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Research on intelligent integration and automatic control of Marine electronic and electrical system

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ABSTRACT

With the rapid development of modern information technology, especially the application of big data, the Internet of things, cloud computing and other technologies, the ship industry is ushering in an intelligent revolution. Intelligent integrated platform and automatic control technology have become the key factors driving this change. This paper comprehensively analyzes the intelligent integration and automatic control technology of ship electronic and electrical system, and discusses its potential and challenges in improving the efficiency, safety and economy of ship operation. This paper first summarizes the composition and functional characteristics of the ship electronic and electrical system, and then expounds the design idea, system architecture and implementation steps of the intelligent integration platform. On this basis, the application of automatic control technology in ship electronic and electrical systems, including the key subsystems such as energy management, auxiliary decision making and state monitoring, as well as the safety control problems facing these technologies in practical application. The paper also analyzes the application prospect of intelligent integration and automation control technology in the ship industry, and puts forward the strategies and suggestions to deal with the challenges of technology and management. Finally, the paper summarizes the research results and prospects the future research direction, aiming to provide theoretical support and practical guidance for the intelligent development of the ship industry, in order to realize the intelligence and automation of ship operation and improve the safety of shipsSex and economy, to contribute to the sustainable development of the ship industry. Through the research of this paper, it is expected to provide new ideas and solutions for the development of intelligent integration and automatic control technology of ship electronic and electrical system, so as to promote the ship industry to a more efficient and intelligent direction.

KEYWORDS

ship electronic and electrical system; intelligent integration; automation control

1 Introduction

In the field of Marine transport in the 21st century, ships as the main means of transport, the technological progress is directly related to the efficiency and safety of global trade, as shown in the figure below. With the rapid development of information technology, especially the wide application of big data, Internet of Things, cloud computing and other emerging technologies, intelligence has become a new trend of the development of the ship industry. Intelligence can not only improve the operation efficiency of ships, reduce the cost, but also enhance the safety and environmental adaptability of ships, which is of great significance to cope with the increasingly complex Marine environment and improve the international competitiveness. The background of this study is based on the multiple challenges facing the ship industry, including the need to improve energy efficiency, reduce environmental pollution and improve ship safety management. The development of intelligent integrated platforms and automated control technologies provides a new way to solve these challenges. The intelligent integration platform can realize the high degree of integration and information sharing of various ship systems, while the automatic control technology can improve the accuracy and response speed of ship operation and reduce human error.

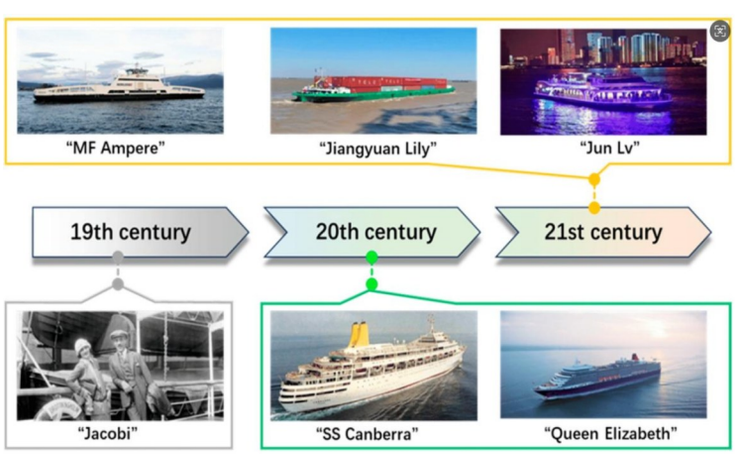

Figure 1

The research significance lies in that through the application of intelligent integration and automatic control technology, the operation state of ships can be optimized, the reasonable distribution and use of energy can be realized, and the economic benefits of ships can be improved. At the same time, by improving the automation level of the ship, the labor intensity of the crew can be reduced, the working environment of the crew can be improved, and the safety of the ship can be improved. In addition, the application of intelligent technology also helps ships to better adapt to the complex Marine environment and improve the ability to deal with emergencies.

