A Multi-Agent Based Intelligent Engineer Room Monitoring and Diagnosis Method for Marine Safety
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EXTENDED ABSTRACT

The maritime transportation is growing rapidly in near decades with the development of thriving and prosperous world trades for its comparatively low costs and high efficiency comparing with other different types of transportation. Behind this significant flourish, however, high price, including lost of people's lives and properties, environmental pollution, has been paid due to dangers and risks, such as marine equipment failures, bad weather, collision and human error etc., which are potentially in existence everywhere during a voyage that probably would had been thought as a woriless and romantic experience. Accordingly, palmier are marine transportation markets, more attentions should be paid for marine safety.

Among all the possibilities that would threaten the maritime safety, failure in marine system is one of the most dangerous situations, especially if a ship encounters big wind and wave. Therefore, monitoring, diagnosing and obviating faults exactly and timely are the premise of marine safety.

On the other hand, autonomy, humanlessness, and intelligence are the development tendency of modern marine vehicles. To diagnosis and isolate faults for marine equipments during a voyage without or with little human interference makes us to face new challenges because intelligence and experience of operators are indispensable part within the close loop of control systems on board traditionally. So, a monitoring and diagnosis system with human intelligence and autonomy is necessary.

Traditional monitoring and faults diagnosis (MFD) method is to build a diagnosis module aiming at single key equipment and this module is always dissociative with control and monitoring process. This framework will reduce the efficiency of diagnosis subsystem due to diagnosis module cannot read and share information with DCS and PLC equipments. Moreover, to keep the MFD system effective, it is essential to encapsulate different tasks and to define strict interfaces between plant components and between components of the MFD system, although it is quite difficult. To guarantee flexibility – changing needs in case of an industrial application, the MFD system has to be configurable and expandable without the need of modifying any line of code (Luder 2001). The diagnostic knowledge about marine components is available on different parties (marine engineer, component manufacturers, etc.). A modern MFD system should be able to integrate the diagnostic knowledge from all available sources, even if different diagnostic mechanisms are applied. To achieve an overall diagnosis of a marine system, several diagnostic tasks have to be performed in parallel. This requires new strategies to handle diagnostic conflicts that might occur among different diagnostic results.

Multi-agent system (MAS), about which rapid progress has been made, is an important research branch in distributed artificial intelligence (DAI) parallelized with distributed problem solving (DPS). Possessing modularity, adaptability and other attractive characteristics, MAS drew much attention in recent years and is adopted by many researches in modern control system.
In this context, a hybrid intelligent multi-agent method for MFD is presented in this paper as shown in figure 1, which separates MFD process into several steps executed by different types of agents. This MFD system integrates different heterogeneous intelligent algorithms to deal with existing problems mentioned above. In the figure, many agents with different capabilities are connected together by accessing common object request broker functionalities and through communication networks to form a multiagent society. In this society, each individual has a special skill that can work autonomously and independently. On the other hand, agents in the figure trend to seek cooperation to fulfill more difficult tasks if they believe that better rewards will gain by cooperation or the job assigned to the agents is impossible to achieve with their own capability. Management agent is the one who takes charge of negotiation within the formation of a cooperation alliance. When a task is received, management agent decomposes the task into sub-jobs or steps if necessary, and then adopts contract network protocol to distribute them to appropriate agents to form a cooperation alliance.

Woolridge and Jennings classified MAS as one kind of intelligent FieldBus Control System (FCS). Compared with traditional Distributed Control System (DCS), the multi-agent based MFD system in figure 1 has the following advantages: (1) Flexible system integration: User can freely choose the equipments from different vendors to integrate the system. Traditional DCS has poor interoperability among different vendors' protocols and interface because it is not an open system. While MAS adopts unified communication language, protocol and Ontology, which eliminated the difference on Agent knowledge level. (2) Improved the system precision and reliability. MAS used digitalized intelligent sensor and actuator equipments which simplified system architecture, strengthened internal function, reduced the interlacing with external equipments. Compared with DCS, MAS improved the precision of measurement and control, reduced the transfer error. Furthermore, MAS approach will bring us: modularity, scalability, adaptability, concurrency, dynamics, and reliability. Here, we don't discuss these features in detail.

All the agents in proposed method have the same hybrid behavior architecture, where the agents are capable of reactive and deliberative behaviors. The special capability is encapsulated in information processing module (IPM) inside the hybrid behavior architecture. Different method in IPM determines different type of agent. As shown in figure 1, ten kinds of agent are designed in this system.

Faults diagnosis for complex marine control system is the process of mining valuable omen variables from mass data collected by sensors and mapping omen variables to faults modes. Thereby data mining plays an important role in diagnosis. In this paper, a new hybrid intelligent monitoring and diagnosis method is proposed in figure 2. This method divided the process of data mining and fault mode mapping into several independently data fusion modules, which are implemented by different agents.

The multi-agent based intelligent monitoring and diagnosis method proposed in this paper has been used in marine engineer room as simulation experiment. The system was coded in Jade and Matlab 6.5. At the end of this paper, some simulation results are given to demonstrate the efficiency of the method.