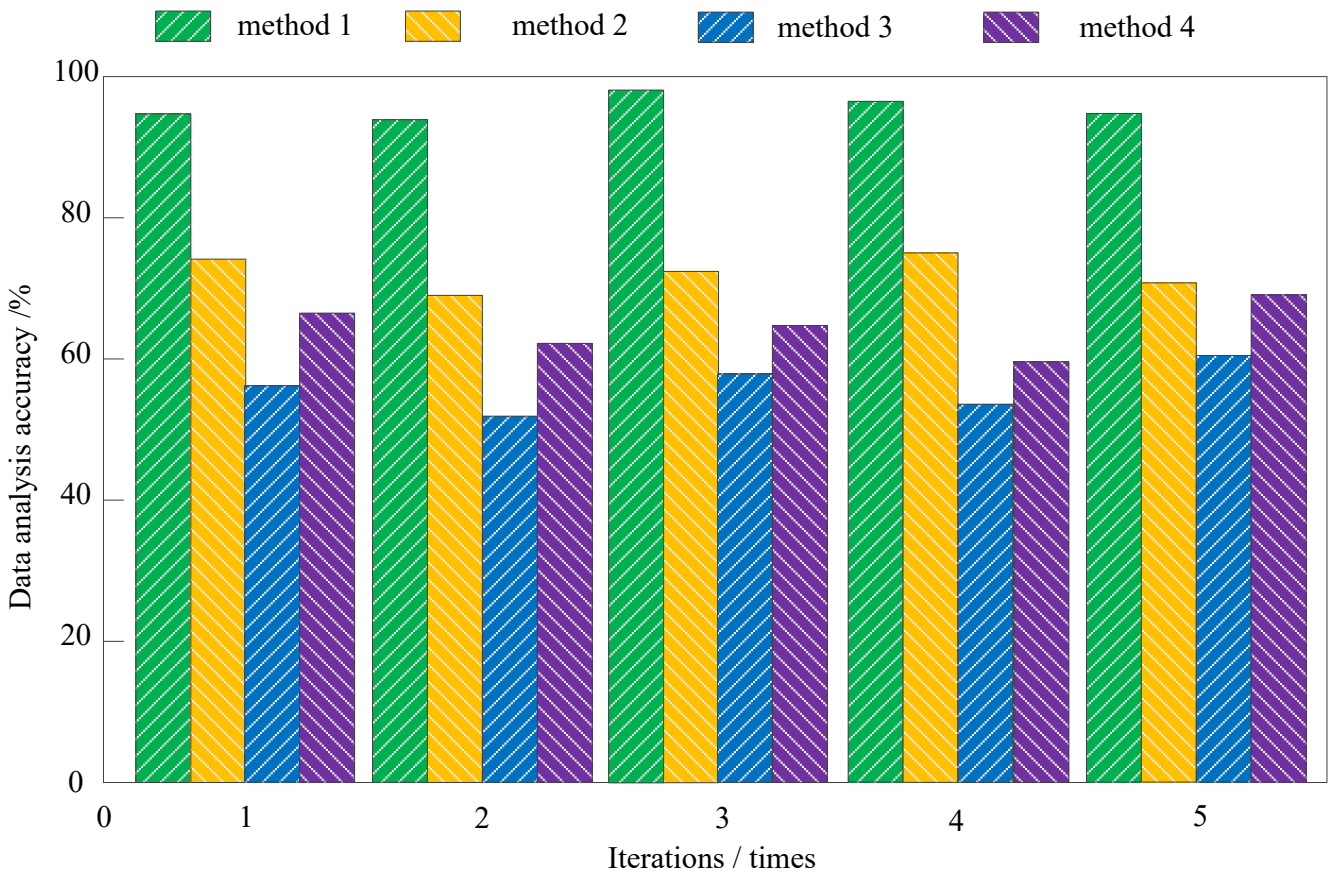

Figure 3. Data analysis accuracy of different methods.

The analysis method of marine environmental monitoring data based on information visualization, the analysis method of marine environmental monitoring data based on optical video, the analysis method of marine monitoring data based on B/S and the analysis method of marine environmental monitoring data based on metadata were adopted to test and compare the data analysis accuracies of different methods. The test results are shown in Figure 3.

Figure 3 shows that the data analysis accuracy of the marine environmental monitoring data analysis method based on information visualization in multiple iterations was higher than that of the analysis method of marine environmental monitoring data based on optical video, the analysis method of marine monitoring data based on B/S and the analysis method of marine environmental monitoring data based on metadata. Because the marine environmental monitoring data analysis method based on information visualization realized the analysis of marine environmental monitoring data by evaluating equation, making thematic map and generating evaluation report. Thus, the analysis accuracy of the analysis method of marine environmental monitoring data based on information visualization was improved.

