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Research on intelligent city traffic management system based on WEBGIS

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Abstract: Aiming at the problem that the traditional urban traffic management system can't effectively integrate the data, which leads to the low efficiency of data processing and the effect of traffic management, a smart city traffic management system based on WEBGIS is designed. Based on the traditional system, the dynamic traffic data acquisition hardware module is designed. According to the weekly similarity characteristics of traffic flow data, the traffic flow in different time periods is predicted and the road signal is controlled. The WEBGIS technology is used to deal with the traffic accidents, and the effective management of the urban traffic is realized. Simulation results show that the designed management system can effectively reduce the congestion of urban trunk roads and improve the efficiency of traffic management.

Key words: WEBGIS technology; smart city; urban transportation; management system; system design;

0 Introduction

With the rapid growth of China's urban development, the continuous growth of urbanization scale and the popularization of Internet advanced technology in all aspects of daily life, the traditional urban management mode has been difficult to meet the needs of social and economic development. How to use Internet technology to improve the efficiency of urban management has become the goal and focus of the government. Therefore, "Internet plus city management" came into being. Taking the management of urban traffic congestion as an example, traffic congestion has become one of the important restrictive factors for the economic and social development and the improvement of people's living standards in some cities of China. The effective supply of urban road traffic resources and the daily travel demand of citizens are increasingly unbalanced. How to effectively solve the problem of urban traffic congestion with advanced Internet technology is imminent. In recent years, China's urbanization process has been accelerated, and Internet technology has been widely used. It has become a general trend to apply advanced mobile Internet technology to urban management and reform the traditional urban management mode that does not adapt to social development and improve the quality of urban management. As one of the important links of urban management, the problem of urban traffic congestion is becoming increasingly prominent. With the development of economy and social progress, the wealth of residents is growing day by day. Cars have become the standard configuration for more and more families. With it, more and more cars are driving on the road, more and more cars are parked in the parking lot, and residents are wasting more and more time on the road, Traffic congestion, parking difficulties, taxi difficulties and other issues have become the current traffic problems faced by many large and medium-sized cities in China, and with the increase of travel time caused by urban traffic delay, the increase of travel cost caused by no-load loss of vehicles, air pollution, etc.Internet plus city management city has innovating the management mode of urban traffic congestion in China, integrating the development of advanced technology of mobile Internet with city traffic congestion management, and forming a new mode of urban traffic congestion management which is based on the "Internet plus urban management" as the way to realize and

infrastructure. It promotes the urban development more comprehensively and effectively, and embodies our government. Internet plus city management will also become a new driving force and new engine for city city traffic congestion management innovation.

With the rapid development of information technology, the Internet of things, cloud computing and other emerging technologies are applied to all aspects of urban construction and management, and the construction of smart city is gradually promoted in China. The construction of smart city not only improves the efficiency of urban management, but also improves the life experience of urban residents [1]. The Internet of things and Internet technology are used to connect the infrastructure used in urban management, and information and communication technology are used to connect and integrate various urban management systems and service departments, so as to form intelligent urban life, improve the utilization rate of urban management resources, save energy and cost in traditional urban management, and reduce the negative impact on the environment, to achieve the fine and dynamic management of the city, and improve the effectiveness of urban management and improve the quality of life of citizens. With the rapid development of economy, the use of urban motor vehicles is increasing in multiples. The increasing demand for transportation services brings great pressure to the management of urban transportation system. The traditional urban traffic management system needs to obtain data from different data sources when carrying out traffic management. The difference of data standards seriously affects the processing efficiency of the management system. In addition, each module of the traditional traffic management system is independent of each other, which can not achieve effective data and function integration, and is prone to data disconnection problem [2].

WEBGIS is based on the traditional GIS technology, using the convenience of network connectivity and the sharing of data interconnection to realize the function expansion of traditional GIS technology [3]. WEBGIS can seamlessly integrate with other information services in the web at any time. It can establish flexible GIS applications, make maximum use of network resources, and provide personalized services. This paper will study and design the intelligent city traffic management system based on WEBGIS, and verify the feasibility of the system in the actual urban management.

1 Hardware design of intelligent city traffic management system based on WEBGIS

The hardware part of smart city traffic management system is mainly composed of dynamic traffic data acquisition module and static traffic data acquisition module. After collecting real-time traffic information in the city, the two hardware modules transmit the real-time traffic information to the central server of the system through LAN. The server and the upper computer of the system analyze and process it to realize the management of urban traffic. This paper mainly designs the dynamic traffic data acquisition module. The static traffic data acquisition module uses the hardware part of the traditional traffic management system. The following is the design of the dynamic traffic data acquisition module.

