

STUDY OF THE TIME-COLLOCATION OF SIGNAL LAMP AT INTERSECTION

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ABSTRACT

Nowadays, the traffic problem is increasingly serious, which has become many cities' big concern. This paper studies the microscopic traffic simulation technology home and abroad, mainly introduces the research phase, research content, the achievements as well as the mainstream traffic simulation software. The paper deliberates the affection of roundabout and crossroads for the urban traffic. Firstly, in this paper, the Webster method is quoted to calculate the cycle of signal lamp, and then the time-collocation of signal lamp which is got investigated and surveyed-data are used at the VISSIM to simulate the traffic condition, finally, it is concluded that the traffic volume of crossroads is slight better than the roundabout.

Keywords: Traffic management, Traffic signal control, VISSIM micro simulation, Signal lamp interval time.

1. INTRODUCTION

With China's rapid economic development, people's living standards continue to improve, this convenient and efficient tool for automobile also entered thousands of households, the growing motor vehicle ownership has brought serious traffic problems, people to delay on the road of time is also in constant increase. Fan Ran in the [1] through a variety of simulation software analyzed and compared a variety of simulation software, Two different optimization methods are proposed for the intersection, and the optimization software is used for distribution and combining with the case of Beijing city found the problem. Li Keping pointed out that intergreen interval is the guarantee of signal control intersection traffic flow operation, phase empty traffic flow and the next phase to enter the intersection traffic flow does not occur conflict of the safety time interval, compared countries green light interval calculation method, discusses the factors, and puts forward the guidelines for the calculation of our country green interval duration, concrete calculation method. In [2], the influencing factors is discussed, and the calculating standards of China's green light interval, detailed calculation steps etc are put forward. He design the traffic survey scheme of Taishan Avenue in [3] combined with the actual situation, and has carried on the design of signal phase and signal timing plans, increased its capacity. Research of an intersection in Harbin by Yan Ruixue in [4], was optimized in two aspects of time and space and propose intersection optimization scheme is improved through comparison between the new and old schemes. Luo Meiqing in [5] elaborate the validity of VISSIM software in the practical application in detail, and the combination of Changchun City Gongnong square intersection simulation, which shows the practicability of the Vissim simulation software. The [6] describes the microscopic traffic

simulation is an efficient and safe analysis tool, and it can provide a controllable, repeatable environment research and evaluation performance. In [7] are introduced the use of VISSIM software in detail. In [8] Wang Zhibiao described the traffic simulation model and traffic flow model, analyzes the current research condition of domestic and abroad, and introduced the use of VISSIM software. Ci Yusheng introduces the principle of cellular automata in [9], the establishment of cellular automata simulation model, the influence of the connection point of entrance condition through simulation experiment on the ramp, have certain reference significance. Using the feasible optimized signal distribution scheme in [10], Zou Liang, obtained good results by using Vissim micro simulation model. In the [11], Sun Jian proposed the adjustment of the simulation parameters of Vissim according to the situation of China, and pointed out the parameters of the micro simulation model for improving the aspects of the improvement. Lou Yuexin through the design of two or three phase of the intersection in the [12] to achieve the purpose of traffic guidance. Qian Jun in [13] analysis the conflict types, distribution and control method of urban road intersection, presents the purpose and role of intersection traffic channelization, explains the meaning of intersection signal control and briefly put forward intersection traffic organization and optimization measures. Chen Dashan in [14] through the study of the optimization of signal lamp group with to ease the intersection capacity low, traffic delay too long, after simulation modeling and operation. The results show that optimized traffic delays to the more evident in remission.

This paper consider the impact of the roundabout and crossroads for city traffic. Through the relevant formula and the algorithm and the mentioned above, as the intersection of the configuration is more reasonable timing scheme,

combined with VISSIM simulation software to compare the roundabout and intersection traffic capacity.

2. TRAFFIC THEORY

The Webster method is based on Webster (Webster) estimation of the vehicle delay in intersection, and through the optimization of the cycle length, a series of matching parameters are determined. Including Webster Fa, the principle, the step and the algorithm, is the classical method of signal timing calculation in intersection.

