

Study of SF₆ circuit breaker fault diagnosis expert system

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Abstract. Set the expert analysis and diagnose system of the moisture content in SF₆. make good use of the manual work blur NN technique and illegibility technique and expert system technique to deal with the illegibility and uncertainty in the course of analyzing of moisture content in SF₆ switch and make good use of the superiority of all kind of the reasoning method, and get over the shortage of existent ,so that we can find the answer of the question in the great extent ,and improving the nicety rate of the diagnose and the reliability of current analysis.

Introduction

The expert system technology appeared in the nineteen sixties, so far, the expert system is still not a strict definition of recognized, is generally believed that the expert system is an intelligent system with expert level problem solving ability in relevant fields, it can use the experts in the field of many years of accumulated experience and expertise, to simulate human thinking process experts, to solve the difficult problem can be solved by experts.

Due to a series of characteristics of expert system of their own, SF₆ circuit breaker diagnostic analysis has been carried out some research on how to use the expert system of many experts and scholars at home and abroad, but can diagnosis expert system used in the actual production of a few, the main reason is the SF₆ circuit breaker diagnostic analysis of knowledge not only very rich, but very complex. This knowledge includes not only the deterministic and reliable knowledge, but also the uncertainty and fuzzy knowledge, it is clear that the traditional expert system cannot use the simple method of knowledge processing rule and frame to adapt to the knowledge in this field based on the requirement of processing.

Based on this, this paper proposes an expert system model based on fuzzy neural network. Using the knowledge of traditional methods of deterministic diagnosis knowledge in the process of SF₆ circuit breaker, i.e. rules based on the forms of representation and reasoning of fuzzy, uncertain, in which knowledge is used to deal with the fuzzy neural network. In the process of problem solving, take corresponding methods of inference for reasoning in different stage, give full play to the advantages of two kinds of reasoning methods, to overcome their shortcoming, which can find the solution of the problem of the maximum.

The overall structure of the system design scheme

This system mainly consists of the following parts: man-machine interface, inference engine, explanation module, learning module, neural network module of dynamic database module, knowledge base module, knowledge database management module etc. System structure diagram is shown in Fig. 1.

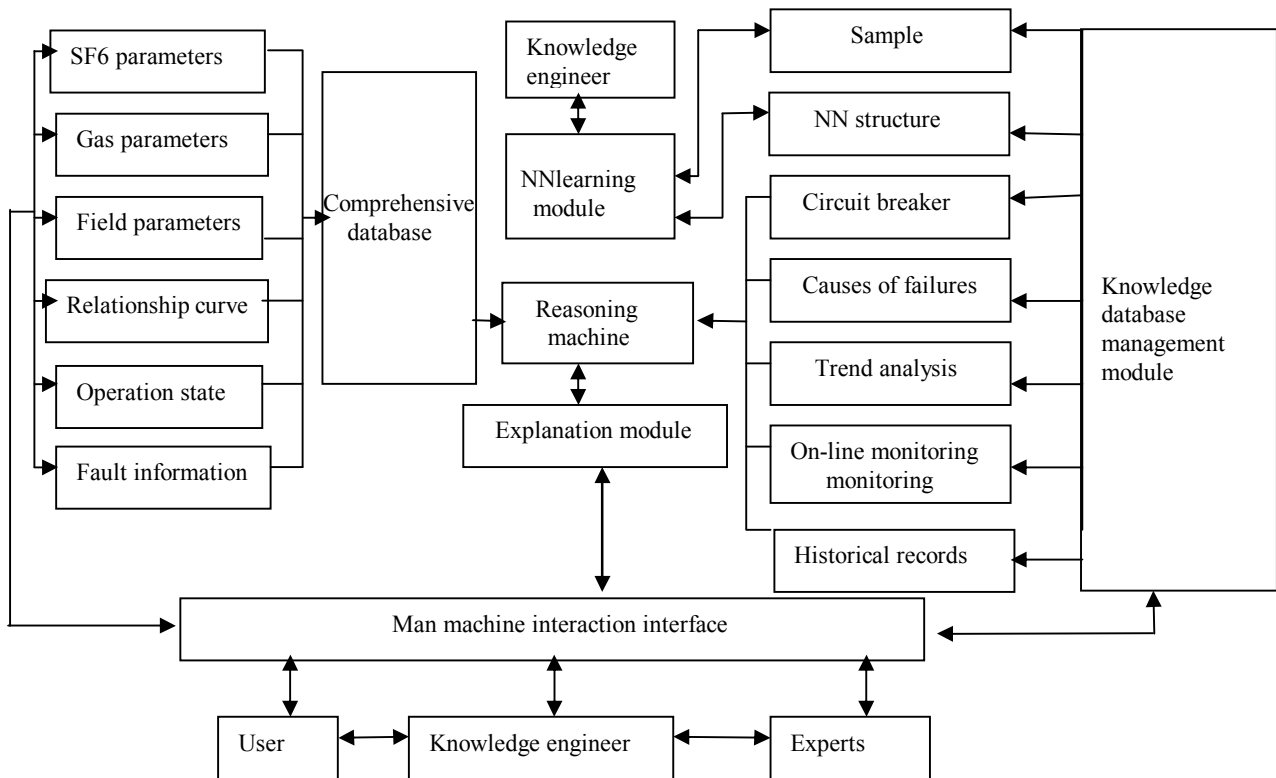


Fig.1 The whole system structure diagram

(1) The human-computer interaction interface for users, knowledge engineers and domain experts to communicate through the man-machine interface and the system. Knowledge engineers through it can be to neural network learning module, knowledge base structure, sample of neural network knowledge base management, maintenance and updating of adjustment. The user through it and get the final answer questions.

