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Offshore Engineering Project Management Method based on Data Fusion

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Abstract: With the development of science and technology, the research on relevant theories and key technologies of water quality detection(WQD) based on data fusion(DF) technology has become a research hotspot. It plays an important role in the management of marine engineering projects. It can not only improve the accuracy and sensitivity of WQD, but also produce greater social and economic benefits. Therefore, this paper studies and analyzes the application of offshore engineering project management(OEPM) method based on DF. This paper takes the management of water quality inspection project of ocean engineering as the research object. This paper briefly analyzes the DF technology and algorithm, and discusses the application of multi-sensor DF technology in water quality management of marine engineering projects; Through the experimental analysis, the feasibility and effectiveness of applying the DF technology to the OEPM method are verified.

1. Introduction

With the development of coastal economy in China, the water body and ecological environment in China are seriously polluted. Due to the influence of water pollution, eutrophication and red tide occur frequently in a large area of China. In order to accurately evaluate the quality of marine water, marine engineering project management methods have become the current research hotspot, such as water quality simulation method, fuzzy comprehensive detection method, grey system theory method, etc. these methods have also been successfully applied to the marine water environment quality detection, and have achieved fruitful research results. However, these methods have certain defects. In this paper, multi-sensor data are fused to reflect the overall quality of the marine water environment, and the marine engineering project management is carried out.

Based on the application research of OEPM methods in DF, some scholars have also put forward their own methods. McLeroy p g applied the multi-sensor information fusion technology to the water environment monitoring system. Although the above two methods can obtain accurate evaluation of water quality, their stability is not good and they are vulnerable to the influence of the external environment [1]. Chaurasiya R B combines multi-source water quality data based on DS evidence theory, but the basic value of reliability distribution function of this method is obtained by monitoring personnel or expert system according to experience, with certain error. In view of these problems, this paper proposes DF and establishes the management model of marine engineering water quality project. The model has high prediction accuracy, fast convergence speed and strong simulation ability within the prediction error range, and has good generalization ability in actual prediction [2].

This paper will establish a relatively complete set of marine engineering project management methods through the research of multi-sensor DF technology on the planning management of marine engineering projects under construction. The characteristic of multi-sensor DF technology is that it relies on certain criteria to analyze and synthesize data in different time and space, and obtain more accurate category or state detection than a single sensor. Through effective DF technology, multiple data or groups of data can be processed at the same time, so as to obtain data that can accurately reflect the water quality and improve the management of marine engineering WQD projects [3-4].

2. DF Technology and Analysis of OEPM

2.1. Overview of Multisensor DF Technology

2.1.1. DF Process

The process of DF can be simply divided into four steps. The first step is to receive signals and exchange data between the sensor and the computer. The second step is to process the data collected by the sensor. The third step is to import the data into the fusion center to complete the extraction of data attribute values. Step 4: perform DF calculation and analysis [5-6]. Fig. 1 is a schematic diagram of the DF process.

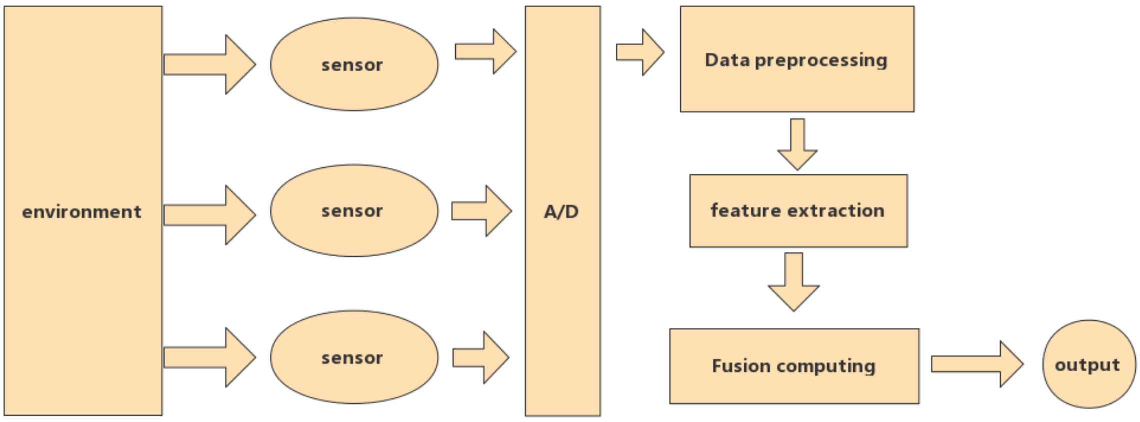

Figure 1. Schematic diagram of DF process

2.1.2. Data Layer Fusion

Data layer fusion can directly fuse the original sensor data without preprocessing the data. The fusion process of data layer fusion is shown in Fig. 2.

