Optimization Model of Urban Rail Transit Operation Management Based on Neural Network Algorithm

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Abstract. In order to improve the accuracy of urban traffic flow information and improve the efficiency of traffic control, this paper studies the application of artificial intelligence technology in urban traffic. This paper mainly introduces the intelligent transportation data acquisition and control system based on artificial intelligence and neural network architecture, and points out the trend of the integration of neural network technology and intelligent transportation. This paper designs an intelligent transportation data fusion method based on neural network, and applies it to real-time acquisition, inductive dynamic control, optimal path planning and so on. In this paper, the application of geographic information system (GIS), various intelligent sensors and electronic tag positioning technology in intelligent transportation system (ITS) is described in detail.

Keywords: GIS, ITS, Data fusion, Virtual environment

1. Introduction
Intelligent transportation system (ITS) is a kind of technology that integrates advanced science and Technology (information technology, computer technology, data communication technology, sensor technology, electronic control technology, automatic control theory, operational research, artificial intelligence, etc.) [1]. It can form an integrated transportation system to ensure safety and save energy [2-3].

The predecessor of intelligent transportation system is intelligent vehicle road system [4]. Intelligent transportation system (ITS) can effectively and comprehensively apply advanced information technology, data communication technology, sensor technology, electronic control technology and computer technology to the whole transportation management system, so as to establish a real-time, accurate and efficient comprehensive transportation and management system which plays an important role in a wide range and all directions.

Through the harmonious and close cooperation of people, vehicles and roads, the intelligent transportation system can improve the transportation efficiency, alleviate the traffic congestion, improve the road network carrying capacity, reduce traffic accidents, reduce energy consumption and reduce environmental pollution. The emergence and application of new security technology of intelligent transportation system has a strong pertinence [5]. The patrol vehicle can send the video information back to the highway management center in real time, which enhances the real-time management of its. In addition, the application of other new technologies also provides further support
for the efficient system management.

2. Subsystem

The basic framework of intelligent transportation system is shown in Figure 1.

![Figure 1. The basic framework of intelligent transportation system](image)

(1) Data acquisition and processing function. This function can realize the data acquisition of switching value and analog value of rail transit operation equipment, and can also realize the data processing and storage under certain conditions;

(2) System operation monitoring and time alarm function. This function can not only realize the real-time monitoring of the analog value of the main equipment of the rail transit operation system, but also realize the effective intelligent monitoring of the switching value state of the equipment, which has the function of accident alarm exceeding the limit; it can also alarm the events whose state changes; it can record the events in sequence, and automatically process and control the handled accidents. In addition, it also has sound and light, image, telephone alarm and other functions;

(3) Operation control function. With the help of keyboard or mouse, the artificial intelligence automatic control of rail transit operation system can control the circuit breaker and electric disconnector to adjust the excitation current. According to the sequence control procedure, the operators of rail transit operation system can realize the simultaneous grid connection with load or shutdown operation. In addition, in order to meet the needs of all levels of system operation duty, the rail transit operation system will also limit the operation authority of operators;

(4) Fault recording function. This function is mainly manifested in analog fault recording, sequence recording, switch displacement and waveform capture. For example, through personal computers, closed-circuit television, etc., to provide public consultation on travel mode and events, route and train number selection, etc., and provide real-time operation information of vehicles to waiting passengers through display at bus stops.

Therefore, we need to give full play to the overall capacity and comprehensive benefits of the network to ensure the operation safety and reliability of the system. According to the requirements of urban rail transit network operation, this paper establishes the rail transit Comprehensive Operation Coordination Center (COCC) and the rail transit Emergency Treatment Center (ETC). On this basis, it is of great significance to further develop the auxiliary decision-making technology of urban rail transit network operation coordination and emergency response.

