Research on Intersection Phase Timing Method Based on Interval Detection Data

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Abstract: The traditional traffic detector can only obtain detection data of the section, but the current traffic detection technology provides a better data application environment for the control of traffic signal. Based on these interval detection data, a new traffic state expression method and a new intersection phase timing method based on interval detection data are proposed. A number of experiments show that the intersections phase timing method based on interval detection data can better reduce the delay of vehicles at intersections and reduce the traffic jam at the entrance direction, and thus significantly improving the level of traffic service at intersections.

Introduction: The research on traffic signal timing has always been an important research topic in the field of urban traffic engineering. Compared with unsaturated traffic, supersaturated traffic flow is characterized with the complexity and uniqueness. How to solve the problem of supersaturated traffic control in morning and evening rush hours in cities is a hot topic in the research field of traffic signal control.

1. Different Approaches to Cross Signal Ports

1.1 Different Viewpoints on Signal Control at Intersections

In the initial study, Li Ruimin (2015) [8] et al. took the minimum delay as the optimization goal of supersaturation. Due to the complexity of supersaturated traffic flow at intersections, researchers began to implement multi-objective optimization control for supersaturated intersections. Talmor[11] (2007) increased the maximum traffic capacity for the optimization goal of supersaturated intersection. Lertworawanich (2011) [7] proposed an optimal control method based on the goals of anti-overflow control at intersections, balanced import release delay and maximum traffic capacity. Wang Li et al. (2016) [12] divided intersection control states according to the controllability of traffic flow release at intersections, and adopted different control strategies for different states. Campbell(2014)[1] made studies and analysis on the three causes of supersaturated conditions at intersections and found that supersaturated intersections are characterized with distinct laws of queue accumulation and dissipation. Therefore, the management of queues at intersections has become an important goal of traffic signal control at supersaturated intersections. Qi Chi et al. (2012)[9], Hao Jiangen (2013)[4] and Hu Peng (2016)[5] dynamically adjusted the time of green traffic light of each phase in real time according to the control idea of queue length balance. Considering vehicle detection, arrival and departure, FC Fang(2010)[3] established a traffic signal control algorithm based on queue length and queue storage.

1.2 Different Modeling Methods of Signal Control at Intersections

Xiang Weiming et al. (2014)[13] analyzed the stability and bounded property of signalized intersections using Lyapunov function method, and established a hybrid control strategy suitable for susaturation signalized intersections with the goal of reducing the number of queued vehicles.Sun Weili(2016)[10] proposed a Quasi-optimal feedback control strategy based on queuing. The

supersaturation period was divided into queuing period and dissipation period to constrain queuing. In recent years, the development of software computing base and artificial intelligence technology provides more technical support for signal control at supersaturated intersections. Lee(2005)[6] proposed a real-time adaptive control method for traffic signals of the technical time Kanto window. Royani used the fuzzy neural network technology to estimate intersection signal control and apply genetic algorithm to adjust model parameters. Abbas(2015)[2] proposed a traffic signal control system based on fuzzy rules. Lertworawanich(2011)[7] proposed a closed fuzzy control method based on multi-level artificial intelligence technology.

2. Interval Detection Data

2.1 Interval Data and Detection Data

The interval data is completely different from the section detection data. The interval detection data can be used to analyze the vehicle movement characteristics within the detection interval to obtain the detection data representing the traffic operation characteristics of the interval.Taking millimeter wave radar detection as an example, generally, millimeter wave radar is installed on the signal light pole with the detection range covering a distance of 350 meters upstream from the signal light pole and 8 driving lanes and tracing 256 vehicles at the same time to the greatest extent.

3. Description of Traffic State at Intersections Based On Interval Detection Data

3.1 A Saturated Intersection Signal

A key problem in the study of signal timing method for supersaturated intersections is how to accurately describe the supersaturated traffic state. Many existing studies were conducted to use vehicle queuing to express the oversaturated traffic state, but the queue length fails to express the undersaturated traffic state. Therefore, at present, descriptive models for most of the traffic state are relatively complex, or can not cover all the traffic state.

3.2Basic Parameters of Flow, Speed and Density

Flow, speed and density are three basic parameters of traffic flow. Since density is more difficult to be obtained compared with detection, occupancy rate can be used to replace density. Flow and occupancy rates are used to describe the release situation of the vehicles of section, that is, the traffic supply situation. The vehicle speed in an interval at the upstream direction of the section can reflect the traffic demand of the upstream section. Traffic state is the result of the interaction between traffic demand and traffic supply.

4. Calculation Method of Phase Timing at Intersection

4.1 The Essence of Calculation of Intersection Phase Time

The essence of calculation of phase time at intersections is to allocate the traffic supply capacity at intersection according to the traffic flow demand so as to reach the traffic release equilibrium as far as possible. When the channelization conditions at intersections remain unchanged, the distribution of the traffic supply capacity at intersections is to allocate the signal period according to the phase, so as to make the traffic operation of all phases balanced. Therefore, the calculation of phase time at intersections includes two processes. The first process is to calculate the signal period at the intersection, and the second process is to allocate the signal period at the intersection according to the traffic state of the phase. In each calculation process, constraints for intersection set by manual experience should be satisfied, including maximum period, minimum period, minimum time of each phase and maximum time of each phase at the intersection. These constraints will be applied in the above two steps to ensure that the calculation results of signal timing at intersection meet the manual requirements.

4.2The Relation Curve Of Traffic State Level and Period

The corresponding relationship of the curve between the traffic status level and the cycle generally refers to that if the difference between a certain traffic status and the cycle boundary of the next level and the next level is smaller, and when the intersection is within the range of the traffic status of this level, the period change of the signal is less sensitive to the change of traffic state, that is, the more stable state of the signal cycle at the intersection is more suitable for flat peak or low peak traffic state, otherwise, it is suitable for peak traffic state.

5. Conclusion

5.1 Interval Detection Data and Control of Traffic Signal

The interval detection data makes many assumptions and formulas in modeling for traffic signal control simple and even these assumptions and formulas can be omitted. However, interval detection data also contain a lot of other information, such as vehicle acceleration and queue length, which have not been applied in the research. The next step of the research of this paper is to simplify the modeling and calculation process of traffic signal control and improve the practical application ability of adaptive traffic signal control and the comprehensive optimization ability in supersaturated traffic state.

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