Optimization Design of Road Vegetation Watering Truck Path in Eastern District of Panzhihua City

Tianhao Ding [1, a], Su Fan [1, b], Yong Huang[1,c,*]

[1] Intelligent Manufacturing Institute, Panzhihua University, Panzhihua, China

[a] 1203193413@qq.com, [b] 2350399069 @qq.com, [c] 940192741 @qq.com

*corresponding author

Abstract

This paper mainly studies the path optimization problem of road vegetation irrigation in Bin san District of Panzhihua City. Firstly, the development status of vehicle routing problem at home and abroad is briefly introduced. Then, the theoretical knowledge of China's postal problem is introduced, and the practical problems are analyzed and reconstructed. The network model of the problem is solved by various algorithms. Finally, the simulation is carried out by Flexsim software. The aim is to make the driving route of the watering vehicle the shortest and solve the problem of path optimization in real life. In this paper, we use the two methods of parity method, breaking circle method and integer programming on odd point graphs to solve the path optimization of China's postal problem. According to the results, we can see that these algorithms are very convenient and effective for solving the problem of a single problem.

Keywords

Vegetation watering vehicle, path optimization, Lingo, integer planning.

1. Introduction

This paper mainly studies the path optimization of road vegetation watering vehicles in Bingsan District of Panzhihua City. The watering truck needs to start from the garage and walk through all the streets in the area. After watering the green vegetation of each street, return to the garage. The theoretical problem of this issue is the issue of China's postal route, which is a type of TSP traveler's problem. A postman departs from the post office, delivers the mail to all the streets under his jurisdiction, and finally returns to the post office. How to arrange his driving route to make the total length of the road shortest. This question was raised by the Chinese mathematician Professor Mei Meigu in 1962, so it is called China Post. Road problem. This problem can be seen as the optimization of the route of logistics and distribution. The watering truck is the logistics distribution vehicle, and the water is the cargo. With the increasing competition in the market, the acceleration of the integration of the world economy and the rapid development of science and technology, many enterprises have taken cost reduction and efficiency as an important means to improve competitiveness, and introduced advanced path optimization theory into the operation of enterprises. In management. Path optimization is still in the development stage of China's cash. Among the many problems, the efficiency of vehicle driving is a more prominent one. Whether the vehicle's driving path is scientific and sound is a key part of determining the efficiency of the vehicle's driving operation. As an important content and means to realize the rationalization of the vehicle's driving path, researching the vehicle's driving path helps the enterprise to reduce costs, improve operational efficiency, and comprehensively improve The efficiency of the operation makes the company gain a firm foothold in the increasingly fierce competition in the market today, allowing the company to obtain more profits and more long-term development. In today's fast-changing science and technology, only by maximizing the efficiency of vehicle operation and minimizing the cost of transportation can enterprises achieve sustainable and healthy development before they can survive

in the fierce competition. In view of this, the optimization of the running route has become an urgent task.

2. Situation Analysis

2.1 Traffic conditions in Panzhihua City

The urban road network skeleton of Panzhihua City presents the road network structure of "east-west belt extension and north-south river crossing". The total length of urban roads is 390 km and the density of road networks is 7.56 km/km2. The road area is 3.89 million square meters, and the urban per capita road area is 7.7 square meters. The proportion of road structure is extremely unreasonable. The structure ratio of main, secondary and branch roads is 1:0.25:1.95. The secondary trunk road is seriously insufficient.

The large number of branches connecting the main trunk roads are mostly broken roads and residential life roads connecting the residential areas. The width of the roads is too narrow, the road connectivity is poor, and the traffic conditions are insufficient.

From the perspective of road conditions, the width of the roadway in Panzhihua City is mainly 7-12 meters wide, accounting for 52.7% of the total length of the road in Panzhihua City. The current width of some main roads is generally about 15 meters, as for the width 20 The road above the meter is currently basically absent.