The method of Webster is based on the vehicle delay time minimum as the optimization target, therefore, its core content is to calculate the length of the vehicle delay and the optimal cycle time. Here the cycle length is established on the basis of the calculation of the vehicle delay, it is a more commonly used calculation method in the traffic signal control currently.

The next Formula is the method of Webster:

$$C = \frac{1.5L + 5}{1 - Y} \quad (1)$$

Where C is the optimal period; L is the loss of cycle time, usually taken as 3; Y is the key of car flow ratio summation.

The total loss of time is:

$$L = nl + AR \quad (2)$$

Where l is the loss of time phase signal n is phase number signal. AR is all red cycle in all the time. The traffic flow rate of the intersection is more than Y for the traffic flow ratio of the critical traffic lane, that is, the intersection traffic flow rate is:

$$Y = \sum_{i=1}^n y_i \quad (3)$$

The so-called critical lane, refers to each phase of the signal, the traffic volume of the largest of the lane. The ratio of the traffic flow in the critical lane is equal to the traffic volume and the saturated flow rate of the lane. In fact, by the formula (11-4) to determine the signal cycle length OC after field test investigation found, usually than using other formulas to calculate some short, but still than the actual need to use the cycle to long. Therefore, the actual situation, in order to guarantee the minimum delay, the cycle can be in the range of 1.50C - 0.750C.

It is worth noting that the Webster model is affected by the size of the traffic volume, the use of a limited range of. When the traffic volume is too small, easy to cause the signal cycle if set too short, not conducive to driving safety. Therefore, the need for the lower limit of the specified period, the reference to the west, generally 25 seconds. And when the traffic volume is too large, causing the setup cycle is too long, the vehicle delay time suddenly rapid growth, but will cause traffic congestion. The unsaturated traffic flow is usually the upper bound of the optimal period in 120 seconds. However, the multi-phase signal and saturated traffic flow situation is not often breakthrough the on-line.

Currently widely used signal method is through the following formula.

$$I = Z/U_a + T_s \quad (4)$$

That I is the calculative interval of green light; Z is the distance from the stop line to the conflict point. U_a is the speed of vehicles in the crossing. T_s is the vehicle braking time. When calculating the change interval of $I < 3s$, with the yellow light time of 3S; when $I > 3s$, the 3S with the yellow light, the rest of the time with the red light.

3. EXAMPLE



Figure 1. The layout of Weixing Square

Between using the data from the September 25, 2014 -10 month 25 days, we choose to work on 17:00-18:30 evening peak as the survey period. This paper is mainly use of the VISSIM to simulate the traffic situation, in this simulation, we must investigate data include: 1) lane width and lane number

of satellite square rotary office; 2) lane width and the number of lanes straight office is connected with the satellite square; 3) To set out the traffic flow entrance place; 4) through the turntable models; 5) survey satellite around the Plaza road condition information. Observations were recorded every 5 minutes for a period of time.

Weixing square is located in the Chao yang District of Changchun City, is a standard non priority roundabout traffic hub. The people of the North Main Street, 9 Lane two-way, followed by 3 straight road crossings and 1 straight road crossing and left back into the lane, 5 crossing; the people of Nantong Main Street, 8 Lane two-way, followed by 3 straight road crossings and a straight road and left back into the lane, 4 straight out crossing; West Wexing road, two-way Lane 3 straight road, crossing and 1 straight road crossing and left back into the lane, 3 straight out crossing; East Satellite Road, two-way lane, 3straight road crossing, 3 straight out crossing.

