Scalable Computing: Practice and Experience, ISSN 1895-1767, http://www.scpe.org

Volume 26, Issues 4, pp. 1841–1851, DOI 10.12694/scpe.v26i4.4648

OPTIMIZATION AND IMPLEMENTATION OF MULTI SOURCE INFORMATION FUSION ALGORITHM FOR MARITIME SAFETY MANAGEMENT DRIVEN BY ARTIFICIAL INTELLIGENCE

SHUANGYI GE* AND CHENGCHENG SHAN†

Abstract. In order to ensure the relative stability of ships sailing at sea, a wave compensation platform compensation system based on artificial intelligence and information fusion is proposed. The experimental results indicate that during a motion cycle, when motion tube 1 moves downwards, motion tubes 2 and 3 will move upwards for 1/4 cycle, followed by motion tube 1 moving upwards for 1/2 cycle, and then move in the opposite direction. When cylinder 1 moves downwards from the high position, cylinders 2 and 3 move downwards. The phase difference between moving cylinder 1 and cylinders 2 and 3 is 90 degrees. In addition, the displacement phase calculated in real-time is consistent with the displacement phase of moving cylinder 1. The upward displacement of point A caused by the downward movement of the moving cylinder needs to be compensated by the downward movement, while the upward movement of points B and C needs to be compensated.

Key words: Wave compensation, Frequency domain filtering, Frequency domain integration, Data fusion

1. Introduction. The Internet of things (IOTS) connects people, things and systems, Combined with intelligent services, they can communicate with each other anytime and anywhere Communicate to meet information resource processing requirements.

In modern times, the ocean plays an important role in people's production and life. Especially in the 21st century, with the gradual decline of land resources and the worsening of living environment, people are constantly turning their attention to the ocean. The development of the ocean can not only alleviate human demand for resources, but also reduce human pollution on land and purify people's living environment. It is particularly important to increase the ocean development technology related to the development of the ocean. For example, the stable platform technology to be studied in this project is affected by wind, current and waves, so its motion form will inevitably be a complex composite movement [1]. This composite motion is composed of ship's roll motion, pitch motion, yaw motion, heave motion, heeling motion, and pitch motion, among which roll motion, pitch motion, and heave motion have the strongest impact on the performance of ships or marine equipment. The marine stabilized platform can keep the stabilized object relatively stable in the inertial coordinate system when it is disturbed. The development of marine stable platform is extremely important to give full play to helicopter offshore operation, improve the working accuracy of shipborne equipment, and ensure national defense security and economic development. Because of the advantages of parallel mechanism, such as large stiffness, stable structure, strong bearing capacity, high accuracy and small motion inertia, the parallel stable platform has attracted great attention. For the parallel stable platform, based on the complexity of the structure and the coupling of the motion, the establishment of an accurate dynamic model is the basis for the dynamic analysis, is the necessary condition for the evaluation of the dynamic characteristics of the mechanism and the dynamic optimization design, and is also the prerequisite for achieving the high-precision control of the parallel stable platform [2]. With the rapid development of Internet and cloud computing technologies, The interconnection network is connected not only to the computer, but also to the daily life The square side of the face, step by step into any time and place A point can be used to build an interconnected iot network for any device. The things network combines computer data with real and real world data. According to the industry forecast, the number is believed to be everywhere the collection of information, so that the Internet of things

*Spic Jiangsu Offshore Wind Power Co., Ltd., Yancheng, Jiangsu, 224000, China. (Corresponding author, ShuangyiGe7@163.com)

†Spic Jiangsu Offshore Wind Power Co., Ltd., Yancheng, Jiangsu, 224000, China. (ChengchengShan8@126.com)

technology can and security the question is facing a great challenge.

