Hindawi
Scientific Programming
Volume 2022, Article ID 3002923, 7 pages
https://doi.org/10.1155/2022/3002923

Research Article

Research on the Intelligent Assignment Model of Urban Traffic Planning Based on Optimal Path Optimization Algorithm

Yuan Lu,[1] Shengyong Yao,[2] and Yifeng Yao[1]

[1]*School of Architecture and Design, Beijing Jiaotong University, Beijing 100044, China*
[2]*School of Traffic and Transportation, Shijiazhuang Tiedao University, Shijiazhuang 050043, China*

Correspondence should be addressed to Yifeng Yao; yfyao@bjtu.edu.cn

Received 4 November 2021; Revised 1 December 2021; Accepted 2 December 2021; Published 13 January 2022

Academic Editor: Tongguang Ni

Congestion and complexity in the field of highway transportation have risen steadily in recent years, particularly because the growth rate of vehicles has far outpaced the growth rate of roads and other transportation facilities. To ensure smooth traffic, reduce traffic congestion, improve road safety, and reduce the negative impact of air pollution on the environment, an increasing number of traffic management departments are turning to new scientifically developed technology. The urban road traffic is simulated by nodes and sidelines in this study, which is combined with graph theory, and the information of real-time changes of road traffic is added to display and calculate the relevant data and parameters in the road. On this foundation, the dynamic path optimization algorithm model is discussed in the context of high informationization. Although the improved algorithm's optimal path may not be the conventional shortest path, its actual travel time is the shortest, which is more in line with users' actual travel needs to a large extent.

1. Introduction

With the rapid development of global economy, the demand for transportation is becoming more and more urgent. However, the possibility of building and expanding roads in big cities is becoming smaller and smaller, and it is impossible to meet the traffic demand only by relying on the construction of infrastructure. Urban traffic congestion has become increasingly global [1]. In recent years, the congestion and complexity in the field of highway transportation are increasing day by day, especially the growth rate of vehicles has far exceeded that of roads and other transportation facilities [2]. More and more traffic management departments rely on today's scientific development of new technologies to ensure smooth traffic, reduce traffic congestion, improve road safety, and reduce the adverse impact of air pollution on the ecological environment [3]. In many cities, the road planning time is earlier, which cannot meet the requirements of modern traffic, resulting in some roads being very crowded. If there is a traffic accident on the main road or road renovation, it will cause long-term congestion and form a certain traffic vicious circle [4]. The intelligent transportation system (ITS) is to make full use of modern communication, positioning, sensors, and other information-related technologies [5] to reduce traffic congestion, improve road throughput, improve traffic safety conditions, and quickly realize the collection and transmission of traffic information, so as to achieve the purpose of reasonably allocating traffic resources and improving ground traffic conditions [6, 7]. Path optimization is the most basic and key part of the dynamic path guidance system. Its main function is to realize the path planning function for users before and during travel, guide vehicles to reach the destination along the optimal route, and realize real-time vehicle guidance based on urban road network information and real-time road traffic condition information [8, 9].

With the rapid development of information technology [10, 11], the development of urban motorization has been continuously promoted. The traffic development of large and medium-sized cities in the world gradually presents problems in road congestion, traffic congestion, and environmental pollution [12]. The resulting traffic accidents and environmental pollution not only inhibit the sustainable development of urban economy to a great extent but also affect the quality of life of urban residents [13]. Traffic jam has seriously affected the operation effect of the urban traffic system, affected the development speed of the city, and caused a great waste of social resources. Even the most advanced traffic system designed and deployed ten years ago cannot adapt to the current reality [14]. After entering the 21st century, due to the influence of geographical environment and historical factors, the available land area of the city continues to shrink, but the number of vehicles continues to surge, so it is impossible to increase the number of roads in the city indefinitely [15]. Traffic management departments increasingly rely on today's scientific development of new technologies to ensure smooth traffic, improve road safety, and reduce the adverse impact of traffic congestion and air pollution on the ecological environment [16]. Combined with graph theory, this study simulates urban road traffic as nodes and sidelines, adds the real-time change information of road traffic, and displays and calculates the relevant data and parameters in the road. To delete the network factors irrelevant to path selection, so as to save the storage space of road network simulation expression, establish the association of storage node elements and line elements, respectively [17].

