Research Scheme for Fault Diagnosis of Air Conditioning System Based on Fuzzy Logic

Jing Wang

School of Computer Science Zhuhai College of Jilin University Zhuhai, Guangdong

312900384@qq.com

Keywords: Fuzzy logic; Fault diagnosis; Air conditioning system

Abstract: This study is a mechanism study on the failure of air conditioning systems in buildings. The fuzzy control logic theory is used to analyze the nonlinear coupling relationship between fault representation and fault causes. The fault mode set of air-conditioning system is established and the fault diagnosis of air-conditioning system is constructed Fuzzy expert system. The research methods and implementation schemes proposed in this paper have important basic and practical value for online fault diagnosis and remote fault monitoring analysis of air conditioning systems.

1. Introduction

In this study, the fuzzy identification method is used to study the fault diagnosis and fault precursor prediction theory of the air conditioning system in the building. The expert system is generated by this method to form a hybrid air conditioning expert system. Based on the mathematical calculation process, combined with the model calculation analysis, Together with the traditional expertise, it will more effectively process the fault signal of the air conditioning system in real time and analyze the relationship between the signal and the cause. The improvement of effective mathematical processing methods (fuzzy recognition, artificial neural network) and information processing technology (software and hardware) provides powerful technical support and real-time application possibilities for theoretical research of fault diagnosis of air conditioning systems.

2. Research Status

The application of air conditioners has penetrated into various fields of society, the system has become increasingly complex, the equipment has become more diversified and large-scale, and the degree of self-control has been increasing. The phenomenon of air conditioning system failures also increases, and the losses caused by them increase. Therefore, it is very important to conduct research and analysis of the fault mechanism of the air conditioning system and establish an effective and accurate fault judgment mode for real-time online monitoring of the air conditioning system, fault precursor prediction and optimal operation of the system.

Foreign research on building automation theory has been carried out earlier, and technology has gradually matured. In the mid-1980s, the international introduction of expert systems into the air-conditioning field began, and in-depth research and discussion on fault diagnosis, energy analysis and optimization operation. Since 1986, ASHRAE (American Society of Heating and Refrigerating Engineers) has held a seminar on the application of knowledge-based systems in the field of refrigeration; since then, ASHRAE magazine has opened a column dedicated to artificial intelligence and expert systems. The IEA Annex 17, 21, 25 and other sub-projects of the International Energy Organization have studied the fault diagnosis of refrigeration systems as an important issue.

In China, in 1987, under the proposal of Professor Yan Qisen of Tsinghua University, the application research of expert system in the field of HVAC was started in China. Ma Jimin (graduate of Professor Yan Qisen) of Nanjing Institute of Engineering and Technology was the first to carry out research in this field. His research is to design an expert system DFDRT for developing equipment fault diagnosis and repair using Turbo Prolog language, and use it to realize a prototype

  DOI: 10.25236/icemc.2019.064

of the refrigeration system fault diagnosis and repair expert system.

3. Research Objectives and Content

The research objective is to monitor the important physical objects in the building, the various air-conditioning valves of the building, the cooling, heating, running, dripping, leaking, building temperature and other building facilities inspections, mainly to achieve the following objectives:

- Obtain the air conditioning system fault judgment criteria
- Establish the air conditioning system fault diagnosis model
- Establish an air conditioning system online fault diagnosis and fault precursor prediction expert system

The research is mainly based on the characteristics of modern large-scale building complex systems, intelligent real-time monitoring and control of widely distributed air conditioning equipment in the building group, such as fans, hot air curtain systems, temperature detection and regulation power systems. Make the building environment more intelligent, optimize the operation mode, and integrate operations. Specifically include:

- Establish an air conditioning system fault knowledge base
- Construct a fuzzy pattern matching model
- Establish an online real-time fault matching model and forecasting model for air conditioning systems

4. Specific Implementation Plan

The fuzzy expert system refrigeration system fault diagnosis field will be established, the refrigeration system fault knowledge base will be established, the fuzzy expert matching system will be constructed by using fuzzy pattern matching method, and the judgment and prediction model of refrigeration system fault diagnosis will be established. The model will be modified and optimized through experiments.