(2) The explanation module is the system and the user (including knowledge engineers and domain experts) a bridge of communication between. It is responsible for user input information and other relevant information into the system to identify the system, and the final output (including the reason and its credibility, produced and corresponding solution) into the user can understand the information.

(3) The reasoning module is the inference engine using the system already has the knowledge, reasoning with specific information monitoring process includes dynamic comprehensive database, the causes, the reliability of fault and the solution. The inference engine of the system including neural network reasoning module and module based on reasoning rules of two parts. "The cause" a fault scene information inference using neural network module, "between the faults causes a solution using rule-based reasoning".

The reasoning module structure as shown in Fig. 2 (dotted line surrounding part).

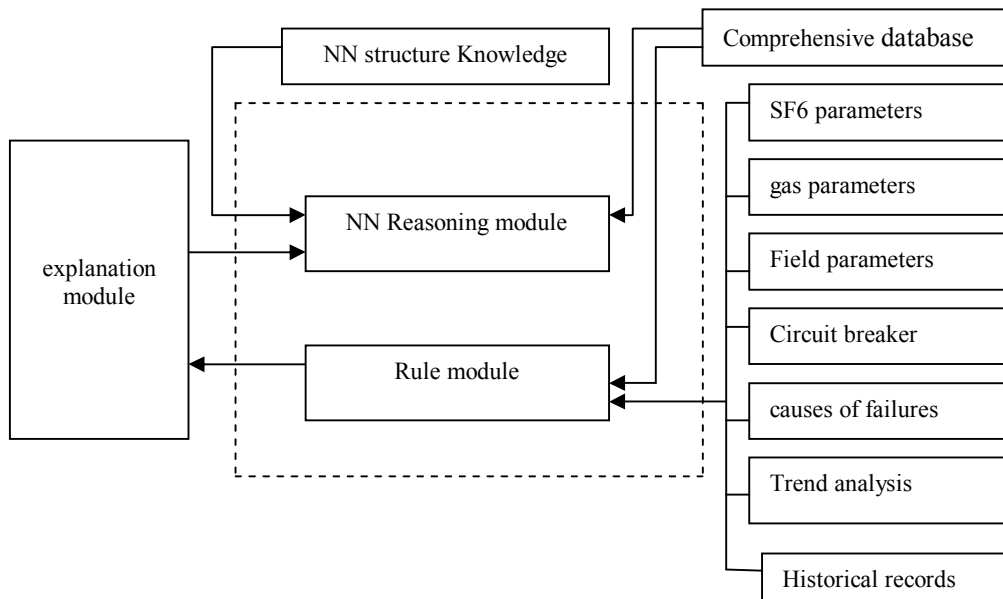


Fig.2 Reasoning module structure diagram

(4) Neural network learning module, neural network learning module to study how to obtain expert knowledge. The learning module is proposed for the structure of the neural network (including the network layer, the input, output and the number of hidden nodes), the organization for training samples, using the learning algorithm of neural network. Through the learning of samples, to obtain the required weight distribution, thus completing the acquisition of knowledge. In this paper, according to the SF₆ circuit breaker micro water content diagnosis analysis of reality, adopts the method of combining fuzzy logic and neural network to realize fuzzy neural network, and the realization of the SF₆ circuit breaker micro water content analysis diagnosis knowledge into the knowledge base using BP algorithm.

(5) The sample knowledge base, knowledge base, artificial neural network SF₆ circuit breaker micro water content of knowledge base, knowledge base, causes of trend analysis knowledge base, SF₆ circuit breaker on-line monitoring of moisture content database and history database including knowledge base, storing the corresponding knowledge respectively. The knowledge base is the foundation of system has excellent performance. To the knowledge of system is more reliable, laboratory test fault diagnosis of SF₆ circuit breaker literature reviewing and quite a long time. In lab experiments are analyzed from three aspects:

1) Pressure to predict the circuit breaker can be used over a long period of time, for example: SF₆ gas circuit breaker in the pressure less than or equal to a specific value is not in conformity with the provisions, the initial pressure of SF₆ gas in SF₆ circuit breaker is a value, beginning 72 hours after pressure into another value, and then after 72 hours change. Curve according to the variation of the graph, and need how long after pressure in a specific value. In order to estimate the life of the switch to SF₆.

2) From the sensor measured the relative humidity is converted to rules given 20 degrees, humidity content standards, to see whether it meets the requirements of the standard, in order to make the alarm.