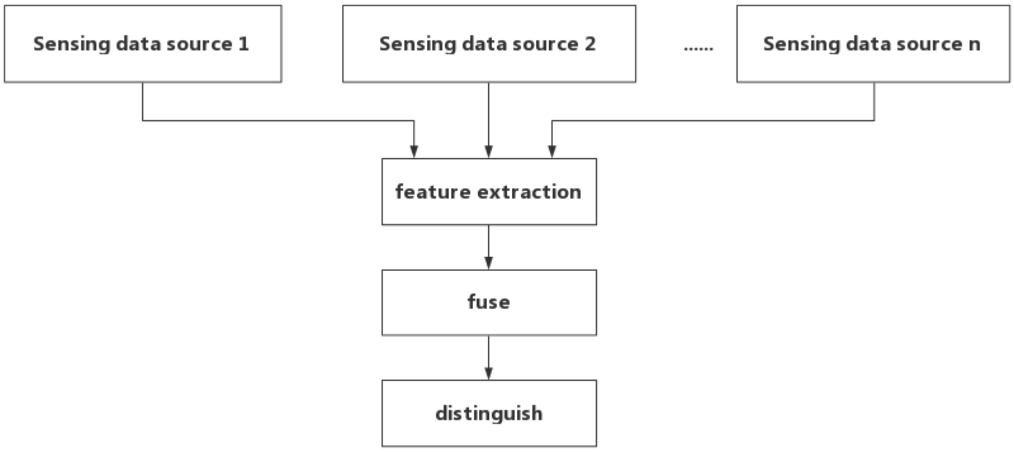

Figure 2. Data layer fusion

2.2. Application of Multi-Sensor DF Technology in Water Quality Management of Offshore Engineering Projects

The basic theory of OEPM comes from project plan management, but it has many differences. The biggest difference is that the data volume of offshore engineering project is large, and the resulting change is that special processing methods need to be considered when the data volume reaches a certain level for the originally simple requirements [7-8]. The management process is from coarse to fine, from fuzzy to clear, and takes a relatively long time. There are the same problems with the project plan management. Corresponding to the continuous improvement of various types of information, the plan management is also a process from general to detailed. Generally, the project based plan management is divided according to the time and the degree of detail. After the division, a multi-level plan is formed, which is the so-called multi-level plan [9].

WQD based on multi-sensor DF technology is to input the data of various sensors into the designed neural network framework through the computer, and realize the continuous dynamic monitoring of water quality in time and space through DF processing. At present, the main parameters of water environment pollution detection include dissolved oxygen, chemical oxygen demand, phosphate and other parameters. The methods mainly include chemical detection technology, physical detection technology, biological detection technology and so on [10-11].

From the planning management of offshore engineering projects to the construction of WBS, to the sorting out of task list, to the logical relationship, to the estimation of construction period and working hours, to the completion of target plan. However, plan formulation is only the first step of plan management. Having a good plan does not mean good plan management. After plan formulation, we need to consider how to detect and feedback the plan. After the plan is formulated, the plan benchmark shall be defined as the basis for the evaluation of the future plan implementation process. In addition to the benchmark plan, the plan benchmark also includes the budget quantity and budget cost [12-13]. The plan is composed of tasks one by one. Each type of task has its own completion criteria. Only after such a set of criteria is established can the completion of the task be clearly defined. The actual progress of the whole project plan can be summarized after the completion of all task items. After the establishment of standards related to progress detection, data feedback can be quantified into analyzable data. Next, the establishment of plan progress detection and data feedback are studied [14].

2.2.1. Problems to Be Solved In Multi Project Management of Offshore Engineering

Based on the characteristics of offshore engineering projects, the following problems need to be solved in the multi project management of offshore engineering enterprises.

