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Intelligent Management System of Marine Engineering Service Based on Genetic Algorithm

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Abstract: Nowadays, countries in the world pay more and more attention to the rights and interests of the ocean, and the ocean has become an important environmental resource and natural resource on which human beings are extremely dependent. With the development of technology and the huge demand for the development and utilization of marine oil and gas resources, my country's marine engineering equipment manufacturing industry has entered a stage of rapid development. The purpose of this paper is to study the construction of an intelligent management system for marine engineering services based on genetic algorithms. Focus on the information integration and intelligent management of marine engineering service systems, use underwater sensor network and marine Mesh network technology to collect marine resource data, and establish a marine multidisciplinary dynamic data system based on the Vue.js system. , using the IGA-BP algorithm to predict the evolution trend of the marine physical environment, and construct an intelligent marine disaster early warning method for marine engineering. The experimental results show that the IGA-BP early warning model is better than the BP early warning model.

1. Introduction

In decades of marine engineering research and observation, a large amount of valuable marine scientific data has been accumulated, but due to the limitations of data storage and management conditions, many data have not played their due value [1-2]. Therefore, it has become an important task to use information technology to better store and manage marine scientific data, provide more convenient services for marine engineering, increase the utilization of marine scientific data, and promote the development of marine engineering [3-4].

Information technology has become an important technical support for research in the field of marine engineering activities [5]. Some scholars have designed and optimized the mechanical ship launch system based on the MATLAB/SIMULINK platform. It is designed to provide optimum

response and control performance for offshore vessels. On the basis of the mathematical model, through SIMULINK, the graphic model of the intelligent release system of the offshore engineering ship and the control target model of the optimization system are determined [6]. Some scholars have developed an application debugging marine engineering management system using C# language, studied the debugging and division of labor of the project, and successfully applied it to many projects, and achieved good results [7]. Ocean engineering observation and survey data are the foundation for understanding ocean engineering and engineering design [8].

Based on genetic algorithm and marine engineering service system, this paper proposes an intelligent early warning strategy for marine disasters. Firstly, the basic concept and structure of underwater sensor network, the working process of Vue.js system are analyzed, and the marine engineering service system based on Vue.js system is established. Secondly, the algorithm steps of the IGA-BP algorithm are explored, the algorithm comparison research is carried out, and the role of the IGA-BP algorithm in the marine engineering service system in the intelligent early warning of marine disasters is verified.

2. Research on Intelligent Management System of Ocean Engineering Service Based on Genetic Algorithm

2.1. Underwater Sensor Network

UWSN is an underwater wireless self-organizing network mainly composed of underwater sensor nodes with communication and simple computing capabilities through underwater acoustic communication. Underwater reliability, the underwater acoustic communication method based on OFDM technology is adopted. The node realizes the collection of underwater resources and environmental information by carrying different sensors (such as marine biochemical sensors). Further, the collected data is transmitted to the underwater convergence node. And uploaded by the aggregation node to the intelligent data gateway deployed at sea [9-10].

2.2. Maritime Mesh Network

The maritime Mesh network is mainly composed of ship nodes (communication nodes), and the transmission and sharing of UWSN collected data between ship nodes is realized through VoIP [11-12]. This paper proposes to use the VHF frequency band to set up a wireless Mesh network (VHF-WMN) to realize the networking between ships. The MAC layer of the VHF-WMN adopts the 802.11 protocol. The IEEE802.11s standard defines how to construct the WMN framework through the interconnection of wireless devices. In addition, the IEEE802.11s MAC protocol supports real-time business applications and multicast communication under multi-hop network topology; The physical layer adopts maritime VHF radio transmission, which is also the frequency band shared by AIS data transmission and maritime VHF voice communication system. At present, the commercial VHF terminal equipment that has been developed can be used for IP networking. We configure a VHF terminal on each ship as a Mesh access point (MeshAP), and form the ship's WMN backbone network through multi-hop links between MeshAPs. VoIP enables wireless data communication between ships. The IEEE802.11s-based WMN is compatible with IEEE802.11s-based devices, and both such devices and satellite communication terminals with 802.11s interfaces can access VHF-WMN as Mesh Clients [13-14].

2.3. Vue.js System

Vue.js has a relatively complete ecosystem, including the following main parts:

Vuex: A state management pattern developed for Vue.js applications, which uses a centralized storage to manage the state of all components of the application;

Axios: A Promise-based HTTP library officially recommended by Vue.js, with functions such as sending asynchronous requests, intercepting requests and responses, and preventing CSRF (CrossSiteRequestForgery, cross-site request forgery) on the client side;

Vue-cli: It can help developers develop a complete application with rich plug-ins and integrate most of the tools in the ecosystem with very little configuration. The development of this platform is based on the Vue-cli system [15-16].

