

Study on steam turbine malfunction decision support system based on distributed integrated intelligent theory

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Abstract

Shipping steam turbine malfunction decision support is a complex system problem. In this paper, the method of Real time On-line Decision Support system for off-site emergency of nuclear power plants (RODOS) is used for reference, and the distributed system structure, system-integrated philosophy and intelligent-run mechanism, are introduced to system, then the frame and structure of shipping steam turbine distributed integrated intelligent malfunction decision support is put forward. This system can make full use of the independence, response and consciousness of distributed integrated intelligent theory, and offer effective support to malfunction treat decision-making of steam turbine.

Key words: Distributed; Integrated; Agent; Steam turbine; Decision support system

1 Introduction

Marine steam power has a large number of system device and sophisticated structure, it is used for long-term on the sea rugged surroundings, so it is hard to avoid failure. Power system is the "heart" of the whole marine, when the equipment fails, if there is right and operative measure to emergency dispose in time, it is related to max work capacity of marine, life security of ship's staff, marine vitality and mission finishing. So it is of important engineering and operation significance to research steam power system malfunction decision support system. At the same time, steam power system malfunction decision is a large system with different factor and attribution, for example: steam is divided into high parameter and low parameter by pressure and temperature parameter; working fluid - water has liquid state and vapor state, in one circulation liquid state and vapor state need interconvert; There is mass redundant equipment in the system, it is needed to switchover according to the power requirement, and so on. Therefore steam power system malfunction emergency disposition is a complicated system decision problem. Only using scientific decision-making theory and method to direct, advanced computer as realtime decision auxiliary means, it is satisfied emergency decision-making demand.

The RODOS system[1], American ARAC system are able to make effective emergency decision for nuclear accident. The paper uses RODOS(Real time On-line Decision Support system for off-site emergency of nuclear power plants) for reference, from system engineering point, puts distributed architecture, system integration concept and intelligent act mechanism into Marine steam power system accident emergency decision, puts forward steam power distributed integrated intelligent malfunction decision support system.

2 Theory of distributed integrated intelligent decision support system

Distributed integrated intelligent theoretical basic idea[2] is: First of all, with the help of system theory, the paper builds up much agent distributed system architecture based on parallel decomposition, then according to the point of information theory, puts each agent together with control network via net information flow, at last integrates different aspect and hierarchy agent together with operational research method, makes them work together, completes system overall objective.

The distributed integrated intelligent theory is distributed system architecture, system integration concept and intelligent work mechanism. The frame of distributed integrated intelligent theory mainly includes three aspects: First is distributed architecture, second is system integration concept, last is intelligent work mechanism.

Define Agent as follows[3]:

$$\text{Agent} = \langle \{Msg\}_{j \in N}, \{Mst\}_{j \in N}, \{D/K\}_{j \in N}, MsgInt \rangle$$

thereinto, $\{Msg\}$ is information queue; $\{Mst\}$ is method gather; $\{D/K\}$ is data/knowledge; $MsgInt$ is information interpreter.

The structure of Agent includes: information queue; knowledge/ data; method; interface. The structural representation of Agent is present as fig 1.

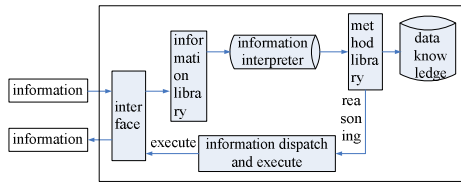


Fig 1 Structure of Agent

3 steam power distributed integrated intelligent malfunction decision support system

3.1 RODOS nuclear accident emergency decision support system

RODOS^[1] is a comprehensive integration nuclear accident emergency decision support system. It utilizes manifold models and data to evaluate, display and estimate the accident result in each distance, and simulate the accident effect of every countermeasure. RODOS system can be divided into three function subsystem: analyze subsystem, countermeasure subsystem, and evaluation subsystem.

The function of analyze subsystem presents the radioactive concentration distribution and dosage and dosage distribution of ratecurrent and future environment.

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The function of countermeasure subsystem estimates the shield action cost of every optional shield action, which is according to the now and future radioactivity status and weather condition from analyze subsystem, thereby quantitatively estimates relative merits of every combination of shield action.

The evaluation subsystem assesses the feasibility, validity and public acceptability of optional shield actions. According to certain decision rules, the evaluation subsystem chooses the best shield action programme based on the advantages and disadvantages order of each shield operations.

3.2 Distributed architecture of steam power malfunction decision support system

The distributed architecture of steam power malfunction decision support system is composed of system layer and application layer, which is present as fig2. Thereinto system layer is charge of management and maintance of whole decision support system, including system management, system communication and system maintenance etc. Application layer is in charge of solving and executing the optimum decision programme,

including mathematical model analyze module, countermeasure and assessment module, intelligent monitor and execution module, and human intelligence(ie human oneself) etc.

