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System Development and Design of Ship Power Machinery in the Context of Artificial Intelligence

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Abstract: A ship power machinery monitoring system can help ship personnel to keep abreast of the operating rules of ship power machinery and equipment and carry out initial fault diagnosis, which is important for improving economic and social benefits. The purpose of this paper is to study the system development and design of ship power machinery in the context of artificial intelligence. The importance of ship power machinery monitoring system and the relevant theory of virtual instrumentation technology are explained, and the feasibility of applying virtual instrumentation technology in ship power machinery monitoring system is analysed and discussed; on the basis of the study of ship power machinery system, the overall design scheme of ship energy machinery monitoring system is proposed in conjunction with the demand analysis of the monitoring system; finally, the parameter configuration and modification are used to determine the alarm scheme of the monitoring system is verified that the design method can improve the rationality of the monitoring system design and can meet the requirements of the system designer, system user and system administrator as far as possible.

1. Introduction

As the "heart" of a ship, the ship's power machinery directly affects the safety of the ship, so it is particularly important to strengthen the research on the monitoring system of marine energy machinery. The traditional ship monitoring and management mode has defects such as disconnection between the ship and the monitoring centre, delayed information, ineffective monitoring and slow response speed [1-2]. With the development of signal processing technology represented by computer technology and artificial intelligence technology, ship diagnosis technology is also developing rapidly. The ship monitoring system based on virtual instruments is gradually improved, and the emergence of this system has overcome the defects of traditional ship monitoring and management to a certain extent, realising dynamic, timely and comprehensive management of ship information.

As the basic generating unit of a ship, the stability of the ship's power equipment is particularly important. A number of scientists have proposed a method for remote monitoring of noise data from marine energy equipment. Through mathematical modelling of existing noise data monitoring algorithms, the characteristics of single frequency channel noise signals were obtained, and simulation experiments verified the effectiveness of the method [3]. Other scholars have developed a ship power machinery dismantling system that combines reality with reality and good human-computer interaction. The system uses Unity3D as the development engine and runs on HoloLens devices. It enables the manipulation of virtual models, while the user can see the real physical world. The system uses Server/Client mode for Socket data communication to enable collaboration in virtual disassembly. The system solves the space and time constraints of disassembly in a realistic environment and greatly saves the cost of disassembly. The system has been experienced and tested to a high degree and therefore has great application and promotion value [4]. Therefore, it is important to monitor and manage the ship power machinery to ensure the safe navigation of ships and to guarantee the smooth passage of waterways [5-6].

This paper takes ship power machinery as the research object and adopts technologies such as virtual instrument, field bus and remote wireless data transmission to design and develop a set of on-site and remote monitoring system for ship power machinery, realising digital, intelligent and networked monitoring of the operating conditions of power machinery such as left and right main engine working conditions, generator working conditions and auxiliary engines. When the equipment fails, the shore-based mechanics can provide corresponding technical support.

2. Research on the System Development and Design of Ship Power Machinery in the Context of Artificial Intelligence

2.1. Feasibility of LabVIEW for Ship Monitoring

LabVIEW supports a variety of hardware configurations and can seamlessly connect with various field devices, thus facilitating data acquisition. In addition, LabVIEW also has powerful network communication functions, supporting a variety of network communication network protocols and built-in functions such as TCP/IP and Datasocket, which enable field measurement and control instruments to communicate with each other and pass parameters to remote devices [7-8].

Most of the devices currently used to implement monitoring systems are implemented in the form of microcontrollers or configuration software, which has certain shortcomings, whether in terms of human-machine interface or functional implementation. The microcontroller is difficult to display historical curves and build a friendly human-machine interface in real time, and it is difficult to achieve data transmission; and although the configuration software can design a friendly human-machine interface, it has limited functions, general performance and low cost performance [9-10]. In contrast, LabVIEW has the capability of HMI. In contrast, LabVIEW has many advantages such as friendly human-machine interface, powerful functions, short development cycle and easy maintenance [11-12].

