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Research on the Application of Artificial Intelligence Technology in Power System of Forestry Operation Engineering

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Abstract:

In forestry operation engineering, power equipment is the main energy consuming equipment. The control accuracy of power equipment has a great impact on efficiency and energy consumption. As power equipment, motors are widely used in power plants and industrial and mining enterprises. This paper studies the application of artificial intelligence technology in power system. The basic concepts of artificial intelligence technology, such as artificial neural network, expert system, genetic algorithm and fuzzy theory, are expounded. From the practical point of view, the application characteristics and existing problems of them in power system fault diagnosis are analyzed. This paper analyzes the zero crossing breaking technology of intelligent AC contactor, which is the core component of motor controller, and applies the artificial neural network technology to the breaking time prediction of intelligent contactor. It provides a new method for the AC contactor to fall into the best zero crossing breaking area and realize the zero crossing breaking of intelligent AC contactor. In this paper, the causes of various motor faults are analyzed, and the accurate criteria of motor faults are obtained on the basis of symmetrical components. At the same time, in the motor fault diagnosis, the application of expert theory. Finally, this paper points out the latest development trend of the application of artificial intelligence technology in power system.

***Keywords**: Forestry operation engineering, artificial intelligence, power system, fault diagnosis.*

I. INTRODUCTION

With the rapid development of social economy, the importance of electric power in national social life has risen to the height of national security [1]. With the development of industry, the demand for power supply is higher and higher. High precision processing industry, people's livelihood medical industry and so on have strict requirements for the continuity and quality of

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power [2].

However, with the deepening of the modernization process, the scale of the power network is becoming larger and larger, and the operation is becoming more and more complex, which puts forward a severe test of power supply for the large power system [3-4]. The power system must ensure continuous power supply, reliable power supply, and standardized power quality. However, in the actual power operation, it is difficult to avoid all kinds of faults. Due to the natural climate change, human factors and so on, especially the transmission line faults caused by long-term exposure to natural conditions. Therefore, it is necessary to establish a set of perfect power system fault diagnosis system to realize the identification of power system fault area and fault location, so as to realize the normal operation of power system quickly [5].

The main purpose of power system fault diagnosis is to quickly identify the fault components and the protection and switch of misoperation and refusing operation, so as to provide reliable basis for dispatchers and realize the power system fault recovery quickly. The fault diagnosis system of power system can provide the information of knife switch displacement and relevant protection measures when the circuit breaker is in error, and find the fault components through fault records [6-7]. However, the power system is too complex, resulting in the acquisition of fault information in the presence of uncertainties. In order to solve these uncertain problems to the greatest extent, this paper focuses on the research of power system fault diagnosis system based on artificial intelligence, mainly studies the fuzzy Petri net and multi. Agent power system fault diagnosis system. By improving the pelri net model of power system fault diagnosis, the fault diagnosis of the whole power system is realized. The hardware structure design and software design idea of power system fault diagnosis are discussed, which provides the basis for the normal operation of power system.

II. FAULT DIAGNOSIS TECHNOLOGY

2.1 Basic principles of power system fault diagnosis

With the continuous expansion of the scale of the power system, fault diagnosis is carried out in the power grid dispatching center. Once a fault occurs in the power system, the dispatching center will receive a lot of alarm information, especially when complex faults occur. Moreover, the misoperation, misoperation, protection and channel problems of the circuit breaker lead to many uncertain factors. It is impossible to determine whether the received alarm signal is correct or not, and whether the fault may exist if the alarm signal is not received. At this time, the staff of the dispatching center must analyze the unprocessed alarm information and read the fault point. Because the power system is too complex, it is very difficult for the

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staff to judge the fault quickly and correctly. Therefore, to determine the fault point, we must first determine the fault area, obtain the nature of the fault, and determine whether the relevant protection action is correct, so as to provide the basis for fault repair [8].