2. Literature Review. Through comprehensive analysis of wave compensation technology in recent years, we can find that there is a pattern in the industry: internationally, academic research on wave compensation technology is mainly focused on the lateral anti-swing of restraining load swing, while the vertical control of reducing the impact of ship motion, especially the impact of wind and waves on underwater equipment, has been very mature [3]. For example, Qiao, W. et al. discussed and investigated the cognitive differences and correlations between Safety I and Safety II in the maritime industry. To this end, they conducted questionnaires and semi-structured interviews with seafarers and maritime experts to collect raw data related to Safety I and Safety II. Then, they use empirical statistical method and fuzzy analytic hierarchy process (AHP) to further process the data from seafarers and maritime experts. The results show that the influencing factors related to personal aspects are generally considered as the leading factor of safety concept I, while organizational factors have a greater impact on safety concept II, which is crucial to the development of organizational resilience [4]. The new version of China's Maritime Traffic Safety Law 2021 (MTSL 2021) was officially implemented on September 1, 2021. MTSL2021 may significantly change the maritime traffic safety regulatory framework of waters under Chinese jurisdiction, especially the maritime safety regulatory framework of foreign ships. MTSL2021 will have an important impact on the navigation of foreign ships in waters under China's jurisdiction and China's future maritime law enforcement. However, the regulatory framework applicable to foreign ships in China's new MTSL is not without shortcomings. Some problems, including some vaguely worded clauses and provisions, the space left for discretion and the overlapping of regulatory powers between different law enforcement agencies, may bring uncertainty to the predictable, transparent and consistent results of maritime law enforcement. Zhang, H. et al. reviewed China's reform of the relevant system of maritime safety management of foreign ships, analyzed the deficiencies and problems in the new regulatory framework, and discussed its potential impact on China's maritime law enforcement [5]. Zhang, M. et al. proposed a prediction analysis method to study maritime ship traffic in more detail. This method uses Lempel-Ziv algorithm and TOPSIS based on similarity of ideal solution to manage traffic safety. Lempel-Ziv algorithm quantifies the entropy used to evaluate the irregularity and unpredictability of ship travel time series, and TOPSIS ranks the complexity. The results presented use the automatic identification system (AIS) data, which corresponds to the complex inland river traffic scene encountered in the Yangtze River. They show that the high complexity means that the time series of ship travel is neither periodic nor random, but depends on the evolution mode of traffic encounter. They analyzed the correlation between the complexity of traffic flow and the number of maritime accidents, indicating that the higher the complexity of traffic flow, the more accidents may occur. Therefore, they concluded that the proposed method can help (1) accurately distinguish the complexity of traffic flow, indicating that the higher the complexity value, the higher the irregularity and unpredictability of maritime traffic flow, and (2) provide useful reference for optimizing the traffic management within the operation life cycle of the fleet and maritime safety management in areas with high traffic flow complexity [6].

The basic framework of Internet of Things based on cloud computing: Internet of Things The network image generates a large amount of data, which travels in the cloud Reason and analysis, produce information, which can be used in things Programs should be used for the intelligence service or person in the network. Be right A large number of target data to achieve high efficiency management, need to present the strengthening of the cloud frame is on the basis of the substance the real-time service of the network is energy consumption, security and privacy And instant side lift effects are a must.

This paper introduces the processing technology of redundant data in multi-sensor measurement, and uses the weighted average method of these processing technologies to further data fusion processing of the test data processing results to obtain more useful and effective displacement compensation. The results show that redundant data fusion technology is also an effective and feasible method.

3. Research methods.

3.1. Common sensor redundancy data fusion methods. Common data processing systems run only on local computers Unlike computing, which deals with local data, cloud computing requires users to download it from the cloud the data information is processed and shared with other users in the cloud. The need for massive data generated by the Internet of Things Knowledge, collection, transmission, and ultimately the ability to tease, all of this is based on data processing The platform. Relying on cloud computing can improve the operational efficiency of the Internet of Things , Information security lays a solid foundation for the construction of the two networks.

At present, the data fusion theory and methods are mainly divided into four types of two major plates, including the estimation and statistical methods in classical processing, and the information theory and artificial intelligence methods based on modern theory. There are more specific divisions under various theoretical methods. In multi-sensor measurement system, the methods of redundant data fusion mainly include: weighted average method, least square method, Kalman filter method, Bayesian estimation method, etc.Cloud computing model types can be divided into private cloud, public cloud, community cloud and hybrid cloud four deployment, they are respectively for different use of the environment. The effective play of the advantages of cloud computing depends on scientific and reasonable security.

In this case, it is necessary and important to study security technology and strengthen encryption. In order to Ensure data security, establish information security system perfect identity authentication management body One cannot be without the other.

