Power Electronic Circuits Fault Diagnosis Technology Based on Genetic Algorithm Neural Network

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Abstract: The traditional power electronic circuits fault diagnosis method always has the problem of inaccurate fault diagnosis due to the complex input-output relationship. This paper presents a power electronic circuits fault diagnosis technique based on genetic algorithm neural network. By combining genetic algorithm with neural network, the problem of power electronic circuits is transformed into a mathematical problem, and the fault diagnosis model of power electronic circuits is constructed by solving the maximum of function to optimize fault diagnosis technique and finish the fault diagnosis of power electronic circuits. Experiment shows that this technique has the advantages of low cost and very high feasibility, which is worth promoting.

Keywords: Genetic algorithm; Neural network; Electronic circuits; Fault diagnosis method

1. Introduction

Modern science and technology cannot be separated from the electronic circuits. However, when the electronic circuits is in use, some failures may occur due to disrepair or the operating intensity is too large. The manifestation which can be seen is that the power switching devices are damaged. Power switching devices are the most-used tools in electronic circuits and are prone to damage. Such damage can directly cause a power outage. However, for a fault, the time is very short from the occurrence to the outage, only a few tens of milliseconds, and it is hard for staff to detect it even if the experience is sufficiently rich, which will often be affected by external factors, resulting in misdiagnosis. Genetic algorithm is a randomized search method evolving from the evolution law (the genetic mechanism of the survival of the fittest) of the biological world. It can carry out the most direct operation with the object structure, which does not require guidance in the middle. So it will not be limited by the continuity of the function it owns parallelism, and have the best overall optimization ability. The probabilistic method is used to find optimization. In a short period of time, it can automatically obtain and guide the optimized search space, and has the ability to independently adjust the search direction, without the hard rules [1]. Because of the advantages mentioned above, genetic algorithm is favored by all walks of life. Genetic algorithm can be seen in many fields, such as combinatorial optimization, machine learning, signal processing, adaptive control and artificial life. In this paper, the fault diagnosis method of power electronic circuits is studied based on genetic algorithm, the fault model and test sample are designed, and the feasibility of the technique is verified through experiments [2].

2. Application of Genetic Algorithm Neural Network in Fault Diagnosis of Power Electronic Circuits

Most of the early power electronic circuits are detected by BF algorithm, but the error reduction of the BF algorithm is the anti-gradient direction, which is prone to appear local minimum, this will make the calculation become very difficult. And as the sample increases, the input and output relationship becomes more complicated, local minimum points will appear in each relation, which reduce the convergence rate of the network greatly and affect the initial position of the network structure directly. However, the initial unreasonableness will make the network convergence speed become lower to form a vicious cycle, and even occur the situation of non-convergence. Genetic algorithm, also known as GA algorithm, is a key technology in modern intelligent computing and belongs to the field of computer science artificial intelligence. It is not only a search heuristic, but also an evolutionary algorithm. Even when the fitness function is improperly selected, it also can converge the local to the best results, so it can show the absolute advantage in the diagnosis of power electronic circuits [3].

Genetic algorithm can transform the power electronic circuits fault problems into mathematical problems, by optimizing the maximum function to complete the optimization, cited x as a decision variable, by shaping the objective function, constraints, basic space to solve x, generally the solution which is able to meet all the con-

straints is the feasible solution set. The basic computing process of genetic algorithm in power electronic circuits fault diagnosis is shown as follows:

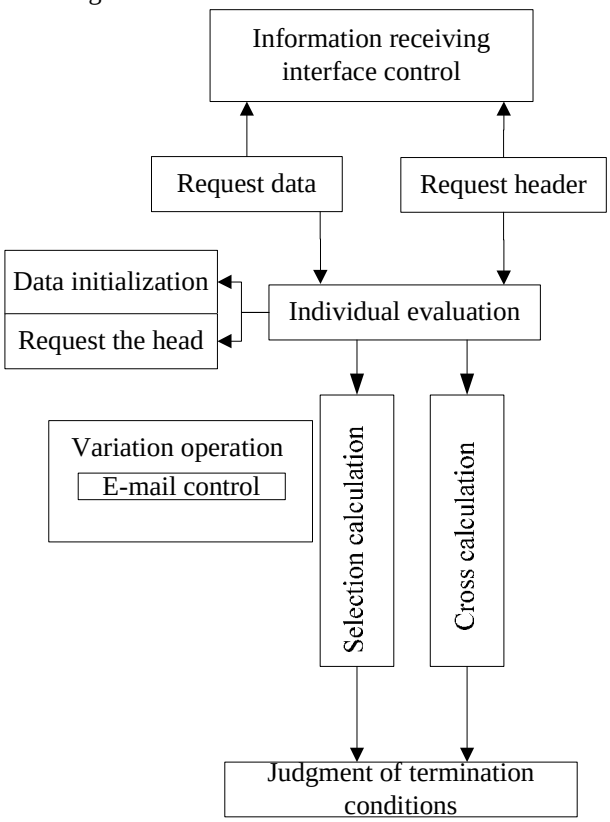

Figure 1. The basic Computing Process of Genetic Algorithm in Power Electronic Circuits Fault Diagnosis

Analysis of Figure 1 shows that the genetic algorithm is divided into six steps in the fault diagnosis of power electronic circuits:

Firstly, initialize the data in the electronic circuits, calculate out the initial population by counting the evolution algebraic counters. When t = 0, the maximum algebraic algebra value is T, and there are altogether M initial algebraic groups, the generation method is randomly generated and recorded as P (t);