In the operation of the power system, whether the system fails or the original fails, the relay protection device in the system will make the circuit breaker give an alarm signal, so as to remove the fault. The fault diagnosis system of power grid uses the powerful computing function of computer to realize the diagnosis results of the original dispatcher's work and other related units. The analysis results are fast and accurate, so that the dispatching center staff can quickly realize the fault recovery. The basic principle of power grid fault diagnosis is based on the symptom information generated after the system failure. Firstly, the branch power, current, node voltage and other electrical quantities of the power grid change, then the protection device sends out the protection action signal, and finally the state of the circuit breaker changes. The diagnosis process is shown in Figure 1.

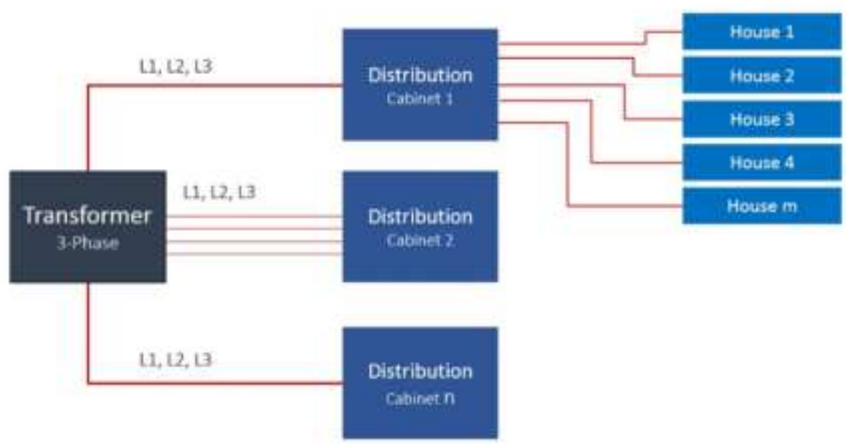

Fig 1: Development of information related to power grid fault diagnosis

2.2 Fault area identification and fault handling method

In the operation of power system, there are not many fault elements, and in a short time after the accident, the protection action cuts off the circuit breaker, and then isolates the fault elements, so as to avoid the occurrence of greater accidents. After fault recovery, the fault component is located in an isolated passive network. By identifying the network topology before and after the fault, the post fault passive network is formed. Then, the so-called fault area is the passive network containing the fault component.

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To identify the fault information through the switch information, it is necessary to judge according to the change of the displacement switch information. If the switch has no switch displacement before and after the fault, it belongs to the normal stop operation area. At the same time, it can identify the power failure area affected by the failure of the upper level components through the protection and switch information.

When a fault occurs in the power system and the circuit breaker trips, the dispatcher of the power system analyzes and processes the system as follows: first, determine whether the fault occurs according to the specific situation of the circuit breaker tripping and the display of the system dial. The parameters that the field personnel refer to are: the fluctuation of dial frequency, whether the power flow of the line is in the zero state, whether the bus voltage is zero, etc. if it is confirmed that the system has a fault, it is necessary to diagnose the size of the fault according to the influence and scope of the surrounding stations. If the result of the diagnosis is that the system has failed, then it is necessary to use the fault information about the system and the equipment that has been cut off to preliminarily determine the original fault. If only one device has power failure, then the device is a fault device. If multiple devices have power failure, then further diagnosis and analysis are needed.

2.3 Fault diagnosis model

In the power system, the important component is the relay protection device. It is an automatic device, which can accurately reflect the fault of the power system, the information of the circuit breaker and the alarm information. It is used to realize the isolation of the fault point and the power supply as soon as possible when the fault occurs, so as to control the fault within the scope of the original fault. The main objects of fault diagnosis are components (line, bus and transformer) and protection equipment (protection and switch, etc.).

When the power system fails, the working principle of relay protection device is to quickly remove the fault components from the power system, reduce the scope of power outage, and reduce the impact of fault components on the normal operation of the power system. Because of the existence of relay protection device, in its protection range, there will be no misoperation and misoperation, but it is easy to produce misoperation in the process of relay protection. Usually, there are two kinds of relay protection: main protection and backup protection. The function of backup protection is to work by backup protection when the main protection can not work normally, and there is fault protection overlap area between the two kinds of protection, which has redundancy.

Each relay protection device has a certain protection range, and there is a specific

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relationship between the protection and the circuit breaker. Generally, the fault area can be determined by the action information of the circuit breaker and the protection, so it can provide the basis for the judgment of the fault. Figure 2 is a simple power system fault diagnosis model diagram.

