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Marine Engineering Safety Monitoring under Cloud Computing Environment

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Abstract: With the increasing pace of ocean development, today's monitoring and alarm systems for marine engineering projects have been paid more and more attention by people. The purpose of this paper is to study marine engineering safety monitoring based on cloud computing environment. Complete the research and implementation of cloud monitoring technology, apply cloud computing technology to the monitoring field in the offshore underwater detection platform, and develop a cloud monitoring system based on the cloud platform. Thereby, the shortcomings left by the traditional monitoring system of the offshore underwater detection platform are solved, so that the entire cloud monitoring system can perform real-time monitoring of data anytime, anywhere. The application of this technology is verified on the basis of 120GB data volume. The experimental results meet the expectations in advance, and at the same time, the value of marine data can be fully exerted, which provides an important reference for marine engineering construction and promotes social economy. develop.

1. Introduction

The ocean covers three quarters of the earth's surface, and the ocean contains a large amount of oil and gas, which has become one of the most important energy sources for human beings [1-2]. With the in-depth development and development of offshore oil and gas resources, the functions of new marine technology equipment are increasing, and infrastructure such as offshore operations and large buildings with a service life of decades may occur due to the deterioration of the marine environment. Aging and other risk accidents [3-4].

For these possible disasters and potential dangers, experts put forward the concept of safety monitoring, and a scholar proposed the monitoring and evaluation system design of data flow, system function and database. A set of subsystems, including experimental model subsystem, data exchange subsystem, data query subsystem and safety assessment subsystem, are developed for seismic response experiments of free-span submarine pipelines. The basic functions of the submarine pipeline health monitoring and safety assessment system have been initially realized [5]. Others describe a simulation-based monitoring and diagnostic approach to overcome the lack of data. The frigate propulsion system model has been used to generate a database of different failure conditions in the plant. Monitoring and diagnostic systems based on Mahalanobis distance and artificial neural networks have been developed. Experimental data measured during sea trials have been used for model calibration and validation. Test runs of this procedure have been carried out on a number of simulated degradation cases: in all considered cases, the developed model has successfully detected failures [6]. As the number of crews on ships at sea decreases to reduce operating costs, ship operators are increasingly relying on advanced monitoring systems to ensure the proper functioning of onboard equipment. The Non-Intrusive Load Monitor (NILM) is an inexpensive, powerful, and easy-to-install system for this task. Lindahl P A proposes a NILM-based framework to perform fault detection and isolation, with particular emphasis on systems employing closed-loop hysteretic control. Such controllers can mask component failures, ultimately leading to destructive system failures. The NILM system uses neural networks to perform load decomposition and compute operational metrics related to machine health [7]. Therefore, it is very important to study the safety monitoring of marine engineering.

Based on the in-depth study of sensor technology and cloud service technology, this paper studies the marine engineering safety monitoring system, and proposes to reintegrate the existing software and hardware resources to establish a dynamic information service model based on the Alibaba Cloud platform. Finally, it is of great significance for the realization of the marine engineering safety monitoring system in the cloud computing environment to use the system analysis to calculate the return period extreme value of the significant wave height.

2. Research on Marine Engineering Safety Monitoring under Cloud Computing Environment

2.1. Sensors

In order to realize long-term real-time online monitoring of marine engineering, the requirements for sensor technology as the core of the entire sensing system are very high [8-9]. However, for many sensors such as resistance strain gauges, due to the existence of zero drift, they cannot theoretically meet the needs of long-term monitoring, and the strain information can best reflect the load response of engineering structures [10-11].

In this paper, the following sensors are installed: displacement sensor (KTC), dual inclination sensor (LCA328T), and pressure sensor (YBPCM: PCM300) to monitor the sinking displacement of the onshore offshore platform, the platform tilt angle, the bearing pressure of the pile legs and the foundation. It is transmitted to the control center to display the health status information of the offshore platform in real time [12-13]. ESA02 type rope displacement sensor (rope sensor, rope electronic ruler, rope encoder), the parameters are shown in Table 1.

