Fault Detection of Distributed Power Distribution Network Based on Grey Wolf pack Algorithm

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ABSTRACT

The integration of distributed power supply into the distribution network is an important trend in the development of the current new power system. In view of the problem that the system can not quickly and accurately obtain the fault type and locate the location of the fault when the current distributed power distribution network fails. Introduce a detection method to optimize the current fault analysis system of distribution network based on the grey Wolf pack algorithm (Grey Wolf Optimization, GWO), and optimize the fault detection algorithm based on the optimization of distribution network structure. In addition, a complete analytical model of complete fault information such as medium calculation, misoperation and action is constructed to improve the analytical model of detecting complex fault situations in the distribution network. Through example analysis, the effectiveness of the fault detection model of distributed power distribution network based on gray Wolf swarm algorithm is verified, reducing the probability of fault miscalculation of distribution network to a certain extent, and solving the problem of low accuracy and slow speed of distribution network fault detection in the traditional algorithm.

Key words: grey wolf pack algorithm; distributed power supply; fault detection; algorithm optimization; particle swarm

1. INTRODUCTION

The fault detection of the distribution network is mainly based on the fault alarm information received by the control system, quickly and effectively identify the fault of the fault components of the distribution network, and provides relevant fault information and parameters, so as to provide reference for maintenance staff. However, with the access of a variety of new energy distributed power sources to the distribution network, the applicability of failure detection methods in the traditional distribution network is not strong. In order to ensure the normal operation of the power system without affecting the social demand for electricity, it is necessary to ensure the effectiveness of the fault detection algorithm of the distribution network, quickly and accurately locate the fault section of the power system, and take measures to eliminate the fault in time. Currently of distributed distribution network fault detection method has a lot of research, some scholars research to improve the genetic algorithm fault location method in the distribution network achieved good results, but in the analysis of the fault cause and specific data parameters, easy to fall into local condition analysis, and the algorithm calculation time is longer, search dimension is too large to affect the detection efficiency, unable to timely provide fault detection data reference.

Based on this, the use of gray Wolf pack algorithm (Grey Wolf Optimization, GWO), a new type of group intelligent optimization algorithm, its operation principle is simple, simple setting parameters, and has a strong search ability. By applying GWO algorithm to the current complex fault reduction system containing distributed distribution network, the unified direction can determine the rules and construct the switch function adapted to the switching of a variety of new

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energy generation. According to the characteristics of the switching function of each region, the hierarchy of the distribution network is divided, and the simplified equivalent model of the distribution network is established.

On the basis of GWO algorithm, combined with the actual fault model, the position update formula is optimized on the basis of GWO algorithm, and the crossover and variation operation are introduced, which further improves the convergence speed and optimization accuracy of the algorithm. Finally, the established hierarchical model is located by the GWO algorithm, and the accuracy and fault tolerance in the structure of the algorithm are improved by using the verification mechanism.

2. ALGORITHM LOCALIZATION OF THE HIERARCHICAL MODEL

2.1 Optimization of the grey pack algorithm

GWO algorithm is to simulate the feeding behavior of gray wolves in nature and the registration system in the pack. The letters a, b, c and d represent the head Wolf, the deputy leader, the ordinary Wolf and the bottom Wolf in the pack respectively. When using this algorithm to solve the optimization problem, assume that the number of gray wolves in the Wolf pack is N, where the position of the n th gray Wolf in the d-dimensional search space can be expressed as:

$$X_n = \left(X_{n1},\ X_{n2},\ \cdots,\ X_{n3}\right) \quad (1)$$

The optimized individual particles in the gray pack are labeled as a, the suboptimal particles as b, the third best particle as c, and the remaining particles as d. Grey wolves are hunted according to formula _ (2).

$$\begin{cases} D = \left|C \cdot X_p(n) - X(n)\right| \\ X(n+1) = X_p(n) - A \cdot D \\ A = 2l \cdot r_1 - l \\ C = 2 \cdot r_2 \end{cases} \quad (2)$$

N iteration, is the position of the prey, and is the n iteration is the position of the gray Wolf particle, and A, C respectively, and with the increase of the number of iterations, l will increase with the number of iterations and decrease to 0. And gray wolves usually according to the position of a, b, c prey is the location of the fault point, and update the position of hunting, through the formula (3) (4) to describe its updated position:

$$\begin{cases} F(t+1) = \frac{F_1+F_2+F_3}{3} \\ F_1 = F_a - A_1 \cdot D_a \\ F_2 = F_b - A_2 \cdot D_b \\ F_3 = F_c - A_3 \cdot D_c \end{cases} \quad (3)$$

$$\begin{cases} D_a = |C_1 \cdot F_a(t) - F(t)| \\ D_b = |C_1 \cdot F_b(t) - F(t)| \\ D_c = |C_1 \cdot F_c(t) - F(t)| \end{cases} \quad (4)$$

2.2 Cross-variant optimization

In order to solve the problem of locating the fault area in the distributed distribution network, the two states of the fault area are expressed as 0 and 1, and the location of the gray wolves is updated according to the location of the binary representation. In order to increase the diversity of particles in the gray Wolf group after iteration, the binomial crossover operation is performed to ensure that the probability of the crossover and the value of relative adaptation are not change. At the same time, the variation operation can further improve the diversity of wolves, prevent the problem of poor overall optimality of the algorithm, and change the operation of the crossed gray Wolf particles (as shown in Equation 5)

$$x_d^i = \begin{cases} x_{a,d} + r_3(x_d^{q1} - x_d^{q2}),\ rand_d^i < \mu \\ x_d^i,\ other \\ \mu = 0.08 \times x_{a,d} \end{cases} \quad (5)$$

According to Equation (5), the mutation probability of the current optimal Wolf pack particle is 0, and the worst grey Wolf particle mutation probability is 0.08.