The dynamic traffic data acquisition module is composed of geomagnetic data collector and data receiver. The data collector uses the vehicle detector embedded in it to detect passing vehicles at fixed distance intervals or according to the actual management requirements. Different direction magnetoresistance sensor is used in vehicle detector. When the vehicle passes by, the iron nickel alloy film on the sensor will change its resistivity in the changed magnetic field. The change of magnetoresistance of the iron nickel alloy film can be measured by the output voltage of the bridge connected to it. After the vehicle detector analyzes the geomagnetic disturbance signal

generated by the vehicle passing by, it is processed and analyzed by the main control chip S3C2440A of the dynamic traffic data acquisition module [4]. S3C2440A chip has the ability of low power consumption and high speed parallel processing. The real-time data processing frequency can reach 400MHz. After the main control chip S3C2440A of dynamic traffic data acquisition module analyzes and processes the received vehicle detection signal, the RF chip CC2420 receives and transmits the processed data to the system data receiver. After receiving the signal, the traffic information data receiver exchanges data between the data receiver and the system central server by TDMA communication mode.

TDMA communication mode can ensure that the central processor of traffic management system can timely analyze the data collected by hardware part, so as to avoid causing greater traffic management pressure and improve the efficiency of urban traffic management [5]. The traffic information data receiver sends the traffic data packet with time T_1 to the central server at time T_1, and the central server receives the data packet sent by the data receiver at time T_2, and stamps the time stamp of T_2 time. In the process of data transmission and communication, the time difference between the data receiver and the central server can be the sum of the absolute time difference of communication between them and the data packet transmission time, thus realizing the time synchronization under TDMA communication.

On the basis of the hardware part of the traffic management system designed above, the software part of the system is designed by using WEBGIS technology to realize the urban traffic management in the smart city.

2 Design of intelligent city traffic management system software based on WEBGIS

2.1 Traffic signal control

Because the traffic flow data changes periodically, we can use the weekly similarity characteristics of traffic flow data, and use the method of weighting the historical data and modifying the time series prediction model to make short-term traffic flow prediction. Taking working days as an example, if only the historical data of the last five working days are used, the short-term traffic flow prediction can be realized according to the following steps [6].

The traffic flow prediction function is constructed as follows:

$$Q_d^w(t,n)=\sum_{k=1}^{5} w_k\left[(1+\eta_k)q_k^{w^*}(t,n)\right] \quad (1)$$

In formula (1), $Q_d^w(t,n)$ represents the predicted traffic flow at n hours after time t on the d day of week w; w_k represents the weight of week k; η_k represents the correction coefficient of week k; $q_k^{w^*}(t,n)$ is the historical traffic flow of week w^*, day k and time t [7]. The weight is obtained by comparing the real-time traffic flow data before the current time of the forecast day with the corresponding traffic flow data before the current time of the historical working day. That is, the closer the data of five working days is to the data before the current time of the forecast day, the greater the weight is. The calculation formula is as follows [8].

$$w_k = \frac{\theta_k}{\sum_{k=1}^{5} \theta_k} \quad (2)$$

In formula (2), θ_k is the anti random interference factor. The anti random interference factor can avoid reducing the weight of historical data and affecting the prediction accuracy due to large data error. Using the predicted traffic flow data and using the principle of fuzzy eclectic planning to control the traffic signal, the traffic flow changes can be predicted in advance, and the congestion of urban traffic main roads can be reduced.

2.2 Emergency traffic disposal using WEBGIS technology

When there is a traffic accident on the road, when the system receives or detects the accident, it uses the vehicle GPS and the hardware module of the management system to locate the location of the accident. When using GPS for vehicle positioning, if t_g^j is the GPS time when the positioning satellite transmits the signal; t^j is the satellite clock time when the positioning satellite transmits the signal; T_g is the GPS time when the signal receiver receives the satellite transmitting signal; T is the receiver time when the signal receiver receives the satellite transmitting signal, then the transmission time of the GPS satellite signal can be calculated according to the following formula [9-12]:

$$\tau^j = T_g - t_g^j \quad (3)$$

In the actual measurement process, because the GPS time of satellite cannot be measured, the following formula is used instead of the above formula:

$$\tau^j = T - t^j \quad (4)$$

According to the deviation between GPS satellite clock time and receiver time, the above formula can be converted into the following form[13]:

$$\begin{cases} \tau^j = \left(T_g - t_g^j\right) + \Delta t - \Delta t^j \\ \Delta t = T - T_g \\ \Delta t^j = t^j - t_g^j \end{cases} \quad (5)$$