The research content involves the design and implementation of the intelligent integration platform of the ship electronic and electrical system, including the construction of the system architecture, the breakthrough of key technologies and the implementation of the system integration. At the same time, this paper will also discuss the application of automatic control technology in the ship electronic and electrical system, analyze its impact on the ship performance, and put forward the corresponding safety control measures. Research methods include literature review, technical analysis, case studies and expert interviews to ensure that the results are scientific and practical.

The research will provide theoretical support and practical guidance for the development of intelligent integration and automatic control technology of the ship electronic and electrical systems, and has important reference value for promoting the technological progress and industrial upgrading of the ship industry. Through the in-depth research of the intelligent integration platform and automatic control technology, this paper expects to provide new ideas and solutions for the intelligent development of the ship industry, and promote the development of the ship industry to a more efficient, more intelligent and more environmentally friendly direction.

2 Intelligent integration of ship electronic and electrical systems

In the field of intelligent integration of ship electronic and electrical systems, the core of the research is how to realize the efficient operation and intelligent management of the ship system through advanced technology, as shown in Figure 2. As the core of the ship electronic and electrical system, the intelligent integrated platform undertakes the important tasks of data collection, processing, analysis and decision support. This chapter explores in detail the design ideas, system architecture, and implementation steps of the intelligent integration platform, and how they work together to improve the overall performance of the ship.

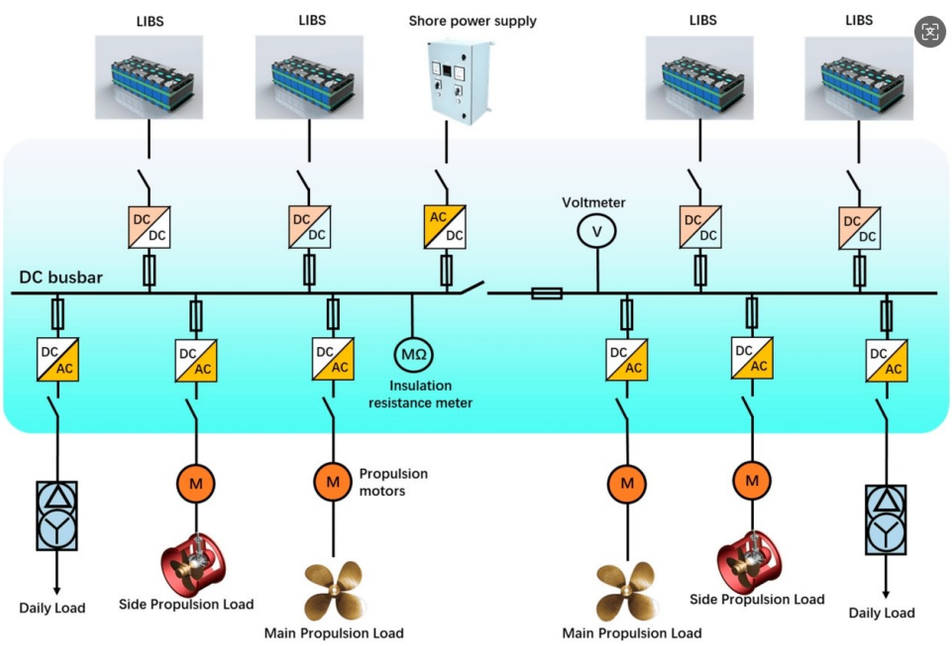

Figure 2

The design idea of the intelligent integration platform starts from the deep understanding of the needs of ship operation. The platform must be designed to take into account the operating status of the ship in different environments, including navigation, berthing, maintenance and other different modes. In the design process, the real-time performance, reliability, safety and scalability of the system should be considered comprehensively. The intelligent integration platform should also be designed to follow the principles of modularity and standardization to facilitate future upgrading and maintenance. In addition, the design of the platform needs to consider compatibility with existing ship systems to ensure seamless connection between old and new systems.