3.1.1. Weighted average method. To avoid arbitrary or even malicious use of data r fusion, you should first build numbers According to the security center, data security levels are divided, followed by users of different levels Set different permissions to ensure that data fusion meets requirements within a certain range Before it can be used.For multi-sensor measurement system, the purpose of position-level data fusion in real-time tracking is to judge the validity of a set of measurement data obtained, and then obtain the fusion data according to certain rules, and then send the data back to the control system for control. To make the returned data most effective, it is necessary to determine a reasonable fusion rule. It is an effective method to adjust the proportion of the measured data in the fusion results by weighting coefficients [7,8].

The weighted average method is the most simple and intuitive method, that is, the redundant information provided by multiple sensors is weighted and averaged as the fusion value. This method can process the dynamic original sensor readings in real time, but the workload of adjusting and setting the weight coefficient is large, and it has certain subjectivity. The maximum likelihood estimation method is not only applicable to any population, but also has consistency, asymptotic normality and asymptotic minimum variance under a wide range of conditions. Although the obtained statistics are not necessarily unbiased, they can often be modified into unbiased estimators. However, not all parameters to be estimated can obtain the likelihood estimator, and when using the maximum likelihood estimation method to obtain the estimator, it is often required to solve a likelihood equation [9].

The mathematical model of weighted average can be simply expressed as:

At time K, the system has n sensors at the same level. The measured value of the target is: $X_{Ki}(i = 1, 2, Ln)$, and X_{Ki} is n data that can be directly operated or transformed for operation. According to the weighted average fusion algorithm, the corresponding weight value of each sensor data is $a_{Ki}, (i = 1, 2, Ln)$, and the final data processing result is as follows 3.1:

$$X'_K = \sum_{i=1}^{n}(a^*_{Ki}X_{Ki}) \tag{3.1}$$

where a_{Ki} shall meet the following formula 3.2:

$$\sum_{i=1}^{n} a_{Ki} = 1 \tag{3.2}$$

The purpose of the algorithm is to determine the weight of each sensor at the same time, so a_{Ki}, n are the number of sensors in the system.

3.1.2. Least square method. The criterion of the least squares method is to select X to minimize the estimation performance index (sum of squares of estimation error). When the accuracy of each data measurement is different, the weighted processing shall be adopted to give greater weight to the measurement results with higher accuracy. The least square method is based on the error theory. Among the data processing methods, the error is the smallest and the accuracy is the best. In practical work, it is often necessary to process the newly acquired data in real time. Each additional data needs to recalculate all the data, and the amount of calculation is large.

The processing principle of the least squares method has been introduced in the above chapters, and will not be repeated here.

3.1.3. Kalman filtering method. Kalman filter is mainly used to fuse low-level real-time dynamic multi-sensor redundant data. This method uses the statistical characteristics of the measurement model to determine the optimal fusion and data estimation in the statistical sense. If the system has a linear dynamic model, and the error between the system and the sensor conforms to the Gaussian white noise model, the Kalman filter will provide the best estimate in the unique statistical sense for the fused data. The recursive characteristic of Kalman filter makes the system not need a lot of data storage and calculation. This method has good real-time performance and is suitable for processing dynamic, low-level and redundant data. The disadvantage is that it can only deal with linear problems, low observation degree and easy to diverge [10].

Algorithm principle of Kalman filter method. Let the system state equation be as follows 3.3:

$$x(k+1) = Ax(k) + u(k) \tag{3.3}$$

The sensor observation equation is as follows 3.4:

$$y(k) = Cx(k) + v(k) \tag{3.4}$$

where $x(k+1)$ and $x(k)$ are the state variables of the system at k+1 and k respectively; $u(k)$ is system noise; $y(k)$ is the observation variable of the system at k time; $v(k)$ is the observation noise; C is the state transition matrix of the system; A is the observation matrix of the system;$u(k)$ and $v(k)$ are white noise with zero mean value.

Based on Equation 3.3 and Equation 3.4, the one-step state vector estimation can be obtained as follows 3.5, 3.6, 3.7:

$$\hat{x}(k|k-1) = A\hat{x}(k-1|k-1) \tag{3.5}$$

$$P(k|k-1) = AP(k-1|k-1)A' + Q \tag{3.6}$$

$$\hat{y}(k|k-1) = \hat{C}(k|k-1) \tag{3.7}$$

where $\hat{x}(k|k-2)$ is the state estimation value at time k according to the estimation value at time c; $\hat{x}(k-1|k-1)$ is the k-1 moment estimate; $P(k|k-1)$ is the prediction covariance matrix; $P(k-1|k-1)$ is the error covariance matrix; $\hat{y}(k|k-1)$ is the observation value at the time of k according to the estimated value at the time of k-1, and there are:

The system noise covariance is as follows 3.8:

$$Q = E\{u(k)u'(k)\} \tag{3.8}$$

The observed noise covariance is as follows 3.9:

$$R = E\{v(k)v'(k)\} \tag{3.9}$$

Based on the observed value at the current moment and the estimated value at the previous moment, the updated value of the measurement vector of the following formula 3.10,3.11,3.12 can be obtained:

$$K(k) = P(k|k-1)C'(CP(k|k-1))C' + R)^{-1} \tag{3.10}$$

$$\hat{x}(k|k) = \hat{x}(k|k-1) + K(y(k) - Cx(k|k-1)) \tag{3.11}$$

$$P(k|k) = P(k|k-1) - KCP(k|k-1) \tag{3.12}$$

where $K(k)$ is the Kalman gain; $P(k|k)$ is the covariance matrix.

3.1.4. Bayesian estimation method. Bayesian inference is to estimate some unknown states with subjective probability under incomplete information, then modify the prior probability with Bayesian formula, and finally make the optimal decision with the modified probability.Bayesian estimation is a common method to fuse high-level information of multi-sensor in static environment. It regards each sensor as a Bayesian estimator, and synthesizes the correlation probability distribution of each target into a joint posterior distribution function. With the arrival of the observed value, the likelihood function of the assumed joint distribution is constantly updated, and the data is finally fused through the maximum or minimum of the likelihood function. Bayesian reasoning solves some problems in classical reasoning. Its difficulty is to define a priori likelihood function, which is more complex when there are multiple potential assumptions and multiple conditional independent events. It requires that some assumptions are mutually exclusive and lack general uncertainty [11,12].

Principle of Bayesian optimal estimation algorithm. Assume that the consistency measurement data set is $X = \{x_1, x_2, L, x_t\}$ in the measurement data obtained from m sensors measuring the same parameter, where $m \geqslant t$. Then the optimal result of the measured parameters is as follows 3.13:

$$P(\mu|x_1, x_2, L, x_t) = \frac{p(\mu; x_1, x_2, L, x_t)}{p(; x_1, x_2, L, x_t)} \tag{3.13}$$

If parameter μ obeys $N(\mu_N, \sigma_N^2)$, and x_k obeys $N(\mu, \sigma_k^2)$, and let $a = \frac{1}{P(x_1, x_2, L, x_t)}$, a is a constant independent of μ, so it is the following formula 3.14:

$$\begin{aligned} P(\mu|x_1, x_2, L, x_t) &= a \prod_{k=1}^{t} \frac{1}{\sqrt{2\pi}} exp\left\{-\frac{1}{2}\left[\frac{x_k-\mu}{\sigma_k}\right]^2\right\} \times \frac{1}{\sqrt{2\pi}\sigma_0} exp\{-\frac{1}{2}\left[\frac{x_k-\mu}{\sigma_0}\right]^2\} \\ &= a \cdot exp\left\{-\frac{1}{2}\left[\frac{x_k-\mu}{\sigma_k}\right]^2 - -\frac{1}{2}\left[\frac{x_k-\mu}{\sigma_0}\right]^2\right\} \times \prod_{k=0}^{t} \frac{1}{\sqrt{2\pi}\sigma_k} \end{aligned} \tag{3.14}$$

The exponential part of the above formula is a quadratic function of μ, so $P(\mu|x_1, x_2, L, x_t)$ is still normal distribution, assuming that it follows $N(\mu_N, \sigma_N^2)$, that is, the following formula 3.15:

$$\begin{aligned} P(\mu|x_1, x_2, L, x_t) &= \frac{1}{\sqrt{2\pi}\sigma_N} exp\left\{-\frac{1}{2}\left[\frac{\mu-\mu_N}{\sigma_N}\right]^2\right\} \\ \mu_N &= \left[\sum_{k=1}^{t} \frac{x_k}{\sigma_k^2} + \frac{\mu_0}{\sigma_0^2}\right] / \left[\sum_{k=1}^{t} \frac{1}{\sigma_k^2} + \frac{1}{\sigma_0^2}\right] \\ \hat{\mu} &= \int_{\Omega} \frac{1}{\sqrt{2\pi}\sigma_N} exp\left\{-\frac{1}{2}\left[\frac{\mu-\mu_N}{\sigma_N}\right]^2\right\} d\mu = \mu_N \end{aligned} \tag{3.15}$$