Table 1. ESA02 cable type displacement sensor parameters

Name	Parameter
Measuring stroke	800mm
repetition error	0.04%
Comprehensive error	0.18%
Pulling speed	120mm/s
Protection class	IP 50

The LCA326T series sensor is a new generation of digital and small-sized inclination sensor products. The internal dual-channel gravitational inclination design is used to measure the static gravitational acceleration and convert it into the inclination change value [14-15]. Therefore, the tilt angle and pitch angle of the sensor output relative to the horizontal plane can be measured, as shown in Table 2.

Table 2. Dual tilt sensor sensor parameters

Name	Parameter
Resolution	0.1
Measurement axis	X,Y axis
Anti-vibration	10-800Hz
Protection class	IP 60
Weight	98g

YBPCM: PCM300 universal pressure transmitter adopts diffused silicon pressure core as the sensitive element, and the built-in digital processing circuit converts the sensor millivolt signal into standard current and voltage output signals.

2.2. Design of the Overall Architecture of the Cloud Monitoring System

In the overall architecture of the cloud monitoring system, the underwater common platform in the data acquisition layer includes an underwater connection platform, a data transmission warehouse and a power supply warehouse. It is mainly responsible for the acquisition of underwater data and sends the data to the data through the serial port. The industrial computer in the remote transmission layer, and the industrial computer in the data remote transmission layer is mainly responsible for data analysis and remote data transmission [16]. The remote transmission of data mainly adopts the TCP/IP protocol, and uses Socket for remote programming. Finally, a web application development environment such as Nginx load balancing server, web server and database server is built on the cloud platform to develop user login, data monitoring, video monitoring, remote control and historical data query functions [17-18].

3. Design and Implementation of Cloud Server Layer for Marine Engineering Safety Monitoring

In the entire cloud monitoring system of the offshore underwater detection platform, the design of the cloud server layer is to build various development environments on the cloud platform for web project development, data storage and centralized management. In order to be able to develop web projects, this paper deploys Nginx load balancing server, web server, JDK and other environments on the cloud platform. In addition, in order to be able to store data, this paper first selects the database and optimizes its performance, then deploys the database server on the cloud platform and designs and implements the database table structure.

This article clearly chooses Alibaba Cloud as the background of the cloud platform to implement the environment deployment of the cloud monitoring system. In order to complete the research and implementation of the cloud monitoring system based on the cloud platform, this paper firstly opened the cloud server. Because the lightweight application server provides a standard environment image, it has the characteristics of rapid construction, user can customize the environment arbitrarily, and easy security management and operation and maintenance monitoring. Therefore, this paper chooses a lightweight application server as a cloud server for deployment. In order to deploy the web development environment on Alibaba Cloud's lightweight application server, it can realize user login, real-time data monitoring, historical data access, video monitoring and remote control functions, as well as the performance that 1,000 users can access concurrently at the same time.

4. Analysis and Research of Marine Engineering Safety Monitoring under Cloud Computing Environment

4.1. Efficiency Comparison

The wave data in sea area A was used in this experiment. The wave data and sea surface wind field, flow field and other data are stored in the same NetCDF file, the time span is 1 year, the spatial resolution is 0.125 °×0.125 °, and the time resolution is 1 hour. Generally, we define a spatial location and a time point as a "space-time point", there are about 3 billion space-time points in this region, and each space-time point includes 40 feature variable values.

The centralized storage method stores each year's data in a NetCDF file, which is divided into 12 files by month, with a total data volume of 120GB. When performing long-term series of effective wave height-cross-zero cycle scatter diagram statistics, it is necessary to process multiple NetCDF files, and the frequent opening, reading and closing of file data streams takes a lot of time, and secondly, the performance of the computer, including memory, CPU, etc. It also affects the processing time of the data.