As a complex system engineering, urban road traffic intelligent control mainly involves disciplines including automation control, engineering technology engineering, system engineering, and optimal dispatching [18]. Because it has many factors such as randomness, complexity, and uncertainty, people cannot establish an accurate mathematical model, so they must rely on intelligent methods [19]. In the transportation system, urban transportation is a very important part. The intelligent development of urban transportation is an important component of the whole intelligent transportation system and the primary task. At the same time, the intelligent development of urban transportation is also a hot spot in the field of traffic intelligent control [20]. The path optimization algorithm studied in this study is an essential and important part of the intelligent transportation system. Its role is to provide path guidance to travelers, and the provided path is the optimal path based on real-time traffic information. In this way, it can reduce the residence time of vehicles on the road, so as to avoid traffic congestion, congestion, and improve urban traffic.

The remainder of the study is laid out as follows. In Section 2, background study and literature review are elaborated. The methodology is discussed in Section 3, followed by experimental setup and results in Section 4. Finally, Section 5 concludes the study.

2. Related Works

The intelligent transportation system can effectively use existing transportation facilities or transform existing facilities and comprehensively use various modern technologies to integrate people, vehicles, roads, and related environments into a system, so that it can play an intelligent role, which can effectively alleviate traffic congestion, ensure smooth traffic, improve road capacity, and reduce the incidence of traffic accidents and a large amount of energy consumption [21, 22]. The urban road network model in the study by Yang and Daoyuan [23] was created using mathematical dynamic programming, which greatly simplified the calculation of the optimal path. Pan and Ma [24] proposed that historical data be added to optimal route selection based on predecessors and that historical data and current road traffic conditions be used to consider all problems in road transportation. Adjustments must be made when traffic conditions change dramatically in order to achieve the best route selection and calculation. However, due to the difficulty in obtaining historical data, this idea is limited and cannot be implemented in practice. In the study by Fulu et al. [25], the Dijkstra algorithm is proposed to realize the optimal route selection in an urban intelligent transportation system, based on the problem of urban traffic. However, selecting and setting parameters in this algorithm is extremely difficult, and traffic lights at road intersections are not taken into account. The use of closed-loop adaptive methods to solve the optimal path selection problem based on urban traffic system problems has been proposed in the study by Sanchez and Herrera [26], so that road traffic conditions can be accurately evaluated according to real-time road conditions, and the optimization calculation function can be used to calculate the optimal path. Calculate the best route. This method performs well in real-time. Because the objective function and linear programming are used in the calculation of the optimal path, the selection of the optimal path cannot achieve real-time effects when the weight of the linear programming changes, affecting the system's accuracy. A sequential algorithm for finding the average shortest path was proposed in the study by Xia [27]. This algorithm can reduce the computational complexity of optimal path selection while increasing its efficiency.

From the traveler's point of view, on the one hand, urban traffic construction gives them more choices in the choice of travel routes. On the other hand, better traffic conditions also reduce the incidence of urban traffic accidents, which not only improves the lives of residents but also improves the civilization of cities. On the basis of previous studies, this study first discusses the algorithm of static optimal path and its complexity, analyzes the traffic confidence and entropy, explains the complexity of traffic information and its complexity through the concept of entropy, and gives the influence of traffic information on traffic behavior. On this basis, it discusses the dynamic path optimization algorithm model under the condition of high informationization.

3. Route Selection Model Based on Real-Time Traffic Information

3.1. Road Network Model and Data Storage Structure. With the rapid growth of urbanization, urban traffic efficiency is becoming increasingly important, and path planning is becoming increasingly important in daily life. Path planning is the process of finding the best path through traffic by artificially designing the system, so that the destination can be reached in the shortest time or by driving the shortest distance. Because the starting point and destination of our travel are both from two nodes in this network and the optimal path can be selected through the search algorithm [28], we should first form a relatively complete network based on the conditions of urban roads, so that we can search for the optimal path in this network. Create a road network model that corresponds to the real-world road network. A road network model can be constructed as follows:

$$\begin{cases} G = (V, E, W), \\ V = \{v_i | i = 1, 2, \ldots, n-1\}, \\ E = \{\langle v_i, v_j \rangle | v_i, v_j \in V\}, \\ W = \{w_{ij} | \langle v_i, v_j \rangle \in E\}. \end{cases} \quad (1)$$

Among them, V represents the set of vertices, E represents the set of edges (sections), and sections $\langle v_i, v_j \rangle$ and $\langle v_j, v_i \rangle$ are the two different sections. W represents the weight set of the road section $\langle v_i, v_j \rangle$, and its attribute value can be selected according to different optimization goals. For the actual urban road network, the traffic information in two directions of the same road section is generally different, so the directed graph is used to express the actual road network. Directed graph increases the storage capacity of the road network, but it can express the real information of outlet network more comprehensively.