- Using the tree-shaped network link method and using time-sharing processing technology to monitor the widely distributed special equipment and object objects in the building. The system software scheduling diagram is shown in Fig.1.

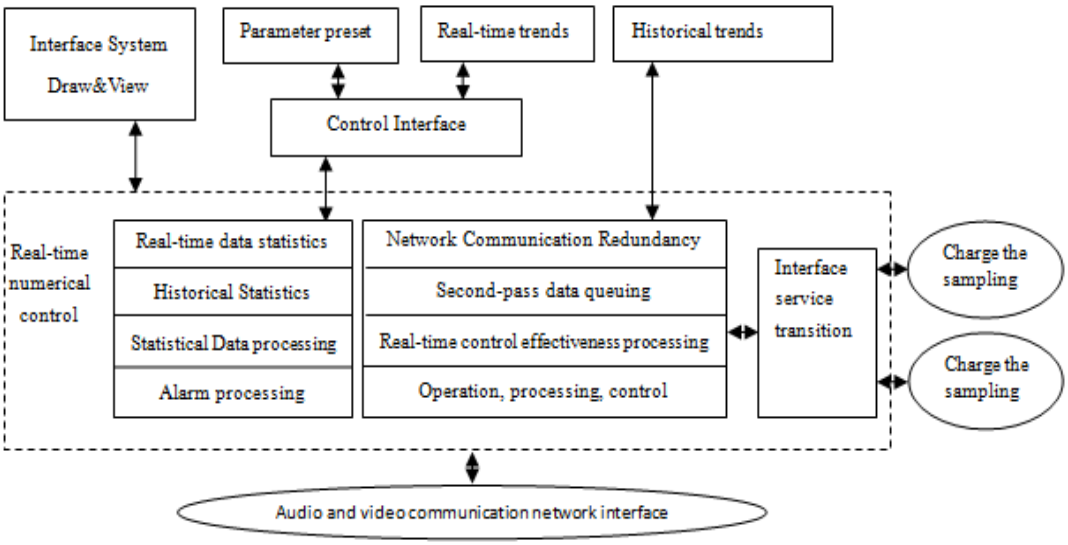

Figure. 1 The System Software Scheduling Diagram

- STC microcontroller, embedded MSP, etc. as the terminal, using remote control mode and intelligent independent working mode to start the classification monitoring object, remote collection (such as zero offset, lifting system up and down, motor phase loss, temperature and humidity, Power

supply system switches and other parameters) to complete the data feedback within the building group.

- Fully use optical fiber transmission technology as a carrier to integrate digital signals, analog signals, digital video, audio and conventional telephone signals to carry large-volume data automation tasks. The use of video differential technology to perform holographic auxiliary monitoring of audio and video composites for special occasions, to improve the system reliability level.
- Establish the air conditioning system fault knowledge base in the field of air conditioning system fault diagnosis, construct the expert system by fuzzy pattern matching method, establish the judgment and prediction model of air conditioning system fault diagnosis; modify and optimize the model through experiment.
- Perform system modeling and simulation, complete the preparation of the central control program on the basis of database technology, and complete the overall development of the visualization system.

5. Main Technical Routes

The basic technologies involved in this study have been validated in various teaching and research. The main researcher's related projects include intelligent elevator security inspection system, etc. The results obtained by the cluster elevator intelligent monitoring system were confirmed by the authoritative department. The main technical routes include:

- Establish a domain knowledge base, including universal rules and facts in the field of air conditioning and application objects.
- Establish a global database, store the rules and facts related to the specific application object, and store the rules and facts generated in the reasoning process.
- Establish a reasoning and execution organization for the hybrid expert system, and express knowledge engineering with reasoning and calculation.
- Establish a fuzzy mode matching fault diagnosis model for air conditioning systems.
- Conduct typical fault test of air conditioning system, establish online fault diagnosis and precursor prediction analysis.

