Exploration of Health Management in Ship Main Power Plant

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Abstract. With the change of market environment, consumer demands are diversified, complex and comprehensive, this paper introduces the new concept, architecture and core technology, predicts the industry capability and demand in the main power device industry, and integrates it with digital twin, cloud service and 5G network. This paper expounds the diagnosis and prediction of ship faults in the meta-universe, constructs a meta-learning model of health management based on detection data, integrates the multi-source data information of ships, and then emphasizes the importance of meta-universe application in the health management of the ship main power device, so as to promote the digitalization of the ship industry.

Keywords: metauniverse; digital twin; virtual simulation; health management.

1. Introduction

Ships in the world of active health and safety management using information system is to build digital, information, wisdom modern powerful technical management system, the establishment of modern powerful management system needs a lot of modern digital simulation modeling analysis, will form a real machinery and equipment in the universe world and the height of the modern digital machinery and equipment close fusion.universe power plant system can build new dynamic system model, stable data analysis, using control to provide technical support, so the universe immersive simulation world provides a powerful tool, for the fault diagnosis and prediction and remaining life prediction and health state management is of great significance.

2. Yuan Universe and Its Application in the Shipbuilding Industry

2.1. Meta universe

Universe refers to the artificial intelligence, extended reality, block chain three technology as the core, by many Shared infrastructure, standards and protocol of the digital universe, the network communication technology, interactive technology, computing ability, core algorithm of the rapid launch, the universe world presents a significant development potential.

In essence, the emergence of metacosmic science is the result of the great improvement of the recording and transmission strength of people's social media, which makes the former only "recording and transmitting news" become the "recording and transmission experience" of today, so as to realize the "distant" formation of the body. Just like today's network, the meta-universe is not such a simple technology, but an ecology gradually jointly built by many enterprises to propose various high and new technologies. The parts of the meta-cosmic ecosystem will be interconnected and interoperable. In the metaverse, all kinds of people and objects have fixed identities, so that individuals and digital goods can move from one virtual world to another, and even into the offline real world, through augmented reality. This means that in the meta-verse, information can be unimpeded transmitted across platforms and across worlds (including between virtual worlds, and between virtual and real worlds).

2.2. The Application of Yuan Universe in the Shipbuilding Industry

As the global industry moves to "Industry 4.0", the comprehensive digitalization of industry has almost become the general trend. As one of the more important pillars in the industrial system, the shipbuilding industry is also bound to face the challenge of comprehensive digitalization. In this

situation, how to make good use of the digital resources and deeply cultivate the digital process of the shipbuilding industry is one of the important directions for the development of the current shipbuilding industry.universe world as the future digital science and economy under the new social form and state, will extract key data through data analysis and processing, and accordingly establish fault analysis, diagnosis and prediction model, in artificial intelligence and big data technology support, to the management equipment and system for monitoring, diagnosis and prediction, develop maintenance strategy, establish the whole ship power plant perfect intelligent operational management system, promote the development of the universe exploration ship industry.In general, the digital shipbuilding industry, not only can improve the level of system manufacturing automation and science and technology, and through the integration of information and communication technology, people, equipment, things, ship complete interaction, promote the development of the ship intelligent, digital, to improve the ship equipment intelligent operations technology localization of independent research and development ability, break the foundation of foreign technology monopoly.

Recently, the emergence of the ship metauniverse has brought infinite possibilities to the digitalization of the ship industry. According to the "Global Shipbuilding Information Development Report 2021 edition", the digital transformation of the shipbuilding industry will go through three stages: business online (business data), operation efficiency, and digital operation. By integrating multi-modal data, such as ship route planning, ship energy efficiency, weather sensing, and Internet of Things data, some ship enterprises have been exploring ways to assist their business decisions through big data and computing, the Internet of Things, and data visualization technology. Ship metaUniverse will be applied to remote monitoring through artificial intelligence (AI) and augmented reality (AR) technologies to timely, comprehensively and accurately precipitate the corresponding data, meanwhile, combine digital twin to provide solutions for the ship industry with more refined, real-time and multi-dimensional computing.