CONCLUSION

The 21st century belongs to the ocean. With the continuous development of ocean technology, more and more ocean data are obtained by advanced ocean exploration technology. How to use ocean data effectively to get ocean phenomena and motion laws has become an important part of ocean research. At present, the data analysis methods of marine environmental monitoring lead to low efficiency and low accuracy in data collection. This article puts forward a method to analyze the marine environmental monitoring data based on information visualization, which can collect marine environmental data in a short time and realize the analysis of marine environmental monitoring data with high accuracy. The proposed method solves the problems in current methods, and lay a foundation for marine environmental monitoring.

LITERATURE CITED

Chen, C. and Zhao, S.H., 2016. Drought monitoring and analysis of Huanghuai Hai Plain based on TRMM precipitation data. *Remote Sensing for Land & Resources*, 28(1), 122-129.

Ding, M.; Zhang, M., and Liu, B., 2017. Design and application of lightning visualization based on android mobile device. *Meteorological Science and Technology*, 45(6), 1125-1128.

Gu, F.; Guo, J.; Yao, X.; Summers, P.; Widijatmoko, S., and Hall, P., 2017a. An investigation of the current status of recycling spent lithium-ion batteries from consumer electronics in China. *Journal of Cleaner Production*, 161, 765-780.

Gu, F.; Guo, J.; Zhang, W.; Summers, P., and Hall, P., 2017b. From waste plastics to industrial raw materials: A life cycle assessment of mechanical plastic recycling practice based on a real-world case study. *Science of the Total Environment*, 601, 1192-1207.

Gu, F.; Zhang, W.; Guo, J., and Hall, P., 2019. Exploring "Internet plus Recycling": Mass balance and life cycle assessment of a waste management system associated with a mobile application. *Science of the Total Environment*, 649, 172-185.

Guo, G.G.; Fan, W.; Zhang, S.M.; Zheng, Q.L., and Wang, X.X., 2016. Advances in mining and application of vessel monitoring system data. *Marine Fisheries*, 38(2), 217-224.

Li, M.; Chen, W.Z., and Yang, J.P., 2016. An analysis method for the online monitoring data of tunnel structure. *Rock and Soil Mechanics*, 37(4), 1208-1216.

Liao, G.X.; Dai, L.L.; Lu, W.Z.; Ye, J.Q., and Liu, C.A., 2016. Risk analysis of marine oil spill pollution using a stochastic simulation approach: A case study of Binzhou chenier plain and national wetland nature reserve. *Marine Science Bulletin*, 35(4), 467-479.

Liu, W.Q.; Yang, J.W.; Gui, H.Q.; Xie, P.H.; Liu, R., and Wei, J.J., 2018. Study on the development of multi perception system for "Internet Plus" smart environmental protection. *Engineering Science*, 20(2), 111-119.

Liu, X.Q.; Yuan, S.; Shi, W.Q.; Wang, X.; Xu, N.; Chen, Y., and Chen, W.B., 2017. Design of the video-based monitoring and analysis system of sea ice to nuclear power projects in sea ice region. *Marine Environmental Science*, 36(5), 791-795.

Song, L.L.; Kang, L.C.; Wang, Y.; He, L., and Xin, B., 2016. Visualization and service of marine environmental data based on B/S. *Marine Science*s, 40(7), 124-131.

Sun, X.B., 2017. Design of environment monitoring system for underground coalmining face based on EZMac protocol. *Coal Engineering*, 49(3), 15-8.

Wang, H.; Li, H.; Yin, W.Q.; Li, Y.W.; Qian, Y., and Hu, F., 2016a. Remote monitoring system for henhouse environment based on wireless transmission. *Journal of Nanjing Agricultural University*, 39(01), 175-182.

Wang, M.; Jing, J.E.; Deng, M.; Li, Y., and Li, S.Q., 2016b. Development of visualized software for data preprocessing of marine controlled-source electromagnetic method. *Progress in Geophysics*, 31(4), 1845-1851.

Wang, M.; Zhang, D.; Cheng, Y., and Tan, S.K., 2019. Assessing performance of porous pavements and bioretention cells for stormwater management in response to probable climatic changes. *Journal of Environmental Management*, 243, 157-167.

Yu, H.B.; Li, J.H., and Tao, B.R., 2016. Research on greenhouse environmental monitoring system based on Beidou satellite system. *Jiangsu Agricultural Sciences*, 44(08), 398-402.