From the parameters of the above two formulas, the following formula 3.16 is obtained:

$$\mu_N = \left[\sum_{k=1}^{t} \frac{x_k}{\sigma_k^2} + \frac{\mu_0}{\sigma_0^2}\right] / \left[\sum_{k=1}^{t} \frac{1}{\sigma_k^2} + \frac{1}{\sigma_0^2}\right] \tag{3.16}$$

Therefore, the Bayesian estimation $\hat{\mu}$ of μ is as follows 3.17:

$$\hat{\mu} = \int_{\Omega} \mu \frac{1}{\sqrt{2\pi}\sigma_N} exp\left\{-\frac{1}{2}\left[\frac{\mu-\mu_N}{\sigma_N}\right]^2\right\} d\mu = \mu_N \tag{3.17}$$

Therefore, $\hat{\mu}$ is the optimal fusion estimation data of μ.

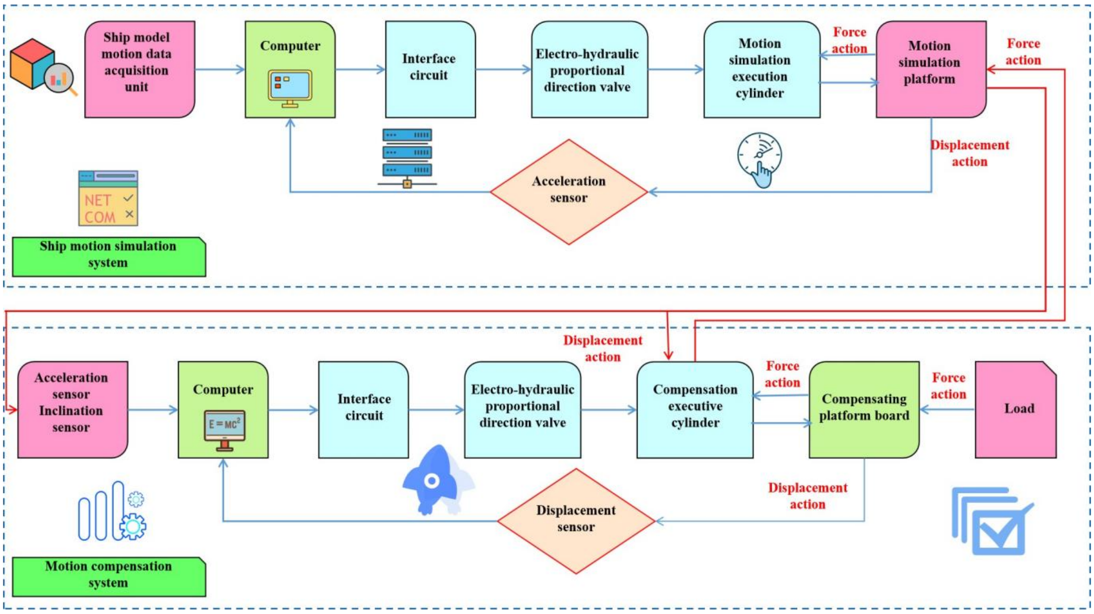

Fig. 3.1: Block diagram of motion compensation test system

3.2. Block diagram of wave compensation test system. The wave compensation test system mainly includes the ship model motion simulation system and the motion compensation system. According to the test flow, the test system block diagram shown in Figure 3.1 is obtained.

The test process is as follows: first start the ship motion simulation system to simulate the ship roll, pitch or heave motion, and then start the motion acquisition module in the motion compensation system to collect the simulation input of the instantaneous acceleration and inclination of the simulated motion in real time through the acceleration sensor and inclination sensor. After the computer compares the feedback data of the displacement sensor with the calculated displacement data, the digital analog output of the data acquisition card transmits the control signal to the electro-hydraulic proportional directional valve to drive the oil cylinder for compensation, and completes the displacement compensation of the platform [13,14].

3.3. Construction of real-time acquisition processing and compensation program system. During data processing and analysis and program writing, the acceleration signal data processing is completed by processing the collected data at one time. However, in actual compensation, the compensation signal is required to be real-time. Through real-time calculation, the collected signal is processed quickly and the latest control signal is output to the proportional direction valve to drive the executive cylinder to compensate the compensation platform plate. In addition, since previous work is based on the Visio Basic platform, it is necessary to transplant and modify the processing program written by MATLAB.