The system architecture of the intelligent integration platform usually includes the following key parts: data

acquisition layer, data processing layer, data analysis layer and user interface layer. The data acquisition layer is responsible for collecting data from various sensors and equipment of the ship, including environmental parameters, mechanical status, energy consumption, etc. The data processing layer cleans, transforms, and stores the collected data to ensure the quality and availability of the data. The data analysis layer uses advanced algorithms and models to conduct in-depth analysis of the data to extract valuable information and support decision making. The user interface layer provides operators with an intuitive, easy-to-use interactive interface, allowing them to easily monitor the ship status and management system.

The implementation steps of the intelligent integrated platform involve multiple stages, first, demand analysis and system design, to clarify the function and performance requirements of the platform. The second is the choice of hardware and software, including sensors, processors, storage devices and operating systems. Then is the system integration, the modules and components according to the design requirements, and debugging and optimization. Finally, testing and deployment, by simulating and actually running the performance of the test platform, to ensure that it meets the design requirements and is deployed on the ship.

In practical application, the design and implementation of intelligent integrated platform should be combined with the characteristics and requirements of specific ships. For example, the intelligent engine room installation scheme of a new polar research ship is a typical example. The scheme realizes the real-time monitoring and optimization management of the ship power system through the integrated platform, and improves the operation efficiency and safety of the ship in the extreme environment. Through the analysis of this case, the application effect and potential value of the intelligent integration platform in actual ships can be deeply understood.

3 Application of automatic control technology and safety control measures

Automation control technology plays a vital role. It not only improves the operation efficiency of the ship, but also enhances the safety and reliability of the ship. Energy management, auxiliary decision making and state monitoring are the three main aspects of the application of automatic control technology in ships.

The energy management main system monitors the operation state and power demand of the generator set in real time, automatically adjusts the load and operation mode, optimizes the energy distribution, and improves the energy utilization efficiency. This not only reduces fuel consumption, but also reduces emissions, while ensuring a stable power supply. The auxiliary decision subsystem provides intelligent task assignment for the crew, including preliminary plan, remote control and operation assistance, and status monitoring. These functions are realized through the wireless information transmission network of the whole ship, which improves the intelligent level of ship operation. Some data are shown in Figure 3.

