Research on health management technology of ship cabin equipment

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Abstract. The research and development of health management technology of ship cabin equipment is backward, which can’t meet the development needs of intelligent ship. In view of the current large number of ship cabin equipment and low operation and maintenance level, the study of cabin equipment system and reliability analysis are carried out with the cabin equipment as the research object, and the data of the cabin equipment are modeled by data collected and processed. The health management system of cabin equipment is developed to realize the functions of health management, such as equipment fault diagnosis and predictive maintenance, to improve the automation and intelligence level of equipment operation and maintenance.

1. Foreword
As a typical product of ship supporting, marine cabin equipment has the industrial characteristics of large quantity, wide range, high technology and high added value. It is an indispensable part of intelligent ship[1]. Its R & D, design, manufacturing and service level is not only an important symbol of the overall development level of the shipbuilding industry, but also an important embodiment of the comprehensive competitiveness of China’s shipbuilding industry. Compared with foreign countries, there is still a big gap in product digitization and intellectualization. Most of the equipment still stays in the stage of simple control and basic monitoring alarm, and still faces the problem of insufficient competition in high-end functions, which can’t meet the needs of industry technology development[2,3]. In view of the current ship cabin equipment is numerous and the operation and maintenance level is low, the ship cabin equipment health management technology research is carried out and the ship cabin equipment health management system is designed to realize the health management of ship cabin equipment and improve the automation and intelligent level of equipment operation and maintenance.

2. Architecture design of equipment health management system
The architecture of ship cabin equipment health management system is mainly divided into field equipment layer, data acquisition layer, data analysis layer and application layer. The overall architecture of the system is shown in Fig.1.
1) Field equipment layer uses advanced sensing technology to obtain the key monitoring parameters of cabin equipment;
2) Data acquisition layer uses intelligent acquisition equipment to collect the key monitoring parameters of the perception layer, which is the source of the original data of the system;
3) Data analysis layer is the core of the system. The main function is data storage and data processing analysis. It can realize online real-time data management, ship cabin equipment operation status analysis, intelligent fault diagnosis, alarm and other functions.
4) Application layer presents real-time monitoring data to relevant personnel through human-computer interaction, and displays alarm information and fault information.
3. The Research of key technology

3.1. Real time online fault diagnosis technology

There are a lot of equipment in ship cabins, which are scattered and hidden, so it is difficult to carry out regular inspection, and it is difficult to find equipment abnormalities in time. Based on the full investigation, the real-time online fault diagnosis technology is put forward to realize the staff to find out the equipment faults and hidden dangers in time, carry out maintenance and repair in a targeted way, reduce unnecessary repair, thus prolong the repair cycle and reduce the production cost[4].

By installing various sensors in the ship cabin system, using a variety of signal processing methods for fault feature extraction, using neural network, expert system and other methods for real-time online fault diagnosis, so that the staff can find the equipment fault in time and take corresponding maintenance measures. The data of vibration, key phase, instantaneous speed, oil parameters and thermal parameters are collected, and the data communication and fusion analysis with the engine monitoring system are carried out, and these data are transmitted back to the operation and maintenance platform in real time. Through the fault analysis and diagnosis module, the remote inspection of the equipment operation status is completed, and the abnormal status of each measuring point of the equipment is effectively mastered. Then, according to the equipment working status parameter information and fault diagnosis model, the diagnosis and positioning of the equipment fault is realized, and then the faults and hidden dangers are found in time, targeted maintenance and repair are carried out, so as to reduce unnecessary repair and production cost.

3.2. Real time online fault diagnosis technology

Signal directed graph (SDG) is a qualitative mathematical model, which uses directed branches to connect the nodes according to certain rules to form a network topology[5,6]. It can describe the relationship between process variables and fault deduction process in an intuitive and simple graphical way, contain a large amount of potential information, and express the mechanism and relationship of the system[7]. Based on the SDG fault prediction model, using the predicted fault characteristic parameters to evaluate the current performance state of the fault and early predict the fault, it can more effectively realize the early identification of the cabin equipment fault, so as to effectively reduce the economic and personal losses caused by the fault with strong concealment and difficult to detect. The specific process of prediction is shown in Fig.3.
3.3. **Predictive maintenance technology**

According to the on-line monitoring information, the reliability indexes are evaluated and predicted in real time, and the remaining life reliability of a specific equipment object is objectively analysed. It can help the maintenance personnel to find out the abnormal symptoms of the equipment in the early stage, so as to find out the cause of the fault as soon as possible and predict the impact of the fault, so as to realize the planned and targeted condition-based maintenance. Make full preparation before maintenance, including preparation of data, tools, parts and testing instruments for maintenance, improve maintenance quality, reduce spare parts reserve and maintenance times, avoid excessive maintenance and reduce maintenance cost.

![Flow chart of fault prediction based on SDG.](image)

**Table 1. Equipment maintenance strategy management.**

| Number | Fault name                              | Terms of settlement                                                                 |
|--------|-----------------------------------------|-------------------------------------------------------------------------------------|
| 1      | The oil supply pipeline is not connected| Check the status of the valve between the oil bunker and the fuel supply unit        |
| 2      | Filter element blocked                  | Switch the standby primary filter and clean the filter element                       |
| 3      | Booster pump 1 Failure                  | Switch to booster pump 2 to work, check the problem of booster pump 1               |
| 4      | Booster pump 2 Failure                  | Switch to booster pump 1 to work, check the problem of booster pump 2               |
| 5      | The pipeline is blocked                 | Check the valve status after booster pump. If it is opened, it may block the heater and plate cold self-cleaning filter. It is necessary to switch the heat exchanger and clean it in time |
| 6      | Low heater power                        | Increase the power of the heater; increase the steam temperature; increase the opening of the temperature control valve; switch the heater and clean it regularly |
| 7      | The heat exchange effect of cooler is not good | Increase the heat exchange area of the heat exchanger; clean the surface of the heat exchanger regularly; check the temperature of the cooling water and the status of the inlet and outlet valves of the cooling water |
4. **System development and Application**

Ship cabin equipment health management technology can realize the ability of fault diagnosis and predictive maintenance of ship cabin equipment, bid farewell to the waste of resources caused by manual regular maintenance, reduce the maintenance cost, improve the automation and intelligent level of cabin equipment operation and maintenance, and improve the operation reliability and safety of ship cabin equipment. In this paper, the fuel supply unit is taken as the research object, and the ship cabin equipment health management system is developed and tested.

![Figure 4 System application deployment diagram.](image)

5. **Conclusion**

Through the establishment of ship cabin model and health management research, it can effectively improve the functions of cabin equipment such as fault diagnosis, fault prediction and predictive maintenance, enhance the operation and maintenance ability of ship cabin equipment, improve the safety operation and maintenance level, reduce the operation cost of enterprises, and improve the health management level of cabin equipment. The promotion and application of the project will comprehensively improve the digitization, networking, intelligence, safety and operation and maintenance integration ability of the ship cabin core equipment.

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