Table 3. Comparison of centralized file storage and distributed cloud storage

Time span (months)	Centralized file storage	Distributed cloud storage
1	22	25
2	26	29
3	38	30
4	57	33
5	74	36
6	102	38
7	128	40
8	134	40
9	162	41
10	184	42
11	200	43
12	209	43

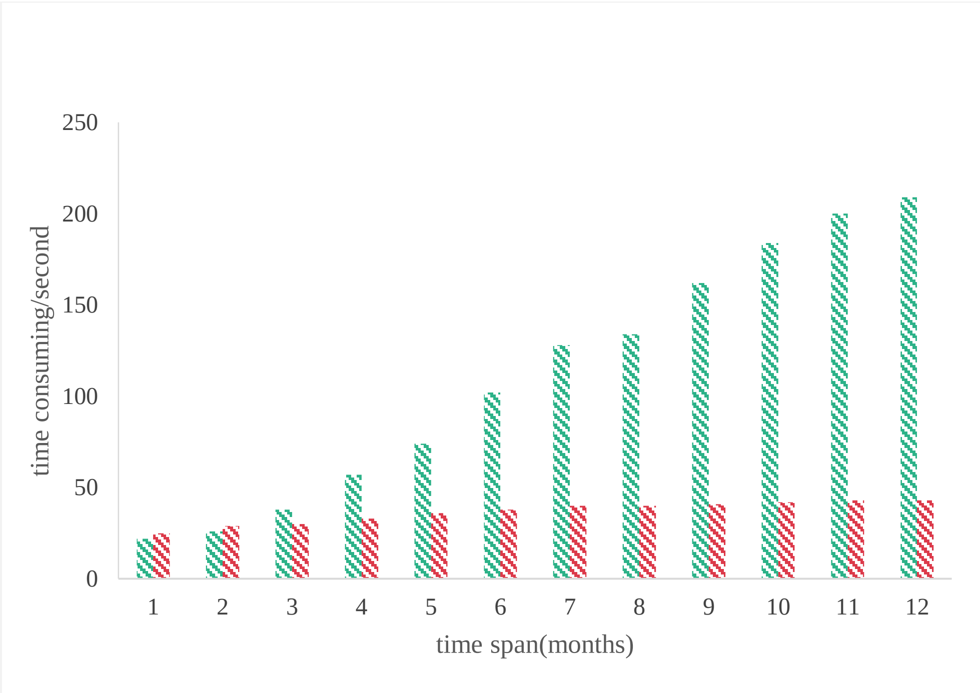

Figure 2. Efficiency comparison chart

It can be seen from Figure 2 that when processing physical ocean data within 3 months, the processing efficiency of the centralized storage mode and the distributed cloud storage mode are basically the same; when the time range exceeds 3 months, that is, with time As the scope expands, the amount of data continues to increase, and the processing efficiency of the centralized storage mode is getting lower and lower. On the contrary, the processing efficiency of the distributed cloud computing mode has been maintained at a high level, and the change range is gentle and basically stable; finally When the time horizon reached 12 months, the processing time for the centralized storage model reached 209 seconds, compared to 43 seconds for the cloud computing model.

4.2. Calculation and Analysis of Extreme Value of Return Period of Significant Wave Height

The calculation and analysis of the extreme value of the return period of significant wave height can bring very important reference value to the construction of marine engineering. On the one hand, it can prevent the design standard from being too low, which will cause the marine engineering to be damaged by wave impact. On the other hand, it can prevent the design standard from being too high, which will cause unnecessary economic waste, and finally make the marine engineering construction both safe and economical.

According to the statistical principle of the joint distribution of wave height and period, the single-point query analysis was carried out using the 40-year marine observation data of the Bohai-Huangdong Sea. In order to ensure the scientific rigor and the correctness of the research results, this paper selects three characteristic points in the following sea areas:

(1) A sea: the position of the feature points selected this time is 60 °11' 15" E, 35 °48" 45" N;

(2) B sea: the position of the feature points selected this time is 60 °3' 45" E, 30 °11' 15" N;

(3) Sea C: The positions of the feature points selected this time are 65 °11' 15" E and 33 °11' 15" N.

Based on the statistical analysis of the wave height-period joint distribution scatter diagram, this paper calculates the extreme values of significant wave heights under different return periods for the three points of sea A, sea B and sea C. The specific calculation process is as follows. The extreme value I-type distribution function is:

$$F(x) = \exp(-\exp(-\alpha(x-\mu)) \quad (\alpha > 0, -\infty < \mu < \infty) \tag{1}$$

In Equation 1, a is the scale parameter of the distribution, and u is the location parameter of the distribution, then, the maximum wind speed (or flow velocity and wave height) during the return period R (with a probability of 1/R) is:

$$R_x = \mu - \frac{1}{\alpha} In(In(\frac{R}{R-1})) \tag{2}$$

The parametric method for the extreme value type I distribution is Gunber's method.