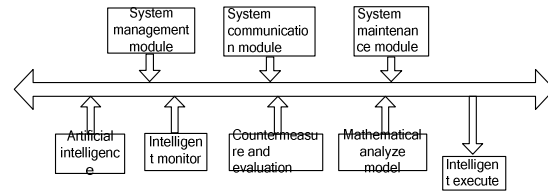


Fig 2 Distributed architecture of decision support system for steam turbine emergencies

3.3 Integrated concept of steam power malfunction decision support system

The integrated concept of steam power malfunction decision support system is that implementation of system hardware adopts locale bus line and exist distributed control system(DCS), intelligent controller and information network integrated mode[4]. The frame of system integration is present as fig3.

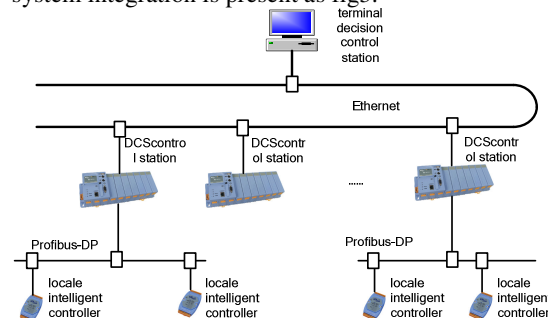


Fig. 3 Structure of integrated system

Thereinto, the integrated mode of locale bus line and DCS is the integration of locale bus line and I/O bus line of DCS, the integration of locale bus line and network of DCS; The integration of locale bus line and intelligent controller is that intelligent controller has applied in many kind of monitor and management system, the application of locale bus line need the help of steam power system intelligent controller,even partly locale bussing technique and products has been already integrated into the intelligent controllers. The essential of integration of locale bus line and information network is the interconnection of isomerous network, the connection of DCS network and Ethernet netwoek via locale bus line, which realizes the intercommunication of information.

3.4 Intelligent work mechanism of steam power malfunction decision support system

The intelligent work mechanism of steam power malfunction decision support system is present that it is a methodical and ordered Agent colony, which together express the system structure, function and behavioral character via the communication, coperation, synchronization and dispatch management of each agent in different kinds of combat employment environment

and equipment failure conditions. The structure of intelligent work mechanism is present as fig4.

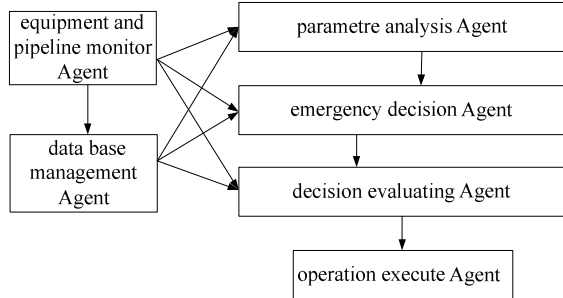


Fig 4 Structure of intelligent cooperation mechanism

3.4.1 Parameter analysis Agent

Analyze Agent mainly finishes the function which is caculation of information and data in decision support system, works out the max work capacity and reliability of system according to the state parameters of equipments and pipelines. The core is computation model of equipment parameter, system connection pipeline model, and decision optimization model etc. Computation modele of equipment parameter can work out the maximum power and efficiency of each equipment on occasions of equipment malfunction; The switch model of system connection can work out the model of switchover of equipment and connection mode of pipeline which make whole system give off the max work capacity on occasions of equipment failure. Emergency intervene action decision is caculating that in the condition of equipment failure, personnel should operate and intervene for the maximum capacity of whole system. Decision optimization model chooses the proper operation mode which is most suit for current mission condition and the easiest to switchover in different kinds of intervene action. The precision of computation model will influence the reliability of analysis data directly.

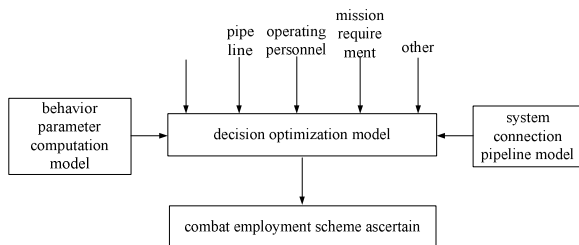


Fig 5 Structure of parameter analyse agent

Once equipment goes wrong, analyze Agent will complete the model calculation which is according to the positon of malfunction equipment and the malfunction condition, combined with the computation model of equipment parametre and pipeline connection mode model from Agent database, then offer data support for emergency decision Agent and evaluation Agent.

3.4.2 Emergency decision Agent

The main function of emergency countermeasure Agent is that puts forward corresponding performable policy, according to equipment failure severity and current marine mission status, Concretely include: selection Agent of combat employment scheme, analyze Agent of marine mission requirement, maintenance decision Agent of malfunction equipment. The concrete structure is present as fig6.