In formula (5), Δt is the deviation between GPS satellite clock time and receiver satellite clock time; Δt^j is the deviation between receiver clock time and satellite clock time[14]. The distance between the satellite and the signal receiver can be roughly obtained by multiplying the above-mentioned time with the speed of light, and the three-dimensional space coordinate system can be established according to the geometric relationship between the receiver and the satellite. In the space three-dimensional coordinate system, the location of the actual traffic accident is obtained by calculation.

After determining the actual location of the traffic accident, a traffic network map with the

accident location as the center and the distance between the accident location and the rescue team as the radius is established by using WEBGIS technology[15-16]. The system designed in this paper selects map services in ArcGIS Server to provide rescue Map Service. Using this service, the traffic management system combines the real-time traffic data collected by the system to plan the best rescue route, so as to improve the emergency handling efficiency of urban traffic. In this paper, ant colony algorithm is used to plan the optimal emergency disposal route. The following figure shows the planning process of ant colony algorithm [17-18].

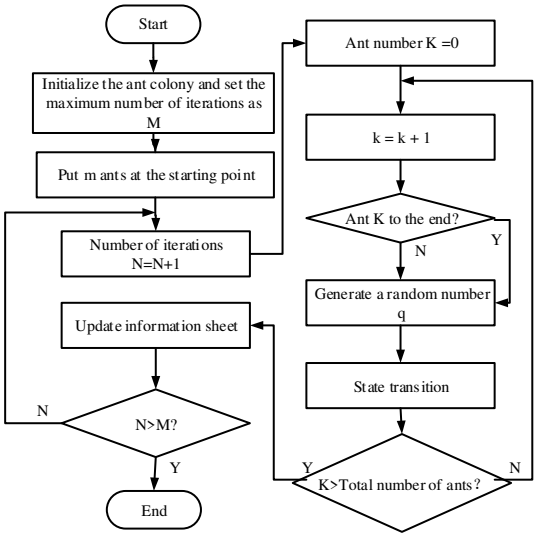

Figure 1 emergency disposal path planning based on ant colony algorithm

The state transition rules of ant colony algorithm in the above figure are as follows[19]:

$$S=\begin{cases}\arg\max\left\{\left[\tau_{it}(t)\right]^{\alpha}\left[\eta_{td}(t)\right]^{\beta}\right\}, q\le q_0\\ w, q>q_0\end{cases} \quad (6)$$

In formula (6), S is the set of the next position in the ant's path; w is a random value; q_0 is a constant; q is a random value on the interval [0,1]; α determines the ant's path of advance; β judge whether the direction of ants is correct; $\tau_{it}(t)$ is the residual amount; $\left[\eta_{td}(t)\right]^{\beta}$ is the degree of inspiration. According to the above process, call the shortest path as the result of algorithm planning. The rescue team goes to the accident location according to the path planned by the system. The traffic management system can speed up the progress of the disposal team and improve the disposal efficiency by controlling the flashing time of traffic signals. Through the above process, the design of intelligent city traffic management system based on WEBGIS is completed. The performance of the management system will be tested through experiments[20].

3 Simulation experiment

In this paper, the intelligent city traffic management system based on WEBGIS is studied, and WEBGIS technology is used to effectively improve the application and processing efficiency of traffic management mode in different periods of urban traffic, and relieve the traffic pressure of

the city. In order to verify whether the traffic management system designed above can be applied in practice, this section will carry out experimental verification.

3.1 Experimental content

This experiment from two angles, using the WEBGIS based smart city traffic management system and two traditional traffic management system contrast form, intuitively and effectively test the effectiveness and feasibility of the traffic management system designed in this paper. Taking the traffic management system based on GIS as the comparison group A, the traffic management system based on visual inspection as the contrast group B, the intelligent city traffic management system based on WEBGIS designed in this paper is taken as the experimental group.

