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Evaluation of Large Signalized Intersection with New Pedestrians Twice Crossing

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Abstract

Phase sequence and pedestrian cross pattern have significant impacts on the capacity of intersection. This paper concentrates on realigning a signal phase sequence to design a new pedestrian twice crossing (PTC) pattern providing additional time for pedestrians. To fully evaluate the operational performance of such an intersection with applying the realigned signal phase and the new PTC pattern, another two similar intersections with different signal phase sequences and cross patterns are established using VISSIM. One applies a typical 4-phase signal sequence*, and pedestrians only can cross the street in vehicle-through phase. The other applies the same vehicle signal sequence as model 1, but pedestrians apply a normal PTC pattern to cross the street. Five indices such as vehicle average travel time (VATT), vehicle average delay (VAD), pedestrian average travel time (PATT), pedestrian average delay (PAD), and the number of vehicles and pedestrians crossing the intersection per hour are employed to evaluate the performance of these three developed scenarios. The simulation results show that three models have very little gaps in VATT, VAD and the number of vehicle and pedestrian crossing the intersection. The New PTC pattern, however, makes a significant progress in pedestrian PATT and PAD compared with other two patterns.

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Keywords: Pedestrian twice crossing; Phase sequence; Performance analysis; *VISSIM* simulation

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1. Introduction

Transportation is a complicated system where various subjects and activities like road design, signal phase design and arrangement, infrastructure, vehicles and pedestrians appear in one platform. The system needs to be systematic in order to make all components work better. Considering the increasing vehicle and pedestrian volumes, it is necessary to optimize signalized intersections to help reduce pedestrians and vehicles' waiting time, especially at large scaled intersections.

In order to improve passing efficiency at the intersection for both pedestrians and vehicles, the fully utilized spatial and temporal resource of the intersection should be paid more attention. PTC (crossings involving two phases of the pedestrian signal and usually protected by a refuge island) is an efficient and safe way to help people cross a wide road compared with POC (crossings throughout one phase of the pedestrian signal), which can increase passengers' satisfaction and reduce time waste, although it has proved to be challenging and even controversial in the signal design filed[1,2,3,4]. In this paper, the intersection model applying a new PTC pattern is established through adjusting a phase sequence and adding new signal phases at median barrier to reach the aim of fully using intersection spatial and temporal resources.

The main purpose of this paper is to put forward a new PTC pattern by realigning phase sequences to decrease waiting time for pedestrians. Then, the performance of the intersection applying the new PTC pattern will be assessed through comparing with that of the similar intersections applying either POC pattern or PTC pattern under the typical 4-phase signal program† by using *VISSIM* simulation. Furthermore, the new PTC pattern is proved to have as less negative effect as possible on vehicle flows based on the number of vehicle passing through the intersection per hour. According to these analyses, a conclusion is drawn that the new PTC pattern leads better efficiency at an intersection.

The paper is structured as follows: Section 2, the relevant literature regarding the signal phases for PTC and its applications are reviewed. Details of the new method are stated in Section 3. Section 4 shows that *VISSIM* simulates three scenarios including the intersection employing the POC pattern under the typical 4-phase signal control, the intersection employing the normal PTC pattern under the typical 4-phase signal control, and the intersection employing the new PTC pattern under the realigned 4-phases signal control, then does a comparison to evaluate an intersection performance based on the simulation outputs. Section 5, the conclusions and discussions are put forth in.

2. Past works

It is seen that an intersection resource is not properly utilized and accidents occur due to the incorrect setting of phases, sequences and a poor intersection geometry design. The concepts of a ripple change to improve intersection efficiency were proposed and the feasibility of carrying out ripple changes at typical signal timing scheme was analyzed, then the implement conditions of ripple changes was confirmed[5]. The relationship between an intersection geometry design and signal phase sequences was discussed and the effects of the priority order of the left-turn phase and the straight phase on the number of conflict points were analyzed[6]. Adjusting phase sequence has little influence on avoiding the traffic overflow due to the vehicle queue length increase in one cycle[7]. Different phase sequence setups have only resulted in the traffic overflow occurring in different time. The phase sequence realignment can decrease conflict points in time domain, which can guarantee vehicle passing the intersection safely and efficiently.

PTC is a flexible-efficient pedestrian cross pattern. It is especially applicable to large signalized intersections which have abundant vehicle and pedestrian flows, more lanes, and central pedestrian safety islands. A reasonable PTC signal phase design can improve the safety of pedestrians crossing the street, increase the pedestrian passing efficiency, and reduce pedestrian's illegal crossing rate[1,2,3,4].

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† The typical 4-phase signal program has 4 vehicle signal phases, and its sequence is through phase on east-west direction, left-turn phase on east-west direction, through phase on north-south direction, and left-turn phase on north-south direction. When an intersection applies POC pattern under such a signal plan, pedestrians only can use two through phase to cross the street. When an intersection employs normal PTC pattern under such a signal plan, pedestrians can additionally use left-turn phase to walk to the central of road to wait the forthcoming through phase.