Under the condition of rail transit network operation, the construction of COCC and etc is based on advanced management concept and professional technology, which is the technical platform, information center and command center of rail transit network operation management. COCC is responsible for the operation command and coordination under various operation states of the network, and establishes a platform for train operation management information, passenger information, equipment information and management information; at the same time, it establishes a set of top-down, fixed operation management process covering all posts under various operation states; it communicates and shares information through a common information platform, With the support of
the common information platform, the coordinated operation of the whole rail transit network line system is completed.

COCC is the basis of realizing the network management of rail transit, and undertakes the coordination management function under the condition of network operation. Its basic functions can be defined as information sharing, supervision and coordination, command issuing, assistant decision-making, etc. Etc is a comprehensive command center for handling rail transit network emergencies, and also a basic industry unit serving Shanghai emergency response center. When a major accident occurs, the relevant personnel can concentrate in the emergency center to understand and summarize the voice, video and data information of relevant places through special communication facilities, so as to implement emergency command. Its main responsibilities include formulation and management of emergency plan, coordination and command, information transmission and sharing, emergency linkage, etc. The functional orientation of the two centers is shown in Figure 2.

After the completion of cocc and etc, it will form a hierarchical control and management network with the existing rail transit line (regional) control center (OCC), Shanghai emergency linkage center and other relevant departments. Under normal conditions, COCC is responsible for formulating and coordinating the operation plan of the whole network line, monitoring the network operation in real time and dynamically, while OCC and station are respectively responsible for line traffic command, passenger dispatching, on-site service and fare collection. Under the condition of emergency, etc starts, develops emergency disposal plan and reports to relevant control center, responsible for on-site rescue, passenger evacuation, external linkage, etc.

Figure 2. Framework diagram of COCC function positioning

3. Traffic Guidance Model and Algorithm

Traffic system refers to the main traffic intersection in the city or the highway network layout induced traffic guidance screen for travelers, indicating downstream road traffic conditions, so that travelers choose the road right, which provides induced travel service for travelers, and adjust the distribution of traffic flow, to improve traffic conditions.

The traffic system consists of four subsystems: induced traffic flow collection system, vehicle positioning subsystem, traffic information service subsystem and route optimization subsystem. The following two parameters are defined to evaluate the vehicle scheduling algorithm [6-8]:

Definition 1: The success rate $r^s$ of vehicle joint execution in a feasible work list. The $\{a_1, a_2, \cdots, a_n\}(n > 1)$ represents the N vehicles contained in the list of viable jobs and then $r^s$ represents the product of $r^{a_i}$, that is:

$$r^s = \prod_{i=1}^{n} r^{a_i} \quad (1)$$
Definition 2: The overall delay cost $c^U$ of the vehicle in the infeasible work list. The infeasible work list contains a total of $M$ vehicles $\{a_1, a_2, \cdots, a_m\} (m > 1)$. $c^U$ represents the sum of the delay costs of the $m$ vehicles:

$$c^U = \sum_{i=1}^{m} (c^u_i) \quad (2)$$

The data to be using equation (3) is normalized.

$$x_i = \frac{x_i - b_i}{a_i - b_i} \quad (3)$$

The construction of COCC and ETC is the integration of advanced theories, methods and technologies in the network operation and management of urban rail transit, which should reflect the functionality, practicability and reliability. From the perspective of network operation management, COCC and etc should be based on the distribution and characteristics of passenger flow in rail transit network, and coordinate and optimize the operation plan of each line. Optimize the train diagram of each line, formulate and manage emergency plans under various special circumstances. Implement scientific and reasonable emergency response to ensure the efficient, safe and reliable operation of rail transit network.

(1) Analysis and early warning technology of network passenger flow distribution. Based on the passenger transport organization mode, ticket system and ticket price under the condition of network operation, this paper analyzes the composition of passenger flow and passenger travel characteristics after the network operation of rail transit. Considering the spatiotemporal dynamics, agglomeration and route complexity of the passenger flow in rail transit network, the distribution of passenger flow in the network and the influence of new line access on the redistribution of network passenger flow are determined. The system requires to study the basic characteristics and composition structure of passenger flow under the condition of network operation, and establish a unified and comprehensive index system of rail transit network passenger flow reflecting the characteristics of passenger flow under the condition of network operation. The multi-level and classified passenger flow forecast is used as the basis of operation planning to realize the passenger flow early warning based on the historical passenger flow data and transportation capacity.

