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Research on Dynamic Route Guidance System Based on Comparison of Shortest Path Algorithms

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Abstract

In this paper, the route optimization system, which is the weakest part of the traffic guidance system, is studied. Through the MATLAB visualization program, this paper compares the Dijkstra algorithm, A* algorithm and greedy best first search algorithm, and concludes that A* algorithm has the characteristics of short search time, high search accuracy and high efficiency, which is suitable for traffic guidance.

Keywords

Traffic guidance system; Route optimization; Dijkstra; A*; Greedy best first search.

1. Introduction

Dynamic route guidance system (DRGS) is an important branch and one of the key technologies of intelligent transportation system. Using modern technologies such as computer and communication, DRGS can realize the even distribution of traffic volume in the whole road network and ensure the safety and smoothness of the road network. Travelers can make corresponding choices by providing real-time traffic information and the best path. Although the traffic guidance system has been relatively mature in developed countries, the research on the application of big data in dynamic traffic guidance has just started. Lam, T N and C. O. Tong [1] proposed a route calculation scheme based on historical and current traffic modes for dynamic route guidance in order to consider the temporal and spatial effects of traffic distribution on travel time in congestion sensitive networks. C Zheng [2] described the guidance information system and discussed its structure and functions in detail, discussed the feasibility of its implementation, and finally discussed the basic problems of the implementation of the system based on Beijing practice. In order to provide the best travel route for road users, Wahle, J [3] and others proposed a two-step procedure. Firstly, the real traffic data were used for online simulation to calculate the actual travel time and traffic load. The data was then processed in a route guidance system that allows road users to optimize based on their personal preferences. To solve this multi criteria optimization problem, fuzzy set theory was applied to the dynamic path guidance problem. The parallel algorithm of traffic prediction and path optimization proposed by Deng Qingqing [4] can improve the speed and efficiency of route guidance in large-scale traffic networks. Moreover, the model and implementation method of parallel traffic flow prediction for large-scale road network had practical application value for the realization of real-time online prediction in traffic flow guidance system. Zhao Dan [5] studied the dynamic path optimization problem according to traveler demand and road capacity, that is, to obtain the optimal path with the shortest distance, shortest time and minimum cost between two points. Compared with the traditional static guidance system, the path in the simple physical sense or the static time is the shortest, which has important theoretical significance and engineering application value.

The dynamic traffic guidance products based on big data are also in the development stage. There are still many loopholes in the current traffic guidance system, such as: the route guidance scheme does

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not have the characteristics of diversification, the number of economic and efficient non-static flow allocation induction models is insufficient, the cost of linking big data with route guidance is too high, there is no guidance system suitable for China's national conditions and there is no clear guidance system There are many problems, such as how to select the road resistance function that conforms to the actual situation, and the information collection and processing of big data need high technical requirements. There are also difficulties in combining big data with traffic guidance, such as how to process a large amount of data in a short time and use it for traffic guidance, how to conduct real-time data docking, how to release information to ensure the efficiency and excellent traffic guidance route The choice of algorithm.

Therefore, the main content of this paper is as follows: the key technology of the current guidance system is studied: the imperfect link of the current traffic guidance system route optimization sub link is taken as the main consideration content, and the route optimization algorithm in this link is mainly studied, and the most suitable algorithm for traffic guidance system is selected.

2. Traffic Guidance System

Traffic guidance system, also known as route guidance system, is based on modern technology such as computer, communication, electronic equipment and Internet. It provides the best route guidance instruction to the traveler according to the starting point and destination of the trip, or helps the traveler to find the best route from the starting point to the terminal point by obtaining real-time traffic information. This kind of system combines the vehicle, the person, the road, improves the road traffic system with the method of deriving the traveler's travel mode, avoids the generation of congestion, reduces the unnecessary stay time of vehicles on the road, and finally completes the reasonable distribution of traffic flow in each section of the road network.

The principle of dynamic traffic guidance is shown in Fig. 1.

