IOP Conference Series: Earth and Environmental Science

PAPER • **OPEN ACCESS**

Expert System for Fault Diagnose Based on the Test Equipment for a Missile

To cite this article: Hong-liang Cui 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **242** 032053

View the article online for updates and enhancements.

This content was downloaded from IP address 139.219.8.96 on 09/10/2019 at 22:08

Expert System for Fault Diagnose Based on the Test Equipment for a Missile

Hong-liang Cui

(High-tech Institute,Fan Gong-ting South Street on the 12th, QingZhou 262500 , China.)

Abstract: The essay introduces the framework and principle of expert system for fault diagnose, analyzes in details the software system and the hardware system, studies the knowledge obtaining, knowledge expressing, knowledge reasoning and other key questions for expert repository separately under the accurate diagnose and fuzzy distinguish circumstances.

1. Function and Principle of Missile Testing Equipment

1.1 Main Functions of Missile Testing Equipment

This test equipment is an important part of the missile weapon system. It undertakes the task of testing the performance and parameters of the missile and determining whether the quality of the missile meets the technical requirements, which is a key point to determine whether the missile can be launched successfully. It mainly checks the hardware and software of the missile system, checks whether the instruments in the missile system are connected correctly and whether the work matches, checks whether the missile system is connected correctly with other subsystems and whether the work matches, checks the reliability of the flight software operation of the system, etc. The test result is an important basis for analyzing and judging the performance of missile system[1].

1.2 Working Principle of Missile Testing Equipment

The test equipment is mainly composed of geodesic microcomputer, acquisition controller, monitoring device, power supply/simulator and so on. They are all connected by I/O bus and special bus interface. Analog quantity test circuit, digital quantity test circuit, switch quantity test circuit and other circuits are connected by measurement and control bus and geodesic microcomputer. The structure block diagram is shown in Fig. 1.

Content from this work may be used under the terms of the Creative Commons Attribution 3.0 licence. Any further distribution of this work must maintain attribution to the author(s) and the title of the work, journal citation and DOI.
Published under licence by IOP Publishing Ltd

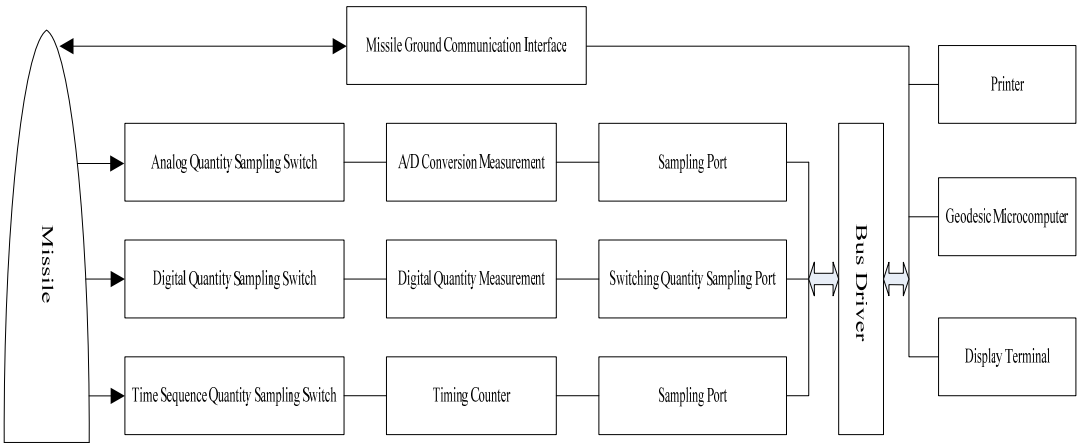


Figure 1. Structure block diagram of missile test equipment

2. Requirements of Expert System and Its Development Platform

2.1 Requirements of Expert System.

The test equipment is a product of the 1970s. It uses a large number of separating elements, with poor working reliability. The equipment has been used for a long time and a lot of troubleshooting experience has been accumulated, so it has the basic condition of using expert system to diagnose the fault of the equipment[2]. The expert system needs to realize the following functions for ground test equipment:

1) Real-time monitoring should be carried out for ground test equipment to respond to fault signals;

2) According to the fault phenomena, expert diagnosis system is used to find out the cause of the fault;

3) Based on expert knowledge and experience, methods or suggestions for troubleshooting are put forward.

2.2 Development Platform of Export System.

Considering that the storage and organization of data should have the characteristics of reliability and correlation, the expert system uses relational database technology and C++Builder(CB) front-end development tool to realize the application under Windows.