2.4. Identifying Participants

According to the actual needs of the marine engineering product structure and configuration management system, three different roles are provided in the marine engineering product structure and configuration management system, including grassroots enterprise employees, department managers and system administrators. The activities and functions that can be engaged in participation are also different, and the specific analysis is as follows:

(1) Basic-level employees of the enterprise: mainly perform the following operations: manage personal basic information and passwords, manage parts, product BOM, and product configuration [17-18].

(2) Department manager: mainly perform the following operations: manage personal basic information and passwords, and manage product platform information [19].

(3) System administrator: mainly perform the following operations: manage personal basic information and passwords; manage users, departments and administrative rights [20].

2.5. Analysis of System Functional Requirements

The system needs to manage personal basic information. Due to the huge number of employees in marine engineering product manufacturing enterprises, if only managed by administrators, it will bring huge workload to the administrators, so the maintenance of personal basic information is carried out by each user. Do it yourself, that is, all users have the right to modify personal basic information. In this function module, the user can modify basic personal information, such as login name, email, mobile phone number, etc., and the user can also modify the system login password in this module. Figure 1 is a use case diagram for personal information management.

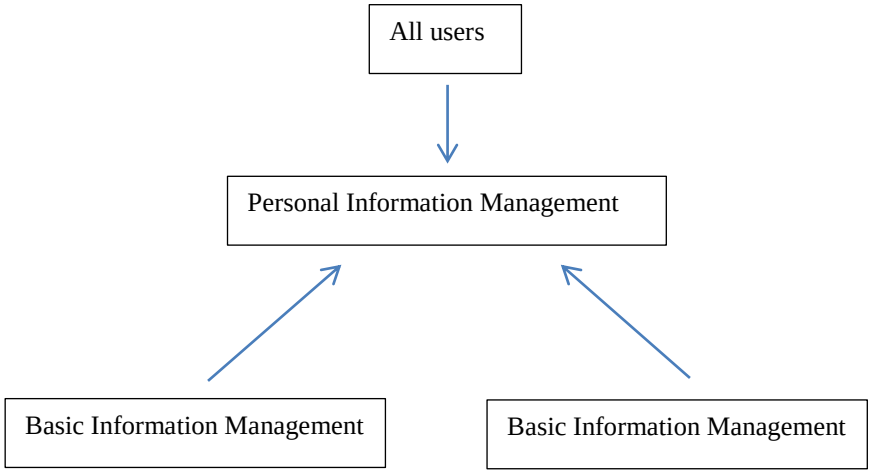

Figure 1. Personal information management use case

3. Investigation and Research on Intelligent Management System of Ocean Engineering Service Based on Genetic Algorithm

3.1. Intelligent Management System of Offshore Engineering Services

The global wind and wave database constructed in this paper is a three-tier C/S structure. The user enters the required data on the global wind and wave database application, such as the time range and the starting longitude and latitude, etc. The application server of the global wind and wave database accepts the data. request, send the data request to the global wind and wave database server, the database server extracts the data, returns the results required by the user to the client, and finally displays the data output by the application on the client, such as the frequency division table of wind and waves and wavy rose diagrams, etc.

3.2. Early Warning Performance Test

The early warning performance test was carried out using the survey data of red tide biological Noctiluca in 2022 in the sea around the ocean island as an example. There are 20 groups of data in total, the first 10 groups are used as training data, and the last 10 groups are used as prediction data. All 20 sets of data are used for calculation in statistics.

3.3. IGA-BP Early Warning Model Input and Output Data Preprocessing

Since the hyperbolic tangent function requires the input value range to be between 0-1 and the output value range to be between 0-1, so as to ensure that the network has sufficient input sensitivity and good fitting to the sample, and at the same time consider the early warning The model should have high sensitivity to the biological density of red tide before red tide occurs, so the input and output data are normalized. The normalization treatment should be linearly determined according to the six physical and chemical factors and the upper and lower limits of the density of Noctiluca, using the following normalization formula:

$$\overline{S} = \frac{S - S_{\min}}{S_{\max} - S_{\min}} \tag{1}$$

In the formula, Smax: the upper limit value, not necessarily the maximum value of the data used, and a certain margin can be added. Smin: The lower limit value, not necessarily the minimum value of the data used, and a certain margin can be added.

The output density data of Noctiluca is also between 0 and 1. After linear conversion, the actual possible density of Noctiluca is predicted. The conversion formula is:

$$S = \overline{S} * (S_{\max} - S_{\min}) + S_{\min} \tag{2}$$

The flow chart of the IGA-BP algorithm is shown in Figure 2. The algorithm steps are as follows:

(1) Generate an initial population randomly by using immune genetic algorithm;

(2) Apply the network parameters representing each individual to the BP network structure after decoding;

(3) If the variance sum of an individual is less than the set threshold, the accuracy requirements are met;

(4) At this time, the variance sum of each individual is the antigen, and the goal is to minimize the variance sum. The current population is the initial antibody population. The fitness value of the

individuals in the population is calculated, and the fitness value is from high to low. Sort antibody populations;

(5) Calculate the concentration of each individual in the antibody group, and combine the fitness to calculate the comprehensive fitness. The higher the fitness, the greater the probability of selection; the lower the individual concentration, the greater the probability of selection;

(6) Select the current new antibody group (there is a generation gap, only select the good comprehensive fitness), crossover and mutation operations;

(7) The program ends.

