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Short Research Article

Traffic Simulation, Optimization and Evaluation of Adjacent Intersections Based on VISSIM Model

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Abstract

This paper mainly aims at alleviating the traffic congestion on urban roads and analyzes the traffic at adjacent intersections. First, the paper briefly introduced the VISSIM model, and then selected the traffic situation at the intersection of Weibin road and Fengcheng first road and the intersection of Weibin road and Fengcheng second road in Weiyang district of Xi'an city as research objects to simulate. Fanally, on the premise of basic meet the actual conditions, the optimization of channelization and signal timing at the intersection reduces the maximum queue length and the average stopping times of vehicles, so that the traffic of the section can run efficiently and smoothly, and provides an effective experiment for the optimization of the intersection.

Keywords

Adjacent intersections, traffic simulation, traffic optimization

1. Introduction

The problem of traffic congestion is an urgent problem to be solved in many cities with rapid economic development. The conventional thinking is that the traffic facilities can not keep up with the increase of traffic flow, so a lot of road construction and transformation are carried out, but the result is unsatisfactory. Through the accumulation of literature reading, we find that we can optimize traffic congestion by improving traffic signal control and road channelization.

However, traffic congestion on urban road sections is usually caused by a local area and distributed in a diffuse manner. The study of a single intersection can no longer meet the traffic requirements. In this paper, two adjacent intersections are considered as research objects.

In this paper, the classic traffic simulation modal VISSIM is used to simulate the traffic situation in the

selected congested section, and the simulation results are verified with the actual situation. In the case that the error is within the acceptable range, the optimization scheme is proposed, and the simulation modal is used for simulation and evaluation.

2. Method

2.1 VISSIM Modal

The microscopic traffic simulation model VISSIM is basically an accurate simulation based on the geometric shape of the road network and the dynamic traffic behavior of each vehicle. This simulation is based on the difference between the vehicle type and the driver's driving behavior. By using the modal to simulate the traffic condition of the road section, the 3D animation pictures of intersections, vehicles, roads and signal lights in the road network can be viewed intuitively and clearly in the actual situation.

By using VISSIM modal, we can analyze the vehicle driving mode under such conditions as the composition of traffic conditions, the setting of lane number, and the control of signal light, etc. By using the simulation results, we can optimize the simulated vehicle behavior and evaluate the traffic behavior of section traffic.

2.2 Traffic Simulation and Validation

2.1.1 Traffic Simulation

This section selects two adjacent intersections in Xi'an city, Shaanxi province. During the same time period (evening peak period), the traffic flow information of these two intersections is calculated, simulated and verified with the actual road condition information.

According to the data information collected by VISSIM modal, the traffic situation at the intersection of Weibin road and Fengcheng first road and the intersection of Weibin road and Fengcheng second road was investigated. From 17:30 to 18:30 on workday (Wednesday, April 19, 2017), data on traffic volume, signal timing, lane number and functions, as well as the queue length and stop times of vehicles were collected. Summarized as follows.

a. Road Geometry Dimension Data

The shape of the intersections investigated in this paper is a standard cross, and the width of each lane model is 3.5 m. This is shown in Figure 1.

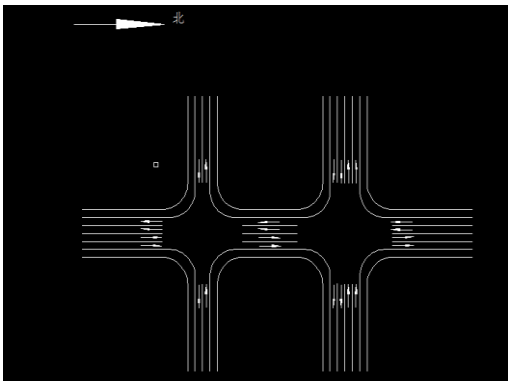

Figure 1. Road Geometry

b. Signal Timing Data

The intersection of Weibin road and Fengcheng first road adopts a three-phase signal timing scheme. Signal cycle is 312s. The green time, red light time and yellow light time in all directions are shown in Table 1.