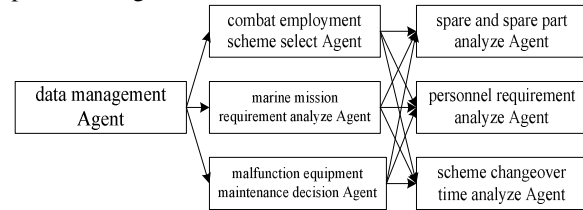


Fig 6 Structure of countermeasure agent

Each sub-Agent has respective spare and spare part Agent(offering variety, quantity, performance of equipment and pipeline spare and spare part), personnel requirement Agent(including technical class and members of post and maintenance work personnel at each level), analyze Agent of scheme switching time(including marine misson time, repair time and equipment work time etc). Concrete content of each emergency countermeasure is filtered in database Agent, then all feasible program will be evaluated by decision evaluation Agent.

3.4.3 Decision evaluating Agent

Decision valuation Agent takes charge for all emergency decision schemes which are sorted in certain ways, for example the evaluating principle are the best reliability, the best maneuverability, the best economy etc, then presents the optimize scheme which is given to decision maker for reference and decision. Decision valuation Agent is the key to decision support system, whatever analyze Agent and countermeasure Agent works well, if decision valuation Agent is not able to prick off the best decision from many schemes, the system also can not reach the optimize object for emergenge accident.

Decision valuation Agent is based on multiattribute utility analysis method, takes RODOS system design concept for reference, brings in expert system, casus reasoning decision, Bayes decision, fuzzy decision etc scientific and rational evaluation decision making techniques, which makes decision evaluation Agent offer optimal decision. The structure is present as fig7.

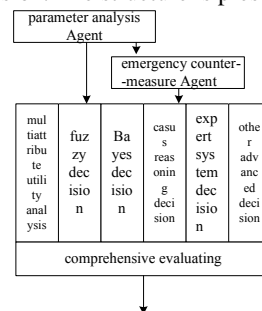


Fig 7 Structure of evaluation agent

3.4.4 Equipment and pipeline monitor

Equipment and pipeline monitor Agent offers work and failure state of equipment and pipeline, including equipment parameter analyze Agent and pipeline status analyze Agent.

Equipment parameter Agent includes equipment monitor Agent and equipment status Agent. Equipment monitor Agent takes charge of collecting different kinds of parameters of working equipment and medium, including temperature, pressure and flow etc; Equipment status Agent mainly takes charge of collecting equipment perfect information, including if equipment is able to work, if equipment is working, and if malfunction equipment is repairing etc information. pipeline state Agent mainly takes charge of collecting pipeline perfect information, including if pipeline is able to use, if pipeline puts through, if pipeline is leakage, and if pipeline need repair etc information. Real time collective data of equipment and pipeline monitor Agent can be sent to data management Agent directly.

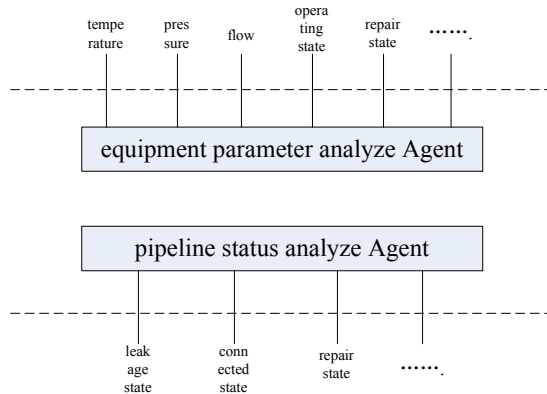


Fig 8 Structure of equipment and pipeline

3.4.5 Data base management Agent

Database Agent is used to collect and store work parameters of equipment and pipeline, operating state parameter, feasible combat employment scheme, computation model of equipment parameter, switchover model of system connection, decision optimization model etc data and information, at the same time stores data information of analyze Agent and emergency countermeasure Agent etc. Database Agent is data information center of steam power distributed intelligent emergency decision system.

3.4.6 operation execute Agent

Operation execute Agent is concrete executive unit of steam power malfunction decision support system, which make optimizing decision scheme from decision evaluation Agent to carry out, including alteration of combat employment schemes, operating action of personnel on duty, arrangement of post, disposition of malfunction equipment, adjustment of equipment

working parameter, malfunction equipment repair programming etc work.

4 Conclusion

The paper is based on distributed control system, locale bussing technique, intelligent control theory, puts forward steam power system malfunction decision support system based on distributed integrated intelligent theory.

Distributed architecture, system integration concept and intelligent work mechanism are joined together, which can satisfy the requirement of steam power system malfunction emergency decision support, embodied as follows: (1) Distributed architecture is suitable for distributivity requirement of mass complex equipments of steam power system. (2) System integrated concept does not only keep existing equipment available, but also establishes the foundation for informatization and digitalization of decision support system. (3) intelligent work mechanism makes most use of autonomy, reactivity and consciousness of distributed, integrated and intelligent theory, to establish accuracy and effective disposition scheme when marine steam power system goes wrong.

Acknowledgements

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