Behavior Analysis of Vehicle Starts under Count-down-Type Traffic Signal Through Survey in China

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Countdown-type traffic signals for vehicles which display the remaining green time and waiting red time have been installed positively in foreign countries. In this study, we analyze the behavior of the vehicle under countdown signal , especially the behavior of vehicle starts when traffic signal changes from red to green. First, we analyze the data of survey in Changchun of China to constructing start-up delay model and distribution diagram . According to the result of the analysis, it can be revealed that countdown traffic signals would shorten start-up delay under several affecting factors, and also alleviate the restless feeling .

Key Words : *countdown-type traffic signals, behavior of vehicle, start-up delay, risky behavior*

1. INTRODUCTION

Signal intersection of domestic and international, have commonly gradually being popularized countdown signals which disply the waiting red time. In Japan, the countdown signals which using for pedestrians have been imported in order to prevent risky behaviors. But countdown-type traffic signals for vehicles which disply the remaining green time have not been imported. On the other hand, in overseas, countdown-type traffic signals for vehicles (example. photo-1, photo-2) are widely using now. The signal countdown timer is an Advanced Traffic Information System that is increasingly popular in traffic congested Asian cities. The timer is a digital clock installed next to the signal head, continuously displaying the number of seconds remaining for each phase of the cycle, including the changes from green to yellow, yellow to red, and red to green. This timer offers drivers an exact indication of the onset of the next phase so that the drivers are able to make a better decision on how they should respond to the upcoming change, or how they should utilize the time waiting for the onset of the green phase. The countdown timer is often claimed to offer many benefits, including improvement of vehicle flow at the intersection, reduced occurrence of accidents, and the reduction of stress in drivers waiting in the queue.

Photo-1 China


Photo-2 Thailand

The cycle time of the traffic signals for vehicles of Japan, generally longer than Europe and the United States. This kind of condition, the remaining green time or waiting time information is unknown. Because of that, when the green time the driver is very difficult to make a correct judgment for signal changes in timing. In addition, when the red time, the waiting time information is unknown, so it's easy to feel waiting a long time, and it is easily to produce irritable feeling also cause errors of judgment to af-

fects the normal driving. In order to suppress these risky behaviors, countdown signals as one of possible options to inhibit the irritable feeling and errors of judgment. For the driver it`s easily to judge the timing of start-up in the intersection which has countdown, we can known fluency of traffic volume and safety are improved.

This study especially the behavior of vehicle starts when traffic signal changes from red to green. We analyze the data of survey in Changchun of China. Based the result, in future when Japan set countdown signals it can provide the basic data, that is the purpose of this research. The behavior of vehicle when traffic signal changes from green to red is the subject of future research.

2. PREEXISTING RESEARCH

The research about waiting time of vehicle (the remaining green time) by Lum et al.[1] they report a before-and-after study which evaluated the difference in driver response along an approach of a signalized intersection installed with a green signal countdown device (GSCD). The main purpose of a GSCD is to provide drivers with a countdown timing that would help them make informed stopping/crossing decisions during the critical phase-change period. In effect, one may conclude that the longer term performance of GSCD would only help to encourage stopping but not curbing red-violations.

Changes in driver behavior resulting from pedestrian countdown signals by Huey et al [2], countdown timers installed at a signalized intersection affect the queue discharge characteristics of through movement during the green phase. Since the countdown timers display the time remaining (in seconds) until the onset of the green phase, drivers waiting in the queue at the intersection are aware of the upcoming phase change, and are likely to respond quicker.

Effects of countdown timers on queue discharge characteristics of through movement at a signalized intersection by Thirayoot et al[3], the countdown timers display the time remaining (in seconds) until the onset of the green phase, drivers waiting in the queue at the intersection are aware of the upcoming phase change, and are likely to respond quicker.

Behavior and Consciousness Analyses on Effect of Traffic Signals Including Countdown Device for Vehicles by Motohiro FUJITA et al[4] ,they conducted a questionnaire survey and observed surveys via video cameras at signalized intersections with those type of traffic signals installation in Turkey. It is shown that users' satisfaction is improved and driving rage is dropped by the countdown display.

Table 1 Time and Intersection

Time	Intersection	Direction	CD	Camera
September 15 10:00~12:00	Ziyou	East to West	○	×
September 15 14:00~16:00	Renmin	East to West	○	○
September 18 10:30~12:30	Kuanping	North to south	×	○
November 6 9:45~11:45	Weixing	South to North	×	×
November 6 14:00~16:00	Weiming	South to North	○	×
November 7 11:00~13:00	Jiefang	West to East	○	○

Table 2 The outline of road intersections

Intersection	Straight Line	Cycle	Green	Yellow
Ziyou	3	150s	66	2s
Renmin	3	150s	45	2s
Kuanping	2	150s	38	2s
Weixing	3	100s	45	3s
Weiming	3	150s	45	3s
Jiefang	4	150s	50	2s

Driver behavior during flashing green before amber by H. Koll et al[5], The analysis shows that the flashing green increases the number of early stops, as drivers tend to underestimate the duration of the time to the end of amber. The model results show that speed and distance to stop line, and their interaction (potential time to the stop line with unchanged speed) explain the stopping process.