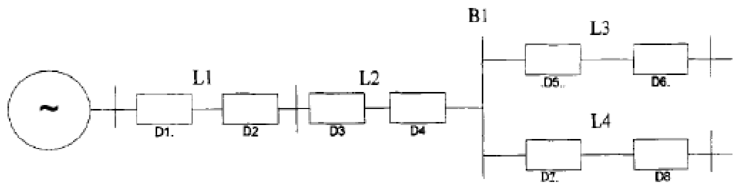

Fig 2: Simple power system model

In fig. 2, D1~D8 represent circuit breakers, L1~L4 are lines, and B1, that is, Bus1, is bus 1.

III. FUZZY PETRI NET AND ITS MODEL ESTABLISHMENT

3.1 Fuzzy Petri net reasoning method

Fuzzy Petri net (FPN) is based on the basic Petri net. The value of the interval [0,1] corresponding to the base is taken as its Tolkien value. Each transition corresponds to a certain factor CF (certain factor). It also specifies the input and output matrix. Fuzzy Petri net is extended from the triple of Petri net, which includes five modules: place, transition, confidence, threshold and weight.

There are several kinds of fuzzy reasoning algorithms based on Fuzzy Petri Net: first, combining fuzzy Petri net with matrix operation, the formal reasoning algorithm is realized in the process of fuzzy reasoning. Secondly, the reasoning algorithm based on fuzzy production rules uses the maximum algebra theory in the reasoning process. Thirdly, in the reasoning process of fuzzy Petri net, the principle based on query is adopted. Fourth, the use of reverse reasoning method.

Generally speaking, in the process of building fault diagnosis model, the fuzzy Petri net reasoning algorithm is used to infer the cause of network fault, and the forward and reverse fuzzy reasoning algorithm is used. The reasoning process of forward reasoning algorithm is as follows: firstly, the fault database set is established, and then whether the transition is enabled or not is judged. If the transition is enabled, judge whether the transition can be ignited, then ignite all ignitable transitions, and put the results into the corresponding result library. The

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purpose of reverse reasoning algorithm is to prepare for forward reasoning algorithm. It can extract rules related to the result proposition and covering the whole knowledge system. This paper focuses on the reverse reasoning algorithm based on matrix operation.

3.2 Power system fault diagnosis model based on Fuzzy Petri net

In fuzzy Petri nets, the distribution and number of tags of Petri nets should be determined first, and then transition is used to realize activation. Next, a simple fuzzy Petri net power system fault diagnosis model is established.

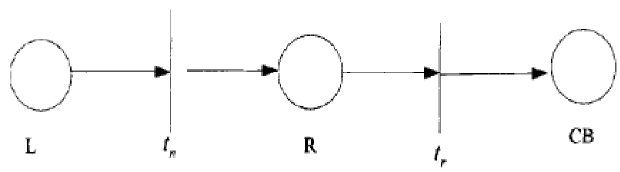

Fig 3: A simple fuzzy Petri net fault diagnosis model

Figure 3 describes a relatively simple fuzzy Petri net model. In the model, L is used to represent the line, R is for protection, and CB is for circuit breaker. If a fault occurs in the system, it is represented by transition t_n, and if the system is in a stable state, it is represented by transition tr. If L contains Token, it means that this Peril network is in active state. When the system fails, t_n is triggered, and Token is transferred from L, a Token will be added to the warehouse R, and if the relay R finds a fault, the circuit breaker CB will act. If the Token in CB increases by one, then if the transition t_r is triggered, it means that the breaker acts, thus eliminating the fault generated by the system.

IV. HARDWARE DESIGN AND SOFTWARE DESIGN OF POWER SYSTEM FAULT DIAGNOSIS

4.1 Overall scheme design

This system adopts the design scheme of "MCU+ADE7758", and determines its overall framework according to the requirements of system functions, technical indicators and chip functions. The power system parameter detection device consists of four units: an input conversion unit, an MCU micro-processing unit, and a display and communication unit. Its frame is shown in Figure 4.