According to industry requirements, enterprise strategic planning, enterprise risk tolerance and the use of existing resources of the enterprise, reasonably select multiple projects; According to the requirements of multi project management, the object must include all the projects in the enterprise. In multi project management, the multi projects should be reasonably grouped and graded according to the characteristics of offshore engineering, and the resources of the enterprise should be reasonably allocated. Through the overall allocation of multi projects, the enterprise benefits can be maximized or the enterprise strategy can be realized efficiently; An offshore engineering enterprise shall establish a multi project management framework in accordance with the requirements of multi project management, and establish a multi project management system in stages according to the requirements of the enterprise's strategic planning and multi project management framework [15-16].

After the construction of the multi project management system, the multi project management system should be continuously optimized according to the effective control of the assurance system and the requirements of the multi project management framework, so as to continuously improve the maturity of enterprise project management. Only when the enterprise continuously optimizes the project management system can the enterprise's project management ability be continuously improved and the resources can be effectively allocated through the enterprise's internal network and processes [17].

2.2.2. Analysis of OEPM Data

Progress and quantity analysis: analyze the deviation of progress and quantity of works as of the current reporting period, and evaluate the required construction period and quantity of works in the plan. Analyze the impact of the current trend of the plan on the progress in the next 3 months. Analyze the impact of the current trend of the plan on the progress of future milestones, especially the important milestone nodes of the contract. Analyze the impact of the current trend of the plan on the planned completion date of the project. Analyze the current production efficiency in the plan, and evaluate whether the future project quantity can be completed on time, so as to form a reasonable resource input to ensure the achievement of the progress date. Use the Gantt chart of the plan management software to display the progress difference.

Critical path analysis: critical path is a series of tasks that determine the earliest completion of the project, and its delay will directly cause project delay. The critical path is calculated by the longest path method. When the critical path does not allow negative total float. Analyze whether the current critical path of the project plan has caused the delay of the project completion date.

Resources and production efficiency: track and monitor the production efficiency of key resources (important types of work, important equipment or facilities) of the project to analyze the development trend of their production efficiency.

2.3. Progress Detection and Feedback of Offshore Engineering Projects

2.3.1. Actual Progress Detection

In order to detect the completion of tasks or achievements more objectively, tasks or deliverables are broken down into more detailed and quantitative steps and corresponding weight proportions are allocated. The general principles are as follows: pay attention to the starting point and conditions of the task, set the weights for the detection steps, including the audit or inspection points, reflect the different responsible participants, and clarify the conditions for the completion of the task. Among all project tasks, design tasks, procurement tasks and production tasks are quite different from each other. On this basis, we will consider how to set their own task detection standards, so as to summarize and feed back the actual project progress and lay a foundation for subsequent data analysis and correction.

The advantages of data layer fusion are mainly reflected in less damage and high accuracy of DF at this layer. The disadvantage is that the fusion of the data layer is the fusion of the original data, so compared with other fusion layers, it needs to process a large number of sensor data, with high processing cost, long processing time and higher requirements for real-time error correction.

2.3.2. Determination of Plan Benchmark

Generally speaking, plan benchmark refers to what is the goal of plan management. In addition to the benchmark plan, it also includes other aspects, such as budget quantity, budget cost, S-curve of the benchmark plan and how to manage the benchmark plan.

Benchmark plan. For offshore engineering projects, the benchmark plan is the target plan determined in the first edition. The benchmark plan shall be approved by the project manager, who usually refers to the participants of the project, planning, design, procurement, production, drilling and other major projects. In addition, the benchmark plan must reflect all the work of the project and be displayed in a bar chart. The benchmark plan is used as the benchmark for the comparative analysis of the current project progress. The benchmark plan usually displays the benchmark bar and the current bar at the same time.

Budget quantity. The so-called budget quantity refers to the quantity of resources allocated according to the requirements of completing the benchmark plan, including labor, equipment, facilities and sites. By comparing the budget quantity with the actual expenditure quantity, the health data of the project progress can be obtained, and the resource input can be arranged.

Budget costs. The cost is calculated based on the allocated resource quantity and unit price, and the benchmark comprehensive plan and budget cost of the project budget cost can be formed accordingly to calculate the earned value. Similarly, for non resource expenses or non direct expenses, you can allocate the expenses to tasks by using the method of one-time expenditure, management and allocation.