In view of the real-time nature of the frequency domain processing technology, the frequency domain processing technology, including frequency domain filtering and frequency domain integration technology, is used in the construction of the real-time processing program. Real-time collection is completed through the Timer control in Visio Basic. Every Timer.interval, a batch of new data is read in and stored in the corresponding array for subsequent program calls and processing. After transplantation, three main modules are added: frequency domain filter, FFT transform and IFFT inverse transform.

4. Result analysis. After adding the real-time processing program of acceleration signal, the compensation system can perform real-time compensation of three degrees of freedom of heave motion, pitch motion and roll motion, and can also compensate for combined motion. Since roll and pitch are similar in processing technology, the following is mainly to discuss and analyze the motion compensation of ship heave and roll [15].

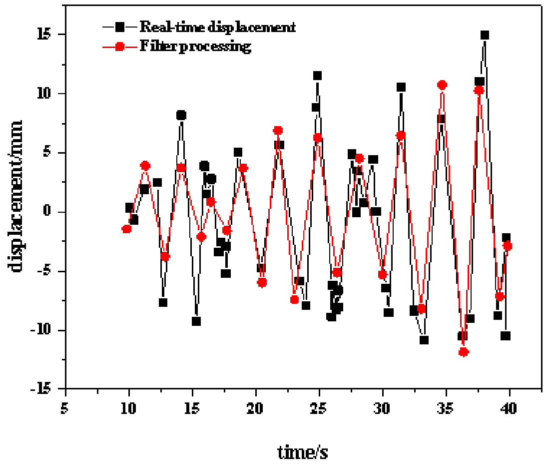

Fig. 4.1: Comparison of real-time displacement calculation and filtering results of heave motion

4.1. Heave motion compensation. The motion simulation platform simulates the heave motion of the ship, due to the inevitable impact of environmental noise, and the selected acceleration sensor has high sensitivity. Therefore, when the real-time acceleration signal is directly collected and compensated after calculation, the compensation effect is relatively poor due to the influence of high-frequency vibration, and the result of calculation is directly reflected in the compensation result. The compensation value is often large or small, which cannot meet the requirements of the assumption. Therefore, it is necessary to effectively process the high-frequency signal to avoid subsequent processing.

It can be seen from the figure that if proper processing is not added, the real-time acceleration signal will be large, basically concentrated between - 1~+1 m/s2, and some even reach 3 m/s2 and above. The acceleration signal processed by real-time frequency domain filtering is concentrated in the range of - 0.4~0.4m/s2, the amplitude is greatly reduced, and the overall trend is obvious. Compared with the post-processing filtering curve, we can see that due to the distortion generated in the real-time filtering process, the real-time filtering curve has many uneven points. On the one hand, it is the real vibration signal, on the other hand, it may be the error caused by the spectral leakage during the filtering process. This is a problem that needs to be solved by adding appropriate processing technology to obtain better acceleration signal [16].

The real-time calculated displacement signal and post-processed displacement signal are shown in Figure 4.1.

It can be seen from the figure that due to the high frequency influence brought in by the acceleration signal in front, some high frequency influence also appeared in the subsequent acceleration integration processing, and the displacement signal after proper filtering is relatively stable.

After the acceleration signal is integrated, the DA output signal is calculated by PID as shown in Figure 4.2.

It can be seen from the figure that the response signal of the compensation cylinder lags behind the calculated DA output signal, and the DA output control signal is not synchronized with the signal received by the compensation cylinder. After a proper phase shift of 1/4 cycle, it is found that the DA output signal is basically synchronized with the response signal of the compensation cylinder, indicating that the DA output signal is 1/4 cycle ahead of the received signal of the compensation cylinder. One of the reasons is that the program solution and signal transmission are time-consuming, and the important one is that the hydraulic control system also has certain hysteresis [17,18].