The unit for traffic volume is vehicles/h, and it refers to the number of vehicles passing by per unit time on a given road section. There are significant differences in traffic volume at different road sections or intersections due to differences in population density in different parts of cities. The ratio of the time spent by a car passing through a fixed road section to the total time is known as the time occupancy rate:

$$\theta_{ij}(t) = \frac{1}{T} \sum_{k-1}^{N} t_k, \quad (2)$$

where $\theta_{ij}(t)$ is the time required to travel on the road composed of node i and node j in the period t. T is the travel time interval, N is the total number of vehicles passing the road segment in the time period T, and t_k is the time for the vehicles to pass the test point.

There are many ways to calculate the travel time of the road section in path planning. Generally, the relationship between the three quantities of road traffic flow Q, speed V, and density K is used to calculate the average speed. $V = Q/K$, pass. The average speed can be calculated as the travel time $T = L/V$. In the model, the relationship between the time t and the traffic occupancy rate $\theta_{ij}(t)$ on the research section and the average traffic density $K_{ij}(t)$ of vehicle operation can be measured as

$$K_{ij}(t) = \frac{\theta_{ij}(t)}{L_e}. \quad (3)$$

In the formula, L_e is the length of the test vehicle, so the number of vehicles passing in this time, $S_{ij}(t)$, can be calculated as

$$S_{ij}(t) = L_{ij} \cdot K_{ij}(t), \quad (4)$$

where L_{ij} is the length of the road section connected by node i and node j.

In the route planning, the BPR function can be used to calculate the road travel time of the vehicle:

$$w_{ij}(t) = t_0 \cdot \left[1 + \alpha\left(\frac{Q_{ij}(t)}{C_{ij}}\right)^{\beta}\right], \quad (5)$$

where t_0 is the zero-flow impedance, that is, when the traffic on the road section is zero, it is the time required for the vehicle to travel, $Q_{ij}(t)$ is the traffic volume of the road section connected by node i and node j, and C_{ij} is the number of vehicles passing through the intersection in a unit time. C_{ij} can be regarded as a fixed value when traffic congestion occurs at an intersection due to control lights, but the actual traffic flow $Q_{ij}(t)$ is a dynamically changing amount, that is, C_{ij} has nothing to do with $Q_{ij}(t)$. α and β are the retarding functions. In the traffic flow allocation procedure, the values of α and β parameters are $\alpha = 0.15$ and $\beta = 4$, respectively.

The delay time of the road section can be measured by the detector in the system. At the same time, the occupancy rate $\theta_{ij}(t)$ and the traffic flow $Q_{ij}(t)$ of the road section can be measured, and the traffic density $S_{ij}(t)$ can be calculated according to the occupancy rate $\theta_{ij}(t)$. The length of the road segment to be solved is constant, so the number of vehicles EE can be calculated. Finally, $S_{ij}(t)$ and $Q_{ij}(t)$ are combined to solve the delay time $d_{ij}(t)$. Then, compare the delay time $d_{ij}(t)$ with all the green light times of the intersection to calculate the waiting time D_{ij}, so that the delay time of the road section can be calculated at the end:

$$d_{ij}(t) = \frac{S_{ij}(t)}{Q_{ij}(t)} = \frac{\theta_{ij}(t) \cdot L_{ij}}{Q_{ij}(t) \cdot L_e}, \quad (6)$$

where $Q_{ij}(t)$ is the traffic flow of the road section connected by node i and node j, and $Q_{ij}(t)$ and $\theta_{ij}(t)$ can be measured by the detector in the system. The delay time of the road section between different nodes i and j can be calculated by the following formula:

$$\begin{aligned} M &= \mathrm{int}\left[\frac{d_{ij}(t)}{t_u}\right], \\ C_{ij} &= \frac{t_u}{\lambda}, \end{aligned} \quad (7)$$

where C_{ij} is the entire signal period, λ is the green signal ratio, and $d_{ij} = M \cdot C_{ij}$.

