Research on Active Coordination Control Method of Distribution Network Power Supply Based on Improved Firefly Algorithm

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Abstract. The location and capacity optimization configuration of distributed power supplies ensures that they. Make better technical and economic use. When the distributed power supply is connected to the distribution network, it will cause the trend size and direction of each branch to change, so that the system loss is not only related to the load size, but also related to the location and capacity of DG. Therefore, it is important to study the rational planning of DG in depth. In order to improve the system network loss effectively, a distributed power distribution power distribution network reactive optimization model with the minimum active loss of the system is established, and an improved multi-target firefly algorithm is proposed for the problem that the traditional firefly algorithm will oscillate repeatedly near the extreme point later in the iteration. In view of the shortcomings of the traditional firefly algorithm, which is easy to precocious and over-dependent on control parameters, the chaotic search strategy and global idea are integrated into the firefly algorithm, and an improved firefly algorithm is proposed, which is applied to solve the planning problem of distributed power supply. The example shows that the proposed algorithm has good practicability and adaptability, and also verifies the practical significance of the proposed model[1].

Keywords: Distributed Power, Distribution Network, Reactive Power Optimization, Improved Firefly Algorithm

1. Introduction
It mainly adjusts the network topology by changing the switching state of the two kinds of switches, such as contact switch and segment switch, and then affects the power flow distribution, and finally achieves the purpose of reducing the network loss, balancing the load and improving the power quality. Distribution network reconfiguration can be divided into optimization reconstruction under normal state and isolation recovery under fault state. After the distributed power supply is connected to the distribution network, it has good economic and environmental benefits. However, due to the randomness and intermittency of DG output, it will bring many adverse effects such as power reverse flow and power quality reduction[2]. As a result, how to better play the role of DG under the premise
of ensuring the safe and stable operation of distribution network system has become an urgent problem in distribution network reconstruction. In recent years, many experts and scholars have made a lot of exploration on the problem of distribution network reconstruction. It is helpful to reduce the system network loss, improve the voltage distribution at the end of feeder, alleviate the voltage overrun of node, but its stability is insufficient, and the algorithm is too dependent on the initial state to search for the optimal solution[3]. The genetic algorithm has been improved from the chromosome segment of the same equivalent length, and the mutation process adopts the method of random allocation of disconnected switching points[4]. The number of unfeasible solutions and the number of iterations in the reconstruction of distribution network are reduced. But the algorithm is easy to fall into the "precocious convergence" strange circle. In recent years, with the depletion of fossil fuels and the deterioration of the environment, distributed power generation technology has attracted more and more attention. Distributed generation has many advantages, such as reducing environmental pollution, improving power supply reliability, improving power quality and reducing network loss. Based on the analysis of the characteristics of distributed power supply, a multi-objective optimization model with minimum purchase cost, minimum network loss cost, minimum investment cost and maximum voltage stability margin is established, which can reflect the layout of DG planning more realistically and scientifically. Based on this, the super-efficiency packet analysis and evaluation method is used to define the weight combination scheme of each objective function, and the DG multi-objective programming problem is transformed into a single-objective programming problem.

2. Reactive power optimization model

2.1. Distributed generation interface model

Distributed generation includes many forms[5]. Need to call 3 interfaces to complete the function, although the model complexity will improve, poor performance. There are generally three types of synchronous machines, asynchronous machines and power electronic inverters for the integration of distributed power sources into distribution.

2.2. Mathematical model of reactive power optimization

The purpose of studying reactive power optimization in distribution network is to arrange the power flow distribution of reactive power reasonably and to maintain the voltage level of the system effectively, to ensure the power quality the operation stability of the system, and ensure the safe and stable operation of the system. The significance of studying reactive power optimization in power system lies in maintaining the voltage level of the system effectively, improving the voltage stability of the system and reducing the active power network loss through the reasonable distribution of reactive power flow.
3. Mechanism of Firefly Algorithm

Fireflies and their peers make search errors and courtship behaviors by emitting fluorescein. Generally speaking, the brighter the fluorescein, the stronger its attraction to other fireflies, and because light travels in the air, the brightness attenuates, so as the distance increases, the attraction decreases, and eventually many fireflies gather around some brighter fluorescein fireflies. Automated molecular group ability, local search ability is strong. The attraction of fireflies is closely related to their brightness, and the individuals with brighter brightness have stronger attraction. For any two fireflies, the less bright fireflies move in a stronger direction. In the process of mutual attraction, the brightness of the growth will gradually decrease with the increase of space distance and the absorption of the propagation medium. In each iteration, the position of firefly is constantly updated, so that the solution of the problem in each update to get the solution of the optimization objective function is transformed into the firefly individual survival of the fittest process.[6] Within the GSO algorithm, each artificial firefly walks in the solution space, these fireflies carry fluorescence and have their own range of sight, called the decision domain (local-decision range). Their brightness is related to the target value in their position. The brighter the firefly, the better the position it is, the better the objective function value. The firefly will look for a collection of neighbors within the decision domain, in which the brighter the neighbor has the higher attraction to attract the firefly to move in this direction, and each flight direction will change with the selected neighbor. In order to achieve a certain number of iterations, all firefly individuals will gather around the individuals with relatively large fluorescence brightness, that is, to find the optimal solution of the objective function of the problem to be optimized. Firefly algorithm makes modern efforts to develop a scientific algorithm, in scientific research occupies a great position. Since the firefly algorithm was put forward, scholars from all over the world have studied, improved and applied the two algorithms. After several years of development, firefly algorithm has a good application prospect in continuous space optimization process and some production scheduling.