3. Fault prediction and health management

With the continuous improvement of the complexity, generalization and intelligent level of ship power equipment, in order to more effectively realize the digitalization and information of ships, and meet the requirements of rapid, accurate and continuous ship protection, PHM skills are generated.

3.1. Development of foreign PHM technology

Industrial developed countries such as the United States and the United Kingdom began the PHM technology research of aero-engine in the 1970s, and on this basis, the relevant technology was expanded to vehicles, ships and other fields. For example, the Ship Integrated Ship Status Assessment System (ICAS), implemented by the US Navy in the 1990s, can reduce unexpected failures and potential damage by detecting, diagnosing, monitoring, evaluating, and managing the status of the ship's operation. After years of continuous research, has the United States, Britain, France and other countries have formed in the related fields of their relatively mature technology system, broke through a lot of PHM key technology, the study of mechanical power structure and mechanical system, the United States has to the industrial application stage, extended to civil vehicles, rail transit, power, Bridges and tunnels and large amusement facilities, etc.

Foreign related technologies, industries and applications of intelligent ships are still in the exploratory stage, and have not yet formed an industrial scale. Japan, South Korea, Europe and other countries and regions on the research and development of intelligent ships is in full swing, the market of offshore intelligent ships has appeared disputes among various countries, the research of intelligent ships has risen to the national level.

3.2. Development status of PHM technology in China

In recent years, with the strong support of national policies, a number of scientific research institutes in China have studied intelligent ships. In December 2015, China Classification Society issued the "Smart Ship Code", which specifically stipulated the six functional modules of smart ship technology. The specification is the world's first smart ship specification, which has had a positive impact in China and even the international shipping industry after its release. The goal of the 38800t IDOLPHIN smart ship developed and built by CSSC is to achieve full-ship information sharing, independent evaluation and decision-making, ship-shore integration, remote support and service, which was put into use in December 2017. In December 2017, Zhuhai Municipal Government, China Classification Society, Wuhan University of Technology and Yunzhou Intelligent Company jointly signed the Memorandum of Cooperation to jointly build an unmanned ship offshore test site in Wanshan Islands, Zhuhai.

The smart Ship 1.0 of the Ministry of Industry and Information Technology has been basically completed, and the smart Ship 2.0 plan is being launched. In 2018, a three-year action plan for smart ships was formulated. In May 2018, the Water Transport Research Institute of the Ministry of Transport and the Intelligent Navigation Technology Co., Ltd. established an intelligent shipping test area in Qingdao.

Current ship maintenance industry is facing intelligent transformation and upgrading pressure, key breakthrough direction in intelligent core parts localization and intelligent energy efficiency and health management system, especially in Marine diesel engine health management means, foreign related technology has been in its infancy, domestic is engaged in the research team and mature technology, and Marine power plant intelligence, will be in the future become the healthy development of high-speed high power Marine engine another "neck" technology.

3.3. Comparison of P HM technology development at home and abroad

By comparing with the booming development of PHM technology in various countries, it is known that PHM technology is still a new concept in various countries, and the research and development started late. Although a lot of practical work has been carried out and remarkable achievements have been made, the preliminary stage mainly follows foreign engineering research, and there are still few scientific studies on basic theories, science and technology, system and comprehensive integration and other related technologies. In PHM control system integration and enabling technology development application field on the one hand, other countries have carried out a lot of relevant scientific research and application, and China only follow the foreign engineering technology development, engineering design technology is lagging behind, PHM control system integration and enabling tools system design related science and technology scientific research is less, there is no specific engineering technology application examples, need to further deepen exploration.

4. Meta-learning model of health management based on detection data

Through the failure prediction technology of ship power plant, on the basis of accurate assessment of the core components of the equipment health state, determine the parameters of equipment performance degradation time series, combined with the experimental small sample data to establish the residual service life model, evaluate the parts or the overall residual service life, to provide decision support for the maintenance guarantee and service cycle management.Intelligent ship PHM is a kind of maintenance strategy and conceptual change, from based on the traditional sensor monitoring alarm to fault prediction, warning and full life cycle management maintenance, its main starting point is to improve the safety of the system, functional completeness and reduce maintenance costs, for less people, time, content in state-based active maintenance guarantee provides a technical basis.