4.2 Design of fault diagnosis software for power system

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The main idea of the software is shown in Figure 5, using the design method of multiple interrupts. After the system is reset and started, after the self-test and initialization, the system starts to wait for the interrupt in a cycle, that is to say, all the functions of the system are reflected in the interrupt service subroutine:

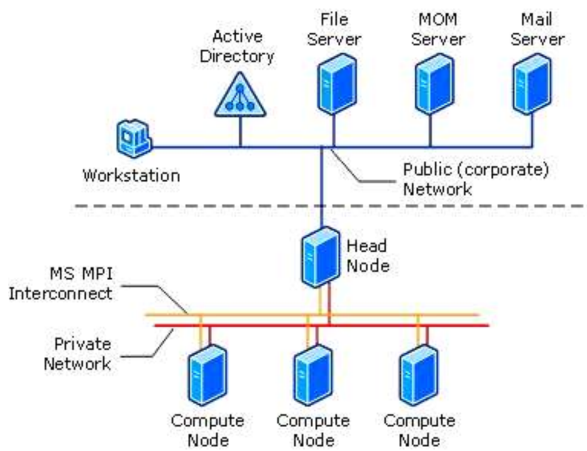

Fig 4: Block diagram of overall system thinking

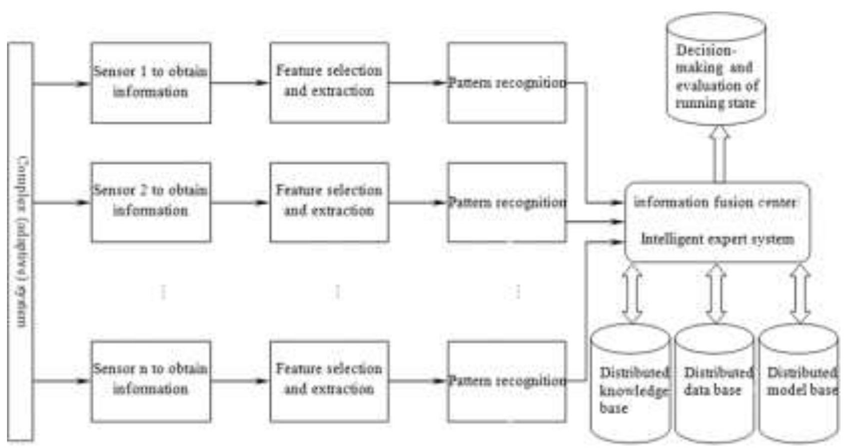

Fig 5: Design idea of software subject

ADE7758 has rich interrupt types, including over-voltage, over-current, under voltage, under current, overheat, wrong sequence, etc. when the protection interrupt is generated, MCU accesses the interrupt status register of ADE7758 to determine the type of fault source.

Software is the soul of the system. All functions of hardware are realized by software, and

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the efficiency of software directly determines the efficiency of the whole system. In this design, under the premise of the normal operation of the hardware circuit, the basic program modules are put together for debugging, and the methods of full speed operation, single step execution and setting breakpoints are used to eliminate possible errors, so that the whole software system can run. In this paper, the software is used to compensate the error. Through the standard sinusoidal signal input with full scale of 0.5V and 60Hz, the effective value of voltage, current and power calculated by ADE7758 are compensated by software [9-10]:

$$K = \frac{X'_{max} - X'_0}{0.5 - 0} \quad (1)$$

$$X = \frac{X'}{K} \quad (2)$$

Where X'_{max} is the measured value of full scale 0.5 input, X'_0 is the measured value of zero input, K is the compensation coefficient, X 'is the measured data, and X is the measured result.

V. DESIGN AND IMPLEMENTATION OF FAULT DIAGNOSIS SYSTEM FOR MULTI-AGENT POWER SYSTEM

5.1 The architecture of MuIti-Agent

According to the hierarchical mechanism of DAI, the Multi . Agent system model can adopt the following hierarchical organizational structures: global diagnosis Agent, knowledge management Agent, information interaction Agent, coordination control Agent, task planning Agent and data acquisition and fault monitoring Agent. The Multi—Agent fault diagnosis architecture is shown in figure 6. This hierarchical structure can be applied to power system. After power system failure, the whole system can be decomposed into several small subsystems by using Multi—Agent technology, which is convenient for management and maintenance. They can quickly solve complex process systems through mutual cooperation.