Therefore, this paper adopts LabVIEW as the measurement and control software of the ship monitoring system, and uses the data acquisition module of LabVIEW to realize on-site data acquisition and the network communication module of LabVIEW to realize remote communication [13].

2.2. Overall System Scheme Design

The purpose of the system is to reflect the various operating parameters of the ship equipment [14]. The overall design scheme of the system is shown in Figure 1.

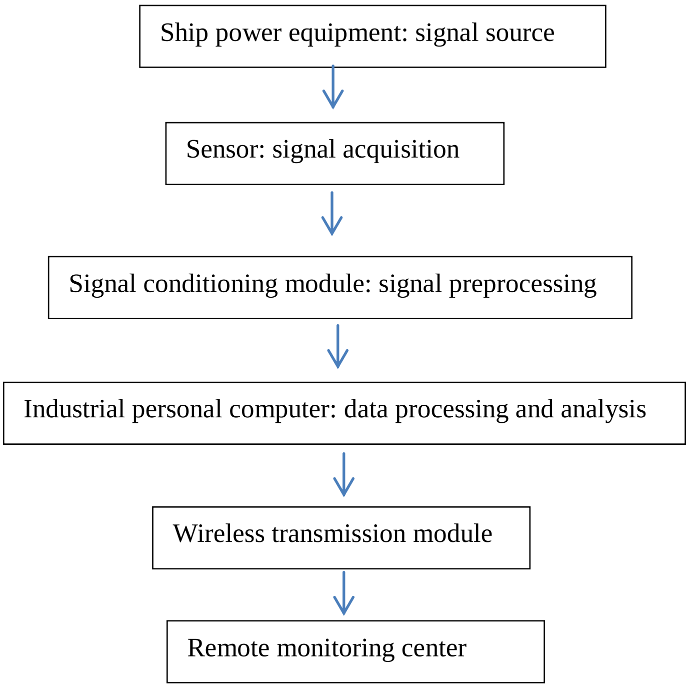

Figure 1. The overall program figure of system

The ship equipment remote monitoring system consists of six main components: signal source, signal acquisition, signal pre-processing, data processing and analysis, wireless data transmission, and remote reception and processing [15-16]. Its working principle: the signal is collected by sensors installed at equipment monitoring points, the collected data information is sent to the field module for pre-processing, then sent to the IPC through the signal analysis, display and storage software system, and the corresponding alarm is given according to the given alarm limit [17-18].

3. Investigation and Study of System Development and Design of Ship Power Machinery in the Context of Artificial Intelligence

3.1. Signal Feature Extraction Based on Labview

When the ship diesel engine is in normal operation, the surface vibration signal contains rich state information, and the signal analysis processing of the collected diesel engine surface signal waits for some characteristic parameters characterizing the state of the diesel engine. At present, as the vibration signal is easy to obtain for real-time monitoring, vibration signal analysis is widely used in fault diagnosis. In the analysis of diesel engine vibration signals, due to the complex structure of diesel engine, many vibration sources and complex propagation paths, and the superposition of interference noise from various equipment in the cabin, the collected signals are greatly disturbed, and there are many difficulties in fault diagnosis. It is necessary to analyse the diesel engine vibration signal in time domain and frequency domain and extract fault parameters with the help of Labview software. It is necessary to use Labview software to analyse the diesel engine vibration signals in the time and frequency domains and extract the fault characteristics.

When the fault develops to a certain stage due to its lack of stability, the cragging coefficient will decline. Due to this feature, we can use the cragging coefficient to analyse the development trend of mechanical faults.

$$\alpha_4 = \int_{\infty}^{\infty} x^4 p(x) dx \tag{1}$$

Where x(t) - the time history of the signal; p(x) - the probability density function of x(t).

The waveform factor is used as a parametric indicator to determine the type of fault. When the waveform factor is too large, a pitting fault may occur, and when the waveform factor is too small, a wear-type fault may occur.

$$K = \frac{Xrms}{\overline{X}_p} \tag{2}$$

Where the absolute mean $\overline{X}_p = \frac{1}{T} \int_0^T |x(t)| dt$.