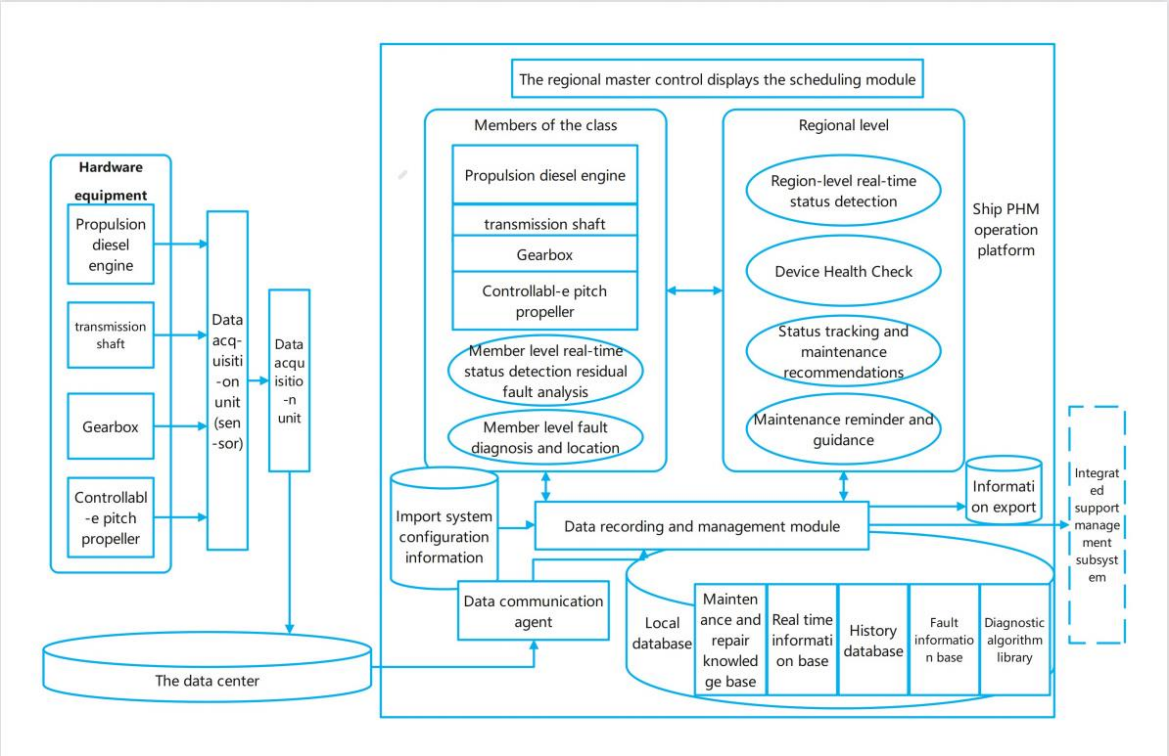


Fig 1. Flow chart of the main propulsion system

In the 21st century, as an era of technological innovation, the domestic and international communities are developing with each passing day, and the amount of scientific and technological information shows an exponential rapid growth. The sudden downtime of equipment will cause great harm, and various accidents caused by equipment failures are also appear in the news, causing people to be concerned about property and life threats. Therefore, residual service life prediction has become the focus and hotspot in the field of equipment system health management.

The early maintenance mode of industrial equipment was repaired after the failure, which can find the corresponding fault quickly, and achieve the perfect repair, but it will waste a lot of production time, and then the preventive maintenance is proposed. Preventive maintenance develops from system maintenance to state-based maintenance. In system maintenance, the intervention is arranged using lifetime-related reliability information provided by the component builder. Now, the predictive maintenance proposes to further refine the equipment status management, to achieve accurate fault prediction, to achieve intelligent while, and to further reduce the cost of maintenance. Industrial intelligence can not only provide a safe and efficient management system, but also realize the accurate cost control system to reduce unnecessary consumption. In the metacaverse, a multi-dimensional non-stationary intermittent process performance index parameter is constructed by obtaining and processing long-cycle state monitoring data and non-stationary intermittent process data, and the remaining service life of the device is predicted according to the combination of this index and related information.