Table 1. Timing Intersection of Weibin Road and Fengcheng First Road

Timing parameters	Go straight and turn right in the north-south direction	Go straight and turn left in the north-south direction	Go straight, turn left and turn right in the east-west direction
Green time/s	33	57	59
Yellow light time/s	3	3	3
Red light time/s	66	42	46
Signal cycle /s	312	312	312

The intersection of Weibin road and Fengcheng second road adopts a three-phase signal timing scheme. Signal cycle is 222s. The green time, red light time and yellow light time in all directions are shown in Table 2.

Table 2. Timing Intersection of Weibin Road and Fengcheng Second Road

Timing parameters	Go straight, turn left and turn right in the north-south direction	Go straight and turn right in the east-west direction	Go straight and turn left in the east-west direction
Green time/s	31	26	34
Yellow light time/s	3	3	3
Red light time/s	48	54	20
Signal cycle /s	222	222	222

c. Traffic Flow Data

Traffic composition is the definition of the composition of each traffic flow entering the micro simulation network. The traffic composition includes one or more vehicle types and their relative proportions in the input traffic flow, as well as a list of the speed distribution. See Tables 3 and 4.

Table 3. Spot Survey of Peak Hour Traffic at the Intersection of Weibin Road and Fengcheng First Road

	West import			North import			East import			South import		
	Straight	Left	Right	Straight	Left	Right	Straight	Left	Right	Straight	Left	Right
Traffic volume (/hour)	250	110	380	512	272	380	341	132	130	621	223	321
Total traffic volume	740			1164			603			1165		

Table 4. Spot Survey of Peak Hour Traffic at the Intersection of Weibin Road and Fengcheng Second Road

	West import			North import			East import			South import		
	Straight	Left	Right	Straight	Left	Right	Straight	Left	Right	Straight	Left	Right
Traffic volume (/hour)	216	330	235	455	243	154	365	76	236	441	313	334
Total traffic volume	871			852			677			1088		

These data are input into VISSIM modal for simulation. As shown in Figure 2.

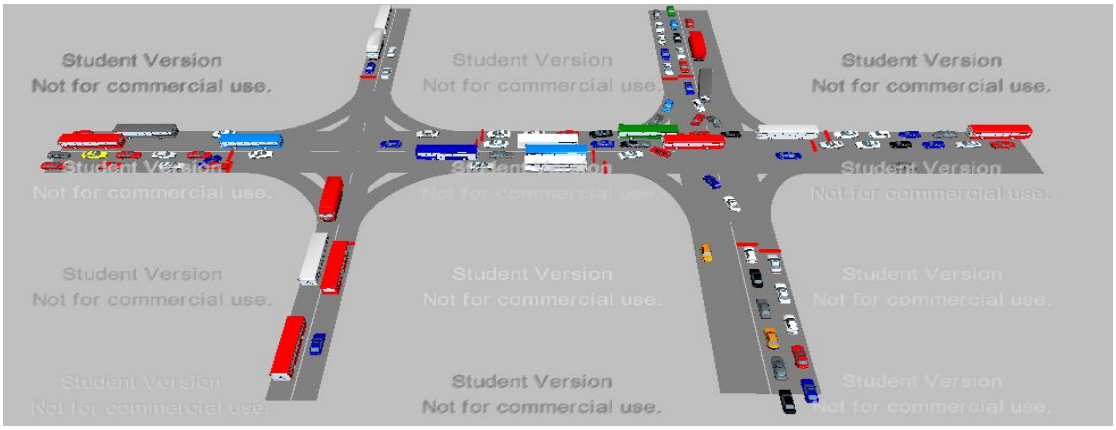

Figure 2. Simulation of VISSIM Modal

2.1.2 Traffic Validation

Since the data of maximum queue length and stop times are easy to be calculated in practice, and the output can also be directly generated in the modal, these data are selected to verify the simulation results. The output results of the model and the actual situation are shown in Tables 5 and 6.

