Application of Neural Network to Electric Power System Fault Diagnosis of PEFP

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1. Introduction

In this paper, we proposed fault diagnostics algorithm using alarms information according to the corresponding faults. To do this, after classified the alarm information according to the fault section, we designed neural network fault diagnostic system to enhance the reliability and the flexibility of the fault diagnostic algorithm.

To show the usefulness of the proposed algorithm, it is applied to the fault diagnosis for the electric power system in the Proton Accelerator Research Center of PEFP.

From the simulation results, proposed algorithm detects faulted section of the electric power system correctly. Proposed fault diagnosis algorithm also estimates faulted section correctly even when the failure operation of relays and breakers occurs.

2. Electric Power System Fault Diagnosis

When faults occur at buses, transformers and feeders etc. in the electric power system, rapid electric power system restoration by operated relays and circuit breakers for the corresponding faulted section is required to enhance the power system reliability and reduce equipment damage [1,2]. But sometimes information of relays and circuit breakers are incorrect for the corresponding fault because of their operation failure or misoperation of the protective devices. In this case, it is difficult to judge the faulted section. Moreover, when the fault is cleared by back-up protection, it leads to the large area of blackout.

Conventional fault diagnosis systems are; rule-based approach, expert system. In this paper, we proposed fault diagnosis system for electric power system by artificial neural network.

3. Electric Power System Fault Diagnosis Design by Neural Network

In this paper, we proposed fault diagnosis system for electric power system by artificial neural network. As a neural network for fault diagnosis, we adopt Radial Basis Function Neural Network because it has the capabilities of solving a diverse group of classification problem and function approximation [3].

3.1. Radial Basis Function Neural Network

In this paper, we proposed fault diagnosis system for electric power system by radial basis function neural network. Structure of the radial basis function is described in Figure 1.

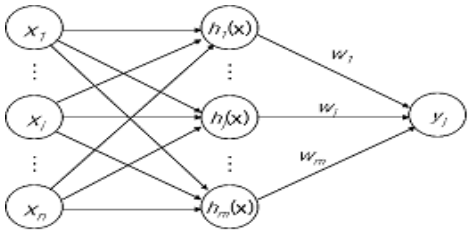

Figure 1 Structure of Radial Basis Function

Following exponential function is used to compute each hidden neuron output, which is described in (1).

$$h_i(x) = \exp(-\| x - u_i \|^2 / \sigma_i^2 \quad (1)$$

where, x : input vector

u_i :center of the i-th hidden neuron

σ_i : spread of the i-th hidden neuron

As shown in (2), the output is produced by linear weighted summation of the hidden neuron output.

$$y_j = \sum_i h_i w_{ij} \quad (2)$$

where, y_j : output of the j-th output neuron

w_{ij} : weight between i-th hidden neuron and j-th output neuron

Center of the hidden layer neuron is created to hold the input vector. The weight between hidden neuron and output neuron is assigned the target value. In this paper, we choose σ_i with proposed Genetic Algorithm-Tabu search, which will be described in the following.

4. Genetic Algorithm-Tabu Search

Genetic Algorithm (GA), one of the probabilistic optimization methods, is robust, and it is able to solve complex and global optimization problem; However, the disadvantage of GA is that it can suffer from excessive computation time before providing an accurate solution because of minimal use of prior knowledge and no utilization of local information[4]. Whereas, Tabu Search (TS) is a meta-heuristic method that guides the search for the optimal solution making a use of a flexible memory system which allows the search history to be taken into consideration. But TS is

reliable to be affected by initial solution, and if local minimum is encountered, it takes much time to execute diversification operation to escape local minimum[5].

In this investigation, hybrid Genetic Algorithm-Tabu Search (GA-TS) was developed, which uses both GA with good global search capability and TS with good local search capability. Best fitness of GA is not enhanced during predetermined generations, individuals of each node with higher fitness value of 10% in the population are set to the initial solution of TS operation to enhance the local search capability of GA operation. After TS operations, best solutions of TS operations are included in the populations of the GA.

To enhance the global search capabilities of GA, strings below the average fitness are stored and prohibited for several generations.

5. Proposed Neural Network Fault Diagnosis Algorithm

When designing neural network fault diagnosis system, parameters of the neural network should be optimized. In this paper, we optimized the spread of the hidden neuron by proposed GA-TS algorithm.

6. Simulation Result

To show the usefulness of the proposed algorithm, designed neural network is applied to the fault diagnosis of the electric power system of PEFP. In this paper, we applied to the detection of the faulted sections of electric power incoming line, 154kV bus, 4 154kV feeder, 2 154/3.3kV transformer, 4 3.3kV busbar and 35 3.3kV feeder. Table 1 describes the simulation parameters and Figure 2 shows the electric power system of PEFP.

Table 1 simulation parameter

simulation parameter		value
GA	no. of gen	200
	no. of population	20
	crossover prob.	0.8
	mutation prob.	0.01
TS	no. of iteration	100
	tabu length	30

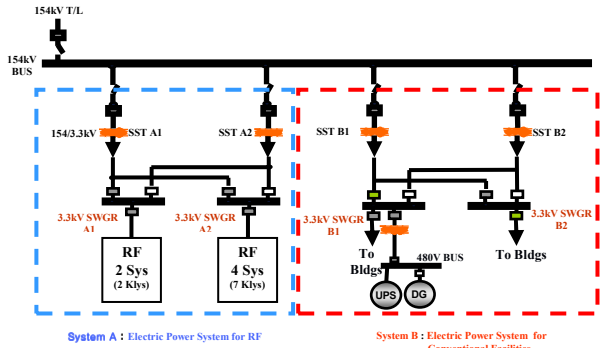

Figure 2 Electric Power System of PEFP

To test the fault diagnosis system, three cases are tested.

In case 1, we assumed that fault occurs at the 154kV bus and corresponding circuit breaker CB 617 and relay 487 operated but 427 fails to operate correctly. In this case, proposed system estimates faulted section correctly even though relay 427 not operated.

In case 2, we assumed that fault occurs at the 154kV/3.3kV transformer SST A1 and corresponding circuit breaker CB 6138, CB 6138-01B-1, relay 487 operated, but CB 1638-01B-2 not operated. In this case, proposed system also estimates faulted section correctly.

In case 3, multiple faults case is tested, that is, fault occurs in 2 3.3kV feeder (feeder #21, RF Sys. #104) simultaneously. In this case, proposed system also estimates faulted sections correctly.

7. Conclusions

In this paper, we designed neural network fault diagnostic system to enhance the reliability and the flexibility of the fault diagnostic algorithm.

To show the usefulness of the proposed algorithm, it is applied to the fault diagnosis for the electric power system in the Proton Accelerator Research Center of PEFP.

From the simulation results, proposed algorithm detects faulted section of the electric power system correctly. Proposed fault diagnosis algorithm also estimates faulted section correctly even when the failure operation of relays and breakers occurs and faults occur in the different section in the power system simultaneously.

ACKNOWLEDGEMENT

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