(2) Coordination and optimization technology of network operation plan. Based on the distribution of network passenger flow, according to the requirements and characteristics of comprehensive coordination of network operation management, this paper focuses on the comprehensive coordination and optimization of train operation plan of each line under the condition of network operation, especially the effective connection of network operation plan at transfer station. After formulating the reasonable matching scheme of the first and last train time of each line, the matching and convergence of the network operation plan in the aspects of transportation capacity, running interval, stop time, etc. are analyzed. The system can analyze the technical parameters of network train diagram compilation, including line running interval, departure interval of the same line in different periods, train turn back and train list storage mode, etc. Based on the reasonable connection between the first and last trains and the coordination of the main transfer nodes, the comprehensive optimization of train operation plan and crew plan of the line network is carried out. Train operation diagram of different passenger flow characteristics, special period and special period is compiled, and the train operation diagram is reviewed and optimized from the matching degree of network operation diagram and passenger flow, train full load rate and other aspects.

(3) Emergency disposal technology of emergency. Based on the construction and operation mode of emergency command system of rail transit network, the computer management system of emergency plan is realized, and the hierarchical management of emergency plan (network layer, OCC layer and station layer) is carried out. To develop the intelligent generation technology of emergency response plan in the case of large passenger flow and emergencies of rail transit based on network operation. According to the execution time (monitoring disposal time) and execution status (completed, in execution, the command has been interrupted), the intelligent monitoring of the disposal process is
realized, and the computer simulation evaluation and optimization of the emergency disposal scheme are realized.

4. Subsystem
The vehicle state transformation can be regarded as a marking process, thus the evolution of the whole traffic flow can be obtained through the iteration of time. Compared with the numerical simulation, the model can consider more details to obtain more accurate traffic flow information. The simulation prototype system is implemented on a single machine system, and the simulation model is proved to be very feasible. On the basis of the prototype system, the dynamic influence of traffic flow, road design speed and driver's behavior on traffic flow state is analyzed. The general vehicle on the road has the best speed. When driving a vehicle on the road, the driver dynamically adjusts the vehicle above. The moving speed and distance of the vehicle constitute the main characteristics of the traffic flow. When the distance of the vehicle reaches the critical value, the dynamic adjustment process of the user cannot be adjusted from the dynamic balance process to the new equilibrium process. A complete optimal vehicle model is proposed by M Bando et al. And the critical state of the traffic flow is analyzed. Figure 3 shows the distribution of vehicle spacing under different traffic flow.

![Figure 3. Distribution of vehicle spacing under different traffic flow](image)

According to the complex network theory, the smoothness of the network model can be measured by the characteristic path. However, the calculation of the characteristic path, especially the calculation of the weighted characteristic path after the introduction of link impedance, requires a large amount of computing resources. This paper introduces the concept of testing vehicles in order to evaluate traffic congestion. The test vehicle is a virtual vehicle, and it is not a real physical vehicle simulation. Traffic congestion assessment based on testing vehicles can be used to evaluate the congestion status of road networks.

5. Conclusion
Under the condition of network operation management, it is very challenging to accurately analyze the distribution characteristics of network passenger flow, formulate reasonable network operation plan, improve the operation coordination of each line, give full play to the overall ability and comprehensive benefits of the system, and the emergency response ability of the system. From the perspective of the requirements of network operation management, we need to accurately grasp the distribution of passenger flow in the rail transit network, coordinate the preparation of line operation plan, and optimize the train diagram of each line, so as to give full play to the overall efficiency of the rail transit network and ensure the high efficiency, safety and reliability of operation. Compared with the general technical system, the integrity requirements of its construction process are more stringent. This paper designs an intelligent transportation data fusion method based on neural network, and applies it to real-time acquisition, inductive dynamic control, optimal path planning and so on. In this paper, the
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