Knowledge-based fault diagnosis expert system is based on knowledge in knowledge base. A good knowledge base management system can facilitate the acquisition of knowledge and the maintenance of knowledge base. In view of the characteristics of missile test equipment, such as many kinds of data, large amount of data, and heavy data management tasks, and the requirements of accuracy, real time and extensibility of various data, this fault diagnosis expert system considers using relational database to store, manage and maintain all kinds of data[3]. Its advantages are:

1) Knowledge base management based on database is a new technology of knowledge base management. For tables in the database, it is not only convenient to create, but also easier for users to maintain. The development of software technology also makes the interface between database and application easier to implement. Therefore, it is very suitable and convenient to use database, especially relational database, to establish and maintain knowledge[4].

2) Systematic organization and storage of knowledge and effective management are the key issues to be considered in the establishment of an expert system. Building knowledge base on relational database and making full use of the functions of relational database management system can facilitate the design of knowledge base management system.

3) The establishment and maintenance technology of knowledge base based on database provides an easy-to-expand and perfect framework for diagnostic knowledge base. Reasonable knowledge base

organization and management system is also the basis for improving diagnostic knowledge in the future. By constantly accumulating experience and continuously improving the existing knowledge system, the intelligent level of diagnostic system can be improved.

3. Design and Implementation of the System

3.1 Structural Model of Hardware System.

The hardware of the system is mainly used for real-time acquisition and detection of the analog quantity test signal, digital quantity test signal and time sequence quantity test signal of the missile ground test equipment. Its structural block diagram is as follows:

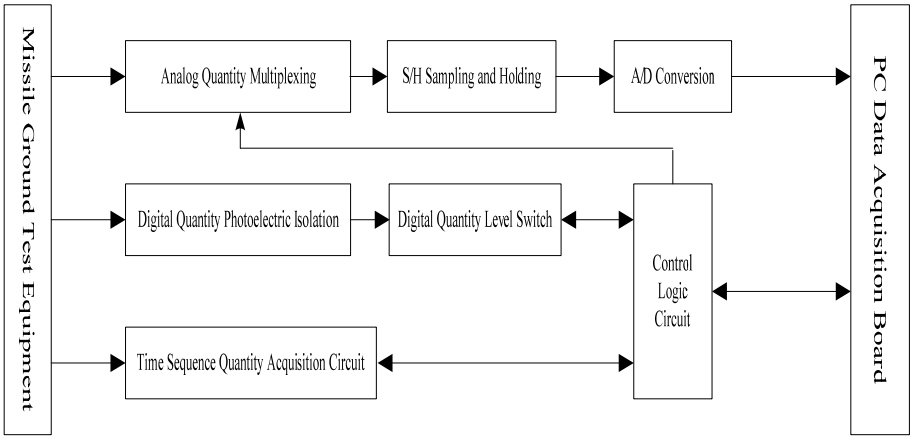


Figure 2. Hardware structure block diagram of the system

3.2 Structural Design of Expert System

3.2.1 Structural Model of Expert System

Through the analysis of the possible faults of the ground test equipment, there are two different ways to distinguish the faults. One is the precise fault diagnosis mode based on inference of determinant factors. The other is the fuzzy discriminant fault diagnosis mode based on multi-factor fuzzy judgment. Therefore, different methods are adopted in the mechanism of knowledge acquisition, representation and reasoning[5]. Fig.3 shows the structure model of the expert system:

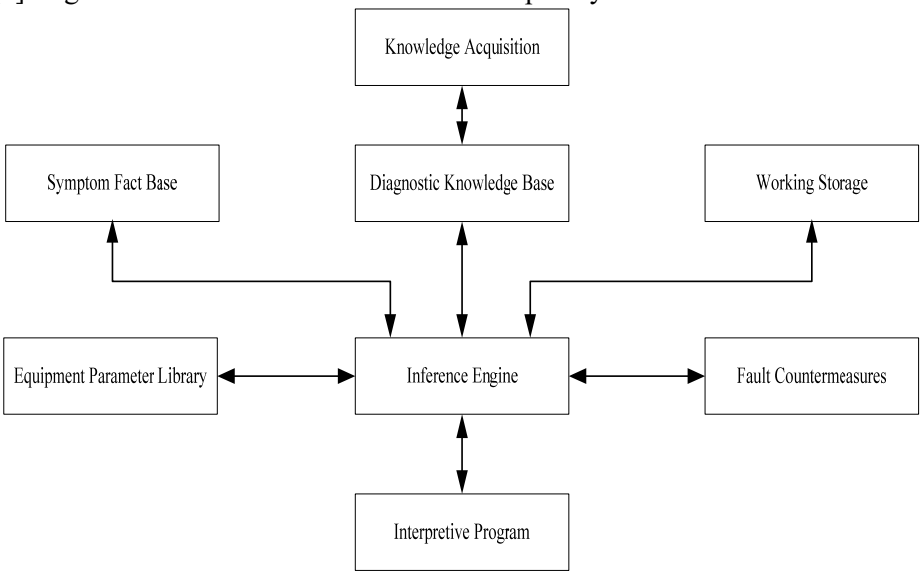


Figure 3. Structural model diagram of fault diagnosis expert system for the equipment