Many factors influence actual traffic efficiency, such as traffic flow and road conditions, which directly limit vehicle traffic efficiency. As a result, these factors should be taken into account in the best route selection model, with traffic density and flow playing a key role. Because these two factors are random, unlike the length of a road section, they are fixed for a long time, and they can be factored into the optimal path selection to improve the system's accuracy.

3.2. Dynamic Path Optimization Algorithm. In the process analysis, first, the system administrator creates the station information database and inputs the number, name, longitude and latitude of the traffic station, and the distance between stations in the database. The system administrator is mainly responsible for maintaining the database [29]. After the database is generated, the relevant users can query the optimal path between sites in the query interface, and the users input the name of the starting site and the name of the target site [30]. The system calls the optimized optimal path algorithm to get the optimal path and displays the optimal path result on the display interface. Figure 1 shows the system flowchart.

Express the dynamic road network as $G = (V, E, W)$, where $V = \{V_1, V_2, \ldots, V_n\}$ is a finite node set, which corresponds to the road nodes of the road network. $E = \{V_i, V_j | V_i, V_j \in V\}$, corresponding to the actual road section between road nodes. $W = \{w_{ij}(t), d_{ij}(t) + D_{ij}\}$. Among them, $E = \{V_i, V_j \in V\}$, which means the time it takes for the vehicle to pass through section (V_i, V_j) at any moment.

$w_{ij}(t)$ is the travel time of the road section connected by node i and node j, and the delay time $d_{ij}(t)$ is the road section between nodes i and j, where D_{ij} is the signal waiting time between nodes, and t_u is the transit time at the intersection. $t_u = 30\text{s}$ when $u = 1$. $t_u = 60\text{s}$ when $u = 2$. $t_u = 90\text{s}$ when $u = 3$.

The objective function of the model is

$$\min T = \sum_{i=1}^{N} \sum_{j=1}^{N} x_{ij} \cdot \left\{\delta w_{ij}(t) + (1 - \delta)\left[d_{ij}(t) + D_{ij}\right]\right\}, \tag{8}$$

$w_{ij}(t) > 0$, $d_{ij}(t) > 0$.

Decision variables are

$$\begin{cases} 1, & 0 < d_{ij}(t) \leq n \cdot t_u \\ 0, & d_{ij}(t) > n \cdot t_u, \end{cases} \tag{9}$$

$$\delta = \begin{cases} 1, & 0 < d_{ij}(t) \leq n \cdot t_u, \\ 0, & t_u < d_{ij}(t) > n \cdot t_u. \end{cases} \tag{10}$$

The formula (9) represents the duration of n green lights, and the size of n is determined by the driver. According to these relations, the time spent on different road sections can be well calculated, and the route is dynamically planned due to the change of the number of signal lights and the change of traffic flow, so as to select an optimal driving route [31].

Aiming at the problem of dynamic path selection, the specific execution steps are as follows. Step 1: initialization, setting the initial node and the destination node. Determine the time occupancy rate, the update time interval of traffic flow, and the size of n. Step 2: find the node adjacent to the starting point, record the node, and calculate the travel time $T_{ij}(t)$ of the road section connected to the node. Step 3: compare $T_{ij}(t)$, if $T_{ij}(t) < t_u$, the road section is relatively smooth, and $T_{ij}(t) = w_{ij}(t)$. If $t_u < T_{ij}(t) \leq nt_u$, then $T_{ij}(t) = d_{ij}(t) + D_{ij}$. If $T_{ij}(t) > nt_u$, the road section is relatively congested, discard the node, and return to Step 2. Step 4: when the next node selected is the destination node, the selection of a set of feasible paths is completed. Step 5: compare multiple groups of feasible paths and take the minimum value.

4. Result Analysis and Discussion

After entering the system, the system administrator first creates the database. Mark the distance values of traffic stations and traffic sections in the database and mainly set the distance values of traffic sections in a straight line way. After the database is created, the user can query the optimal path between traffic stations, input the initial station and the target station, calculate the optimal path according to the optimal path algorithm, and display the optimal path result [27].

During the training phase of the model, it will be tested on the verification set regularly. After continuous analysis and comparison, we finally chose 60 training times as the best training times under the condition that the batch size is 30. Figure 2 shows the trend of accuracy on the verification set along with the training process. Therefore, we can know that increasing the training times within a certain range can improve the performance of the model. On the contrary, too many training times will lead to overfitting, and the performance of the model will decrease.