Among them, the airport road in Bingsan District of Panzhihua City is a two-way six-lane road, belonging to the main road, with a width of about 15 meters and a length of 4.9 kilometers. The roads connected to it are mostly 7-12 meters wide, and there are two-way two-lane roads.

Another important factor affecting traffic conditions is the number of motor vehicles. In the 2016 Panzhihua City statistical report, the city's motor vehicle ownership was 237,100, including 15,15 vehicles and 138,800 private cars; Ten thousand vehicles; 16,500 operating vehicles and 1,597 taxis. And this figure was 82,300 in 2010.

The road width is not enough, and the increase in the number of various motor vehicles has led to traffic congestion, especially during peak hours. Therefore, it is very important to choose the running route and running time of the vegetation watering truck. Choose the right time, avoid traffic congestion, save working time and reduce time cost. Choose the appropriate route and minimize the repeated driving of the route. Reduce costs to a certain extent.

2.2 Current status of vegetation watering truck operation

At present, the watering truck responsible for the road vegetation watering task in the Bingsan District of Panzhihua City has only one 11T watering truck. The fuel consumption of the vehicle is 0.16 liters of diesel per kilometer, and the price per liter of diesel is now 6.16 yuan. In the choice of the driving route of the vehicle, it is generally based on the experience of the driver of the watering truck. As a result, the circuit of the driving route is excessive, resulting in a long running distance, a long working time and a high transportation cost.At present, the company's driving route for the watering of the roads in the Bingsan District is to first water the main road, then water the secondary road, and then return to the starting point, it can be seen that the number of repeated round trips is too large, the total distance of single watering It is 55.20km.In general, the drawbacks of the current driving line of the company's watering trucks are: there are too many circuits in the driving route, there are repeated driving phenomena, too many empirical operations, optimization is not thorough, resulting in excessive total distance and consumption time Too many, can not make full use of the vehicle loading capacity, waste more manpower and material resources, logistics costs are still high, affecting the company's profit.

3. Optimization design of vegetation watering truck path

3.1 Building a network model

The problem of watering vehicle path optimization is a NP-hard problem. Since it is a NP-hard problem, it is essential to establish a network model and draw a network diagram. The plan compiled with the network diagram is called Network Programming (NP). One of the great advantages of the network plan is that the project plan can be graphically and intuitively understood. It is conducive to the control, management, adjustment and optimization of the plan, a clearer understanding of the logical relationship between the research objects and the mutual constraints, and the mastery of the critical path and plan. So there should be a set of methods that make up the network diagram.

The content to be expressed in the network diagram is mainly the process and its logical relationship, and its actual expression is a directed acyclic graph. According to the different expressions of the drawing symbols, the network diagram can be divided into two categories: single code network diagram and double code network diagram. The double-code network diagram uses the edge (arc) to represent the process, so it is called AOA (Activity On Arrow) network, and because its process requires two node codes at the beginning and the end to determine, it is named double code. The single-code network diagram uses nodes to represent the process, so it is called AON (Activity On Node) network. Its edge (arc) is only used to indicate the logical relationship between processes, and because its process only needs one node code to represent it, the list Code.

In practical applications, the two network diagrams have different lengths. The advantages of the single-code network diagram are: the logical relationship between the work is easy to express, and the virtual arrow line is not needed, so the drawing is simple; the use is simple and easy to modify; the network diagram is unique. However, the short board is also obvious: the most important thing is that the process time is expressed in the node, there is no length, so it is not enough to be visual and intuitive; at the same time, the arrow indicating the logical relationship between the work may produce more vertical and horizontal crossover phenomenon.

The main disadvantage of the double-code network diagram is to express the logical relationship between the processes. Sometimes the virtual process must be added, so it is difficult to draw, and the actual network diagram is difficult to be optimal and not unique. However, the double-code network diagram not only can represent the logical relationship between the nodes, but also further express the time relationship between the processes. The advantages are obvious, so the research in this paper is based on the double-code network diagram.