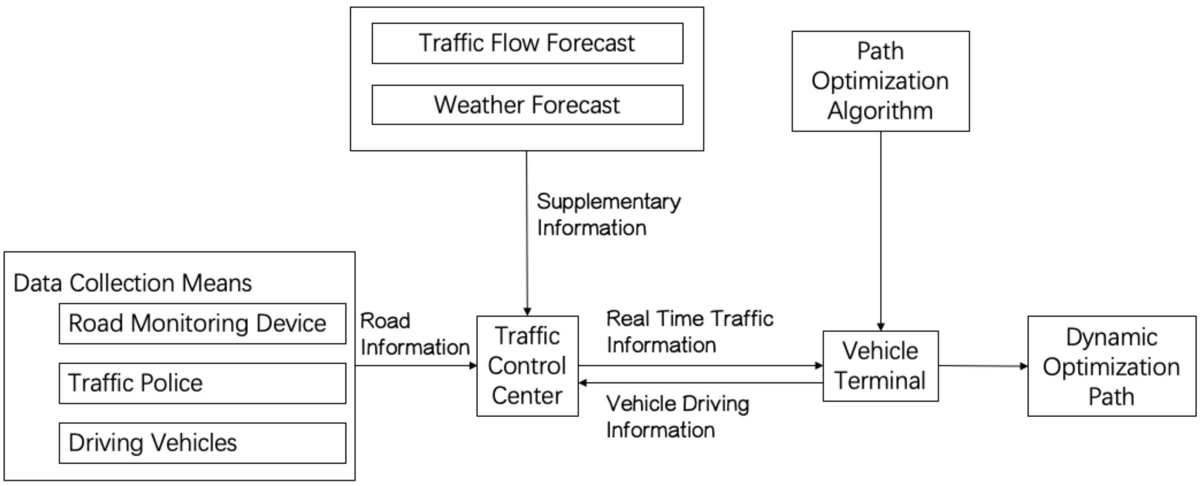

Fig. 1 Principle of dynamic traffic guidance

In Fig. 1, (1) the traffic control center continuously receives the monitoring data from the road conditions and makes short-term forecast of the traffic flow according to the historical data; (2) the vehicle terminal continuously reports the driving information of the vehicle to the traffic control center, including the current position, driving destination and driving speed; (3) the traffic control center sends relevant real-time traffic information to the vehicle terminal; (4) According to the real-time traffic information, the vehicle terminal uses the path optimization algorithm to calculate the optimal path between the current position of the vehicle and the destination, so as to realize the real-time dynamic guidance of the vehicle. Among them, path optimization is a key link in the system. Therefore, this paper chooses to study this issue.

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3. Three shortest path algorithms

The shortest path algorithm is often called in traffic flow assignment, which basically occupies its basic subprocess. The design and optimization of shortest path algorithm is a common concern of researchers in the fields of operations research, graph theory and transportation planning. Therefore, a large number of methods have been studied, among which the most thorough research is in the field of graph theory. The shortest path algorithm includes two sub topics: the identification of the minimum impedance path between points and the calculation of how to minimize the impedance between points. In order to deal with the identification of minimum impedance path between points, it is necessary to calculate the impedance between points and make it reach the minimum limit. The model is designed to find the optimal path and the lowest impedance.

In all kinds of literature, the commonly used algorithms include Dijkstra, A* heuristic search, Freud, matrix iteration and K shortest paths. In this paper, the classical Dijkstra algorithm, A* heuristic search and greedy best first search are selected for comparative study.

3.1 Dijkstra Algorithm

Dijkstra algorithm was proposed in the late 1950s, also known as the labeling method. Usually a point is specified as the starting point, and then another point is specified as the end point to calculate the minimum impedance from the starting point to the end point. Dijkstra algorithm can simultaneously calculate the minimum impedance between all the point pairs in the network. The method is simple and easy, and can accurately search the shortest path.

The idea of Dijkstra algorithm is as follows:

(1) Starting from O, each node label is divided into two types: T tag and P tag. T is a temporary label that represents the maximum value of the shortest path to the point. The P tag is fixed and represents the shortest road weight from the starting point O to the current point.

(2) When labeling, T always changes and P remains unchanged after calibration. Except for the point marked P, all the other points should be marked with T.

(3) In each step of the path finding process, the T tag of a point will be changed to P tag until all T tag become P tag. The weight of the shortest path from the starting point O to other points can be obtained.