This paper analyze the data of survey in Changchun of China for constructing start-up delay model and distribution diagram.

3. SURVEY IN CHANGCHUN

In this study, we observed surveys via video cameras at signalized intersections with countdown-type signals installation in Changchun for two times, first time is September 15 and18 in 2011, second time is November 6 and 7, the two times we survey 6 road intersections, the time and intersection's name the following will introduce in **Table 1**. The outline of the road intersections will introduce in **Table 2.** IN **Table 2** the straight line is unilateral line. The cycle is signal changes from green to yellow, yellow to red, and red to green. The tectonic of the road intersections will show in **Fig.1**, **Fig.2**, **Fig.3**, **Fig.4**, **Fig.5**, **Fig.6**. In addition, for investigation of crossroads traffic condition, this paper just only to analysis the shadow part of straight vehicle.

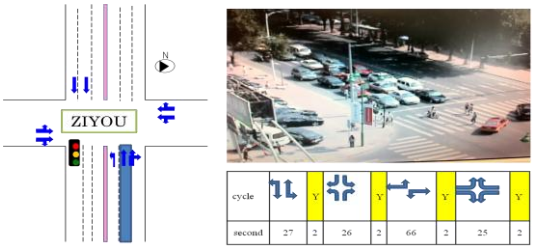

Fig.1 The tectonic of Ziyou

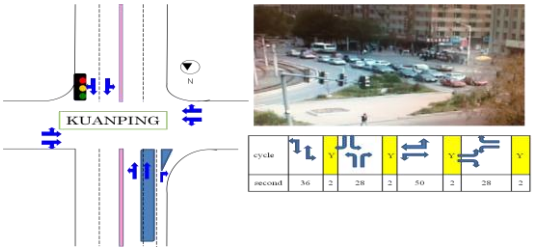

Fig.2 The tectonic of Kuanping

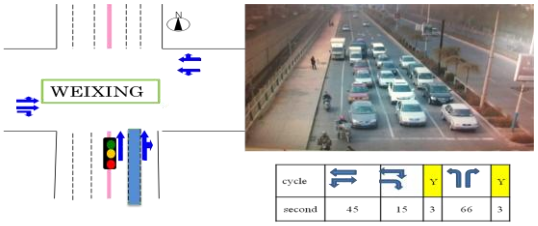

Fig.3 The tectonic of Weixing

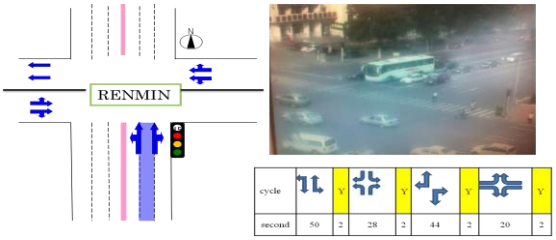

Fig.4 The tectonic of Renmin

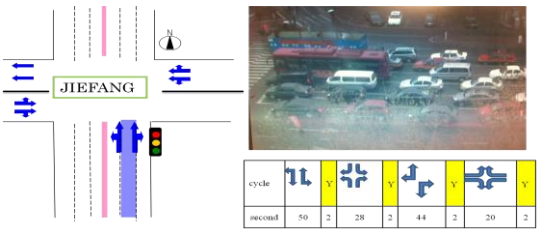

Fig.5 The tectonic of Jiefang

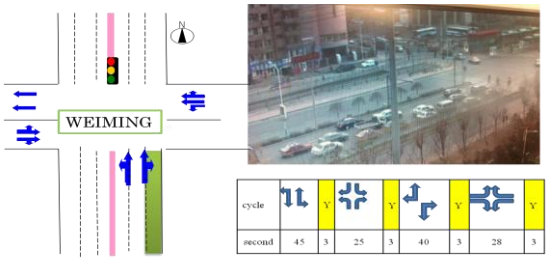

Fig.6 The tectonic of Weiming

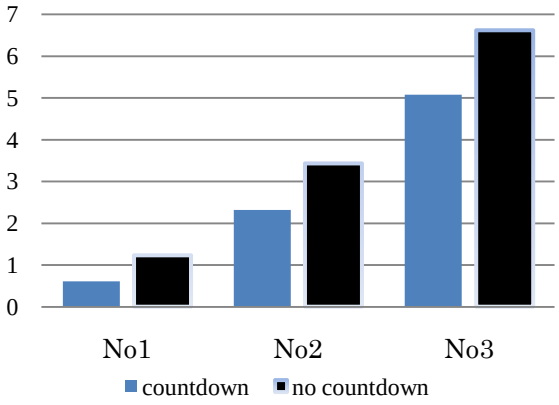

Fig.7 Average value of start-up delay

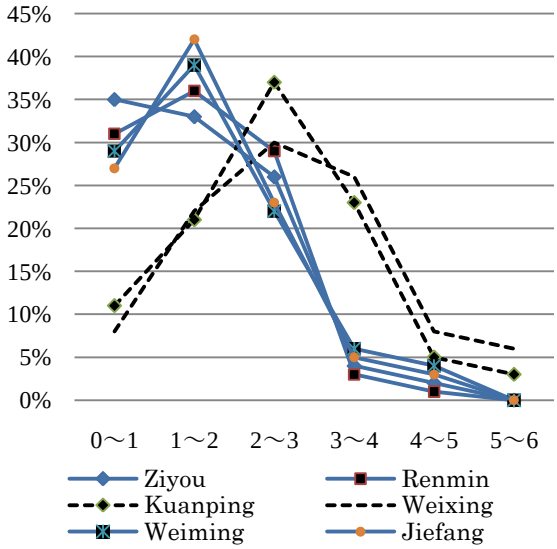

Fig.8 Distribution of the first vehicle start-up delay

4. BEHAVIOR OF VEHICLE STARTS

This chapter according to the data of survey in Changchun to constructing start-up delay model and distribution diagram, also for countdown-type signals to do analysis and evaluation. The start-up delay is defined as the time difference that is the moment through the stop line subtract the moment of signal changes from red to green.

(1) Distribution diagram

Fig.7 is average value of start-up delay from No1(first vehicle) to No3(third vehicle), there compared the intersection which set up the countdown signals and no-countdown signals, from the **Fig.7** we can known the intersection which set up the countdown signals when the vehicle through the road intersection will use shorter time than no countdown signals.

Fig.8 is the distribution of the first vehicle start-up

Table 3 Description of the explanation variable

Explanation Variable	Definition
Waiting time(WT)	The vehicle at the intersection from stopping time the signal change to green used time(second)
Distance from stop line (DFSL)	The distance from the stop line to the stop position
Countdown Signals(CS)	The intersection set up the countdown signals(1), no countdown(0)
Type of vehicle(TOV)	Large size vehicle(1), normal size vehicle(0)