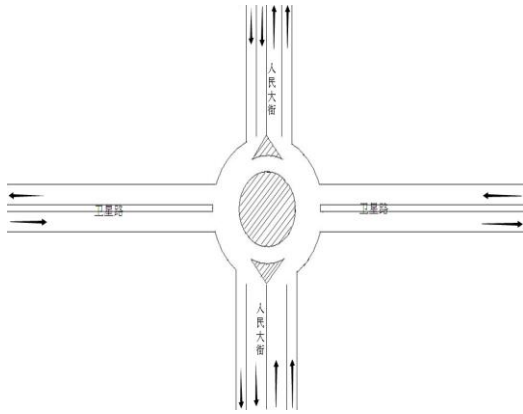


Figure 2. Traffic layout

Table 1. The traffic investigation data

models flow time	Large Vehicle		Mid size Vehicle		Light-Duty Vehicle	
	come	away	come	away	come	away
17:00-17:05	4	10	3	7	114	127
17:05-17:10	5	13	3	8	91	153
17:10-17:15	6	13	0	9	154	137
17:15-17:20	3	8	1	3	71	134
17:20-17:25	4	10	3	5	76	116
17:25-17:30	7	16	1	5	91	137
17:30-17:35	4	18	0	4	85	139
17:35-17:40	7	11	0	6	115	129
17:40-17:45	7	6	1	3	136	112
17:45-17:50	7	4	0	6	72	143
17:50-17:55	4	13	1	12	96	115
17:55-18:00	14	16	0	8	96	143
18:00-18:05	4	12	0	5	109	120
18:05-18:10	7	15	0	0	97	143
18:10-18:15	6	8	0	1	90	143
18:15-18:20	3	7	1	3	60	112
18:20-18:25	2	9	1	3	77	83
18:25-18:30	9	3	0	0	71	88

For now, formula (1) is used frequently to calculate the cycle of signal lamp, in this paper, $L=3$, $Y=0.919$, so it is known that $c=116.96(s)$ which can rough taken as $117(s)$.

To improve the traffic volume of intersection and decrease the queue time during peak time, we can change original roundabout into crossroads which is controlled by a signal lamp, and max the traffic efficiency through regulating the phase and cycle of signal lamp.

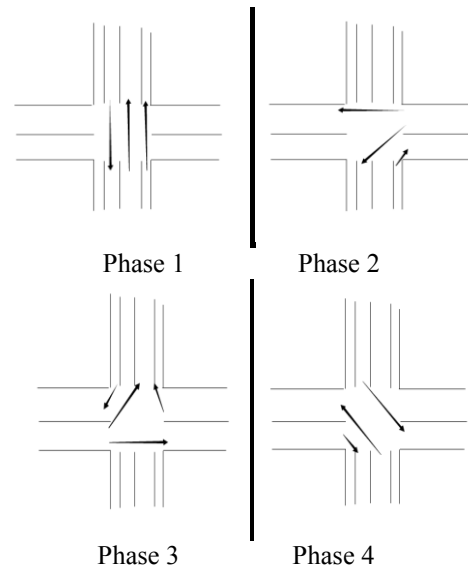


Figure 3. Phase

There are many kinds of urban micro traffic simulation software.

1. PARAMICS Simulation software

SAIS began developing the Paramics software in 1986, and the parallel computing center of University of Edinburgh has contributed to the development of the software. From 1998, SAIS and Quadstone Company developed a different PARAMICS version, by 2012, the latest version of PARAMICS Discovery is PARAMICS 5. At present, PARAMICS is widely used in transportation network simulation of Europe, Australia and the United States. PARAMICS can carry on the microscopic processing to the single vehicle, supports multi-user parallel computing, the user interface is dynamic three-dimensional, and has many interfaces, can expand the application. PARAMICS is powerful, and can simulate a variety of network models from individual nodes to the national scale. PARAMICS can be used in the Windows or Unix operating system, and can be used as the hardware platform of PC or SUN workstation.

PARAMICS has major modules:

1) Browser: provides visual interface, through the interface, Use its main module and various maintenance functions.

2) Edit/simulation/visualization device: is it the main interface, used to create, edit, and operation model, and model of the vehicle can be observed, can satisfy the need of network traffic statistics are generated.

3) Batch operation module: it can generate the statistics data of the traffic status rapidly, but can't exercise the editing and visual function.

4) matrix estimation: can enter the following three kinds of data, path information obtained from the existing models, the second is initial matrix derived from the observed data, three is constructed from the side of the road vehicle counter survey data. We can then generate traffic volume of matrix which is consistent with the above three data items, and can also carry out the sensitivity test to determine the reliability of the survey data.

5) Data analysis tools: the analysis of the statistical results, in the form of graphics or table.

6) Economic analysis module: part of data analysis tools.

7) The batch processor: it can let a multi computer in a network run the module simultaneously, and deal with a lot of running results.

8) Advanced control interface: can use adaptive signal to control, and can connect directly with the intelligent transportation system.