The comparison index of the comparative experiment is the average delay and average parking times of urban roads under the guidance of different management systems. The experiment is carried out in the simulation software. The corresponding management schemes of the three traffic management systems are transformed into corresponding control parameters, which are respectively input into three identical computer platforms as input data. Set 15min as the time interval for data output, and the simulation time is 24h. Record, process and analyze the experimental data, compare the urban traffic situation under the control of the three systems, and draw the conclusion of this experiment.

3.2 Experimental results and analysis

Figure 2 (a) and (b) respectively show the comparison chart of 15 min average total delay in north to south and south to north directions of urban traffic trunk lines under the management of three systems, and analyze the relationship between the curves in the figure.

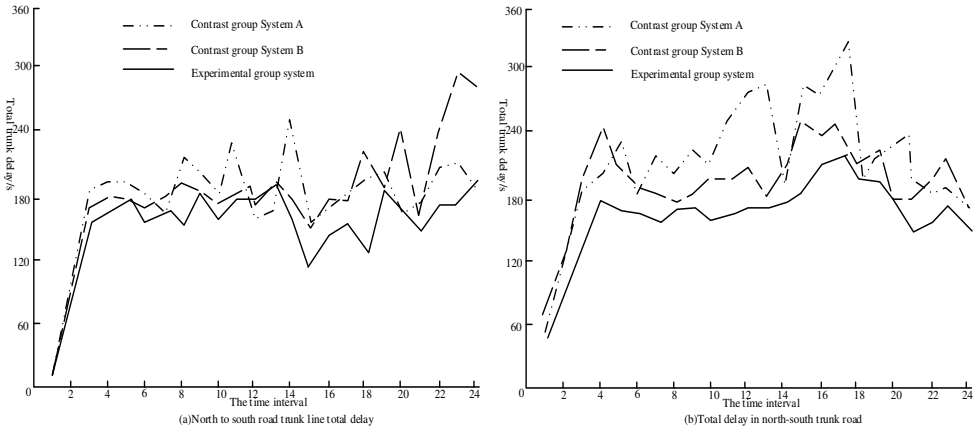

Figure 2 comparison of total delay in north south direction of trunk line

It can be seen from figures (a) and (b) that, compared with the control group system A, the comparison group system B and the experimental group traffic management system can reduce the delay of trunk line vehicles, and the improvement effect for the south to north direction is better than that for the north to south direction. Compared with system A, the maximum improvement rate of average total delay for 5 minutes from north to south in comparison group B is 16.78%; that for 15 minutes from south to north is 39.27%; for two way trunk line, the maximum value is 21.32%. Compared with the control group A, the maximum improvement rate of the average total delay of the traffic management system in the experimental group is 24.21% for the 5 minute north to south trunk line, 43.92% for the 15 minute south to north direction, and 34.11% for the 15 minute two way trunk line. Compared with the control group A system and the control group B system, the experimental group traffic management system gets the least average delay and the

best traffic timing management effect.

The average benefit comparison of the three traffic management systems is shown in the table below.

Table 1 comparison of average benefits of three schemes in interval time

Direction	Index	Control group A	Control group B	Experience group
The main line is from north to south	Average delay /s	181.58	187.55	165.67
	Average parking times	6.46	6.59	5.88
The main line is from south to north	Average delay /s	232.84	213.04	192.26
	Average parking times	7.38	7.3	6.46
Trunk line overall	Average delay /s	414.41	400.60	357.93
	Average parking times	13.84	13.89	12.34
Access Rd	Average delay /s	48.23	47.35	41.14
	Average parking times	0.85	0.84	0.78

It can be seen from the above table that the traffic management system designed in this paper can effectively reduce the delay and parking times of trunk vehicles, and improve the overall traffic efficiency of the road network. Through the above experiments, the effectiveness of the intelligent city traffic management system based on WEBGIS is verified, which can be put into use after actual test.

4. Traffic management strategy of smart city based on WEBGIS

First of all, change the concept of urban traffic congestion management, and pay attention to the service function of the government in urban traffic congestion management. The number of Internet users in China ranks first in the world, and the Internet has become an important part of people's life. We should make progress in the new wave of Internet revolution, change the thinking of urban traffic congestion management, build our city with new management mode, and improve the quality of urban traffic service for citizens. The main function of the government is to provide comprehensive road traffic management and convenient services, which requires that the core management concept of the government is to better meet the needs of the general public and provide 7x24 hours of service for public transportation. Therefore, we should establish a service-oriented government that conforms to the concept of "Internet plus city management", emphasize the role of government in guiding and coordinating traffic congestion management, and gradually achieve the standardization and harmony of city traffic congestion management.