3.2.2 Knowledge Acquisition and Reasoning

An important function of expert system is the learning ability of new knowledge. The knowledge base of expert system can be improved and renewed according to different models. The fault base system of expert system undertakes the important task of preparing learning samples for the learning system. The fault examples of the system can be recorded in the form of {original signal, diagnosis conclusion, maintenance measures}. The example recorded in this way has a strong universality and can be used by multiple expert systems in theory. The expert system for fault diagnosis of warhead ground test equipment of different models can be identified by its own symptom recognition system and the instance can be converted into a form suitable for its own learning. The expert system does a special application window to acquire knowledge, including adding, modifying and deleting operations[6]. According to the different requirements of precise fault reasoning knowledge and fault fuzzy judgment knowledge, different knowledge acquisition window applications are made, which can acquire knowledge not only from maintenance experts and recorded maintenance data, but also from system self learning.

In expert system, the core link is reasoning machine. The reasoning knowledge is stored in the corresponding dynamic database. Knowledge reasoning controls the operation of the whole system and makes it solve problems according to certain reasoning strategies. There are deterministic knowledge and fuzzy knowledge in fault analysis, so two different methods: state chain reasoning and fuzzy reasoning are adopted in knowledge reasoning.

Users check on the spot according to the system prompt to determine the fault phenomenon. The system will then give various reasons for this phenomenon, and give corresponding suggestions to eliminate. If the fault is not resolved, a search for other causes is performed until the fault is resolved. Fuzzy reasoning obtains the evaluation fuzzy matrix through the weight determination, the weighted average model, the quantitative index synthesis and so on, and carries on the synthesis decision to the judgment result[7].

4. Conclusions

The main innovations of the fault diagnosis expert system are as follows: 1. The system realizes dynamic load-free access and multi-channel intelligent scanning, and adopts the whole-process on-line isolation hardware testing technology, which solves the technical problems that the detection and diagnosis equipment interferes with the equipment under test because of the whole-process access, and that the diagnosis equipment can not carry out on-line diagnosis in real time because of its weak monitoring ability. 2. The system adopts the reasoning method combining state chain reasoning and fuzzy reasoning, and uses fault self-learning adaptive algorithm to optimize the description method of state and fault, which improves the efficiency and positioning accuracy of state recognition and fault diagnosis, and ensures the synchronous realization of online monitoring, dynamic tracking and fault diagnosis. 3. The system adopts modular design technology, variable classification and packaging technology, reusability design technology, and realizes the separation of data processing and diagnosis logic in monitoring and diagnosis software, which greatly improves the efficiency, reliability and portability of the software.

With the improvement of equipment integrated support and automatic test level, and the combination of troubleshooting experience with new ideas and new methods, the fault diagnosis expert system will certainly improve the operational ability and detection level of the troops for new equipment, and have important military significance and significant economic benefits for improving the combat effectiveness of the troops and giving full play to the combat effectiveness of weapons and equipment.

References

[1] Wenhu Huang, Songbo Xia and Ruiyan Liu: *Principle, Technology and Application of Fault Diagnosis for Equipment*[M], Science Press, 1996, 174-178.
[2] Bairong Xu, et al. Research on Fault Cause and Diagnosis Technology of a Missile Ground Test

Equipment, Aero Weaponry, 2004, No.6, 34-36.
[3] Maotai Zhao: Principle and Application of Intelligent Instrument[M], Publishing House of Electronics Industry, 2002, 99-108.
[4] Quansheng Xi, Hui Shi, Liya Liu and Jin He: Missile Testing and Diagnosis Technology Based on BIT[J], Computer Measurement & Control, 2011(04).
[5] Lei Zhang: Research on Extraction Method of Fault Feature Points of Missile Testing Equipment[J], Missiles and Space Vehicles, 2017(04).
[6] Yang Xiang: Design and Implementation of Outfield Support System for an Aircraft[D], University of Electronic Science and Technology of China, 2018.
[7] Qian Wang, Zhiqiang Li, Xiaohu Zhang and Penghui Rong: Health Assessment Model of a Certain Air-to-Air Missile Based on Test Parameters[J], Computer Measurement & Control, 2014(11).