The Overall Scheme Design of Embedded Intelligent Automotive Fault Detection Analyzer

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Abstract. With the rapid development of science and technology, control technology, as an important industrial technology, has brought significant impacts to our daily lives. This article studies an embedded intelligent automotive fault detection analyzer with high-performance embedded CPU as the core, Linux as the operating system, built-in network data exchange software package and network interface, built-in real-time database and automotive fault expert diagnosis system. The analyzer comes with multiple bus interfaces that are conveniently embedded in automotive detection equipment and application systems, and can communicate and exchange data through the Internet. Thus, the real-time database and automotive fault expert diagnosis system are embedded into network nodes to diagnose automotive faults in real-time, making a powerful automotive fault diagnosis instrument a reality.

Keywords: Embedded, expert system, fault detect, scheme design

1 Introduction

Starting from the basic principles of expert systems, this article introduces artificial intelligence, the basic structure of expert systems, the basic characteristics of expert systems, and production systems. It also selects embedded microprocessors for the needs of embedded intelligent automotive fault detection analyzers and proposes the overall design of the system.

2 Basic principles of expert systems

2.1 Artificial Intelligence

Until now, the development of artificial intelligence still revolves around data collection and organization, further realizing artificial intelligence. These data are products of the times and the foundation for achieving the development of artificial intelligence. In the operation and processing of computers, knowledge is represented by symbols, which further reflect human knowledge. Therefore, various machines can be used to complete artificial intelligence activities that were originally only human.

People can describe certain things through data models, and previous computational methods can further solve problems, also known as poor structural problems. This type of structural problem is generally not expressed through mathematical models, mainly based on empirical knowledge to solve the fundamental problem, and is also known as non structural problems. In

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the objective world, adverse structural problems are common, and the information provided by these problems is not accurate. For such problems, people generally handle them through practice, and the final results are unpredictable in advance, so there is also a certain degree of uncertainty in themselves.Generally, benign structural problems are solved by referencing computer applications, while negative structural problems are generally solved through artificial intelligence. Inspirational and fuzzy knowledge, search reasoning, and other essential core contents in the field of artificial intelligence. [1]

2.2 Relevant knowledge of expert systems

Expert systems can further emulate human experts in solving various problems that users are capable of by introducing relevant data from human experts. The solutions it provides and the explanations it provides are based on summarizing experience through each problem-solving session, that is, increasing the ability to solve problems through continuous use by experts or users.

Expert systems generally call knowledge based on corresponding production formulas. The production system is mainly composed of three main parts, namely the knowledge base, rule parser, and overall database. The overall database contains information on problem-solving and diagnostic information. All information in the knowledge base needs to be expressed in the form of "if:<premise>, then:<consequence>". When the<premise>corresponds to the facts in the database, the rule triggering system will proceed with the next step of operation as indicated in the<consequences>, Usually, modifications are made to the database information data to form certain diagnostic information data. When users ask questions, the system will include the inquiry information data in the database. [2]

The core of system management is data management, and the core of expert systems is knowledge. Therefore, expert systems are also known as knowledge systems. In the system, general data, formulas, experience and other information data are treated as knowledge. Expert systems mainly revolve around the representation, application, and acquisition of knowledge.

(1) Knowledge representation

Knowledge representation can be understood as solving the problem of formal knowledge existence, mainly focusing on how to represent domain expert experience and knowledge in a form that meets the requirements of computer work operation, that is, how to transform external environmental information data into a series of codes and ultimately form a data structure that meets the requirements.

(2) Knowledge application

The application of knowledge mainly aims to solve a series of related problems on how to operate the applied knowledge, mainly by calling the knowledge stored in the knowledge database for control and operation, and then solving the problems. There are generally only two methods used, namely search and inference.

(3) Knowledge acquisition

Knowledge acquisition mainly involves solving certain problems. Generally, knowledge acquisition is carried out under certain conditions, and the data information provided by the external environment is called the knowledge source. The information data of the external environment generally includes the experience of domain experts, databases, books, and other information data. Knowledge acquisition is mainly about how to obtain the knowledge data of experts from the external environment and how to call the knowledge data required by the expert system from practice.

By adopting an expert system, the answer process is further searched through knowledge acquisition. By introducing expert experience from a certain field, a corresponding knowledge representation is formed and stored in the database. The content of the knowledge database is fully mobilized through reasoning mechanisms, and the corresponding solution is ultimately selected through reasoning. In today's social life, users often cannot accurately describe the reasons behind things, so there are many uncertain factors. In order to further express the existing uncertain factors, it is necessary to carry out calculations through a series of methods such as probability theory and evidence theory, that is, to use uncertain knowledge for uncertainty reasoning.