Table 1. Micronet running data.

| Micronet distribution | The node distribution | Total load |
|-----------------------|-----------------------|------------|
| 1                     | 19; 20; 21; 22        | 360 + j160 |
| 2                     | 7; 8; 9; 10; 11; 12; 13; 14; 15; 16; 17; 18 | 1070 + j520 |
| 3                     | 1; 2; 3; 4; 5; 6; 26; 27; 28; 29; 30; 31; 32; 33 | 1350 + j1180 |
| 4                     | 23; 24; 25            | 930 + j450 |

4. Improved firefly algorithm

4.1. Introduction of global optimality

Aiming at the disadvantage that the firefly algorithm is easy to fall into local optimization and the accuracy is not high, an improved firefly algorithm is proposed. The algorithm divides the group into two subgroups by using the idea of grouping, improves the existing iterative formula by using the beneficial information in the group, and sets up a new iterative formula for reference to the idea of symbiotic biological search algorithm. In the process of evolution, each subgroup uses different iterative formulas to search the optimal solution by cooperation and competition among subgroups. The experimental results of the function optimization problem show the feasibility and effectiveness of the algorithm. From the firefly's updated position formula, it can be found that each firefly moves towards the firefly with stronger brightness in the solution space. At this point, the optimization of fireflies is only related to the brightness of the surrounding fireflies, and the global optimal value is ignored here. If the global optimal value is located in the last coding in one iteration, when a random firefly is compared with the global optimal value, the brightness will be weakened because its fluorescein has been greatly reduced. That is to say, the degree of attraction will be greatly reduced,
which will affect its finding the optimal solution in the solution space. For standard firefly algorithms, brighter firefly individuals (local optima) in each iteration exert their influence on other fireflies and maximize their attraction to move towards themselves. As a matter of fact, the standard FA algorithm, firefly in the process of finding the global optimal solution, increase the number of iterations, reduce the firefly algorithm exploration ability.

4.2. Introduction of Chaos Exploration Strategy
Aiming at the problems that the basic firefly algorithm is easy to converge early, the solution accuracy is not high, and the post-convergence is slow. In order to improve the speed of the algorithm, an optimization algorithm to improve the local search ability of the firefly algorithm is proposed. The chebyshev chaotic mapping function is used to generate the chaotic sequence, initialize the firefly population to obtain a better initial solution. From the point of view of mathematical and physical logic theory, the motion characteristics of the system can be completely defined under the condition of given dynamic model and initial value of the system. However, under the same conditions, the conclusion is no longer suitable for chaotic systems. In addition, chaotic phenomena have their own unique performance characteristics and similar random phenomena revealed in deterministic systems. In the iterative process of the algorithm, the designed chaotic local search operator is used for local search to enhance the local mining optimization ability. At the same time, dynamic change search area is carried out to improve convergence speed. The simulation results show that the improved algorithm improves the optimization accuracy and convergence speed compared with the firefly algorithm.

Figure 2. IEEE-33 node distribution grid wiring diagram.

5. Conclusion
The intelligent optimization algorithm of bionic group is a hot topic studied by scholars at home and abroad in recent years. Its main idea is to study or imitate the social behavior of organisms living in natural groups. In view of the defects such as precocious convergence and over-reliance on control parameters in the traditional firefly algorithm, inertial weights are introduced, and the algorithm parameters are adjusted by using chaos theory, so that the algorithm takes into account the balance of global search and local search capability. A generalized power supply in the distribution network system is used as the control variable to construct an optimal configuration model aiming at the system network loss, voltage level and operational safety performance of the generalized power supply microgrid. Based on the analysis of distributed power supply characteristics, a multi-objective optimization model with the smallest purchase cost, minimal network loss cost, minimal investment cost and maximum voltage stability margin is established, which can reflect the DG planning layout in a practical and scientific way. The firefly optimization algorithm is used to optimize the distribution network generalized power supply configuration and verified by the improved IEEE-33 node system. The results show that the proposed scheme can effectively improve the isolated island operation ability of distributed power supply on the basis of improving the system operating voltage level and reducing the network loss.
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