3) According to the experience of value judgment, such as the 150ppm as the standard value, when the humidity is less than 150, for example, when the humidity is 160ppm, according to the experience and action 20 times, when the humidity of a specified value can't act, and the need to turn off the circuit breaker from the upper level, the circuit breaker to actions occur accident.

In this system, through the consult massive literature and combining with laboratory test procedure for SF₆ circuit breaker micro water content, summed up the analysis for fault diagnosis of SF₆ circuit in common signs, corresponding reasons and trend, and on this basis to determine the neural

network input node number, the node number of hidden layer and the output node number, sums up the suitable for neural network learning sample.

The system knowledge base and reasoning machine

The knowledge base and inference engine is the core part of expert system, is based on expert system have diagnostic ability, and knowledge base and reasoning of knowledge base, so the complete or not, directly affects the performance of the expert system. In this system, the knowledge base of the system can be divided into two parts: "the scene information and fault reason" knowledge and "fault - trend analysis" knowledge base. In "part of the site information and fault reasons", knowledge database used to store the connection weights between each neuron, represented by the weight matrix digital. The inference engine consists of knowledge base are stored in the connection weights of the neurons, through the forward reasoning process from "site information" for "failure". In the "fault trend analysis" section, the knowledge base for some description of "fault" and "trend analysis" relation rules, inference engine based on the front part of the neural network reasoning results, matching rules and arithmetic and reasoning accordingly, one to find solutions to meet the actual production situation and the reasons the specific reasons.

In this system, using BP (Error Back Propagation error back propagation neural network, referred to as BP) knowledge base module algorithm for constructing the system, intelligent network parameters of the network after learning the distribution of system. And, the system can learn again to the sample, obtaining new network parameters have more knowledge and experience, realization of neural network to update the knowledge base.

In the "fault - trend analysis" in the knowledge base includes two parts, one is the analysis of relevant information will be ideal process of SF₆ circuit breaker does not fail when, stored as reasonable in the database, which makes the system reasoning machine by comparing the actual production process parameters and can draw accurate conclusions; the two is the analysis of fault information, fault reason, trend of SF₆ circuit breaker micro water content of common induction and summary, analysis of the relationship between the specific reasons will generate fault and its corresponding trends summarized some rules. All the rules are implemented with the code in the procedures, the relevant knowledge are stored in the form of data tables in the database.

From the above analysis, part of the system knowledge base includes SF₆ circuit breaker fault knowledge base, knowledge base and reason of the structure of neural network trend analysis knowledge base, and the establishment of the knowledge base is the premise of fault information, fault may have on the analysis of SF₆ circuit breaker and a comprehensive summary of the trend.

In SF₆ circuit breaker fault diagnosis and analysis, through the analysis of diagnosis, determine on the basis of the traditional neural network structure, the single neural network is decomposed into several sub-networks, each neural network input node corresponding symptom, the output node of should be specific and several reasons cause of, and with much sub network based on summarizing the learning samples, through the study of BP algorithm on the sample, the rules, rules, in the sample into the connection weights and neuron threshold neural network nodes, to complete the construction of knowledge base. Study found that, when the SF₆ circuit breaker fault occurs, the reasons may include the above aspects, may also include several aspects, where there may be many reasons circumstances, we should determine the order for various reasons, in order to improve the reliability of diagnosis results, accuracy. In this paper in order to solve this problem, proposed building a network reliability neural network, aimed at the defect symptom of different degree of induction, summarize important aspects of reason, on the basis of the appropriate neural network structure, organizational learning and training samples, the neural network is constructed through reasoning are a result of this relationship, and then integrated the network output can reach all the reasons for a diagnosis result credibility. Therefore, the neural network reasoning module of this system mainly includes several sub networks, the corresponding knowledge base should also include structural parameters, the network training samples and the network weights and threshold value knowledge base. According to the rules of

inference module, to establish the knowledge base mainly includes two parts, one is the specific "failure" of the "trend analysis" summed up into a number of rules, another is the trigger and the use of knowledge which rule in what circumstances. In this paper, directly to the established neural network output values and their corresponding rules corresponding relations between the output of the neural network, and the possible values of the preliminary analysis, establishes the corresponding rule firing range, in order to construct the system of rule reasoning module, knowledge base.

Conclusions

Expert system and neural network will be able to play the traditional expert system technology and artificial neural network technology based on the advantages of diagnosis, have stronger ability and adaptation ability. This paper is the combination of expert system technology and neural network technology, the establishment of SF₆ circuit breaker expert diagnosis system. Make full use of the technology of artificial neural network, fuzzy technology and expert system technology to process in SF₆ circuit breaker micro water content, temperature, pressure and diagnosis of the circuit breaker is still running, and residual action number, pressure leakage and so on, and analyzes the diagnostic process of uncertainty and ambiguity problem, improve the accuracy of diagnosis results, and provided to the user should include name, fault location, fault state of the equipment, maintenance, so that the system has good practical application value.

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