When drawing a network diagram, you need to follow certain rules, such as the following:

(1) The logical relationship between processes must be correctly reflected;

(2) Loop lines cannot appear in the network diagram;

(3) Only one arrow line is connected between the two nodes;

(4) There are nodes at the beginning and the end of the arrow line. You cannot lead another arrow line from the middle of the arrow line, nor can you point the arrow line to the middle of the other arrow line.

(5) In a network diagram, each process can only appear once;

(6) The direction of the arrow line will always point to the right or diagonally to the right, and the node number will be from small to large along the direction of the arrow.

But only to meet the above rules, can only say that this double code network map is correct. In fact, a good double-code network diagram should not only be so, but also have its own characteristics in the layout. Generally speaking, a layout-optimized double-code network diagram should satisfy: the node circle is evenly distributed, concise, the arrow line is arranged reasonably, the intersection of the arrow line and the arrow line is as small as possible, and the arrow line and the node circle have no intersection. Among them, the intersection between the arrows is sometimes unavoidable. In fact, there is a double-code network diagram with the least intersection of arrows, but its method is actually

unsolvable, but the actual double-code is used. Network diagrams are generally sparse and have fewer intersections.

At present, there are many softwares for drawing network diagrams at home and abroad, but most of them generate single-code network diagrams or Gantt diagrams, such as MS Project, MS Visio. Therefore, the automatic generation and optimization of the double-code network map becomes more and more important. The automatic generation and optimization of the general double-code network diagram mainly includes three steps.

(1) Node number: Determine all node sets, get the logical relationship between them, and number all nodes.

(2) Node layout: determine the relative position of each node on the double-code network map. This step is the most critical step to determine the optimal layout of the double-code network map. It is decided that the number of intersections and the aesthetics of the double-code network map are the main ones. It is decided by this step. The most common method used is the checkerboard layout.

(3) Node connection: Add the arrow line corresponding to each process (including virtual process) to prevent the arrow line from intersecting with the node.

In the project network diagram, the connection relationship between all the activities in the project is connected by arcs and nodes, and the right of the arc edge is the time to complete the change activity. There are two methods for compiling the project network diagram. One is the arrow line method, the node is used to represent the event, the arrow is used to represent the process network diagram is called the arrow network diagram, and the other is the node method, which uses arrows to represent the event. A network diagram in which a node represents a process is called a node network diagram. In the path optimization problem, the arrow line method is more applicable. The intersection of the path and the path can be represented by a node, the arrow represents the path, and the weight of the arrow is the length of the path.

The network diagram drawn in this paper is divided into the following three steps:

(1) Clear street relationships. Collect and organize data to determine street locations and their adjacent streets.

(2) Draw a network diagram. According to the street relationship, draw a network map.

(3) Empowerment. The right of the arc is the length of the street.

3.2 Drawing a network diagram

First, the main road-airport road is numbered. The starting point is Zijingshan V_1. If there is an intersection with other roads, the intersection point is numbered (V_2, V_3 ...); then the next intersection point of the starting point is marked, and then the starting point is the next intersection point. And so on.