3 The basic structure of expert systems

Expert systems are not only rich in the experience and knowledge of experts in a certain field, but also belong to an intelligent computer program system. They consist of knowledge databases, inference engines, databases, as well as various interfaces and mechanisms, as reflected in Figure 1:

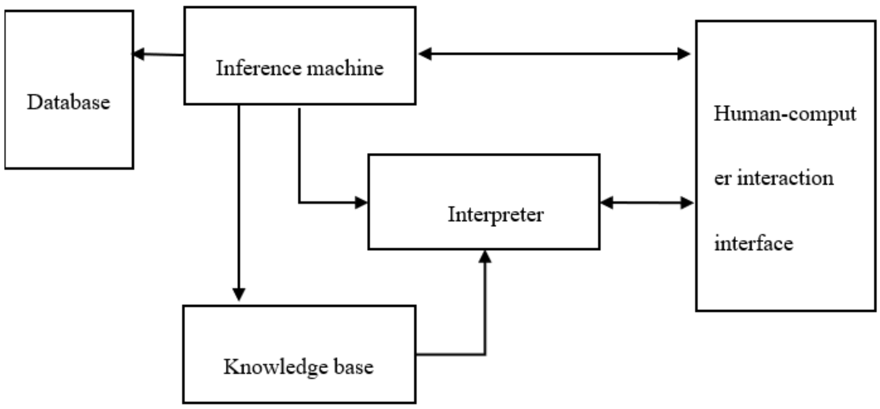

Figure 1 Main structure of expert system.

(1) Knowledge base: mainly used for storing and calling knowledge data. It is located in a relatively independent part of the system and plays a very important role in the entire expert system structure.

(2) Inference mechanism: It controls the operation of the entire expert system and the problem-solving mechanism, also known as inference machine or control mechanism.

(3) Explanatory Institution: An institution primarily used to interpret to users, whose functional strength directly reflects the credibility of an expert system.

(4) Human computer interaction interface: It is a component that connects users with expert systems. Mainly used for inputting and outputting data information, as well as displaying phenomena. Its interaction with users is mainly through media such as text, audio, and video. The optimization of human-computer interaction is crucial in measuring the power of expert systems.

(5) Database: mainly stores and calls the information data that occurs.

(6) Knowledge base and inference engine: are the core components of expert systems. In the various structures of expert systems, the knowledge base is relatively independent and highly valued by researchers in today's research field. Only by further exploring it can we better optimize expert systems and promote their rapid development. [3]

4 The basic characteristics of expert systems

The relevant characteristics of expert systems:

(1) Inspirational. In addition to being able to cite logical knowledge, one can also cite heuristic knowledge.

(2) Transparency. Can meet the reasoning needs of users and answer the problems they need to solve.

(3) Flexibility. The knowledge in the knowledge base can be modified at any time and has a certain degree of flexibility. The main types and functions of expert systems continue to evolve and expand, including consulting functions, diagnostic functions, decision-making functions, design functions, and so on. Different types of expert systems possess expert level skills in their respective fields and are able to solve problems in their respective fields. [4]

Currently, the research and development of expert systems are mainly carried out in three directions: the first is a general programming language, the second is a knowledge processing language, and the third is an expert system development tool. Through literature review, it can be understood that while ensuring the quality and efficiency of the research and development design of expert systems, it is not easy to carry out research and development design of expert systems through language. It is necessary to choose corresponding development tools to meet the research and development design requirements, and then make the designed software meet the usage requirements. The current expert system shell is a relatively good expert system development software.

5 Production systems

Production systems are a common type of structure in the field of artificial intelligence, but they are highly suitable for the application requirements of diagnostic expert systems, making them the fundamental system structure for most diagnostic expert systems. A typical production system can store knowledge rule form data into a computer and achieve diagnostic functions through symbolic reasoning. The impact that exists in it is nothing more than the explosion of rule library combinations and the impact caused by invalid matching searches.

From the perspective of classical production systems, by citing fuzzy mathematical methods, further proposing fuzzy diagnostic tables and inference schemes can more effectively control the search range. But at the level of rule knowledge, this approach will lead to inaccurate final data results.

6 The overall scheme design of this system

This system is a comprehensive application of embedded systems and automotive fault diagnosis expert systems. It is developed as an embedded intelligent automotive fault detection analyzer suitable for automotive fault diagnosis. It receives vehicle operating parameter data from the front end of the sensor, diagnoses it through an expert system, and sends out corresponding fault points, thereby quickly assisting in the diagnosis of vehicle faults. The system itself is actually a microcomputer diagnostic control system, consisting of two parts: hardware and software. [5]

The core processor of the hardware part is the ARM9 core ARM S3C2410 produced by Samsung, which supports MMU embeddable operating systems. The structural diagram is shown in Figure 2 and mainly consists of four parts.