6. Experimental Implementation Plan

- The test was carried out on air-cooled and water-cooled heat pump units, and the digital simulation platform of system related technology was constructed by using Matlab simulation software.
- Collecting temperature signals, pressure signals, flow signals, power signals, etc., through the digital simulation optimization algorithm, the resulting prototype simulation results will be an important basis for the actual results.
- The main feature of the system is that the flow test of the air-conditioning agent needs to add a suitable subcooler after the condenser to ensure that the air-conditioning agent entering the mass flow meter is all in a liquid state, and the remaining test parts are close to the conventional test;
- The system is a second-order response system with delay, and the current data acquisition and processing system can fully meet the requirements in signal acquisition speed and capacity.
- After the laboratory experiment, the use of engineering platform, in the project site to verify the actual installation of various types of building equipment prototype status signal acquisition, detection and transmission and alarm mode and system prototype of practicality, stability and reliability, to ensure practical value.

7. Conclusion

The scale of modern buildings is huge. How to ensure the effective operation of building soft and

hard environment groups is a very challenging topic. The large construction area, the variety of equipment, the wide range of controlled objects, the dispersion of detection systems, the improvement of reliable monitoring, and the high cost of building control systems are all problems of mutual constraints. How to find a balance point in the above contradictions, this paper proposes a more complete design to solve this problem. Research on fault diagnosis theory of air-conditioning system The establishment of expert system for air-conditioning device group control, local area network equipment monitoring, equipment remote monitoring, and the establishment of enterprise unified maintenance management center have important value in basic theory, and are also significant in practical engineering applications in the future. significance.

Acknowledgements

This article has received the Guangdong Provincial Department of Education Teaching Quality and Teaching Reform Project (2017009), Jilin University Zhuhai College Innovation Ability Cultivation Project (2018XJCQ022), Jilin University Zhuhai College Innovation and Entrepreneurship Education Curriculum Development Project, Jilin University Zhuhai College Teacher Teaching Development Fund Project (JZ2018JZA11), Zhuhai Computer Application Technology Advantage Discipline Project (2015YXXK02), Key Laboratory of Symbolic Computation and Knowledge Engineering Ministry of Education.

References

[1] Wang Jing. Application of RS-485 bus communication technology in multi-machine monitoring system[J]. Manufacturing Automation, 2010, 32(11): 46-48. (ISSN 1009-0134/CN 11-4389/TP, Peking University Chinese Core Journal)

[2] Wang Jing, Wang Jie. CAN bus design based on CO2 welding system[J]. Electric Welding Machine, 2009, 41(1): 36-39. (ISSN 1001-2303/CN 51-1278/TM, Peking University Chinese Core journal)

[3] Wang Jing, Zheng Gao, Wu Tuo, Xue Yu. Short-term electric load forecasting based on interval two-type fuzzy logic[J]. Journal of Lanzhou University of Technology, 2011, 37(3): 108-113. (ISSN 1673-5196/CN 62-1180/N, Peking University Chinese Core Journal)

[4] Jing wang, Zhongwei Chen. An Inclusion Measure of Fuzzy Sets and Its Properties [C]. The 4th International Conference on Mechanical and Electronics Engineering, Weihai, 2012, 229-231: 2667-2670. (EI: 20125215836118)

[5] Zheng Gao, Xiao Jian, Wang Wei, Zhou Wenwei. Short-term wind speed prediction based on interval two-type fuzzy logic[J]. Journal of Solar Energy, 2011, 32(12): 1792-1797. (ISSN 0254-0096/CN 11-2082/TK, EI: 20120614748221)

[6] Zheng Gao, Wang Jing, Zhou Wengwei, Zhang Yong. A similarity measure between interval type-2 fuzzy sets [C]. The 2010 IEEE International Conference on Mechatronics and Automation, Xi'an, 2010: 191-195. (EI: 20104813423824)

[7] Zheng Gao, Wang Jing, Jiang Lin. Research on type-2 TSK fuzzy logic systems [C]. The 3rd International Conference on Fuzzy Information and Engineering, Chongqing, 2009: 491-500. (ISTP, accession number:WOS: 000272995300054)