The salient features of the model:

- 1) High speed micro simulator can real-time simulation is made for the hundreds of thousands of vehicles without loss of the details;
- 2) Fully integrated software;
- 3) Has strong portability and scalability;
- 4) Macro data format to provide direct interface
- 5) To achieve intelligent path selection;
- 6) Visualization interactive application environment [1].

2. INTEGRATION Simulation software

In the middle of the twentieth Century 80's, Van Aerde Michel, a professor at the Queen's University, developed the INTEGRATION model. Model integration is considered to be quasi microscopic model, also known as mesoscopic simulation model, because this model of mixed bicycle and the macroscopic traffic flow model and combining the macroscopic traffic parameters and microscopic traffic parameters. The core of the model is the car following model and traffic flow model, including dynamic traffic assignment module, model parameter calibration module, traffic distribution module, signal module, smashing into the control module, an information acquisition module. Integration has been widely used in traffic management, the application mainly include the following aspects:

- 1) Road network traffic flow analysis
- 2) Analysis of the effects of large-scale activities, traffic accident
- 3) Traffic information guidance simulation, for the driver provides information induced services
- 4) Realize the freeway on ramp control, assessment (not) parking fees and other
- 5) The analysis of operating characteristics of the signal control, and signal timing are optimized
- 6) Achieve traffic information collection at the same time, integration also has some defects: mainly manifested in poor user interface friendly, and operation characteristics of intersection traffic description than microscopic simulation model of rough [1].

3. VISSIM Simulation software

VISSIM microscopic traffic simulation software is a German company PTV products, it is a micro simulation modeling tools which can reflect the lane in the model establishment, traffic, traffic signal transformation scheme and bus stations, pedestrian on a variety of realistic traffic conditions, simulation, and evaluated the current situation of the urban traffic simulation. It is an effective tool for the evaluation of traffic engineering design. At the same time, it can also put forward the effective city planning scheme.



Figure 4. The simulation of round

The scope of application of VISSIM microscopic traffic simulation mainly includes the following aspects:

- 1) The bus priority signal control logic design and evaluation
- 2) the feasibility and effect of urban road network construction of the light rail project evaluation
- 3) Weaving area traffic analysis
- 4) Traffic design scheme than the bisection evolution
- 5) Complex layout light rail and bus site traffic impact analysis
- 6) Using the built-in dynamic traffic assignment model to solve the issues related to the route choice problem [1].



Figure 5. The simulation of round

It is found that the simulation software of VISSIM microscopic traffic simulation is suitable for our research, so we use VISSIM to carry on the following research.

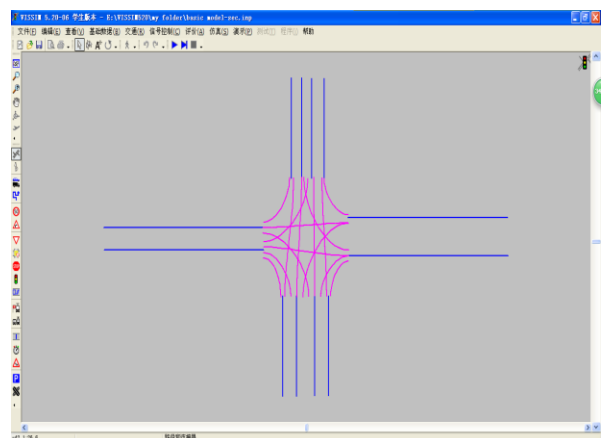


Figure 6. The simulation of intersection

After getting the intersection cycle, phase and the signal distribution scheme of the corresponding phase, we use simulation by VISSIM simulation software to establish the simulation model of intersection and round, and import the

survey data into the simulation model which can obtain the results shown in the following table.