It can be seen that the accuracy of the verification set of the algorithm is increasing with the convergence of the model, which verifies the correctness of the convergence of the network and the effectiveness of the network for feature extraction.

Adjust the initial model horizontally and vertically. Figure 3 shows the accuracy curve of the model, and Figure 4 shows the loss function curve; with the increase of training times, the accuracy of the network is increasing, and the loss function value is decreasing gradually, and the network basically converges after training 73 times.

During training, the loss function reflected by verification is gradually increasing rather than decreasing, which indicates that the algorithm training has entered the trap of local optimization. Figure 5 shows the relationship between iteration times and normal training and overfitting training.

Combined with the test results of test materials, the correlation between subjective evaluation results and objective evaluation results is 92.08%.

Figures 6 and 7 show the fitting diagrams of subjective evaluation results and objective evaluation results of training samples and test samples, respectively. Combined with the test results of test materials, the correlation between subjective evaluation results and objective evaluation results is 92.07%.

The iterative training is stopped when the training set's fitting degree reaches 98.55%. The test set has a fitting degree of 92.17%, indicating that the model's quality evaluation result is similar to the subjective quality score. When there is not much traffic, the travel time can be very short. When a vehicle approaches a particular road section, for example, it comes to a complete stop due to traffic congestion. The travel time is even longer than the traffic volume. As a result, in

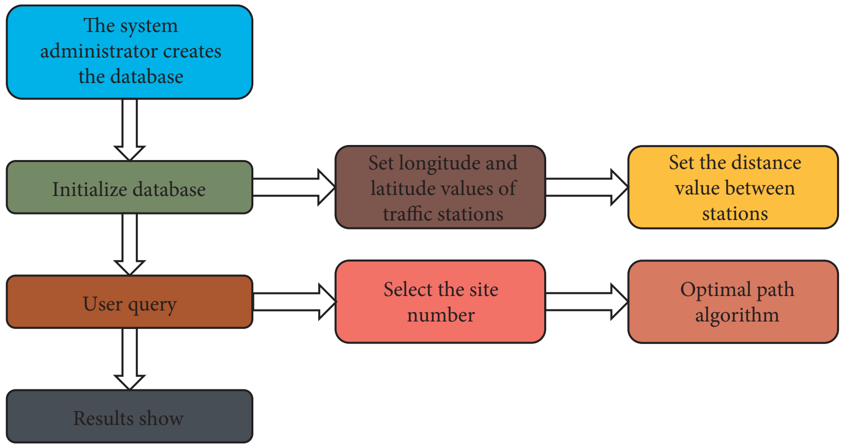

Figure 1: System flowchart.

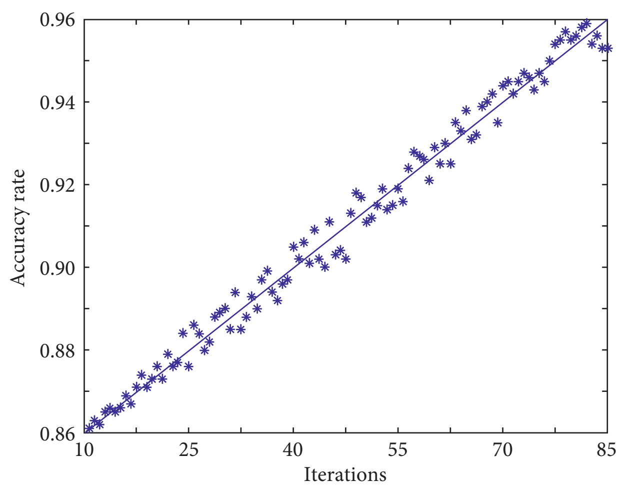

Figure 2: The accuracy trend of the path planning algorithm verification set.

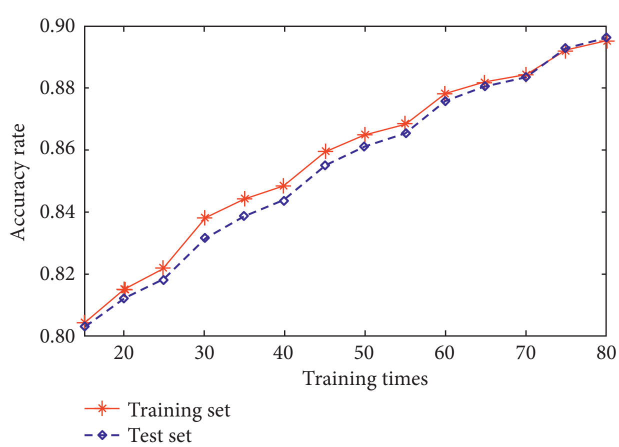

Figure 3: Accuracy curve.

