ISSN 2349-4506
Impact Factor: 2.265

Global Journal of Engineering Science and Research Management

AN IMPROVED TRAFFIC LIGHT PHASE PARTITIONING METHOD BASE ON TRAFFIC FLOW

QIAN LI, YONGHENG WANG*, LIN LI, LAN KUANG
College of Computer Science and Electronic Engineering, Hunan University, Changsha, China
E-mail: wyh@hnu.edu.cn

KEYWORDS: phase division, SUMO, traffic simulation.

ABSTRACT

As time goes on, the traffic flow also has a corresponding change and it may be asymmetry, which would greatly decrease the traffic efficiency. In order to improve the traffic efficiency, alleviate traffic pressure and save transport cost, we hope that the traffic light can play a similar role as a traffic police man to make real-time decisions according to the dynamic environment of traffic. So in this paper, we proposal a variable phase partitioning algorithm according to the real-time situation of traffic flow. To verify the validity of the algorithm, this paper build a multi-agent intelligent traffic simulation platform by using the microscopic traffic simulation tool SUMO and multi-agent intelligent simulation framework JADE. Our approach can effectively reduce the traffic delay which was proved by experiments in the paper.

INTRODUCTION

With the rapid development of social economy and the rising of people's living standard, our demand for public transport facilities is growing. Although increasing and improving the traffic facilities constantly, we seem a bit out of puff in front of the fast-growing demand. In order to alleviate traffic pressure and improve traffic conditions, there is an urgent need to meet peoples' demand by using the advanced science and technology, combining with current traffic characteristics fully. Traffic signal lamp for the meaning of the traffic network is just like our heart for life. Reasonable design of traffic lights can make the traffic more smoothly and has the profound significance for improving the environment, saving energy and promoting economy. The studies of traffic lights mainly divided into three categories according to the research direction. The first is the research phase partitioning method[1][2], the second is about the phase sequence alignment[3] and last is the phase distribution[4], while the part of the third kind is the most studied. In this paper, a kind of variable phase transportation method is proposed according to the previous traditional traffic phase partitioning method, which achieved the aim of improving the efficiency of traffic.

The phase is partitioned and set based on historical traffic flow data, which is immutable in operation process of traffic lights, lacking of real time. Actually, the traffic flow changes over time. Therefore, this paper proposed a real-

This work is supported by the National Natural Science Foundation of China (No.61371116).

ISSN 2349-4506
Impact Factor: 2.265

Global Journal of Engineering Science and Research Management

time decision method according to the traffic flow in real time on the basis of the previous research method, so as to shorten the vehicle delay, improve the transportation efficiency and alleviate traffic congestion.
This paper will put forward a design method of traffic signal phase, give test results and finally obtain the test result, which proved the validity and practicability of the method.

PHASE DESIGN METHODS

Phase, also known as signal phase, that is, in a signal cycle, at the same time obtain the passage of one or more of the traffic flow signals[5].Because Intersections are varied, phase partitioning method is also different form, which Mainly includes two phase, three phase and four phase, six phase and so on. But no matter which kind of phase division almost on the premise of security, this paper studied the phase partition method for the most common intersection (as shown in figure 1), namely four phase partitioning method. In this case, according to the direction of the vehicle ,we detailedly divided into 16, as shown in figure 2, in which a, g, l, m on behalf of the right and b, f, k, n for straight, c, e, j, o represents turn left, d, h, I, p on behalf of turn around, because in most cases, the right of the vehicle is not controlled by traffic lights, in most cases, the turning lane and turn left or go straight to share, so in our study, we only consider go straight and turn left, Regardless of the pedestrian crossing pedestrian crossing.

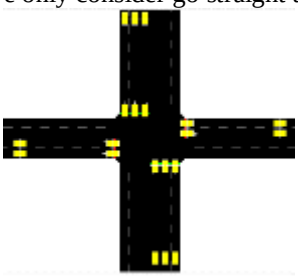

Fig.1 common intersection of we study

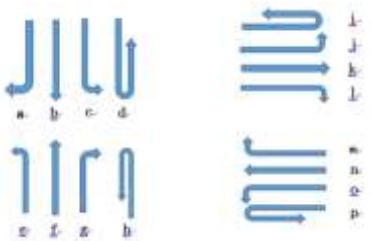

Fig.2 all traffic flow directions

Traditional phase partitioning methods

Traditional four phase partitioning have two methods [6], one is single release method(as shown in figure 3), the other is given symmetric release method(as shown in figure 4), [7] After comparing the performance of the two Intersection signal phase design by model and example, we can get the separate import release method to set straight left share lanes and can maximum limit equilibrium, the utilization rate of the flow to the lane, traffic saturation and delays. However, the total traffic capacity of intersection is small, saturation and delay is large relatively.