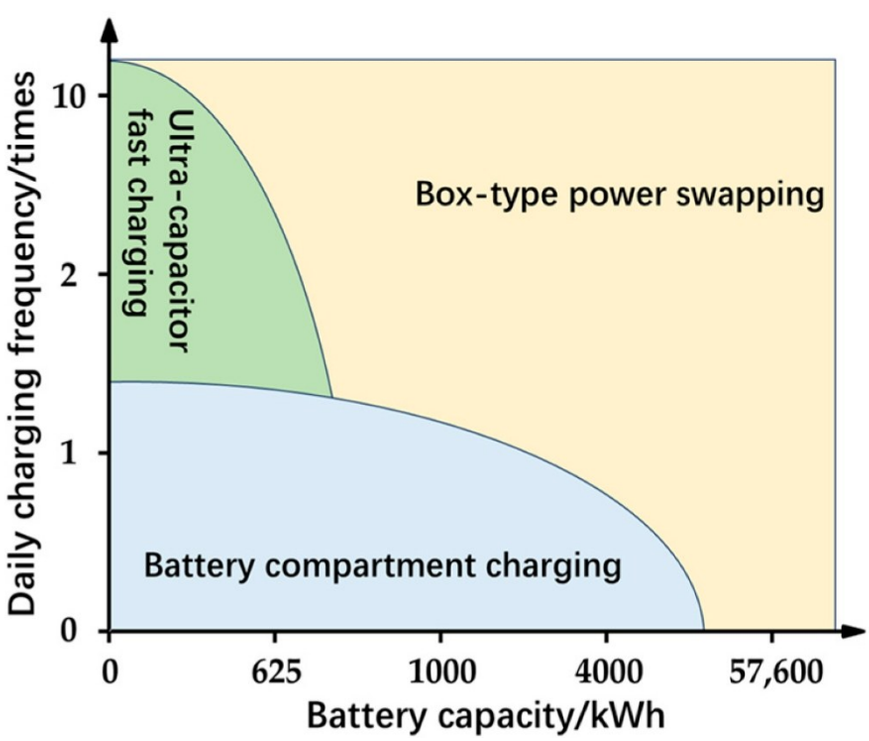

Figure 3

Through the intelligent information communication network, the status monitoring subsystem improves the information transmission rate and channel capacity, optimizes the data structure, expands the information channel, and matches the transmission format, which provides a guarantee for the processing of massive data. This system can handle and distribute exclusive special data, promoting the innovation of functional data construction of electronic and electrical technology.

The wireless information transmission mechanism, especially based on the design of Beidou satellite communication technology, greatly improves the signal transmission speed, which can theoretically reach 20 Gbps, ensuring the real-time communication between the ship and the outside world in the vast ocean, and improving the navigation accuracy and emergency response capability.

However, with the increasing application of automation technology in ship electronic and electrical systems, the safety control problem is becoming increasingly prominent. Effective safety control measures include the optimization of the electronic equipment type selection to improve the stability of the circuit, especially the equipment needed for the information and communication system. Intelligent power matching is also the key. The core computing chip with anti-interference, low power consumption and scalable interface is selected to adapt to the docking with 5G-NR + AI technology in the information data transmission process. In addition, the real-time analysis of redundant information can increase the capacity of the available base channels, laying a solid foundation for the application of related data format signals.

To sum up, the application of automation control technology and the formulation and implementation of safety control measures are very important to improve the working stability and reliability of ship electronic and electrical systems.

4 The challenges and countermeasures of intelligent integration and automatic control

One of the technical challenges is the complexity of the system integration. Modern ship electronic and electrical systems involve numerous subsystems and components that come from different manufacturers and follow different standards and protocols. Integrating these systems into a unified platform requires addressing issues of interface compatibility, unified data formats, and system collaboration. In addition, with the increase of ship system function, the ability of data processing and analysis is also more demanding, which requires more powerful computing power and more efficient algorithms.

In terms of management challenges, the level of automation improves. Traditional operational skills may no longer apply and the need for data analysis, system monitoring and troubleshooting increases. Therefore, the crew training and education system needs to be updated to accommodate these changes. At the same time, the maintenance and management of automated systems also require professional technical support, which may involve remote diagnostics and the establishment of a global service network. In terms of countermeasures, clear technical standards and integration specifications need to be developed first to ensure that different systems and components can integrate seamlessly. This may require cooperation within the industry, as well as the docking with international standards. Secondly, the crew training should be strengthened to improve their understanding and operation ability of the intelligent system. The crews skills can be improved through a combination of simulation training, online courses and practical operations. In addition, a global service network is established to provide remote technical support and rapid response to ensure the stable operation of the automated system.

In terms of technical implementation, a modular design can be used to make the system easier to upgrade and maintain. Modular design can also reduce the overall complexity of the system, as each module can be developed and tested independently and then integrated into the entire system. In terms of data processing and analysis, cloud computing and big data technology can be used to improve data processing capabilities, while using advanced algorithms, such as machine learning and artificial intelligence, to improve the intelligence level of the system.

Security is an important consideration in the application of intelligent integration and automatic control technology. As systems become increasingly dependent on software and networks, protection on cyber attacks becomes particularly important. Therefore, enhanced network security measures, including encrypted communications, intrusion detection systems, and regular security audits, are needed. At the same time, the redundant design of the system should also be considered to ensure that the system continues to operate when the critical components fail. Compatibility issue is also a challenge in intelligent integration. Compatibility issues between old and new systems need to be addressed by designing compatible interfaces and data conversion layers. This not only protects existing investments, but also ensures a smooth transition of the system.

