The Design and Research of Ocean Observation Buoy Operation Status Monitoring System

Yimeng Zhang¹, Lingfeng Liu¹, Yi Guan¹, Kun Song¹ and Jinxing Xu¹

¹National Ocean Technology Center, Tianjin, China
E-mail: 1271028061@qq.com

Abstract. At present, there is no unified monitoring system for ocean observation buoys in China. Some of the existing monitoring systems are only decentralized management and control of observation buoys, and their accuracy and management scope cannot meet the needs. This article describes the design and development process and technical details of the three main modules of the system's real-time monitoring, operation and maintenance management and intelligent decision-making. This system can obtain the real-time status of the entire network of buoys in time, so it can find faults in time, and eliminate and isolate the faults in time to reduce the losses caused by the buoy faults to the entire marine environmental protection system.

1. Introduction
Ocean observation buoy is one of the main means of marine disaster monitoring. It is characterized by all-weather, long-term continuous and fixed-point monitoring, which is irreplaceable by other marine monitoring methods [1]. The research of ocean observation buoy technology itself is also developing in the direction of low cost and multi-factors. The replacement of ocean observation buoys has become more and more routine [2]. The problem of reliable operation of the buoy system has been largely solved [3].

In China, the study of ocean observation buoys started in 1965. China has basically mastered the key core technologies, and the overall level has reached the international advanced level [4].

In recent years, China has started to study the development and application of an integrated marine online monitoring buoy system. Through hydrometeorological and biological indicators, data on conventional marine hydrology, meteorology, water quality and biology can be obtained to reflect the marine environment. However, the online monitoring of marine buoys in China has not yet been formed, and the monitoring of marine observation buoys is currently based on manual monitoring. There is also no unified monitoring system specifically for the monitoring system of the operating status of ocean observation buoys [5]. Some existing monitoring systems are only for decentralized management and control of observation buoys, and their accuracy and management scope cannot meet the demand [6]. In order to make up for the lack of this aspect in China, the design of the monitoring system for the operation status of ocean observation buoys is very critical [7].

2. Composition and design of system
According to the requirements, the ocean monitoring buoy operating state monitoring system can be divided into three main modules: real-time monitoring, operation and maintenance management, and intelligent decision-making. The architecture of the ocean observation buoy operation status monitoring system is shown in figure 1.
3. Design of subsystem

3.1. Real-time monitoring module
The real-time monitoring module implements the unified management of basic static attribute information of buoys and their configured sensors and other important components, real-time monitoring and management of buoy operating status, buoy fault management and fault alarms. By acquiring and judging the real-time status information of the buoy, the fault type and the fault information of the buoy are automatically diagnosed, and the fault alarm information is pushed to the user, and the alarm information is visually presented by ArcGIS.

3.1.1. Equipment basic information management function. The equipment basic information management realizes the unified management of the basic static attribute information of important components such as buoys and their configured sensors. All technical attribute information such as the functional characteristics and measurement accuracy of all buoys and the management attribute information such as the operation and maintenance support unit under the jurisdiction are all entered into the system.

3.1.2. Comprehensive monitoring function of running status. The operation status comprehensive monitoring function realizes real-time monitoring and management of the buoy operation status. In terms of monitoring content, on the one hand, regularly collect status information such as the power supply and position of the buoy, and use it to assist in fault judgment. On the other hand, by collecting a large amount of working data of sensors, based on the theory and technology of machine learning, each device generates a dedicated fault warning line associated with its application environment. The visual presentation technology based on ArcGIS is used in the display form to display the running status information. For fault analysis and diagnosis, the automatic grouping technology of associated alarms is used to intelligently determine the main cause of the fault and give corresponding alarm prompts.

3.2. Operation and maintenance management module
The operation and maintenance management module includes the application process management of spare parts, users, departments and personnel. The module reasonably associate and assign the authority and tasks corresponding to different departments and personnel.

3.2.1. Equipment operation and maintenance process management function. The equipment operation and maintenance management function realizes the digital management of the entire life cycle of the use and operation and maintenance of ocean observation buoys. From the time the buoys enter the network, they track all relevant processes of their operation and maintenance. Processes such as replacement and scrapping, and based on operation and maintenance process records, form a knowledge base.
3.2.2. **Spare parts management function.** Spare parts management mainly focuses on the management of the application process of spare parts, including the storage, removal and replacement of spare parts.

3.2.3. **System user management.** System user management assigns different permissions to various users to ensure that the system meets the business needs of different users and guarantees the safety of operations. To achieve the definition and deletion of department roles and personnel roles in the system, through the establishment of a correspondence table between users and personnel, reasonably assign the permissions and tasks corresponding to different departments and personnel.

3.3. **Intelligent decision module**

By observing the properties of buoys, analyzing data such as measurement data, buoy layout, warnings, and faults, the intelligent decision module can estimate the life of buoys, implement fault warnings, and intelligently diagnose the causes of faults. Management work provides the basis for data decision support.

3.3.1. **Knowledge base management.** The knowledge base management mainly manages buoy information and related management regulations, policies and regulations, etc.

3.3.2. **Statistical analysis and decision support.** Statistical analysis and decision support is based on the information collected by the aforementioned static basic information management operation status monitoring, operation and maintenance process management and spare parts management, and carry out statistical analysis and evaluation through a variety of information organization forms.

4. **Analysis and description of systems business process**

The design of the business process of the system needs to meet the requirements of actual business management. It can provide an automated and informational monitoring platform for the buoy management and maintenance department, uniformly standardize the buoy operation and maintenance workflow, and improve the efficiency of buoy failure repair. To ensure that ocean observation buoys provide stable and reliable basic data for observation and forecasting operation. The design of the operational process of the ocean observation buoy operation status monitoring system is shown in figure 2.

![Ocean Observation Buoy Operation Status Monitoring System Flow Diagram](image-url)

*Figure 2. Business process logic diagram.*
5. Analysis of data flow
The path nodes of the data transmission in the monitoring system for the operation status of ocean observation buoys are divided into four levels: observation buoy, central station, provincial center, and national center. Each node has data file storage. The acquisition of data information of the ocean observation buoy operation status monitoring system needs to be consistent with the data transmission service. The corresponding data file transmission node obtains the data file, and analyzes and judges to form the real-time operation status information of the observation buoy, the specific information content and files. The processing method needs to be combined with the project's monitoring requirements and system implementation in the detailed design process. The data flow analysis is shown in Figure 3 below:

![Figure 3. Data flow diagram.](image)

6. Implementation of ocean observation buoy operation status monitoring system
The System interface of the operational process of the ocean observation buoy operation status monitoring system is shown in figure 4.

![Figure 4. System interface.](image)

Ocean observation buoy operation status tracking (region): According to different users, track the current operation status of ocean observation buoys in different areas, as shown in figure 5.
Take the barometric pressure data as an example to display the historical pressure observation data of the buoy, as shown in figure 6.

7. Conclusion
The system can monitor ocean observation buoys in real time and reduce the failure rate of ocean observation buoys. And through the collected pressure, air temperature, wind speed and other data, you can get the real-time status and historical status of the current sea area. Provide effective help for the protection and restoration of the marine environment and ecology.

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