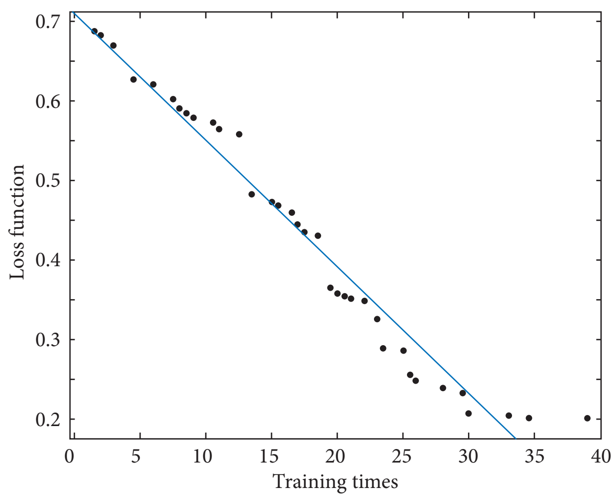

Figure 4: Loss function curve.

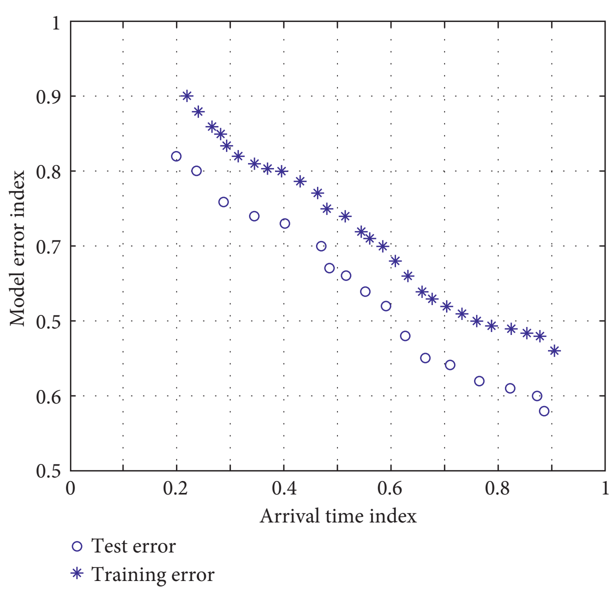

Figure 5: The relationship between the number of iterations and normal training and overfitting training.

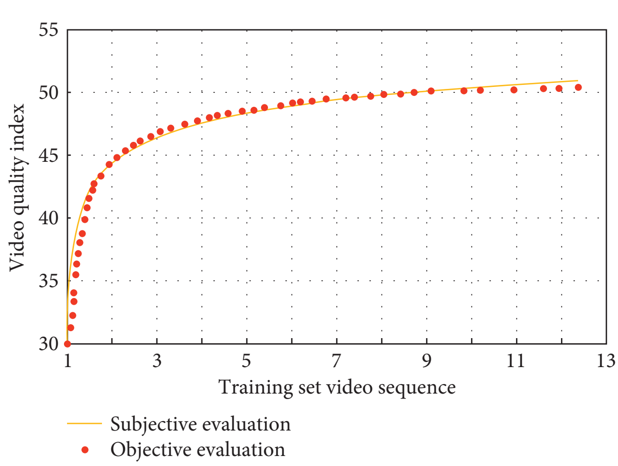

Figure 6: Subjective and objective evaluation values of the experimental training set.

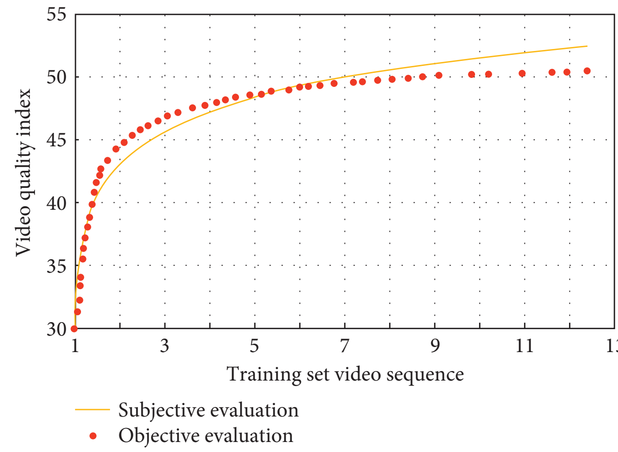

Figure 7: Subjective and objective evaluation values of the experimental test set.

order to effectively improve traffic efficiency, we should collect real-time traffic conditions on the road when planning routes.