From the perspective of network security management, most of the business systems and office computers on ships use common passwords, resulting in extremely low security. The network does not adopt redundant architecture, whether it is network line or network equipment, basically single line, single work, there is no backup mechanism, no

disaster recovery mechanism. In order to improve the level of ship network security management, technical measures and procedural measures can be taken. Technical measures include technical transformation, installation of security equipment and software to improve network security, while procedural measures are mainly to avoid network risks through training, publicity and setting appropriate rights. In the application of intelligent remote monitoring technology, through the advanced sensor, data acquisition and communication technology, to realize the remote monitoring and management of various systems and equipment of ships. This not only improves the safety and reliability of ships, but also reduces the consumption of human resources and maintenance costs, and provides data analysis and prediction functions to help ship managers make more scientific and effective decisions.

5 Conclusion

The research on the intelligent integration and automatic control technology of ship electronic and electrical system reveals the development status and future trend of this field. The discussion of the design ideas, system architecture and implementation steps of the intelligent integrated platform, as well as the application analysis of the automatic control technology in energy management, auxiliary decision-making and state monitoring, provides theoretical support and practical guidance for the ship intelligence. At the same time, in view of the technical challenges, management challenges and safety control problems, a series of countermeasures and suggestions are put forward, aiming to promote the intelligent development of the ship industry. Summarize the research results, we can see that the intelligent integration platform and automatic control technology play an important role in improving the efficiency of ship operation, reducing costs and enhancing safety. The application of modular design, cloud computing, big data and artificial intelligence and other technologies provides powerful technical support for the intelligence of ship electronic and electrical systems. At the same time, the implementation of network security management, intelligent remote monitoring and redundancy design measures provides a guarantee for the stable operation of the system. In addition, the crew training and the establishment of a global service network provide talent and logistics support for the promotion and application of intelligent technologies.

References

[1] Li Y ,Zhou R ,Zhang L , et al.Integration of Eu-based metal-organic frameworks and carbon dots for multicolor visual intelligent detection of phosphate[J].Talanta,2025,284127270-127270.

[2] Luan G ,Wei X ,Wang H , et al.Research on Key Technologies for Automated Control of Packaging Production Lines[J].Modern Management Science & Engineering,2024,6(3):

[3] Beňo L ,Kučera E ,Drahoš P , et al.Transforming industrial automation: voice recognition control via containerized PLC device.[J].Scientific reports,2024,14(1):29387.

[4] Chen J ,An J ,Yan D , et al.Future trends in intelligent lighting control systems: Integrated technologies,multi-systemlinkageand AI integration [J].Building Simulation,2024,(prepublish):1-24.

[5] Karelin N A ,Matigorov A V ,Karelin E N , et al.Automation of Power Supply Control of an Industrial Enterprise[J].Russian Engineering Research, 2024,44(9):1235-1239.

[6] Bei Z ,Wang J ,Li Y , et al.Challenges and Solutions of Ship Power System Electrification[J].Energies,2024,17(13):3311-3311.

[7] Luo Xianshu, Yuan Helan Nian. Explore the application of the current intelligent technology in the automation control of electrical engineering [J]. Chinas Strategic Emerging Industries, 2024, (5): 41-43.

[8] Wu B ,Li G ,Wu J , et al.Optimal topology control for grounding protection sensor networks in shipboard electrical systems[J].Science Progress, 2024,107(1):368504231213430-368504231213430.

[9] Maja P ,Nikola V ,Marija K .Electrification of Inland Waterway Ships Considering Power System Lifetime Emissions and Costs[J].Energies,2021,14 (21):7046-7046.

[10] 0]Setiawan B ,Putra S E ,Siradjuddin I , et al.Study of LoRa (Long Range) communication for monitoring of a ship electrical system[J].Journal of Physics: Conference Series,2019,1402(4):044022-044022.