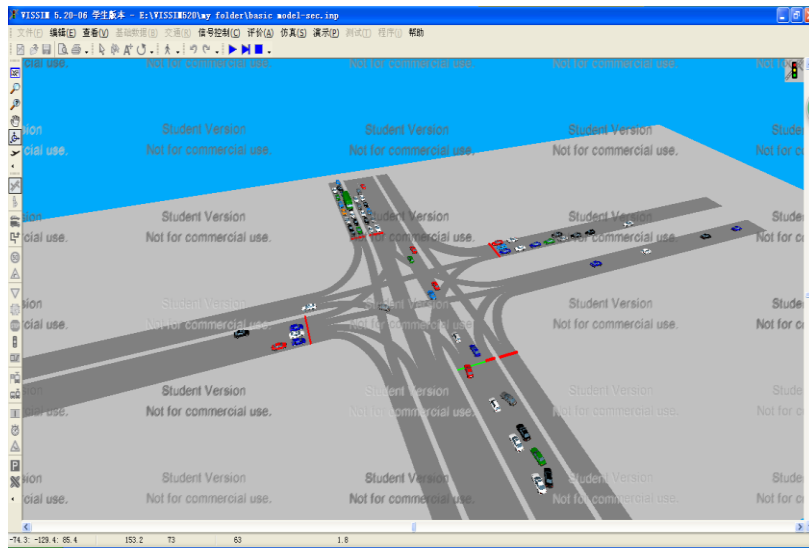


Figure 7. The simulation of intersection

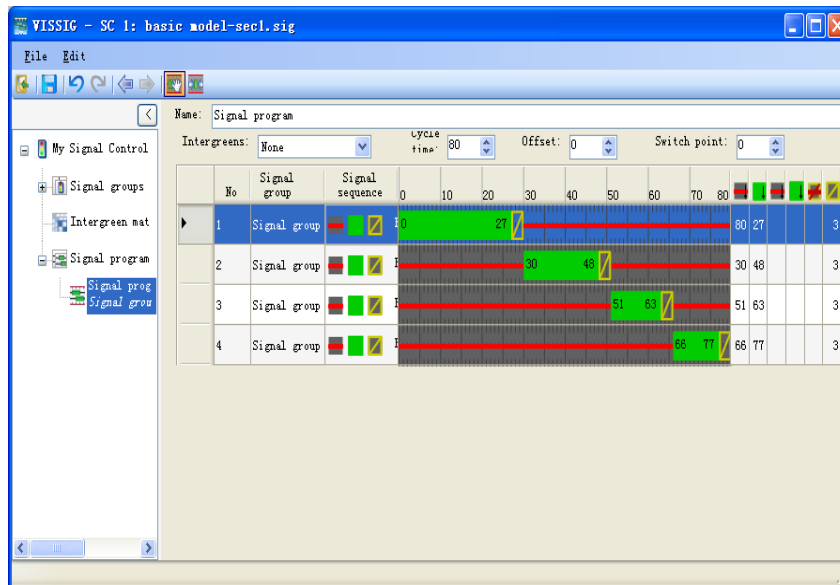
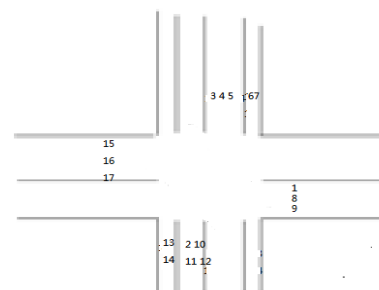


Figure 8. Timing scheme

Table 2. The data detector operating results

Flow Type	Sections	
	round	intersection
1.8.9	107	126
3.4.5	99	119
6.7	136	155
15.16.17	121	143
2.10.11.12	37	45
13.14	41	61

During 0~300(s), the traffic volume at truncation surface (detect data section) is 126.



Take an example like right of the straight road, it is consist of 3 lanes which are cataloged as 1, 8, 9 by the VISSIM.

Figure 9. Crossroads and section map

Through the simulation, it can generate the corresponding file to reflect the data detector, time and queue length detector's condition in the VISSIM project folder respectively. The data detector is used in this paper to evaluate the traffic volume of that intersection. It can be concluded from the consequence that the traffic volume of crossroads is higher than roundabout at the same section and time.

4. CONCLUSION

This paper through on-the-spot investigation, survey data, simulation, simulation around the island for the crossroads, and the of optimal allocation, optimization of intersection traffic capacity, by making use of the VISSIM simulation software, satellite square roundabout and intersection of two in contrast, obtained according to the conclusion of the traffic capacity of the intersection of Changchun City, the satellite Square during the evening rush hour traffic capacity than around the island, planning for the future urban development in the road has a certain reference value. But this study only for the late peak hours, did not study the passage of the whole day, the future research will be more comprehensive on this basis.

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