ISSN 2349-4506
Impact Factor: 2.265

Global Journal of Engineering Science and Research Management

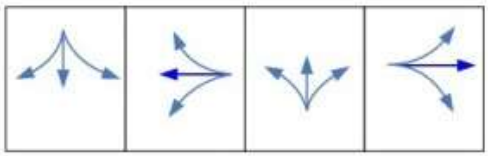

Fig.3 The single release method

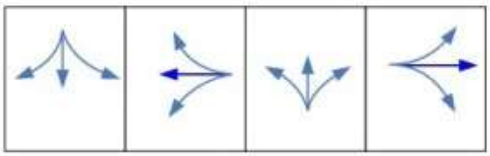

Fig.4 the symmetric release method

The two phase partitioning design have advantages and disadvantages [1]. The proposed symmetry flow is based on the principle of flow balance to propose, which is based on the principles of "phase saturation" to distribute. When the traffic flow saturation is uneven in the same phase, the key traffic flow need a long passage of time, other traffic flow may have been released, which wastes the passage of time. Stand-up release phase form sets a phase separately for each import, and this form can realize the balance of traffic flow in every lane of each import (i.e., each flow in the phase), but in many cases, direct import direction left or right turn traffic flow is uneven, it will bring huge waste to use this form design phase, and its continuity is poorer, the driver is difficult to adapt to the changes in phase.

Phase Design Principles

The basic principle of phase design of intersection signal is proposed in the literature[8~12], summarized as follows:

a) The principle of safety. Safety is always the primary principle of transportation planning and design. Different traffic flows between the internal phases may conflict, so making the conflict as little as possible in the design process, such as non-conflicting traffic streams can be in the same phase release and conflicting traffic exile in different phase of release, is our goal.
b) The principle of continuity. A flow in a cycle can only get a release of the opportunity and all the flows of traffic is only released once at the end of a cycle.
c) The principle of efficiency. The designing of phase is to improve the intersection of time and space resource utilization. Too much phase can lead to the increase of phase switching, which is the increase of the time of loss, reducing the traffic capacity and traffic efficiency. Conversely, too little of the phase will also reduce efficiency due to the intersection confusion.
d) The principle of balance. The principle of balance is to ask the traffic lights to consider the traffic flow to each, to take into account in all directions of traffic and ensure that the rate of the flow between the internal phase in all directions is not large, in order not to waste green time.
e) The principle of customary. Phase division should meet the driving habits and easy to understand for the drivers.

Variable Phase Partitioning Algorithm

In this paper, the main idea is based on the traffic flow to achieve the real-time division of the phase, and use the classic signal timing method. First some conventions should be made before describing the algorithm process.

ISSN 2349-4506
Impact Factor: 2.265

Global Journal of Engineering Science and Research Management

According to the traditional phase partitioning methods, each traffic flow in one direction has one flow in the same direction and another one in the opposite direction. Suppose one traffic flow in a certain direction is L, then the same direction traffic flow is Ls and the opposite direction traffic flow is Ld. For example, the same direction traffic flow of the traffic flow from east to west is from east to south and the opposite direction is from west to east. The traffic flow is marked by the letter X. In order to keep the balance principle, in every phase period, each of all direction traffic flow is released only once. In order to keep safety principle, the yellow light waiting time is set after every phase, and this time in accordance with the general settings of this time. The flow chart of the phase partitioning method is shown in figure five:

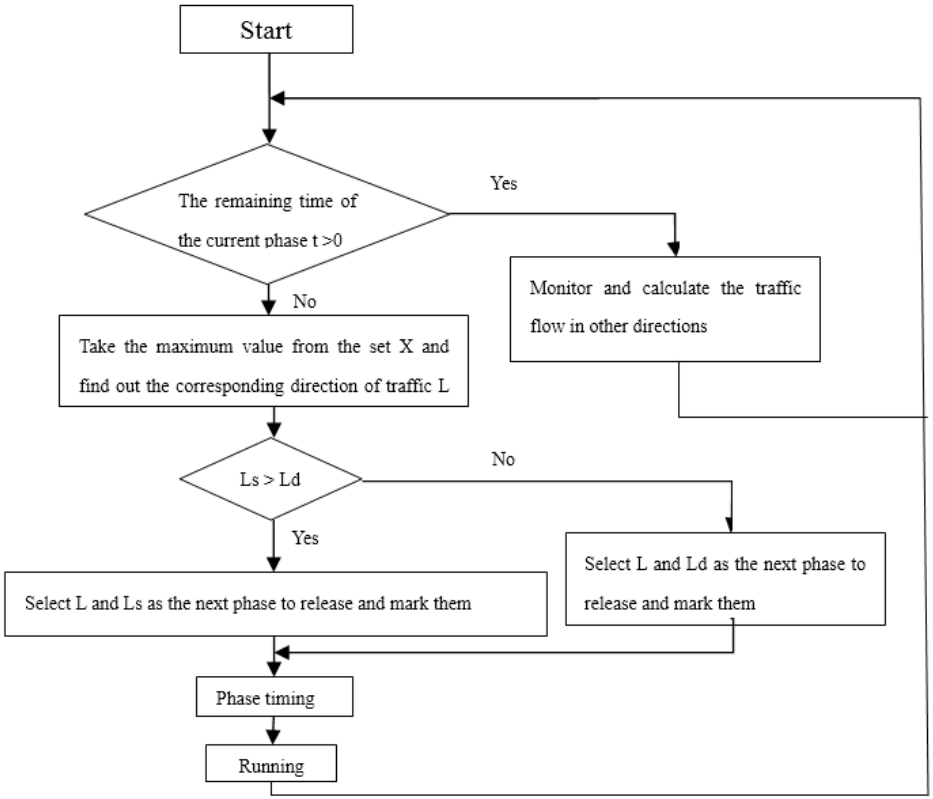

Fig.5 Algorithm flow chart

Algorithm description:

a) During the operation of the N phase cycle, the vehicle flow directions which is not released in current phase

ISSN 2349-4506
Impact Factor: 2.265

Global Journal of Engineering Science and Research Management

cycle are monitored and recorded as X_1, X_2, X_3... X_M (m is the name of vehicle flow directions which are not released in current phase).The remaining release time of current phase is t. If t>0, update the traffic information set X, otherwise perform the next step.

b) Calculating the maximum value of set X, finding the corresponding traffic flow direction L, and then comparing Ls and Ld. If Ls>Ld, L and Ls are marked. If Ls<Ld, L and Ld are marked. These traffic flow directions marked will be released in the next phase.
c) Before the end of the yellow light, the next phase timing is calculated using classical phase matching method;
d) Releasing the vehicles in the directions with tag in the step c);
e) Repeating step a) before the end of this phase cycle.

EXPERIMENT

In order to verify the validity and practicability of the method proposed in this paper. We use microscopic traffic simulation tool SUMO, intelligent simulation framework JADE of multi Agent to build a multi Agent intelligent transportation simulation platform.

System Framework

The framework is shown as figure six in the following:

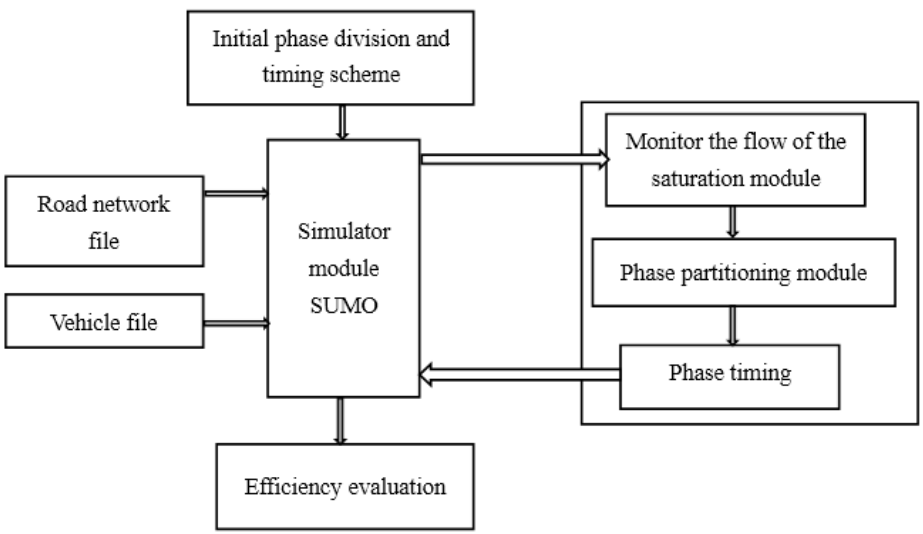

Fig.6 system framework

ISSN 2349-4506
Impact Factor: 2.265

Global Journal of Engineering Science and Research Management

As shown in the figure above, the traffic lights control is divided into two main modules. One is the simulation modules, which uses the simulation tool -SUMO to perform the simulation. SUMO read and run the configuration files. In the initial configuration of traffic lights, we use the following chapters that introduce the phase division and timing method configure traffic light. Because in the process of simulation, the arrival of the vehicle is random, the initial phase of the division and the timing of the change with time, may not be optimal. At this time we need to make appropriate adjustments to reduce the vehicle delay and improve the pass rate of the intersection. And this monitoring and task of adjustment is done by the Agent in the JADE module. When the current phase division of simulation caused some jam, mainly through the calculation of the direction of the flow of saturation to judge, then Agent will use the phase division module and phase distribution module to re phase division and timing and slow the current traffic jam.

The Simulation Results Evaluation

The results of the experiment are shown in Table 1：

Table 1. The results of the experiment

Evaluation index	Single release	Dynamic phase allocation plan
Average vehicle delay	63. 717	62. 284
The average frequency of vehicle parking	1. 006	1. 012
Average speed	10. 282	11. 352
The average parking delay	53. 192	52. 256
The total delay time	14. 566	13. 475
The total stop delay time	12. 160	11. 553
Total travel time	23. 745	22. 453

The results and discussion may be combined into a common section or obtainable separately. They may also be broken into subsets with short, revealing captions.

CONCLUSION

One important reason for the city's traffic jam is that the design of intersection traffic lights control is not reasonable, and the system design offered by this article is a control scheme based on traffic flow can improve the utilization of resources to some extent; Eliminating the phenomenon that in the direction of the red light vehicles queued up to fail, and only a few vehicles in the green light direction; reducing the waste of road resources caused by traffic light

ISSN 2349-4506
Impact Factor: 2.265

which adopting a fixed phase partitioning method; reducing the energy consumption and exhaust emissions as well as noise pollution caused by the traffic congestion. It shortened the average waiting time and improve the efficiency of people's travelling, and created the intangible wealth for the society[13].

ACKNOWLEDGEMENTS

This work is supported by the National Natural Science Foundation of China (No.61371116)
The authors are very thankful to Director Wang for laboratory facilities.

REFERENCES

1. Leiyuan Zhang, Aibing Shu, "A Practical Method of Road Intersection Signal Phase Design". The Seventh Annual Conference of China Intelligent Transportation: Intelligent Transportation Technology. 2012.
2. Liang Zhang, Cunbao Zhang. "Research on Signal Phase Design Method of Flow Asymmetry 'Ten'".The Second National Symposium on Intelligent Transportation and Artificial Intelligence. 2008:77-80.
3. Lunhui Xu, Rankun Liao. "The Optimization of Intersection Traffic Flow Path Based on Phase Sequence". Journal of Guangxi Normal University: Natural Science Edition, 2010, 28(3):5-9.
4. Jiniin Shao, Feng Chen, Xinxin Sun,et.al, "ptimization Design of Multi-Phase Inductive Control Plan" Application of Computer System, 2011, 20(1):48-51.
5. China Building Industry Press. "CJJ/T119-2008 Standard Terminology of City Public Traffic Engineering".2008.
6. WEBSTER F V. Traffic Signal Settings, Road Research Technical Paper, No.39. London: HMSO，1958.
7. Haijun Zhang, Xiaoguang Yang, Yu Zhang. "Comparison of Two Methods for Signal Phase Design of Intersection". Traffic Information and Security, 2005, 23(1):3-7.
8. Federal Highway Administration.2008. "Traffic Signal Timing Manual (TSTM)2008".Department of Transportation,Washington DC,U.S.,2008
9. [Germany] Institute of Road and Traffic Engineering."Guidelines for Traffic Signal Control - Current Specifications in Germany".2006.
10. [Japan] Institute of Road and Traffic Engineering."Planning and Designing of Plane Intersection". 1988
11. Yunfeng Gao,Hongjie Chen. "Research on Phase Optimization of Signalized Intersections". Proceedings of the third annual conference of China Intelligent Transportation.2007:929-932
12. Hongbin Yin, Jianmin Xu. "Road Traffic Control Technology". South China University of Technology press.2000.
13. Wei Zhang, Dai yuan ZHANG. "Traffic Light Control System Design Based on Traffic Flow". COMPUTE TECHNOLOGY AND DEVELOPMENT, 2015(5):196-199.