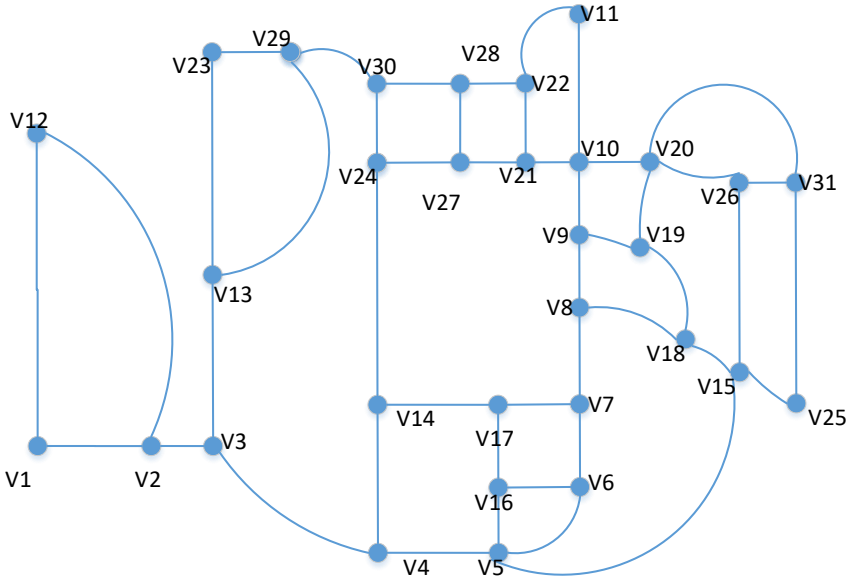

Figure 1 Street network map

3.3 Network model solving

The directed graph is modeled, and the corresponding integer programming model is obtained as shown in Appendix 1, and then solved by Lingo. Enter the above integer programming model in Lingo and run the solution. The results are shown in Appendix 2. The obtained result is plotted as a network diagram, and the obtained network diagram is as shown in 2.

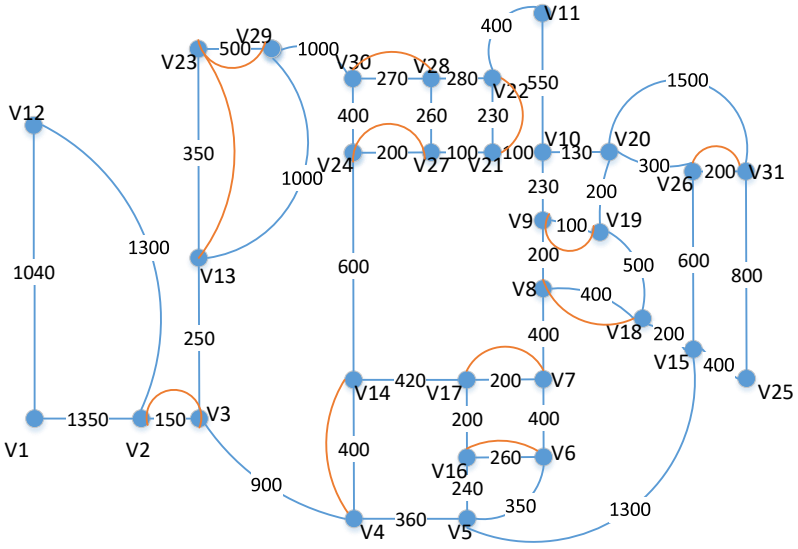

Figure 2 Network diagram of the solution obtained by lingo

The shortest path length obtained by the Lingo operation is 24.78km, and the calculated length is only the length of a vegetation that only waters one side of the road. Therefore, the distance traveled by all vegetation should be twice the calculation result, which is 49.56km.

3.4 Flexsim simulation

The simulation model is built in Flexsim, and the network graph is used to draw the solved network diagram. The A node is used to connect the network nodes, define the virtual distance between the network nodes, add the task executor, and use the A link with the network node. Adjust the parameters so that the task actuator travels along the specified route. The task execution process is shown in Figure 3.

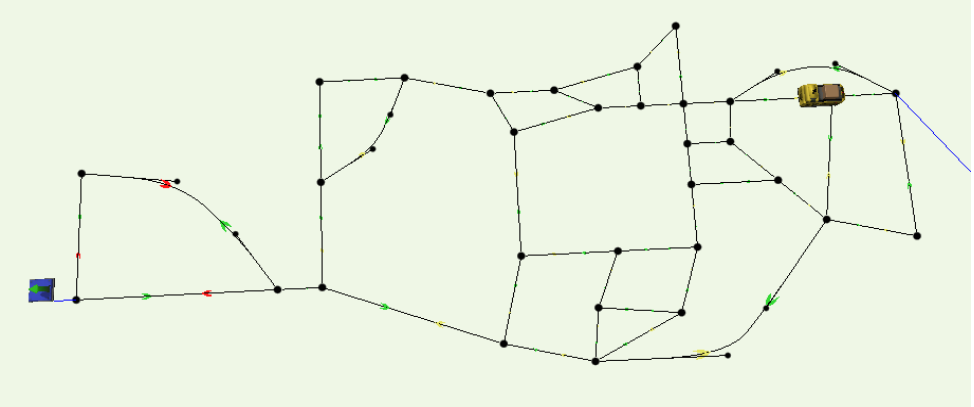

Figure 1 Flexsim simulation model

During the simulation running process, you can observe the running of the simulation model in real time. If you encounter any problems, you can pause at any time. After solving the problem, you can continue to run.