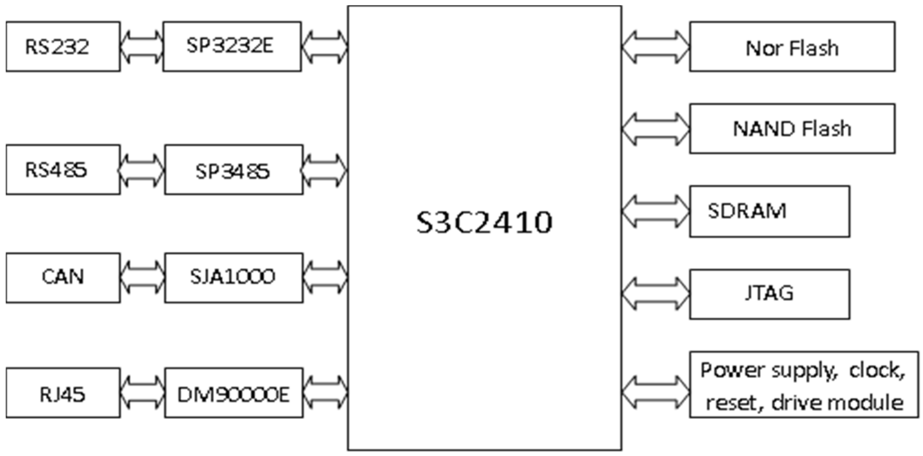

Figure 2 System Hardware Structure Block Diagram.

(1) Processor module, S3C2410 with ARM9 kernel, which supports embedded operating systems;

(2) Memory module, 2M No Flash, is mainly used for bootloader storage tasks in Linux, while 64M NAND Flash undertakes the storage tasks of Linux system and its programs. 64M SDRAM is mainly used as synchronous storage and has dynamism.

(3) The data transmission module, including RS232, RS485, CAN bus, and network interface module, is used to achieve data transmission and support for databases;

(4) Power supply, clock, reset, driver module.

The software has a lot of content, mainly including model libraries, inference engines, main control programs, and knowledge bases, as well as database and other program designs.Figure 3 illustrates the structure and content of the software.

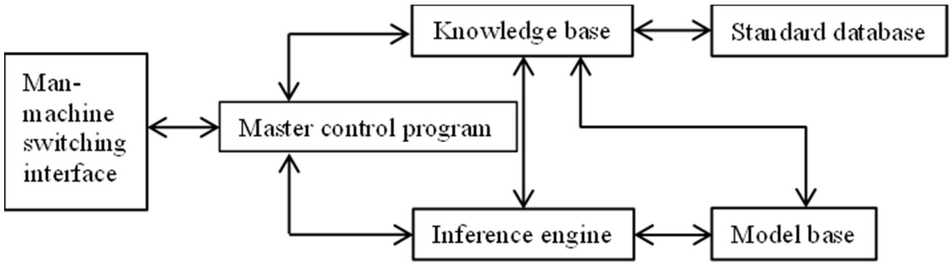

Figure 3 System Software Structure Block Diagram.

Specifically, the model library mainly undertakes the storage task of automotive related rule models and belongs to the core of model management. It can perform operations such as modifying, adding, and deleting models; The inference engine belongs to the core part of the system, which is the key to intelligent guidance and internal coordination. Based on the symptoms represented by faults, it simulates the expert processing and diagnostic ideas to achieve the inference operation goals; The main control program is the basis for system resource invocation, and it is responsible for corrective and diagnostic functions for automotive fault problems; The knowledge base integrates various knowledge contents of the system, including expert knowledge, model base knowledge, and database knowledge. This part can be updated and mainly undertakes the task of collecting corresponding symptoms of fault problems; A standard database stores standard value data as the storage object, which is scientific data obtained through measurement and analysis. In addition, the observation data to be diagnosed is also stored in this database. For the human-computer interaction interface, its core task is to build the connection between the system and users, responsible for receiving data input and undertaking the task of outputting results.

7. Conclusions

This article studies an embedded intelligent automotive fault detection analyzer with high-performance embedded CPU as the core, Linux as the operating system, built-in network data exchange software package and network interface, built-in real-time database and automotive fault expert diagnosis system. The analyzer comes with multiple bus interfaces that are conveniently embedded in automotive detection equipment and application systems, and can communicate and exchange data through the Internet. Thus, the real-time database and automotive fault expert diagnosis system are embedded into network nodes to diagnose automotive faults in real-time, making a powerful automotive fault diagnosis instrument a reality.

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