Evaluate individuals and calculate the adaptability of each individual in group P (t) by setting functions [4];

Carry out selection calculation to the groups. Calculation can be subdivided into three small steps. The selection operation is the initial operation. It is mainly aimed at the groups. By choosing to find the optimal individual, the data contents can be directly "inherited" to the next generation (ie, copied) or generate new individuals through "pairing crossover" and then pass on to the next generation, of course, the individuals should meet the fitness;

Crossover operation can be refined into an independent step, can also be classified into the selection operation, and it is performed for the optimization individual, in which the crossover operator plays a central role in the genetic algorithm;

Variation operation is aimed at the calculation of individuals with mutation in the group. Through the selection, crossover and mutation of group P (t), the next generation group P (t + 1) of variant individual is get, which can effectively record the variation gene value at the mutation locus;

Judgment of termination condition. After the above operation is completed, the individual with the maximum fitness is selected as the output of the optimal solution. In this case, t = T needs to be satisfied, so that the condition judgment can be terminated to find out the fault of the power electronic circuits. However, it should be pointed out that if the function is improperly chosen, the genetic algorithm can only achieve the local optimum and cannot achieve the whole optimum [5].

3. Research on Fault Model Diagnosis Effect of Power Electronic Circuits

The power electronic circuits fault model of neural network is set as shown in Figure 2 below:

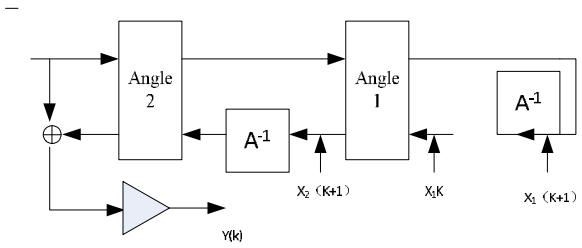

Figure 2. The Power Electronic Circuits Fault Model

By observing Figure 2, it can be known that there are four diodes in the rectifier device of the circuits, and the current passed through is not controllable rectification. In this case, the circuits will produce a variety of faults, the three main types of fault here is studied: First of all, the fault code number of the first category is 001, where the diode works normal, will not appear fault, but the rectifier restriction cannot flow in the switch; Second, the fault code number of the second category is 010. A single diode in the four diodes will be short-circuited and recorded as Xk short circuits (001), X (K + 1) short circuits (002), Yk short circuits (003) and (K + 1) short circuits (004); Finally, fault code number of the third category is C011, a single diode open circuits, the recording method is Xk open circuits (101), X (K +1) open circuits (102) and Yk open circuits (103), Y 104) [6]. Through the coding method, the genetic algorithm regards the corresponding fault code of each group's characteristic signal as a neural network's target output sample. The recording code is divided into six bits, m1, m2, m3, m4, m5 and m6. Using codes to analyze the fault conditions of different circuits can get the voltages of various faults. Finally, the

sampled data are normalized to obtain standard input samples of diagnostic system.

4. Experimental Analysis

There are 50 input layers in the neural network, which contains 10 neuron hidden layers and 12 neuron output layers. The selected function is Purelin function: $D_{mn} = \sum_{m=1,n=1}^{a=x,b=y} d_{ab} / (x \times y)$, a and b are the actual outputs, m and n are the corresponding target outputs, x and y are the samples, and the obtained Dmn is the standard input sample of the broken system [7]. Genetic algorithm experimental circuits fault diagnosis curve is shown in Figure 3 below:

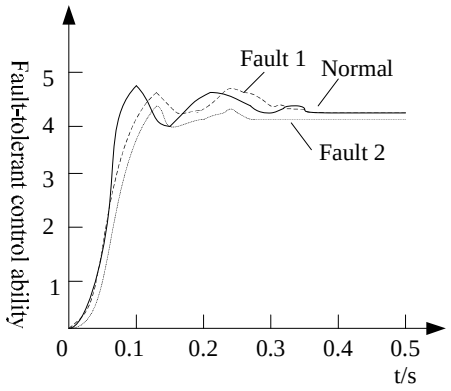

Figure 3. Genetic Algorithm Experimental Circuits Fault Diagnosis Curve

Through the experimental fault diagnosis curve, it can be known that in the rectifier circuits fails, the genetic algorithm can collect power circuits fault data effectively within 400μs, and then the voltage data obtained is normalized, the voltage data is effectively input to the shaped neural network, the obtained output result is: [0. 0382,0.4769,0.9528,0.1025,0.4321,0.7856,0. 9934], and then these values are rounded off, he type of fault code after rounded is [0,0,1 , 1,0,1,1]. Finally, compared with the hypothetical simulation results, the results show that the experimental results are consistent with the simulation results. The proposed algorithm can effectively diagnose the power electronic circuits fault, and the diagnosis time is short, it does not need to spend too many cycles and its cost is low. The accuracy of the analysis results is much higher than the back propagation algorithm (BF analysis), which have great feasibility.

5. Conclusions

The requirement of the traditional back propagation algorithm (BF analysis) is too high for the initial value, and as the relationship between input and output becomes more and more complicated, local minimum appears frequently and are not suitable for the detection of power electronic circuits fault of neural network. The genetic algorithm has the advantage of direct connection between target and result, it can screen multiple points at the same time to find out the optimal value and search the circuits according to the gradient direction to detect the fault of the power electronic circuits of the neural network. In all aspects, such as time, cost and result accuracy, the diagnosis is better than the traditional method, which has a very high market value and deserves to be promoted.

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