Pedestrian(P)	Pedestrian in road intersection(1), other(0)
Residual vehicle(RV)	Vehicle still in intersection(1),other(0)
Left turn vehicle(LTV)	Left turn vehicle still in intersection(1),other(0)
Position of intersection(POI)	Located in the center of city(1),other(0)
Surveillance camera(SC)	There is a surveillance camera(1),other(0)

Table 4 Start-up delay model of the first vehicle
(R=0.88,N=224,F=35.78 Meaningful probability:0.000)

	unstandardized coefficient	standardization coefficient	t
constant	2.71		5.42
WT	-1.37	-0.11	-2.62
CS	-0.54	-0.02	-1.97
TOV	0.29	0.10	2.03
P	1.16	0.48	1.87
RV	0.84	0.03	2.93
LTV	0.85	0.07	2.85
POI	0.06	0.33	2.01
SC	0.05	0.17	1.90

Table 5 Start-up delay model of the third vehicle
(R=0.82,N=224,F=42.03 Meaningful probability:0.000)

	unstandardized coefficient	standardization coefficient	t
constant	1.36		4.87
WT	0.96	0.18	1.93
DFSL	-0.77	-0.08	-2.02
CS	-1.19	-0.47	-2.21
TOV	0.37	0.07	1.90
P	0.39	0.04	2.03
RV	1.07	0.11	1.98
LTV	0.71	0.06	1.79
POI	1.22	0.52	2.63
SC	1.31	0.24	2.28

delay for all of the intersection. In **Fig.8** the solid line is the intersection which set up the countdown, the dotted line is the intersection which used no countdown signal. From the **Fig.8** we can get the same result with the **Fig.7**, the vehicle through the road intersection will use shorter time if the intersection set up countdown signals.

(2) Start-up delay model

According to multiple regression analysis based on the data of survey in Changchun to constructing start-up delay model by SPSS, description of explanation variable will be show in **Table 3**, Waiting time is abbreviated to (WT), the others variable also like this.**Table 4** is the start-up delay model of the first vehicle, the multiple correlation coefficient is 0.88 for the model that is relatively good precision, also can get the following conclusion, when the vehicles wait a long time, the intersections set up countdown signals, start-up delay will use shorter time, other explanation variables will make the start-up delay to use longer time. **Table 5** is the start-up delay model of the third vehicle, as the result of **Table 5** multiple correlation coefficient is 0.82 for the model that is also relatively good precision, from **Table 5** can get the following conclusion, the distance if it far, countdown signals have been used, the start-up delay will be shorter, other explanation variables will make the start-up delay to use longer time.

5. CONCLUDING REMARKS

According to the result of the analysis, it can be revealed that countdown traffic signals would shorten start-up delay time. The future will analyze the behavior of vehicle when traffic signal changes from green to red .

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(Received August 5, 2011)