3. FAILURE POSITIONING IMPLEMENTATION

Using the optimized gray Wolf algorithm to determine the fault area, according to the number of the feeder of the distribution network to set the gray Wolf population particle size for N, randomly generated parameters in search d dimensional space, generate the Wolf role particle adaptation value, the adaptation value in the top 3 particles set to a, b, c, finally according to the updated position using formula (5) cross variation operation.

After determining the fault area according to the hierarchical model divided by GWO algorithm and the parameters of the fault current uploaded by FTU, the fault area is searched for in the fault area by exhaustive method. In order to improve the accuracy of the fault positioning of the algorithm, it is necessary to compare the output positioning section with the positioning results, and output the positioning results. If not consistent, the iterative program will be restarted. The specific fault detection and positioning process is shown in Figure 1.

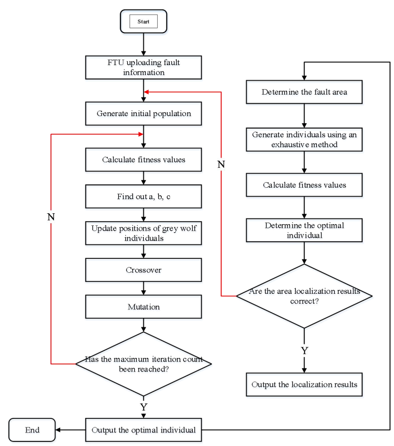

Figure 1 Flow chart of fault location detection of gray pack algorithm

4. INTERPRETATION

4.1 Experiment Procedures

In this paper, the simulation experiment is analyzed for the distributed power distribution network, and the distributed power supply is connected at nodes 12,18 and 25 respectively (as shown in Figure 2).

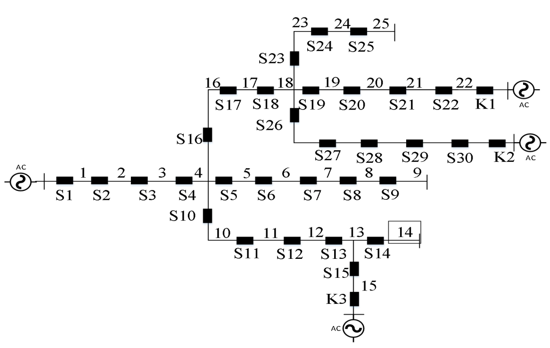

Figure 2 Structure diagram of distributed power distribution network

According to the GWO algorithm, set the total number of populations of the gray pack to N=30, the spatial dimension of the population is d=8, and the maximum number of iterations is 50. If all the sections and segments of the distributed power distribution network in the experiment are put into operation, When the section 13 in FIG. 2 fails, The fault current information uploaded by FTU is [1 11 1 00 000 1-1-1-10-1-1-10-1-1-1-1-10000-10000-100-1-1-1-1-1-1-1-1-1-1], Extract the fault current information for each region as [100 1-1-1-10-1-111-11-1], Using the binary GWO algorithm to analyze and solve the fault points in the weekly judgment area, Then through the exhaustive method to locate the fault area.

However, when the current in the fault position is small, the FTP device cannot detect the information of the fault current, or other fault information error occurs, whether the algorithm can guarantee the accuracy of detection. In distribution network section 16 fault upload the fault information for analysis, calculate the fault location using GWO algorithm analysis results for area A and area B, the area A calculation analysis, the fault results of the first time, the iteration again, if the same, avoid the late repositioning program.

4.2 Analysis of the results

According to the process of the above experiments, different algorithms were compared between the distribution network with distributed power supply. In the same operation environment of the distribution network, certain fault information was input using three different algorithms for 60 simulation experiments. The experimental results are shown in Table 1.

Table 1. Failure location detection and comparison of the three different algorithms

algorithm	single point of failure		twin failure	
	Average time-consuming (s)	precision (%)	Average time-consuming (s)	precision (%)
GA	1.79	89	2.63	78
PSO	1.31	87	1.46	76
GWO	0.07	100	0.08	100

As can be seen from Table 1, the grey Wolf pack algorithm adopted in the paper is less time-consuming and more accurate in the fault detection of hierarchical models. This is because the GA algorithm and the PSO algorithm need to search for the fault information of 30 nodes in the operation, and the calculation value is high, resulting in longer time consuming. The hierarchical model built by GWO algorithm reduces the dimension of calculation and saves the operation time.

5. CONCLUSION

In conclusion, based on the fault detection and positioning model of the distributed power distribution network, the traditional fault location algorithm model improves the low fault detection efficiency and poor applicability of the distributed distribution network system. With the new fault detection method constructed by the GWO algorithm and the hierarchical model, the switching function of each node in the distribution network is simplified, which greatly reduces the dimensionality of the operation and improves the efficiency of the algorithm. In addition, on the basis of GWO algorithm, crossover and variation operations are added to improve the diversity of computing particles and ensure the convergence speed and optimization accuracy of the algorithm. The algorithm is applied to the fault detection with distributed distribution network. The experiment has proved that the algorithm is more accurate and more accurate than the traditional fault detection and positioning algorithm, and has stronger adaptability in the fault detection system with distributed distribution network.

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