Benchmark plan management. The fourth level plan officially approved and released in the first edition is the project benchmark plan. Since the project benchmark plan represents all the task items required for the project, that is, it fixes the project scope, and the project benchmark plan is completed based on the contract requirements and the actual situation, the benchmark plan will not be changed. Unless there is an approved project contract change and the entire project scope changes, the benchmark plan can be changed. The change of the benchmark plan shall be the new benchmark plan after adding the project change part on the basis of the current plan and recalculating the progress [18].

3. Research on DF based on D-S Evidence Theory

Among the DF technologies, decision level fusion is the most mature and widely used fusion method at present. The advantage of DS proof theory is that there is no need to compare multiple sensors. Combined with the characteristics of marine WQD, this paper studies the project management of marine WQD based on DF technology, and verifies its feasibility.

3.1. D-S Evidence Theory

DS method is a DF classification method that can deal with uncertainty estimation. Compared with probability theory, the prior data collection in evidence theory is more intuitive and simple. DS evidence theory can integrate data sources or knowledge or data from different experts according to these characteristics, and finally integrate data from different knowledge bases. The flow chart of the fusion process is shown in Figure 3.

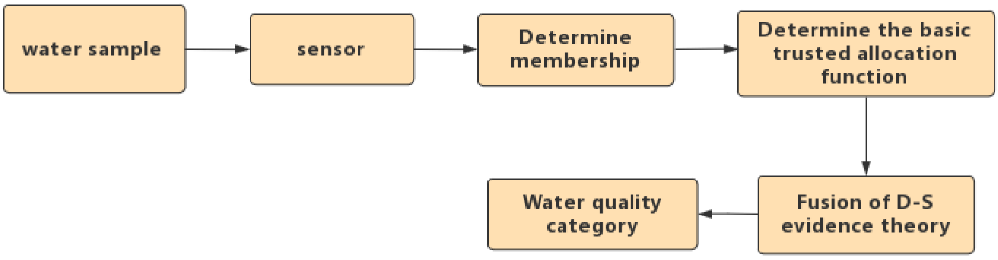

Figure 3. Schematic diagram of fusion process of DS evidence theory

First, the base value of the probability distribution function of each sensor is calculated according to the detected marine water quality parameter information; In order to understand the combination of different types of sensor data and different human body data at different times and places, the proof making process of DS is used to obtain the corresponding data of several sensors; Finally, under certain decision-making rules, people accept trust results based on experience and successful goals.

3.2. DF Algorithm

In order to verify the functional form of the observed eigenvalues relative to the water quality level by the DF technology proposed in this paper, the membership function () is represented by fuzzy sets, where I = 1,2,..., n. j=1,2,3,4 N represents the number of sensors.

The membership function () corresponding to different parameters in the water sample can be determined by different algorithms. The expression of the membership function is:

$$\eta_i^j(x_{in}) = \exp(-\frac{(x_{in} - bi_j)}{2\delta_{ij}^2}), i = 1,2,...,n, j = 1,2,...m_i \tag{1}$$

Where Xin is the nth measurement parameter for measuring water quality; Bij is the characteristic parameter of the nth standard water quality category; δ Ij is the characteristic maximum deviation of the nth standard water quality category.

After calculating the membership values of various water bodies corresponding to the sensor data, it is assumed that γ 1 is the weight of the nth feature parameter, $\sum_{i=1}^{8} \gamma_i = 1$ And γ 1> 0 The fuzzy membership degreeγ1> 0 of the observation sample can be defined as:

$$\eta_i^j(\bar{x}_i) = \sum_{i=1}^{8} \gamma_i \times \eta_i^j(x_{in}) \tag{2}$$

Where$\eta_i^j(\bar{x}_i)$ represents the membership degree of the data measured by the sensor I belonging to the class J water quality. $\eta_i^j(\bar{x}_i)$ indicates the possibility that the water sample measured by the sensor is confirmed to be a certain type of water quality, and numerically indicates the correlation coefficient of the sensor to a certain target.

4. Case Analysis of Water Quality Project Management Method of Marine Engineering based on DF

In order to verify the effectiveness and feasibility of the DF based management method for marine engineering water quality projects, this paper obtains the marine water quality data through the marine monitoring station, and processes and analyzes the data. As shown in Table 1.