After the above processing output, what is the compensation effect of the stable platform? The most illustrative point is the comparison between the compensation amount of the compensation cylinder and the

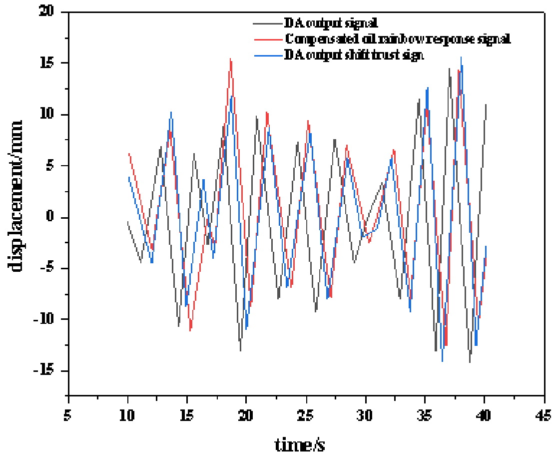

Fig. 4.2: Comparison between the heave motion DA output signal and the compensation cylinder signal

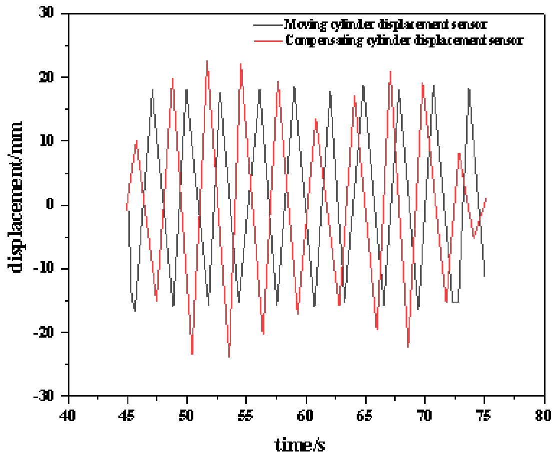

Fig. 4.3: Comparison curve between predicted ROP and actual ROP by neural network

amplitude and phase of the movement amount of the motion cylinder, as shown in Figure 4.3.

It can be seen from the figure that in the 45s∼60s interval, the compensation value of the compensation cylinder is just opposite to the movement value of the motion cylinder in phase, and the compensation value is slightly larger than the movement value in amplitude, that is, it can maintain the movement in the opposite direction with the motion cylinder to realize synchronous compensation. In the interval after 60s, the compensation value lags behind the motion value, and the compensation and motion are not synchronized. Real-time heave compensation has a certain effect, but it cannot achieve effective synchronization, mainly due to the influence of a large number of vibration signal interference, resulting in the movement of the compensation cylinder and the movement of the motion cylinder can not be synchronized, and other existing problems, which need further research and solution [19].

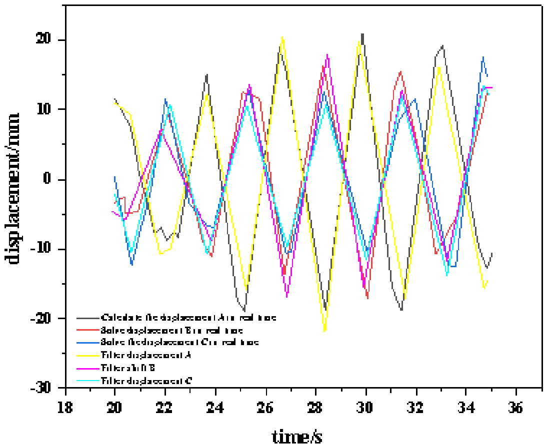

Fig. 4.4: Comparison of real-time calculated displacement and filtering results of rolling motion

4.2. Roll motion compensation. Since the mechanism of pitch motion is the same as that of roll motion in motion simulation, this paper mainly discusses the compensation of roll motion.

After filtering, the amplitude of the acceleration signal is greatly reduced, the field noise is effectively suppressed and eliminated, and the acceleration signal value is closer to the actual value. The signal obtained by real-time processing is still relatively rough and not smooth, and the phase of each accelerometer is also asynchronous, which will affect the subsequent processing. Therefore, like the heave compensation, this is an urgent problem to be solved.

The real-time result of integrating the acceleration signal obtained from real-time calculation is shown in Figure 4.4. It can be seen from the figure that although the acceleration signal calculated in real time is relatively disordered, the noise of the displacement value after the integration processing has been well suppressed, which indicates that the integration processing algorithm is relatively appropriate. One point to be explained here is the calculated displacement amplitude and phase. When simulating the motion of the platform, the compensation platform follows the motion. To realize compensation, the motion of the compensation cylinder should be opposite to the motion of the moving platform. Therefore, when the motion platform is warped, the motion cylinder 1 moves downward, and the compensation platform will move upward. To maintain the relative level of the compensation platform, the compensation cylinder A should move downward, and the compensation cylinders B and C should move upward. That is, the compensation movement of compensation cylinders B and C is opposite to that of cylinder A. Figure 4.4 and Figure 4.5 can reflect this situation.