5. Conclusions

A key component of an intelligent traffic system is the intelligent traffic management and control system. In order to improve and perfect the intelligent traffic management scheme, the urban intelligent traffic management and control system combines various signal monitoring methods to obtain real-time traffic information and constructs a scientific and reasonable intelligent traffic management framework. The optimal route planning algorithm is the core technology of the route guidance system in ITS, so it is of great practical significance to study it. The intelligent transportation system (ITS) is recognized as the best way to solve the three major problems in the field of international transportation. The intelligent traffic management and control system combines information transmission, allowing relevant management personnel and actual users of the intelligent traffic management and control system to obtain the traffic management scheme and real-time traffic road information in a timely and effective manner, maximizing the efficiency of intelligent traffic management. The main feature of the dynamic path selection problem is that the path selection conditions change over time. Because the majority of the traffic parameters used in the analysis are randomly changed, it is more appropriate to use a dynamic model when analyzing urban road congestion. These influencing factors should be taken into account when designing the road congestion analysis model to improve the accuracy of the analysis results.

Data Availability

The data used to support the findings of this study are included within the article.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This study was supported by the National Natural Science Foundation of China (51908028) and the Fundamental Research Funds of Hebei Provincial Universities (ZCT202005).

References

[1] X. Qiao, R. Dai, and J. Gao, "Research on path planning of networked autonomous vehicles based on sharing mode," *Road Traffic and Safety*, vol. 20, no. 2, pp. 73–78, 2020.

[2] X. Yu, M. Lang, and W. Wang, "Multimodal transport path optimization considering fuzzy demand," *Journal of Beijing Jiaotong University*, vol. 42, no. 3, pp. 23–29, 2018.

[3] C. Liu, M. Chen, and Z. Wang, "Underground logistics channel network design based on simulated annealing," *Highway and Transportation Science and Technology*, vol. 294, no. 6, pp. 155–162, 2019.

[4] L. Tian, B. He, and Z. Zheng, "The enlightenment of optimized ant colony algorithm in planning urban traffic routes," *Science & Technology Economic Guide*, vol. 635, no. 9, pp. 148-149, 2018.

[5] M. Miao, W. Cai, and X. Li, "Parameter estimation of gamma-gamma fading with generalized pointing errors in FSO systems," *Wireless Communications and Mobile Computing*, vol. 2021, Article ID 1301878, 14 pages, 2021.

[6] D. Lei, B. Zeng, and Z. Wang, "Planning model and algorithm for reutilization of multimodal transportation of large cargo," *Journal of Railway Science and Engineering*, vol. 016, no. 7, pp. 1810–1819, 2019.

[7] Z. Yang and Q. Zong, "Research on the search simulation of the optimal path of the traffic network," *Computer Applications and Software*, vol. 34, no. 7, pp. 19–23, 2017.

[8] S. Li, Z. Zhang, and C. Yang, "Traffic analysis and route optimization of vehicles on a ramp," *Science Technology and Engineering*, vol. 18, no. 22, pp. 149–154, 2018.

[9] B. Liu, X. Chen, and C. Zheng, "A dynamic multi-path planning algorithm based on A∗ algorithm," *Microcomputer Applications*, vol. 35, no. 4, pp. 17–19, 2016.

[10] M. Zhao, A. Jha, Q. Liu et al., "Faster Mean-shift: GPU-accelerated clustering for cosine embedding-based cell segmentation and tracking," *Medical Image Analysis*, vol. 71, Article ID 102048, 2021.

[11] R. Liu, W. Cai, G. Li, X. Ning, and Y. Jiang, "Hybrid dilated convolution guided feature filtering and enhancement strategy for hyperspectral image classification," *IEEE Geoscience and Remote Sensing Letters*, vol. 19, 2021.

[12] H. Zhongna, "Research on school bus route optimization model and algorithm," *Journal of Chongqing Jianzhu University*, vol. 35, no. 2, pp. 126–130, 2016.