Through the statistical comparison and analysis of the extreme values of the return period of significant wave heights at the three points of sea A, sea B and sea C, this paper finds the extreme value of the return period of sea C among the three feature points. The range of change is large, the value of wave height is high, basically showing a linear upward trend, and the slope is relatively steep; secondly, the extreme value of sea B has a small change range, the value of wave height is small, and the change of wave height also shows a linear upward trend, but it is relatively gentle; Compared with the former two, the characteristic point of sea A has a decrease in the amplitude of wave height change and the value of wave height, and the extreme value of effective wave height in the return period of sea A has the most gentle change and the most stable performance, as shown in Figure 3 shown.

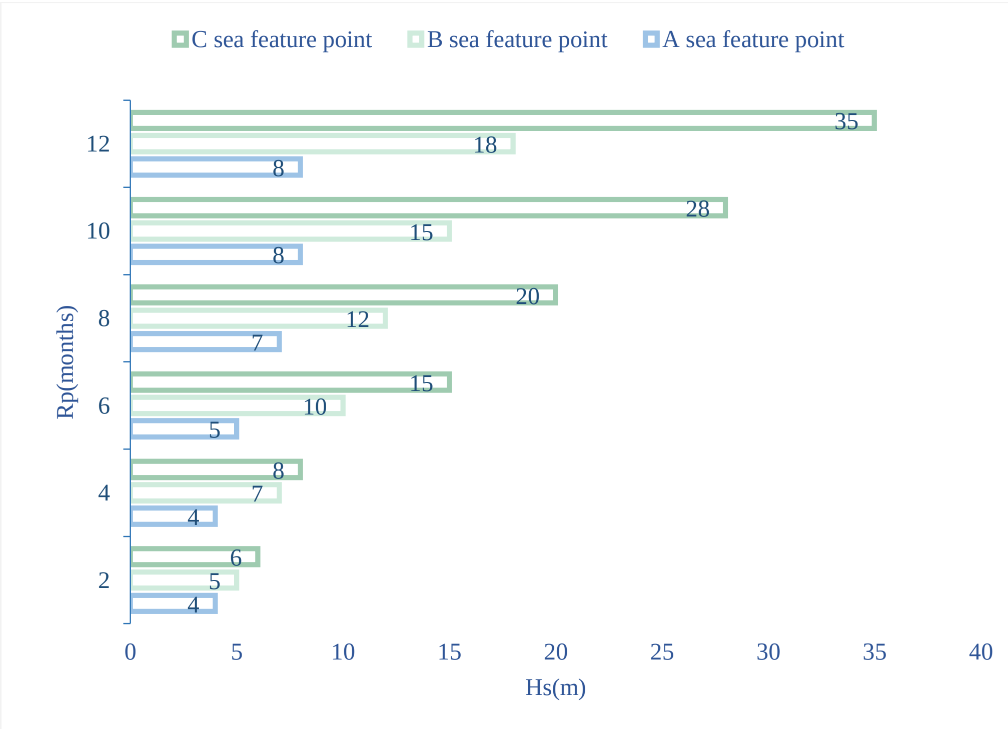

Figure 3. Comparison of extreme value changes in the return period of significant wave heights at feature points

5. Conclusion

The marine environment is complex and changeable, and seawater corrosion will have a certain degree of impact on marine engineering. Invisible damage will not affect the engineering and marine environment in the short term, but after long-term accumulation, it will cause immeasurable losses. The research on engineering safety monitoring is of great theoretical significance. Based on the concept of marine engineering safety monitoring, this paper conducts research on sensor technology, and combines the characteristics of information services to propose a point-to-point information push service method oriented to user needs, and conduct performance tests on the Alibaba Cloud platform. Finally, it is proved that, compared with integrated file storage, cloud computing platform has higher computing power and can effectively improve resource utilization efficiency. Due to limited conditions, this paper only implements a monitoring system that integrates the marine environmental information service module to the cloud. For building a complete integrated information monitoring and integrating more functions into the cloud, the compatibility issues and task scheduling issues that arise remain to be seen. further research.

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Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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