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Transportation Research Procedia 25 (2017) 1213–1226

Transportation Research Procedia

www.elsevier.com/locate/procedia

World Conference on Transport Research - WCTR 2016 Shanghai. 10-15 July 2016

Prediction of arrival flow profile of transit stream on link

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Abstract

It is essential in coordinated control to analyses the relationship of vehicular stream between upstream and downstream on arterial, and the arrival flow profile of section is a useful tool to describe the relationship. The arrival flow profile of transit stream is variable because of lower speed and stopping service. The objective of this paper is analyzing the relationship and characteristic of the transit stream, and predicting the arrival flow profile of transit stream on link. According the road conditions, some critical sections on arterial were defined. Simulation detected data were collected, the arriving vehicles at different signal periods were summarized and counted according to the smaller intervals, and the arrival flow profiles on critical sections were drawn. The impact of arrival flow profile by segment dispersion and stopping service was analyzed. On the basis of the speed cumulative probability distribution, transfer matrix which considers segment dispersion was built. The postpone time of transit vehicle was computed with Monte Carlo numerical simulation method. On the basis of postpone time cumulative frequency curve, postpone transition rate of interval was obtained by shifting the curve and calculating the areas, and the transfer matrix which considers stopping service was built. The arrival flow rate of upstream section multiplied by the transfer matrix made the arrival flow rate of downstream section on link. The results show that Monte Carlo numerical simulation method is feasible, and the relative error of predicted distribution of arrival flow rate is small. The prediction methods of arrival flow rate based on transfer matrix is effective.

Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.

Keywords: arrival flow profile; segment dispersion; bus stopping service; transfer matrix

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Peer-review under responsibility of WORLD CONFERENCE ON TRANSPORT RESEARCH SOCIETY.
10.1016/j.trpro.2017.05.139

1. Introduction

In China's large cities, public transit is a major way of facilitating citizens' activities. Transit flow has its unique operation law in arterial traffic lines. The transit flow moves in platoons in the case of no bus stops on roads; on the other hand, the impacts of bus stops on the road on the platoons are considered.

Arterial coordinated control refers to setting up reasonable traffic signal control parameters in arterial to make vehicles go through many intersections without stopping. Buses operating in arterial need to stop to provide services for passengers to boarding and alighting, which makes buses fail to use the coordinated green wave. A lack of coordination between arterial coordinated and priority bus signals.

Few systematic analyses and predictions are made on arterial vehicle operation flow in arterial coordinated control; in bus operations, current predictions on link travel time and bus stopping time are mostly set to enhance service or management of the public transit system, few are involved in the analyses and predictions on signal control.

Robertson (1969) originally developed platoon dispersion model, it is based on the division of the signal cycle into an integer number of intervals, each with an equal duration, called time steps or interval. The platoon arrival time is based on the "vertical stacking" of any queued vehicles that may exist at the downstream intersection. Soon after that time, the TRANSYT model was first developed by the UK's Transport Research Laboratory (TRL). Shepherd (1994) provides a good review of the detailed features of many of these systems. Nevertheless, despite this competition, TRANSYT is still very widely used.

Yu (2000) presented a calibration technique for platoon dispersion parameters for the widely used TRANSYT platoon dispersion model. Farzaneh (2004) developed a procedure that overcomes this limitation by adjusting the average travel time in the model in order to control the value of travel time factor indirectly. Furthermore, the paper presented numerical examples in order to provide a preliminary investigation of different calibration procedures of the recurrence relationship.

Rakha et al. (2006) improved upon the TRANSYT-7F platoon dispersion model, particularly for time steps greater than 1s in duration, and develops three generalized platoon dispersion models that explicitly account for the effect of the time step duration on traffic dispersion.

The conventional platoon dispersion model in TRANSYT had the well-known weakness of treating queues as if they stacked vertically at the stop-line. The latest TRANSYT offered an alternative form of traffic model, the cell transmission model. Mahera (2010) investigated the sensitivity of the resulting optimal signal timings to the choice of traffic model, through application of TRANSYT-13 to a 6-arm signalized motorway roundabout. Bonneson et al. (2010) described the development of a procedure for predicting the arrival flow profile for an intersection approach. They research indicated that platoon decay tends to have a more significant impact on the arrival flow profile than platoon dispersion.

In existing research, bus traffic flow is not fully considered in vehicle arrival distribution, and is not especially deep on bus stopping. In order to fully understand operations of artery bus traffic flow and prepare for public transit priority under later arterial coordination backgrounds, the paper takes dis-congested traffic flow as research backgrounds, takes artery bus traffic flow as research objects, and puts forward distribution prediction methods of bus arrival flow profile based on transfer matrix.

2. Methodology

Set up detectors in critical sections of each artery segment, collect time information of vehicles passing by critical sections, and summarize data of multiple periods to draw sketches of vehicle arrival flow profile in the sections.

Critical sections refer to possible changes to positions of vehicle arrival distribution on artery. In view of bus traffic flow, bus stops on the artery may change arrival distribution of the bus traffic flow. Define the critical sections at distances between the upstream and downstream of bus stops as shown in Figure 1.