Secondly, change the management mode of urban traffic congestion and establish the information interconnection system of urban traffic congestion management. Cloud computing, Internet of things and big data processing technology, as another revolution in the field of mobile Internet, are not only an innovation in the technical field, but also provide technical support for the innovation of urban traffic congestion management mode, and put forward new requirements. The Internet plus city management mode has enough knowledge and enthusiasm for the relevant government departments to create the new mode and mode of Internet traffic. The new mode and characteristics of the city's traffic congestion management mode are required to be transformed

and innovating, and a network platform city matching the social economic system should be constructed. Traffic congestion management mode, so as to meet the new demands of society, enterprises and the public for urban traffic services. The government should make use of advanced Internet technology to promote the transformation of urban traffic congestion management from "sweat type" to "intelligent type", provide accurate service with efficient means, and create a good urban travel environment for the masses.

Finally, we should make a good plan for the management of traffic congestion under the "Internet plus city management" and strictly enforce it. The creation of a new traffic congestion management mode under the "Internet plus city management" is a systematic project, which includes the application of advanced technologies in mobile Internet, the construction of talents in various departments of government, the reorientation of functions and the formulation of policies, and so on. City Internet plus information technology is the support. The government's active transformation and construction is the priority among priorities. Without the government's attention, organization and promotion, the construction of traffic congestion mode under the "Internet + urban management" will be lack of vitality and can not be effectively implemented. Therefore, it is necessary to do a good job in the scientific planning of traffic congestion management under the new situation, establish a leadership responsibility system, clarify the work responsibilities, do their own job, do their best, grasp the construction and strictly implement.

5 Conclusion

In order to ensure the efficiency of urban traffic management and improve the convenience of urban residents, this paper designs a smart city traffic management system based on WEBGIS. Compared with two traditional management systems, it is proved that the system can effectively improve the efficiency of urban traffic management and achieve better management effect. In the future research, it is necessary to consider the requirements of the communication distance and the use environment of the system hardware, and optimize the endurance of the hardware part of the system, and comprehensively improve the performance of the traffic management system.

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Conflict of interests:

The authors declare that they have no competing interests in this section.