Table 5. Output of Simulation Results

No	Time (s)	60	120	180	240	300	360	420	480	540	600
1	Maximum queue length (m)	8	28	39	9	13	21	3	21	8	7
	Stop times	1	3	1	3	2	1	6	3	2	1
2	Maximum queue length (m)	8	35	42	18	22	17	17	15	10	6
	Stop times	1	10	1	9	2	1	15	10	12	9
3	Maximum queue length (m)	13	15	32	15	7	5	12	22	10	1
	Stop times	6	4	5	5	2	8	5	7	1	2

Table 6. Actual Traffic Conditions

No	Time (s)	60	120	180	240	300	360	420	480	540	600
1	Maximum queue length (m)	8	28	39	10	13	22	3	21	8	8
	Stop times	1	3	3	3	2	3	6	3	3	1
2	Maximum queue length (m)	9	35	42	18	23	17	17	16	10	7
	Stop times	1	10	1	11	2	1	15	10	12	9
3	Maximum queue length (m)	18	15	32	15	7	5	12	22	10	1
	Stop times	6	4	7	5	4	8	6	8	1	3

The error is within the acceptable range, so the model can be used for optimization and evaluation.

2.3 Traffic Optimization at Adjacent Intersections

In this paper, we mainly consider the measures of channelization and signal timing to optimize the intersection.

Due to the geographical location of Weibin road and Fengcheng first road and Fengcheng second road, it was found that the geometric linear transformation of the road was not realistic, so we coordinated and controlled the road section by changing the road service facilities.

After sorting out the collected data, it is found that the traffic flow in the north-south direction is larger than that in the east-west direction, especially the number of vehicles going straight. Therefore, we still kept the original position of the road stop line, and changed the left turn lane at the south entrance of Weibin road at the intersection of Fengcheng first road into a straight left lane, and the lane at the intersection of Weibin road and Fengcheng second road at the intersection of Weibin road and Fengcheng second road into the same lane.

By setting the traffic lights at the adjacent intersection with different timing Settings, different control schemes for traffic flow in different time periods can be realized, so as to reduce the queue length and delay rate of vehicles and to relieve traffic pressure and reduce environmental pollution.

3. Result

The maximum queue length is an important reference factor in the design of intersections and the arrangement of traffic lights. To some extent, the stopping times can reflect the traffic operation status of intersections and the comfort of drivers and passengers, as well as the traffic flow delay of intersections. Therefore, the queue length and stopping times are selected to evaluate the optimization results.

According to the corresponding detector, a series of traffic flow characteristic parameter values are obtained through model simulation. In this paper, two methods of "travel time detection" and "node detection" are respectively adopted to conduct statistics on the data. See Tables 7 and 8.

Table 7. "Travel Time Detection" Results

	Delay time (s)	Maximum queue length (m)	Average stop times
Intersection of Weibin road and Fengcheng first road	20.7	35.4	1.54
Intersection of Weibin road and Fengcheng second road	18.5	22	1.37

Table 8. "Node Detection" Results

	Delay time (s)	Maximum queue length (m)	Average stop times
Intersection of Weibin road and Fengcheng first road	19.5	32	1
Intersection of Weibin road and Fengcheng second road	12.3	12	0.98

This experiment shows that, through the intersection canalization and signal timing optimization can improve the traffic condition. Vehicles (operating at a speed within the speed limit) can obtain the right of way between two intersections as continuously as possible, so as to improve the traffic capacity of urban congested sections, reduce vehicle delays and queue time, and environmental pollution caused by vehicle exhaust emissions.

4. Discussion

In this paper, VISSIM modal is used to study the simulation, verification and optimization of two adjacent intersections. It provides effective verification for the solution of the traffic problem in reality. The purpose is to try to get the most effective solution to the problem of road congestion at the least cost. The main deficiency of this paper is that the optimization scheme is not given in detail. The adjacent intersections can only be qualitatively optimized from the aspects of channelization of

intersections and timing of signal lights. In future studies, the efficiency between different optimization schemes can be considered.

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