Table 1. Marine water quality data sheet

Water quality group	1	2	3	4	5	6
COD(mg/L)	1.28	3.1	1.60	3	3.5	1.12
Dissolved oxygen(mg/L)	6.4	5.2	7.2	5	5.1	6.1
Oil stain(mg/L)	0.05	0.1	0.04	0.05	0.09	0.05
Cadmium(mg/L)	0.00084	0.00057	0.00086	0.005	0.008	0.00057
Zinc(mg/L)	0.0056	0.00180	0.0073	0.050	0.07	0.00180
Active phosphate(mg/L)	0.015	0.032	0.018	0.030	0.040	0.0020
Inorganic nitrogen(mg/L)	0.2	0.34	0.18	0.3	0.35	0.19
Chlorophyll(mg/L)	0.0005	0.008	0.0023	0.005	0.006	0.00072

Table 1 shows the content values of parameters in seawater collected from the water quality monitoring station through sensors and different WQD methods. Take these parameter values as sample data, and calculate the membership degree of each parameter in various water quality. Table 2 and Figure 4 are the membership degree values of the data.

Table 2. Membership data table of T1 time data

Subordinate degree	η_1	η_2	η_3	η_4	η_5	η_6	η_7	η_8
Class I	0.7527	0.6799	0.6040	0.1980	0.3258	0.4258	0.4260	0.3844
Class II	0.2222	0.2764	0.0000	0.3807	0.2464	0.2583	0.3411	0.2482
Class III	0.0241	0.0413	0.2765	0.2931	0.2444	0.2583	0.1752	0.2976
Class IV	0.0010	0.0023	0.1195	0.1283	0.1834	0.0576	0.0577	0.0698

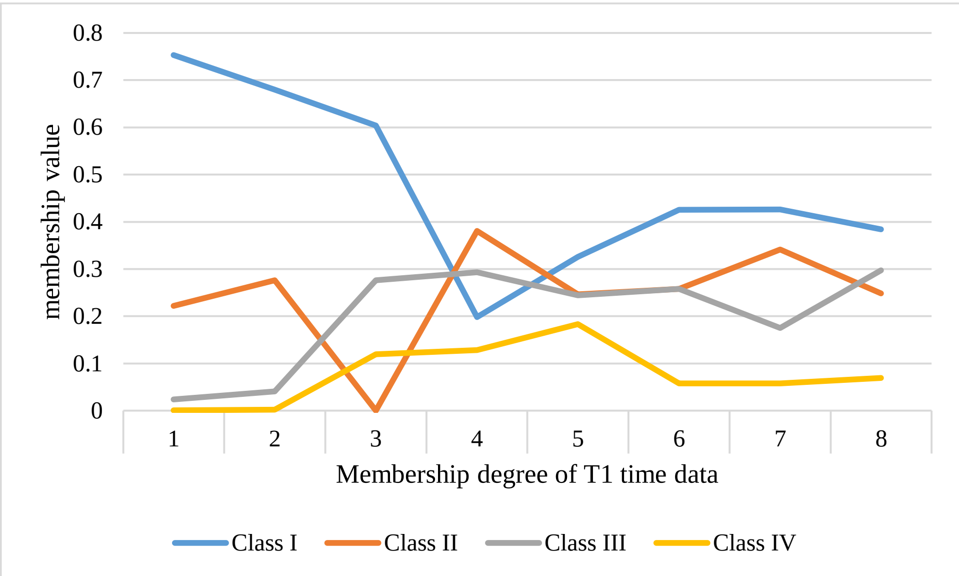

Figure 4. Membership degree of T1 time data

It can be seen from the data in the above table that the obtained data are of class I water quality with the largest degree of membership. It can be concluded that the marine project management based on DF technology proposed in this paper has better distinguishability, which shows that it is effective to apply DF technology to the management of marine project WQD project.

5. Conclusion

In this paper, based on the application of DF in the management of marine engineering projects, the feasibility of applying DF technology to the management of marine engineering projects has been verified by taking the management of marine water quality projects as the research object, and good results have been achieved. But there are also shortcomings. The data layer fusion used in this paper is the fusion of original data, which needs to process a large number of sensor data, with high processing cost, long processing time, and higher requirements for real-time error correction. This influence factor should be taken into account in the experiment. Therefore, the application of OEPM method in DF needs 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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