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Figures

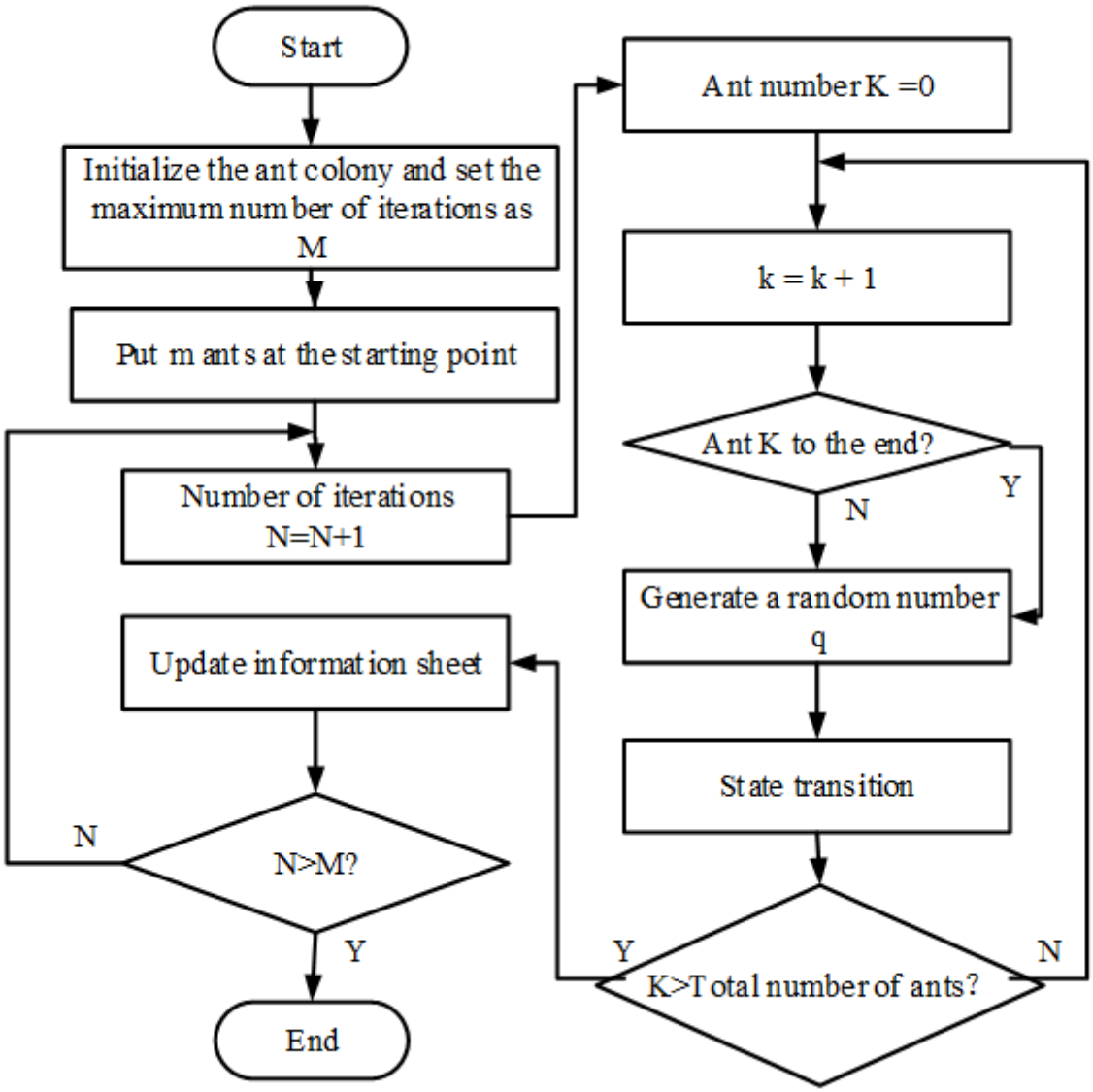

Figure 1

emergency disposal path planning based on ant colony algorithm

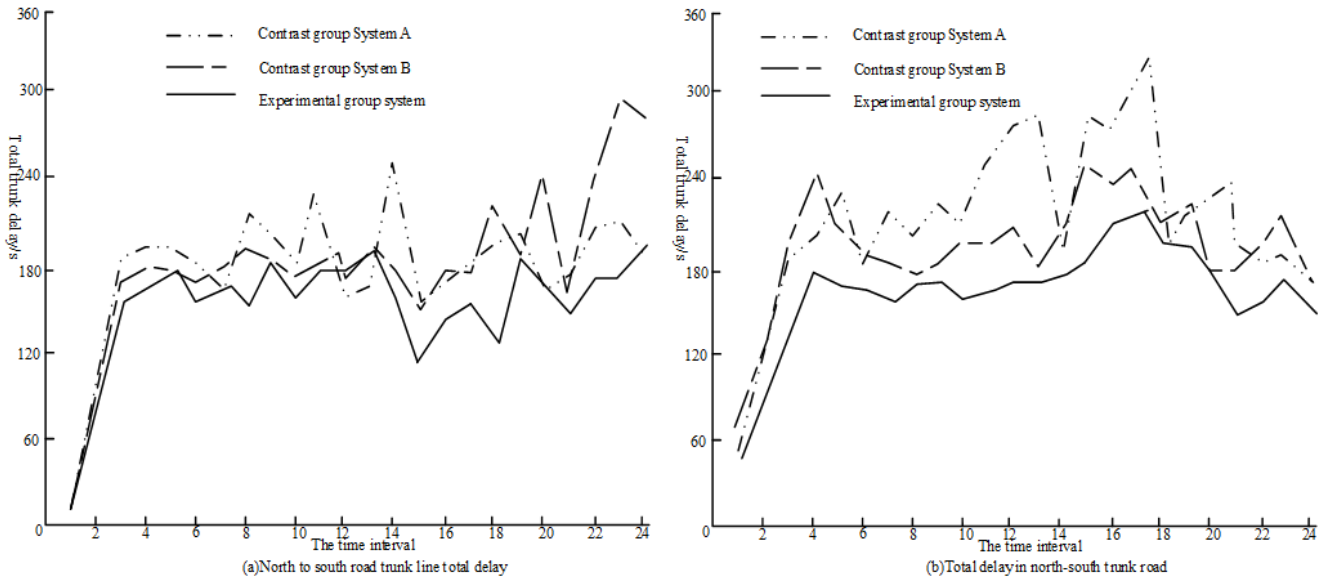

Figure 2

comparison of total delay in north south direction of trunk line