[13] J. An, X. Li, X. Fan, and G. Z. Nie, "Rescue path planning model for earthquake emergency," *Transportation System Engineering and Information*, vol. 19, no. 1, pp. 176–182, 2019.

[14] G. Liu, P. Liu, and W. Mu, "Path optimization of autonomous underwater robots using improved ant colony algorithm with optimal energy consumption," *Journal of Xi'an Jiaotong University*, vol. 50, no. 10, pp. 93–98, 2016.

[15] H. Zhang, H. Chen, and G. Ao, "Driver's personalized route selection based on differential benefit," *Highway and Transportation Science and Technology*, vol. 295, no. 7, pp. 118–124, 2019.

[16] P. Sheng, X. Luo, and J. Li, "Obstacle avoidance path planning in curved road scenes for smart electric vehicles," *Journal of Traffic and Transportation Engineering*, vol. 104, no. 2, pp. 199–208, 2020.

[17] K. Jaiswal and V. Anand, "EOMR: an energy-efficient optimal multi-path routing protocol to improve QoS in wireless sensor network for IoT applications," *Wireless Personal Communications*, vol. 111, no. 4, pp. 2493–2515, 2020.

[18] W. Xu, W. Bian, and W. Wang, "Real-time path planning of hazardous chemicals transportation based on traffic service level," *CIE Journal*, vol. 69, no. 3, pp. 1136–1140, 2018.

[19] W. Wang, J. Wang, and J. Qu, "Virtual hoisting path planning based on improved probabilistic road sign method," *Journal of Computer Aided Design and Graphics*, vol. 30, no. 4, pp. 695–701, 2018.

[20] L. Pan and D. Zhang, "Application of improved floyd algorithm in urban transportation network optimization," *Logistics Technology*, vol. 037, no. 11, pp. 71–74, 2018.

[21] X. Zhao, J. Kang, and H. Lin, "Emergency resource allocation model based on multi-objective path planning," *Journal of South China University of Technology*, vol. 391, no. 4, pp. 82–88, 2019.

[22] Z. Wu and W. Chu, "Sampling strategy analysis of machine learning models for energy consumption prediction," in *Proceedings of the 2021 IEEE 9th International Conference on Smart Energy Grid Engineering (SEGE)*, pp. 77–81, IEEE, Oshawa, Canada, August, 2021.

[23] X. Yang and D. Ji, "Research on travel route planning considering the degree of road congestion," *Urban Public Transport*, vol. 243, no. 9, pp. 53–55+62, 2018.

[24] Y. Pan and J. Ma, "Penalty function solution to the minimum expectation-mean-square error path problem of stochastic transportation network," *Journal of Chongqing Jianzhu University*, vol. 36, no. 4, pp. 96–101, 2017.

[25] W. Fulu, L. Pan, and Z. Li, "An optimization method of dangerous goods transportation routes based on value-at-risk," *Traffic Information and Safety*, vol. 225, no. 3, pp. 23–29, 2020.

[26] L. C. Sanchez and J. Herrera, "Solution to the multiple products transportation problem: linear programming optimization with Excel Solver," *IEEE Latin America Transactions*, vol. 14, no. 2, pp. 1018–1023, 2016.

[27] Q. Xia, "Research on optimization algorithms of single-block train formation plan on railway corridor," *Advances in Applied Mathematics*, vol. 09, no. 1, pp. 18–29, 2020.

[28] H. Akbaripour, M. Houshmand, and T. V. Woensel, "Cloud manufacturing service selection optimization and scheduling with transportation considerations: mixed-integer programming models," *International Journal of Advanced Manufacturing Technology*, vol. 95, no. 1, pp. 43–70, 2018.

[29] L. Hu, W. Naeem, E. Rajabally et al., "A multiobjective optimization approach for COLREGs-compliant path planning of autonomous surface vehicles verified on networked bridge simulators," *IEEE Transactions on Intelligent Transportation Systems*, vol. 21, no. 3, pp. 1167–1179, 2020.

[30] Q. Tan, J. Peng, and J. Wang, "Urban traffic planning optimization research based on spatial syntax axis and line segment models," *Urbanism and Architecture*, vol. 304, no. 35, pp. 90–92, 2018.

[31] H. Zhao, S. Gao, and B. Sun, "Research on automatic parallel parking path planning method," *Science Technology and Engineering*, vol. 17, no. 7, pp. 263–269, 2017.