Table 1. The sensitivity and stability of amplitude domain parameters

	Kurtosis coefficient	Waveform factor
Fault type	Pitting	Wear and pitting
Susceptibility	Good	Difference
Stability	Difference	Good

4. Analysis and Research of System Development and Design of Ship Power Machinery in the Context of Artificial Intelligence

4.1. LabVIEW and Database Connection

This paper uses a set of database connection tools provided by LabVIEW to implement inserts, modifications, deletions, queries and other functions using a MySQL database. The following describes the process of establishing a connection between LabVIEW and a MySQL database.

The LabVIEW database toolset is based on Open Database Connectivity (ODBC) technology, as shown in Figure 2. When using the ODBC API, a data source name (DSN) must be provided to connect to the actual database, so the DSN must first be created.

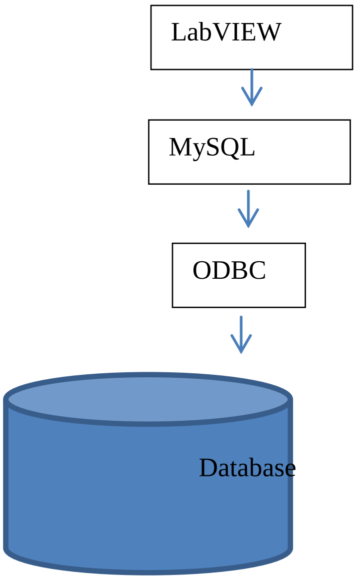

Figure 2. LabVIEW database toolkit is based on ODBC technology

The difference between a DSN user and a DSN system is that a DSN user is only visible to the current user, whereas a DSN can access all users in the system. Click the Add button on the User DSN tab to display the Data Source Driver selection dialog. Select MySQL ODBC 5.2wDriver and click Quit to open the MySQL Connector/ODBC Data Source Configuration window. Configure the data source name, user, password, database to connect to, etc. Click Test to test the connection. Click on OK to complete the DNS setup and LabVIEW is now connected to the MySQL database.

4.2. Parameter Configuration and Modification

In the background database, a parameter configuration table is set up to store and modify the upper and lower limits of parameters of each important component, so as to prepare for failure alarm and issue alarm when the parameters exceed the upper and lower limits. The parameter configuration is shown in Figure 3, where parameters can be queried, added, modified, deleted, etc.

Table 2. Configuration of generator parameters

Sampling parameters	Acquisition channel	Alarm delay(ms)	Alarm upper limit	Alarm lower limit
Power (Kw)	6	1	120	0
Current (A)	11	0.5	100	0
Power (Kw)	12	2	120	10

For example, in summer the lower limit for cooling water temperature should be adjusted upwards compared to winter, as should the oil pressure parameters, which are lower in summer compared to winter, as shown in Table 2. The specific operation is adjusted by the operator entering the parameter configuration interface.