4. Optimization effect

Combined with the comprehensive analysis of total mileage and oil price, the 11T water pump has a fuel consumption of 0.16 liters per kilometer and the diesel price is 6.16 yuan per liter. We found that the mileage saved by each of the two methods is 5.64km, which can be calculated to save 5.54 yuan per watering. In addition to the annual rainy days, it is required to be watered for 300 days per year and watered twice a day to calculate. The annual cost savings is about 3326.4 yuan. Through comparative analysis, the three methods are consistent, and the annual cost savings is about 3326.4 yuan. Although the results obtained by these three methods are consistent, the scope of use of the three methods and the ability to solve practical problems are quite different. The work method and the broken circle method on the parity map are difficult to solve for the complicated road structure, because it needs to be iterated many times, and the previous optimization steps are repeated until the optimal. The method of integer programming is to establish the integer programming model, input the integer programming model into the Lingo software on the computer, solve it through Lingo software, and hand over the complicated and large number of operations to the computer to solve it, which is very convenient. We only need to translate the actual problem into a network model, and then convert the network model into an integer programming model. The actual problem becomes complicated. Correspondingly, the integer programming model is more complicated. The main defects of this paper are that the watering scope is slightly beyond the actual, and the model has some defects. Some influencing factors are also ignored in the calculation process, which is not completely consistent with the actual situation. For example, actual road information, vehicle costs, peak hours, etc. are not considered.

5. Conclusion

This article first introduces the research background of the article and the research status of the path optimization problem at home and abroad. Then it introduces the origin of the Chinese postal problem and the theory of the three methods of operation method, broken circle method and integer programming on the parity map used in this paper. Then the paper analyzes the current situation of road vegetation watering trucks in Bingsan District of Panzhihua City. Firstly, it introduces the traffic conditions of Panzhihua City, explains the necessity of optimizing the route of the watering trucks, and relieves the traffic pressure. It introduces the location of Panzhihua City. The weather characteristics of the dry and hot valleys, the dry and wet seasons are distinct, the rainfall is uneven, the sunshine time is long, and the strong radiation makes the evaporation much far greater than the rainfall, so it is necessary for the multiple vegetation maintenance of the road vegetation one day. Therefore, the effect and benefits of the path optimization of the vegetation watering truck are very important for the enterprise. Although the cost-saving effect of this article is not a lot, it is only a

small area. If I optimize the entire Panzhihua City, I believe that I can get a large capital cost for a company. In the path optimization design of this paper, three algorithms in the logistics path optimization problem are adopted. The operation method, the broken circle method and the integer programming on the parity point map, firstly establish the network model for the actual problem, the operation method and the broken circle on the parity point map. The method solves the optimization of the network model, while the integer programming transforms the network model into an integer programming model, which is solved by using the computer's Lingo software to solve the path optimization problem in real life. Then use Flexsim to simulate, so that the calculation results are visualized, not monotonous expressions, letters and numbers. In this paper, the path optimization of the driving route of the road vegetation watering truck in the Bingsan District of Panzhihua City is applied. The three methods of the operation method, the broken circle method and the integer programming on the parity chart are applied to calculate and analyze. After comparing the three results, it is found that The three methods have the same solution, but the scope and conditions are not the same. After the benefit analysis, it is watered twice a day and watered for 300 days per year. It proves that the optimized single-watering mileage is shortened by 5.64km, the fuel consumption is 0.90 liters per year, and the annual cost savings is about 3326.4 yuan.

Acknowledgments

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