4. Analysis and Research on Intelligent Management System of Marine Engineering Service Based on Genetic Algorithm

4.1. Platform Basic Module Development

(1) User role and user management module

User roles are the basic unit for distinguishing user identities and the basic division of user rights. For the convenience of management, the platform has three basic user roles: ordinary user, ordinary administrator and super administrator roles.

Through the user management module, authorized administrators can manage users in the system, including modifying user information, promoting or reducing user roles, setting user status, and deleting users. When the user status is set to invalid, the user cannot log in, but the user information is still retained, and it can continue to be used after it is set to valid.

(2) Data storage

After the original data set is processed by the program, the metadata of the data set (such as the name of the data set, the observation sea area, the observation time, the project to which the data belongs, the parameters of the data observation, the platform, the data format, the volume of the data set, the density level, etc.) A collection of data for data retrieval or data request. Extract the sampling point coordinates or the geographic location information of the sampling area in the data set and save it to the geographic location data set. Retrieves datasets within an area by picking a specific geographic location.

4.2. Experimental Detection of Marine Disaster Intelligent Early Warning

On the marine comprehensive observation platform, considering that red tide is one of the most harmful marine disasters, a neural network red tide early warning model based on immune algorithm optimization (IGA-BP) is further proposed. Figure 2 is a schematic diagram of the comparison of the effects of the two early warning models, IGA-BP and BP. The abscissa represents the group, and the ordinate represents the square of the error. The detection results are shown in Table 1.

Table 1. Test results

group	IGA-BP	BP
1-5	0.04	0.05
6-10	0.06	0.12
11-15	0.09	0.11
16-20	0.05	0.14

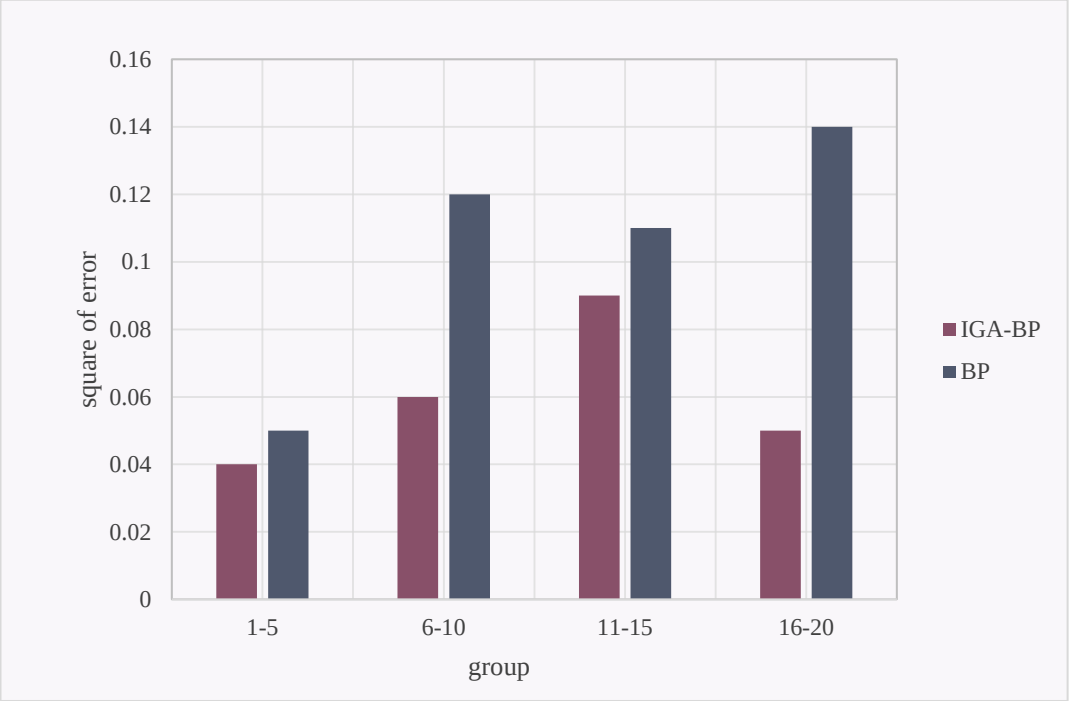

Figure 2. Comparison of output error between IGA-BP early warning model and BP early warning model

After comparison, the first 20 groups of data used to train the network are all fitted more accurately. In the 5 groups of data in the test group, the square of the error of the IGA-BP early warning model is below 0.04, while the maximum square of the error of the BP early warning model is below 0.04. to 0.05, as shown in Figure 3. The point with the largest error may be temporarily not included in the original data error. Even if this factor is considered, the error of the IGA-BP early warning model at this point is lower than that of the BP early warning model. The remaining points also show that the error of the IGA-BP early warning model is lower than that of the BP early warning model. Obviously, in terms of accuracy, the IGA-BP early warning model is better than the BP early warning model.