3.2 A* Algorithm

A* is regarded as the standard heuristic algorithm. The so-called heuristic is to find in the state space, and then evaluate. The advantage of this algorithm is that it can save the time of searching a large number of worthless paths and improve the search efficiency. In this case, the evaluation and estimation of the location is very important. The effect will be different if we choose different evaluation estimates. The evaluation function of A* algorithm can be expressed as: $F(n) = g(n) + H(n)$, Where $f(n)$ is the cost estimation from the initial state to the target state via state n, $G(n)$ is the actual cost from the initial state to the state n in the state space, and $H(n)$ is the estimated cost of the optimal path from state n to the target state (for the path search problem, the state is the node in the graph, and the cost is the distance). The key to find the shortest path (optimal solution) is to select the evaluation function $f(n)$ (or $H(n)$). We use $d(n)$ to express the distance between the state n and the target state

(1) If $h(n) < D(n)$, in this case, the number of search points is large, the search range is large, and the efficiency is low. But the optimal solution can be obtained.

(2) If $h(n) = D(n)$, that is, the distance estimation $H(n)$ is equal to the shortest distance, then the search will strictly follow the shortest path, and the search efficiency is the highest.

(3) If $h(n) > d(n)$, the number of search points is small, the search range is small, and the efficiency is high, but the optimal solution can not be guaranteed.

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The A* algorithm maintains two tables, open and closed. Open saves all the nodes that can be detected but have not been accessed, and closed saves the nodes that have been accessed. The heuristic function is currently in the The nodes in the open table are sorted according to the cost from low to high, and the node with the lowest cost is selected to access each time; the currently accessed node will update the cost information according to the bookkeeping information, and directly connect its children The node accesses the open table, and finally puts the current node into the closed table; the A* algorithm starts by putting the start point in the open table and ends at finding the end point, or the open table is empty, and the closed table already contains all accessible nodes.

(1) Mark the start node and extend the unmarked child nodes;

(2) The evaluation function values of all sub nodes are calculated, and the evaluation values are arranged according to the evaluation values. Find the node with the minimum evaluation value and mark it. If the current node is the target node, the search will be terminated.

(3) Otherwise, return the last marked node to the second step and note the shortest path.

3.3 Greedy Best First Search

The meaning of greedy algorithm is: when dealing with problems, it will always take the current optimal scheme.

The best first search (BFS) algorithm runs in a similar process, but it can evaluate the cost from any node to the target point (called heuristic). Different from selecting the node closest to the initial node, it selects the node closest to the target. BFS does not guarantee to find the shortest path. However, it is much faster than Dijkstra algorithm because it uses a heuristic function to guide the target node quickly. For example, if the target is located in the south of the starting point, the BFS will tend to lead to the South path. Compared with Dijkstra algorithm, BFS runs faster.

Greedy algorithm is from the starting point, like the terminal expansion, expansion will remember the previous minimum ideal cost of the grid. If it encounters an obstacle, it will re select the new one with the least cost until it reaches the target grid.

Each step of greedy best first search will search for the nearest nodes. Then the Manhattan distance from these nodes to the endpoint is calculated, which is the minimum cost heuristic. In the algorithm, the open set and the closed set must be recorded. The open set stores the nodes that should be processed in the current step. For example, when the algorithm starts, it must know the neighbor nodes of the initial node, and find the node with the lowest cost of H (x). The closed set holds the calculated nodes.

Greedy best first search is fast enough when there are few obstacles. However, the best first search can not get the best path, most of them are the second best or more inferior path. The algorithm constantly explores the minimum value of H (heuristic), but the selected path is obviously not the best.

Greedy best first search attempts to extend to the node with the shortest distance from the target, because it can improve the speed of finding the solution. Greedy optimal search is similar to depth first search. Even if its search space is limited, it is not complete, and it is easy to walk into a dead end and eventually become a dead circle.

4. Comparison and result analysis of Dijkstra, A* and greedy best first search algorithms based on MATLAB

In the research of shortest path method, the shortest path planning algorithm of planar mobile robot is applied in many places. The algorithm has the advantages of intuitionistic output and easy to compare the advantages and disadvantages of the algorithms. In this paper, the graph theory and three algorithms are combined to compare the advantages and disadvantages of the three algorithms according to the output results and images in the plane scene of randomly generated obstacles. In MATLAB, it is similar to a given rectangular network, in which two points are randomly set, namely

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the starting point and the ending point. In the next step, Dijkstra will generate the best results in this maze, that is to say, it will generate the best results in this maze. When exploring the path planning problem, the shortest path planning algorithm of planar mobile robot is widely used because of its intuitionistic output and easy to compare the advantages and disadvantages of the algorithms. By determining a certain or some optimization objectives (such as: minimum cost, shortest walking path, minimum travel time, etc.), it finds a best route from the starting point to the end point of the target, which can bypass all obstacles. The optimal path model is widely used in military, transportation, urban planning, design and other specialties. At present, the more popular path planning methods include grid method, symbolic connected graph method, potential field method and so on.