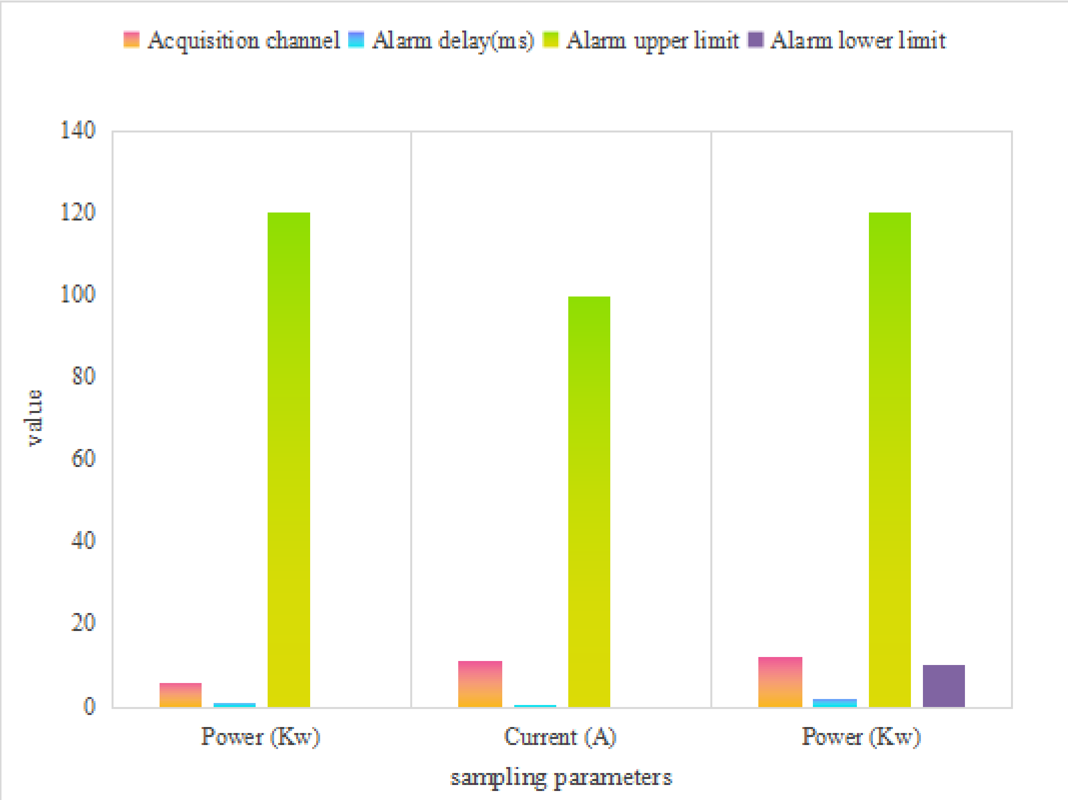

Figure 3. The program of parameters configuration window

This system divides the monitoring status into three levels, normal, over-limit and dangerous. For the convenience of the operator's work, the monitoring interface is designed with a digital meter head display, alarm light prompts, and three colours of green, yellow and red are chosen for the normal, alarm and danger states of equipment operation. When the system is running normally, when all monitoring points are shown to be in the normal state, the alarm light will show green normal state, in a silenced state. As long as one monitoring point triggers an alarm, an alarm sound will be emitted and the light will be displayed accordingly whether it is in alarm or danger state, only when the operator responds to make the monitoring point in alarm response state or automatic recovery state, the system sound and light alarm will be eliminated.

5. Conclusion

The increasing number of types of modern canal engineering vessels, their increasingly complex structures, their increasing efficiency and the gradual automation and intelligence of their operation and design have raised a new topic for the operation and maintenance of modern canal engineering vessels. At present, due to the level and time constraints, only a part of this paper has been carried out on the serialisation of the monitoring system for the power machinery of engineering vessels. A more in-depth and detailed study of the modular and serialised design of the monitoring system is to be improved in future work. (1) No further research has been done on the fusion of diagnosis between multiple diagnosis methods in the monitoring methods of ship power machinery. Further research should fully consider the modularity of new monitoring methods and the fusion of information between multiple monitoring methods. (2) In the serial design of the monitoring system, more monitoring objects are needed to test the reliability and stability of the product. Due to the practical conditions, it is necessary to cooperate more with the engineering ship using units in the future research process to obtain enough experimental objects and experimental feedback data of the monitoring system to meet the demand of system optimization design.

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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.