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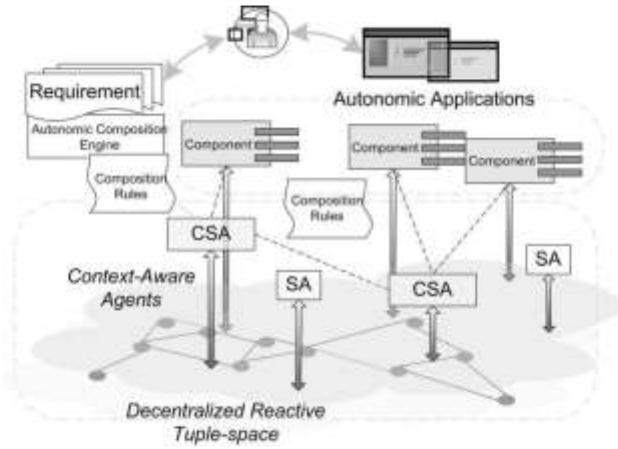

Fig 6: Multi-Agent fault diagnosis architecture

Each Agent completes the following functions:

(1) data acquisition and fault monitoring agent: to achieve the purpose of acquiring fault information through database or SCADA, and then transmit the acquired data to the corresponding Agem.

(2) Knowledge management Agent: it manages and maintains the knowledge base and provides diagnostic knowledge for diagnostic agents.

(3) Information interaction agents: buffer and access the information transmitted by each agent, and complete the information interaction among each agent.

(4) Coordination and control Agent: it is responsible for coordinating the work among agents, and dealing with how to resolve problems when conflicts occur among agents.

(5) Diagnostic agent: This is the core of the diagnostic system, including related diagnostic methods. Diagnosis Agem makes full use of information base to diagnose faults.

(6) Task planning agent: to create and resolve tasks in multi-agent system.

At present, the application research of Multi-Agent technology in substation fault diagnosis has made some achievements, but the application research of Multi-Agent technology in power system fault diagnosis is relatively few. In this paper, fuzzy Petri net reasoning algorithm is embedded into Multi-Agent power system, and a fault diagnosis model of Multi-Agent power

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system based on improved fuzzy Petri net is proposed. The whole system fault diagnosis model is divided into three modules, which are fault information input module, fault processing module and fault information output module.

(1) Fault input module

The main part of fault input module is fault monitoring Agent, which is responsible for collecting real-time fault and running status information in power system. Check whether there is any abnormality in the power system by comparing the standard operating states of the power system. If any abnormality is found, it will immediately send a fault information extraction notice to the information processing Agent, providing preparation for further fault diagnosis.

(2) Fault handling module

The main parts of fault processing module are fault information processing Agent and fault diagnosis Agent.

The fault diagnosis Agent is mainly responsible for deeply diagnosing the fault information of the power system obtained from the information processing Agent, and deeply discovering the location and cause of the power system fault. This process is mainly completed by using the improved fuzzy Petri net reasoning mechanism, finding out the fault reason and giving the fault diagnosis conclusion.

(3) Fault result output module

The fault result output module is mainly a management Agent, which is mainly responsible for displaying the monitored real-time operation state of the power system and the diagnosis conclusions obtained by the fault diagnosis Agent. The management Agent also has the function of man-machine interaction, displays the fault handling methods synchronously and outputs the final fault diagnosis results.

VI. CONCLUSION

With the progress of society, the development of power industry is related to the national economic and social stability. However, due to the increasing capacity of the power system, the structure is also increasingly complex, so the power system failure is inevitable. Once there is a problem in the system, if it can not be dealt with in time, then the whole power system may be paralyzed, and even threaten national security. And its users have higher and higher requirements for the reliability and continuity of electric energy. Therefore, how to use the alarm information generated after the fault to assist the dispatcher in fault diagnosis is a conventional and meaningful research topic. This paper focuses on the research of power system fault diagnosis based on artificial intelligence, and has achieved some research results,

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but there are also some shortcomings. Next, the realization of specific functions in the system will be discussed in more detail.

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