Figure 4.5 shows that in a movement cycle, when the movement cylinder 1 moves downward, the movement cylinders 2 and 3 will move upward for 1/4 cycle, then follow the movement cylinder 1 to move upward for 1/4 cycle, and then move in the opposite direction. When cylinder 1 moves downward from the high position, cylinders 2 and 3 follow the downward movement. That is, the phase difference between the motion cylinder 1 and the cylinders 2 and 3 is 90 degrees. In addition, we can see from Figure 4.6 that the displacement phase calculated in real time is consistent with that of the motion cylinder 1. The upward displacement of point A caused by the downward movement of the motion cylinder needs to be compensated by the downward movement, while the upward displacement of point B and C should be compensated [20].

After the real-time displacement signal is obtained, the DA output signal is calculated to drive the control compensation cylinder for compensation, as shown in Figure 4.6.

From the compensation results, the action phase of the compensation cylinder and the movement cylinder can not be well matched, and the situation of lag and lead often occurs; In addition, the compensation ampli-

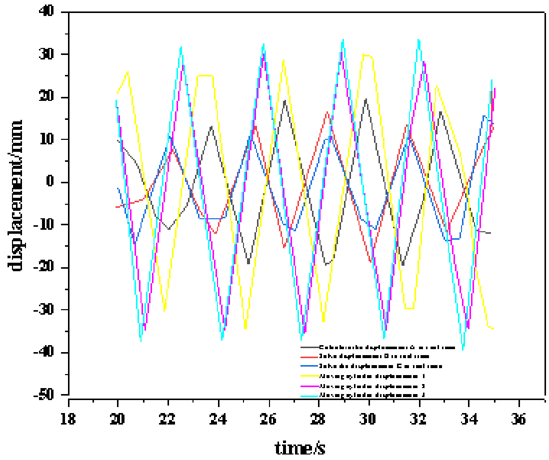

Fig. 4.5: Comparison between real-time calculated displacement of rolling motion and displacement of moving oil cylinder

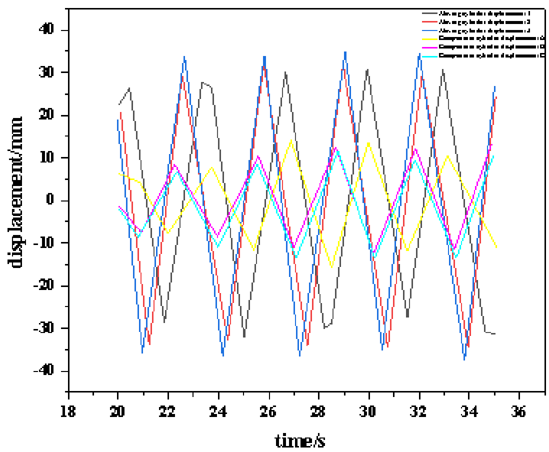

Fig. 4.6: Comparison of displacement of compensation cylinder and movement cylinder

tude is smaller than the motion amplitude, and the motion displacement cannot be completely compensated. Therefore, the compensation effect is not very ideal. There is still a distance from the expected effect, and a lot of work needs to be done. There are still many problems to be solved.

5. Conclusion. Cloud computing security system six bases This module is: management server, cloud computing resource server, data transmission, right Called encryption, asymmetric encryption, client.This paper mainly analyzes and discusses the real-time motion compensation test data of the compensation system from the ship's heave motion and roll motion. We analyze and discuss the simulation of ship motion from the start motion simulation system, input the collected data into the computer through the acquisition card, and then calculate and output the compensation control signal and compensation results by the real-time processing program. In this whole process, the treatment effect of each main joint is good. From the result, the real-time processing compensation has certain effect, but it is still far from the expected effect, and there are also many technical problems to be solved.

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Edited by: Bradha Madhavan
Special issue on: High-performance Computing Algorithms for Material Sciences
Received: Aug 18, 2024
Accepted: Feb 26, 2025