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Editorial

Editors' notes: Special issue on innovative intersection design and control for serving multimodal transport users

To achieve a balanced service for various transport modes, numerous innovative intersection designs and relevant traffic controls have been implemented or are in the research stage. Such design and control alternatives are mostly tailored to serving unique traffic flow characteristics prevailing in different parts of the world. For example, in North America, intersection design and control still mainly focus on serving the automobile mode, although future policies are geared toward multimodal-based services. In some other countries, however, non-automobile transport modes are equally dominant, including pedestrians, bicycles, motorcycles, and public transit. As a result, special design and control strategies have been invented and implemented to best serve these transport modes.

The call for papers for a special issue was first initiated as part of the 14th World Conference on Transport Research which was held in Shanghai, China on July 10-15, 2016 and was sponsored by the World Conference on Transport Research Society (WCTRS). However, the papers included in this special issue also include those submitted independently to the conference. Organized as a virtual special issue, a total of five research papers were finally published along with other regularly reviewed papers in different volumes/issues of the journal of Transportation Research Part C. These papers particularly focus on international perspectives on innovative intersection design and control for serving various transport modes. Each paper addresses some unconventional design and control strategies for achieving safe and efficient traffic operations. Highlights of the research methodologies and results included in each paper are provided next.

Yang and Cheng (published in Volume 74) in the paper "Development of Signal Optimization Models for Asymmetric Two-Leg Continuous Flow Intersections" studied a special type Continuous Flow Intersection (CFI) called asymmetric two-leg CFI, which is more common in practice. The operational features of asymmetric CFI were analyzed, followed by the development of two optimization models for its signal design. The first proposed model followed a two-step process, which determined the common cycle length, phase design and sequence, and green split in the first step and optimized intersection offset in the second step. To benefit both intersection operational efficiency and signal progression with optimizing phase design and sequence, the second proposed model further took the Mixed-Integer-Linear-Programming (MILP) technique to concurrently optimize all signal control variables, using an objective function of maximizing CFI capacity and progression efficiency. With an extensive case study on a field site in Maryland, USA, the simulation results revealed that the proposed models can effectively provide signal progression to both heavy through and turning flows and prevent the potential queue spillover on the short turning bays.

Truong et al. (published in Volume 74) in the paper "Analytical and Simulation Approaches to Understand Combined Effects of Transit Signal Priority and Road-space Priority Measures" studied how transit signal priority (TSP) may be combined with road-space priority (RSP) measures to increase its effectiveness. Previous studies have investigated the combination of TSP and RSP measures, such as TSP with dedicated bus lanes (DBLs) and TSP with queue jump lanes (QJLs). However, in these studies, combined effects were usually not compared with separate effects of each measure. In addition, there were no comprehensive studies dedicated to understanding the combined effects of TSP and RSP measures. It remained unclear whether combining TSP and RSP measures creates an additive effect where the combined effect of TSP and RSP measures is equal to the sum of their separate effects. The existence of such an additive effect would suggest considerable benefits from combining TSP and RSP measures. This paper explored combined effects of TSP and RSP measures, including TSP with DBLs and TSP with QJLs. Analytical results based on time-space diagrams indicated that at an intersection level, the combined effects on bus delay were smaller than the additive effect if there was no nearside bus stop and the traffic condition in the base case was under-saturated or near-saturated. Otherwise, the combined effect on bus delay at an intersection level could be better than the additive effect, depending on bus arrival patterns. In addition, analytical results suggested

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that at an arterial level, the combined effect on bus delay could be better than the additive effect with certain signal offset settings. These results were confirmed by a micro-simulation case study. Combined effects on the main approach and side-street traffic delays were also discussed.