In practical application, we represent the obstacle as a simple polygon, and find the "optimal solution" that the algorithm can find through the calculation of different algorithms. The optimization goal of this paper is to minimize the driving route, and the working environment is a plane scene composed of randomly generated simple polygon obstacles. The working environment of the three algorithms is the same, and the vehicle is regarded as a particle, starting from the same starting point to the same destination. By comparing the length and search method of the found driving path, an excellent algorithm is given, and the algorithm is used to calculate the optimal path of an example. This paper uses the visualization function of MATLAB to compare the effect of the three shortest path algorithms.

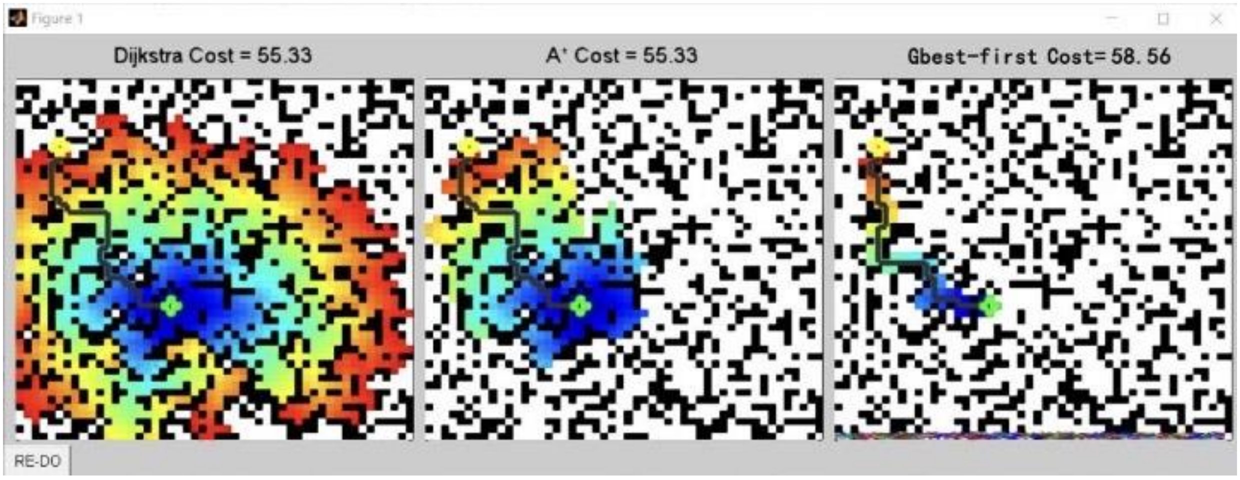

Fig. 2 Algorithm comparison results

From Fig. 2, it can be seen that Dijkstra and A* algorithm have found the same optimal driving path. But greedy best first search algorithm did not find the optimal path, only found the suboptimal path, but its calculation speed is very fast, when the accuracy requirement is not high, and the need for fast calculation speed, it also has certain advantages. Although Dijkstra algorithm and A* algorithm have found the same optimal path, we can see from the figure that Dijkstra algorithm searches from the starting point, circle by circle, which wastes a lot of time and is not efficient. We can understand A* as adding heuristic evaluation cost in Dijkstra, that is, f (T) = g (T) + H (T), f (T) is the cost from the starting node to any node T, and H (T) is equal to the heuristic evaluation from node T to target point. After adding this evaluation index, the particle search path is no longer aimless, which can greatly improve the efficiency of the search.

Through the simulation and result analysis, it can be concluded that A* algorithm has the characteristics of short search time, high search accuracy and high efficiency, which is suitable for traffic guidance.

5. Conclusion

In order to study the better path optimization algorithm in traffic guidance system, this paper compares and analyzes Dijkstra algorithm, A* algorithm and greedy best first search algorithm

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through MATLAB visualization. The results show that A* algorithm has the characteristics of short search time, high search precision and high efficiency, and is suitable for traffic guidance system.

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