10 groups of data of IGA-BP and BP network early warning model were randomly selected, and the time-consuming of the two was compared. The results are shown in Table 2.

Table 2. Comparison of statistics between IGA-BP early warning model and BP early warning model

Group	IGA-BP	BP
1	5.1	8.1
2	3.4	6.4
3	3.8	6.6
4	4.4	5.7
5	4.1	7.1
6	3.7	7.1
7	5.8	7.4
8	5.5	6.8
9	4.6	6.9
10	3.7	7.2

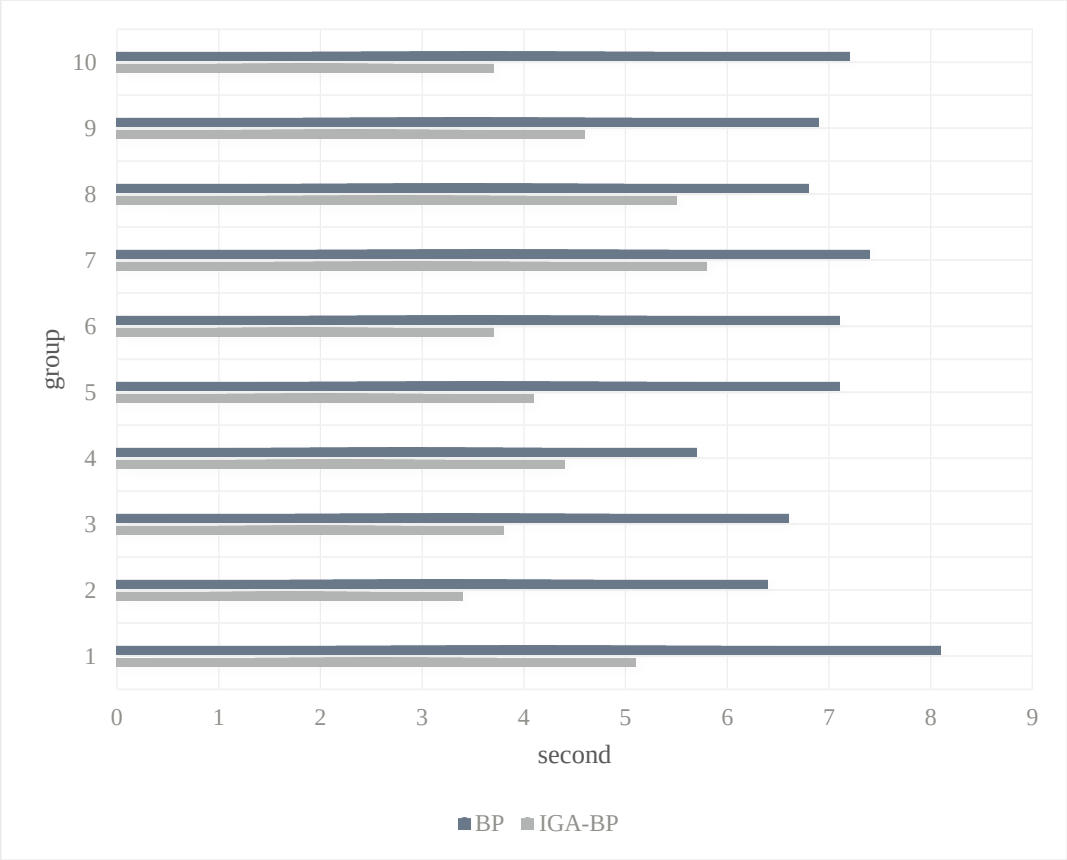

Figure 3. Time-consuming comparison

From the time-consuming comparison, it can be seen that the IGA-BP early warning model is also better than the BP early warning model, as shown in Figure 3.

5. Conclusion

Although the marine engineering service system greatly reduces the redundancy of data and improves the management efficiency of marine data, there is still a lot of room for improvement, mainly including the following points: (1) Due to the amount of stored data The query speed is slow when querying data from the database, and the query speed is a key factor restricting the efficiency of users. Therefore, it is necessary to optimize the query algorithm and improve the data storage; (2) Due to the lack of marine data, this paper constructs The offshore engineering service system can only query for a limited number of years, and the data information of the offshore engineering service system database needs to be updated.

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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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