5. Use meta-matching technology for verification

5.1. Ontology and the similarity matrix

Ontology is used to normalize and formalize heterogeneous information, and thus to solve semantic and syntactic heterogeneity [1] The above problem, is the basis of the mutual operation of information. The ontology consists of multiple entities, consisting of instances representing conceptual classes, relationship properties between concepts, and conceptual classes, which can be represented by a triplet, that is, (C, P, I), where C, P, and I represent the class, attribute, and instance, respectively.

To measure the degree of similarity of the entity time of different ontologies and promote semantic fusion, multiple similarity measurement techniques were proposed and applied in the ontology matching process. The degree of similarity between entities needs to be considered from three aspects, namely, language, semantics and structure, because it is one-sided and lacks certain persuasion to consider the similarity of entities only from a certain imitation aspect [2]. The similarity matrix is then composed of the similarity values between the entities, as shown in Table 1, where O1 and O 2 respectively represent the two ontologies to be matched, $e_{11},\ldots,e_{1n}$Represents the n entities in ontology 1, $e_{21},\ldots,e_{2m}$Each individual, representing the m entities in ontology 2, $c_{11},\ldots,c_{nm}$Represents the similarity values corresponding to each pair of entities.

Table 1. The similarity matrix table

O_1	O_2				
	e_{21}	e_{22}	…	e_{2m-1}	e_{2m}
e_{11}	c_{11}	c_{12}	…	c_{1m-1}	c_{1m}
e_{12}	c_{21}	c_{22}	…	c_{2m-1}	c_{2m}
…	…	…	…	…	…
e_{1n-1}	c_{n-11}	c_{n-12}	…	c_{n-1m-1}	c_{n-1m}
e_{1n}	c_{n1}	c_{n2}	…	c_{nm-1}	c_{nm}

5.2. Ontological element matching problem for multiple objectives

Ontology matching is an effective way to solve the two own heterogeneous problems. By matching the entities with equal semantic connections to achieve the common and mutual fusion of understanding, Figure 2 depicts the two heterogeneous problems themselves, and the rounded rectangles on both sides and their branches represent the entities in the two ontologies respectively. Ontology element matching is a skill of ontology matching, defined as how to determine a suitable set of appropriate weights and thresholds for the similarity matrix so that the ontology matching results are of the highest quality. For the multi-objective ontology coordination problem, the quality of matching results is evaluated by two objective functions. Each weight of ontology element matching corresponds to a similarity matrix obtained by a similarity measure, the similarity matrix for the combination of elements of the comprehensive similarity matrix for the maximum rows and column, the two entities is considered equivalent to the last, after threshold filtering out low confidence matching pairs, the remaining entity pair set is considered a set of ontology element matching results.

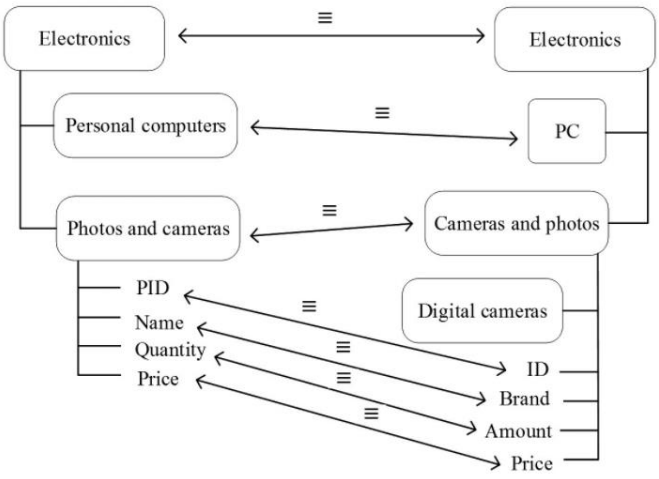


Fig 2. Schematic representation of the two heterogeneous ontologies

6. Summary

Through the application of the meta-universe in the ship industry and the meta-learning model of monitoring data health management, and the design of the specific data model of the ship data engineering by using the meta-matching technology, the meta-universe can play an important role in the ship main power plant.

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