Kamineni and He (published in Volume 71) in the paper "Traffic Signal Control with Partial Grade Separation for Oversaturated Conditions" addressed how grade separation at signalized intersections can overcome the challenges from intersection oversaturation. A lane-based optimization model was developed for the integrated design of grade-separated lanes (e.g. tunnels), lane markings (e.g. left turns, through traffic, right turns, etc.) and signal timing settings. Two types of lane configurations were considered. One was conventional surface lanes controlled by signals, and the other was grade-separated lanes. This problem was formulated as a Mixed Integer Linear Program (MILP), and it can be solved using the regular branch in branch out methods. The integer decision variables helped in finding if the movement was on grade separated or surface lanes, and also the successor functions to govern the order of signal display. The continuous variables included the assigned lane flow, common flow multiplier, cycle length, and start and duration of green for traffic movements and lanes. The optimized signal timing settings and lane configurations were then represented in VISSIM simulation. Numerical examples, along with a benefit-cost analysis showed good savings of the proposed optimization model for oversaturated traffic conditions. The benefit-cost ratio for installing 2 grade-separated lanes (as a tunnel) at a heavily oversaturated intersection (intersection capacity utilization rate equal to 141%) exceeded 17:1.

Pan et al. (published in Volume 69) in the paper titled "Operational Analysis of the Contraflow Left-turn Lane Design at Signalized Intersections in China" studied the impacts of a special intersection design with contraflow left-turn lanes (CLL). An analytical model was developed for estimating the capacity of the left-turn movement. The capacity model was calibrated and validated using field data collected at six approaches at five signalized intersections in the city of Handan, China. The results of field data analyses showed that the use of CLL design improved the capacity of left-turn movements. However, the capacity gains with the CLL design were quite stochastic considering the randomness in the arrivals of left-turning vehicles. Analytical delay models were proposed for estimating the delay to left-turning vehicles at intersections with the CLL design. A procedure was also proposed for optimizing the location of the upstream median opening and the green interval of the pre-signal. Simulation analyses were conducted to compare the delay experienced by the left-turning and through vehicles at signalized intersections with the conventional left-turn lane, the CLL and another unconventional left-turn treatment entitled "tandem design". The results showed that both CLL and tandem designs outperformed conventional left-turn lane design; and the CLL design generated less delay to both the left-turning and through vehicles as compared with the tandem design.

Hu et al. (published in Volume 69) in the paper "Transit Signal Priority Accommodating Conflicting Requests under Connected Vehicles Technology" addressed a special control strategy for Transit Signal Priority (TSP). A person-delay-based optimization method was proposed for an intelligent TSP logic that resolves multiple conflicting TSP requests at an isolated intersection. This TSP logic utilizing Connected Vehicle and handling multiple transit requests, dubbed as TSPCV-M, overcame the challenges bore by the conventional "first come first serve" strategy and presented a significant improvement on bus service performance. The feature of TSPCV-M included green time re-allocation, simultaneous multiple buses accommodation, and signal-transit coordination. These features helped maximize the transit TSP service rate and minimized the adverse effect on competing travel directions. The TSPCV-M was also designed to be conditional, i.e., TSP was granted only when the bus was behind schedule and the grant of TSP caused no extra total person delay. The optimization was formulated as a Binary Mixed Integer Linear Program (BMILP) which was solved by standard branch-and-bound routine. Minimizing per person delay was the objective of the optimization model. The logic developed in this research was evaluated using both analytical and microscopic traffic simulation approaches. Both analytical tests and simulation evaluations compared three scenarios: without TSP (NTSP), conventional TSP (CTSP), and TSP with Connected Vehicle that resolved conflicting requests (TSPCV-M). The measures of effectiveness included bus delay and total travel time of all travelers. The performance of TSPCV-M was compared against conventional TSP (CTSP) under four congestion levels and three different conflicting scenarios. The results showed that the TSPCV-M greatly reduced bus delay at signalized intersections for all congestion levels and conflicting scenarios considered. Simulation based evaluation results showed that the TSPCV-M logic reduced average bus delay between 5% and 48% compared to conventional TSP. The range of improvement corresponding to the four different v/c ratios tested were 0.5, 0.7, 0.9 and 1.0, respectively. No statistically significant negative effects were observed.

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