References

[1] Trauthwein G . Power Playes. Martime reporter and engineering news, 2019, 81(5):44-51.
[2] Iannotta B . Glimpsing the future. The Motor ship, 2018, 99(1163):4-4.
[3] Bakalov I . A Contemporary Concept in Troubleshooting and Fixing Malfunctions Using an Engine Room Simulator in Augmented Reality Environment. Universal Journal of Mechanical Engineering, 2019, 7(2):33-36. https://doi.org/10.13189/ujme.2019.070201
[4] Gnacinski P , Tarasiuk T , Mindykowski J , et al. Power Quality and Energy-Efficient Operation of Marine Induction Motors. IEEE Access, 2020, PP(99):1-1. https://doi.org/10.1109/ACCESS.2020.3017133
[5] Balabin V P , Kamnev M A , Kuchin N L , et al. Efficiency of emergency depressurization systems for marine nuclear reactor containments. Transactions Of The Krylov State Research Centre, 2018, 4(386):107-116. https://doi.org/10.24937/2542-2324-2018-4-386-107-116
[6] Soni T , Dutt J K , Das A S . Magnetic Bearings for Marine Rotor Systems - Effect of Standard Ship Maneuver. IEEE Transactions on Industrial Electronics, 2020, PP(99):1-1.
[7] Singh J , Dahiya R , Saini L M . Single DC source H-bridge topology as a low cost multilevel inverter for marine electric systems. Indian Journal of Marine Sciences, 2018, 47(6):1199-1207.
[8] Javaid U . MVDC Supply Technologies for Marine Electrical Distribution Systems. Cpss Transactions on Power Electronics & Applications, 2018, 3(1):65-76. https://doi.org/10.24295/CPSSTPEA.2018.00007
[9] Demir H S , Christen J B , Ozev S . Energy-Efficient Image Recognition System for Marine Life. IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, 2020, 39(11):3458-3466. https://doi.org/10.1109/TCAD.2020.3012745
[10] Landryova L . Simulation Modelling of Integrated Systems in Marine Technology - ScienceDirect. IFAC-PapersOnLine, 2018, 51(11):490-495. https://doi.org/10.1016/j.ifacol.2018.08.366
[11] Irfan S . Development of trainer sensor as media learning control systems for engine cadets at Merchant Marine Polytechnic Surabaya. Ukrainian Journal of Educational Studies and Information Technology, 2020, 8(2):55-70. https://doi.org/10.32919/uesit.2020.02.05

[12] Mademlis G , Liu Y , Chen P , et al. Design of Maximum Power Point Tracking for Dynamic Power Response of Tidal Undersea Kite Systems. IEEE Transactions on Industry Applications, 2020, PP(99):1-1.
[13] Soliman M A , Hasanien H M , Alkuhayli A . Marine Predators Algorithm for Parameters Identification of Triple-Diode Photovoltaic Models. IEEE Access, 2020, PP(99):1-1. https://doi.org/10.1109/ACCESS.2020.3019244
[14] Thrall J H , Li X , Li Q , et al. Artificial Intelligence and Machine Learning in Radiology: Opportunities, Challenges, Pitfalls, and Criteria for Success. Journal of the American College of Radiology, 2018, 15(3):504-508. https://doi.org/10.1016/j.jacr.2017.12.026
[15] Polina M , Lucy O , Yury Y , et al. Converging blockchain and next-generation artificial intelligence technologies to decentralize and accelerate biomedical research and healthcare. Oncotarget, 2018, 9(5):5665-5690. https://doi.org/10.18632/oncotarget.22345
[16] Syam N , Sharma A . Waiting for a sales renaissance in the fourth industrial revolution: Machine learning and artificial intelligence in sales research and practice. Industrial Marketing Management, 2018, 69(FEB.):135-146. https://doi.org/10.1016/j.indmarman.2017.12.019
[17] Camerer C F . Artificial Intelligence and Behavioral Economics. NBER Chapters, 2018, 24(18):867-71. https://doi.org/10.1016/j.cub.2014.07.040
[18] Kinoshita F , Okamoto T , Yamashita T , et al. Artificial intelligence-derived gut microbiome as a predictive biomarker for therapeutic response to immunotherapy in lung cancer: protocol for a multicentre, prospective, observational study. BMJ Open, 2020, 12(6):1823-33. https://doi.org/10.1136/bmjopen-2020-061674