

Cable Laying Path Planning Based on Optimized Ant Colony Algorithm

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Abstract. To address the large error and low efficiency of traditional manual design in cable laying task, the computer-aided design optimized by Ant Colony Algorithm (ACA) is applied to cable laying path planning. The shortest path for cable laying is solved via the ACA's multi terminal path calculation for complex path planning. Furthermore, the planarized cable laying path is optimized via Gompertz function in aspects of pheromone restriction and self-adaptive adjustment of volatilization factor, thus improves the ACA in both convergence speed and global performance. The simulation results show that the optimized ant colony algorithm can quickly obtain the shortest cable laying path in the task of substation digital 3D cable laying, which saves the cost of manpower and materials, and improves the design accuracy.

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Key words: Ant colony algorithm (ACA), Cable laying, Pheromone, Volatilization factor, Convergence rate.

1 Introduction

In order to adapt to the rapid development of China's economy and people's growing demand for electricity, power enterprises need to increase the scale and speed of grid construction. Among them, cable laying is a key basic link and one of the most complex parts of power plant construction [1]. In the past, the traditional manual design scheme

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was based on two-dimensional design drawings or Auto CAD software for cable laying and on-site cable length calculation. However, due to the large errors and waste caused by manual statistics of cable consumption and calculation of cable length summary, it is difficult to meet the needs of modern engineering. As the number of cables laying increases year by year and the diversified needs of cable laying methods, how to realize the unification of cost saving and efficient laying has become a key problem to be solved at present [2].

Based on the above problems, three-dimensional digital aided design technology of computer is considered to be applied to cable laying design [3]. The core of the cable laying system is the algorithm to calculate the cable path [4-6], and the commonly used algorithms include Dijkstra's algorithm [7], particle swarm optimization algorithm [8] and dynamic programming algorithm. The application of traditional algorithm to heuristic intelligent algorithm in cable laying is conducive to the accurate and efficient planning of cable laying path. Literature [9] proposed an improved Dijkstra algorithm in terms of channel capacity limitation and reducing the number of turns, which was applied to the cable laying of pumped storage power stations and reduced the operation time. Literature [10] applies A-Star algorithm to the laying of cable shortest path, which reduces the workload of designers and improves economic benefits. Literature [11] applies the idea of hierarchical sequence method to the cable laying model. Genetic algorithm and Dijkstra algorithm are combined to solve the shortest path of cable laying. However, this algorithm can only solve the path between two devices and cannot consider the cable laying between multiple device nodes. Literature [12] uses tree and mesh search algorithms to accurately calculate the path and length of cables, but the algorithm is simple in structure and not suitable for large-scale complex power grids.

Aiming at the problems of local optimization and slow convergence in the application of traditional ant colony algorithm to cable laying design, this paper optimizes the algorithm and limits its pheromones to a certain range to avoid abandoning poor paths in the early stage of the algorithm. At the same time, the volatile factors are adjusted adaptively with Gompertz growth function to improve the convergence speed of the algorithm. When the optimized ant colony algorithm is applied to cable laying, it can get the shortest cable laying length in a shorter time, improve the accuracy of algorithm iteration, reduce the pause phenomenon in the algorithm running process, and improve the cable laying efficiency and quality.

2 Cable laying

In order to meet the needs of power grid development and transmission capacity, more and more cables and high-voltage cables are put into use. In the process of cable laying, cables of different sizes need to be placed on the support according to the laying rules, as shown in Figure 1. Circles represent cables of different diameters and types, and the actual cable conditions required by each layer of the support are different.