ANALYSIS ON INFLUENCING FACTORS UPON PEDESTRIAN STOP/GO BEHAVIOR AT SIGNALIZED CROSSWALKS

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1. Introduction

Although signalized crosswalks are operated in a way to give pedestrians a prioritized right of way, more than one-third of the total traffic accident fatalities are pedestrians[1]. The threat to pedestrian safety mainly comes from the interaction with turning traffic in which users' behavior for pedestrians and drivers is the main contributing factor. Understanding pedestrian behavior and identifying influencing factors upon their maneuver is essential to assess the safety performance. Simultaneously, it is of prime importance to rationally improve efficiency of the existing operational policies as well.

After pedestrian green time PG is terminated and flashing green PFG is indicated, drivers don't expect pedestrians to start crossing. In reality, it is observed that pedestrians might start crossing during PFG or even after that[2]. Those pedestrians usually hurry up so that they can clear the crosswalk as quickly as possible[2]. In such conditions, drivers have limited time to take proper actions to avoid collisions which may lead to severe situations. Pedestrian stop/go behavior after the onset of PFG can be affected by pedestrian position and speed, crosswalk length, turning vehicle demand, pedestrian origin-destination, and PFG length. In a past study[2], it was found that pedestrian crossing speed during PFG at long crosswalks is higher than that at short ones. However pedestrian stop/go decision was not analyzed. In another study, it was found that short signalized crosswalks have significantly higher pedestrian go probability which might lead to more risky situations[3].

This paper reports the results of preliminary analysis on the effects of pedestrian origin-destination, crosswalk length, and left-turning vehicle demand on pedestrian stop/go behavior at the onset of PFG.

2. Methodology

The stop/go decision timing after the onset of PFG differs from person to person and dependent on his/her position at that moment. For simplification, this study assumes that all pedestrians choose to stop or to go at the onset of PFG regardless of his/her position. The effect of delay is not considered in this study since the analysis is done at a single signalized intersection only.

Pedestrian origin-destination is defined as the movement direction which is divided into near-side and far-side. Near-side pedestrians are those who start crossing from the side of the vehicular traffic that is exiting the intersection while far-side pedestrians are those who start crossing from the side of the incoming vehicular traffic as shown in Fig.1.

To estimate the stop probability distribution, empirical data is necessary. After collecting the required data, the distance d_c from pedestrian position at the onset of PFG to the mid-point of crosswalk edge (Fig.1) is divided into several bins of 5.0m size. The stop probability $P(x)_i$ for bin i is calculated by Equation (1).

$$P(x)_i = \frac{(No.\ of\ pedestrians\ choose\ to\ stop)_i}{(No.\ of\ pedestrians\ choose\ to\ stop\ and\ to\ go)_i} \qquad (1)$$

For a pedestrian who chooses to go, the travel speed to the crosswalk v_t is calculated by dividing the observed traveled distance d_t from his position at the onset of PFG to entering the crosswalk by the elapsed time Δt (Fig.1). The effects of crosswalk length and pedestrian origin-destination on v_t are also analyzed in this study.

3. Data collection and processing

In order to analyze pedestrian stop/go behavior, video data was collected at the West and East crosswalks of Sasashima Intersection in Nagoya City, Japan. The observation was conducted in the morning peak from 8am to 10am in October 26, 2011. Fig.2 presents the geometric layout and signal phasing plan of Sasashima Intersection. The length of the West crosswalk is 32m while 17m of the East crosswalk. Pedestrian trajectories are tracked every 1.0

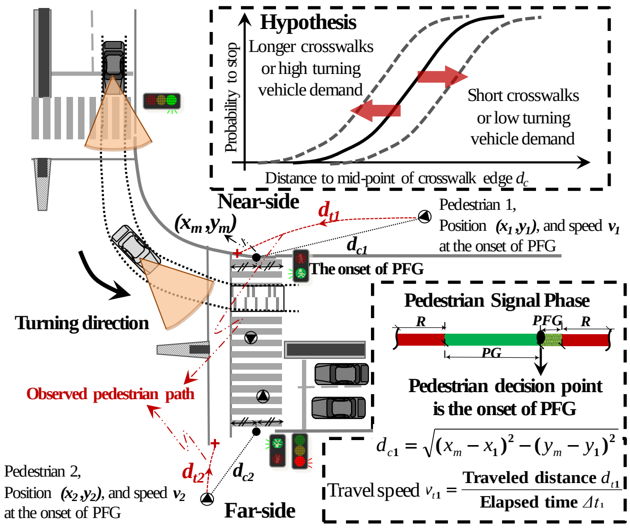

Fig.1 Definition of analysis parameters

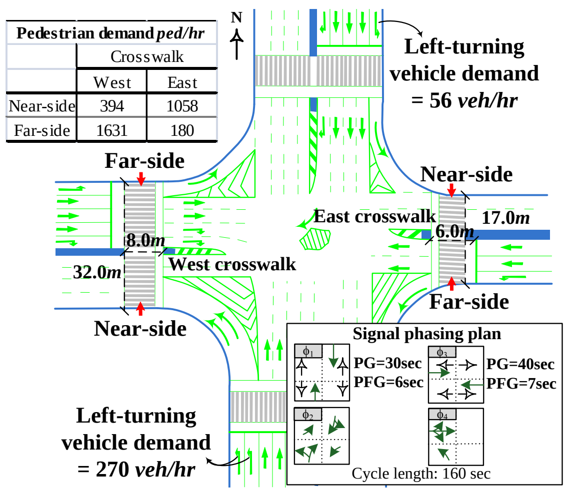

Fig.2 Sasahima Intersection layout and traffic conditions

Table 1 Observed number of pedestrians

Sample Size		West Crosswalk				East Crosswalk			
		Near		Far		Near		Far	
		Go	Stop	Go	Stop	Go	Stop	Go	Stop
$d_c\,(m)$	**0~5**	10	0	25	1	6	0	7	0
	5~10	6	2	27	1	9	1	9	1
	10~15	3	3	17	6	10	1	5	4
	15~20	0	6	6	6	3	1	3	2
	20~25	0	3	3	5	2	1	2	0
	25~30	0	3	0	5	2	8	0	0
	30~35	0	0	3	7	0	4	0	1
	35~40	0	2	0	3	0	0	0	1

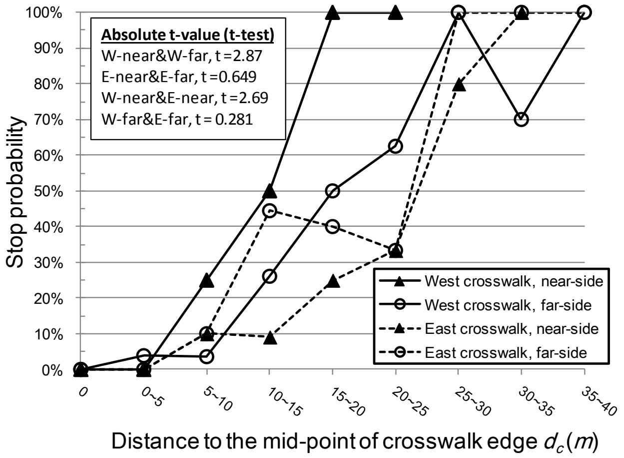

Fig.3 Observed stop probability distributions

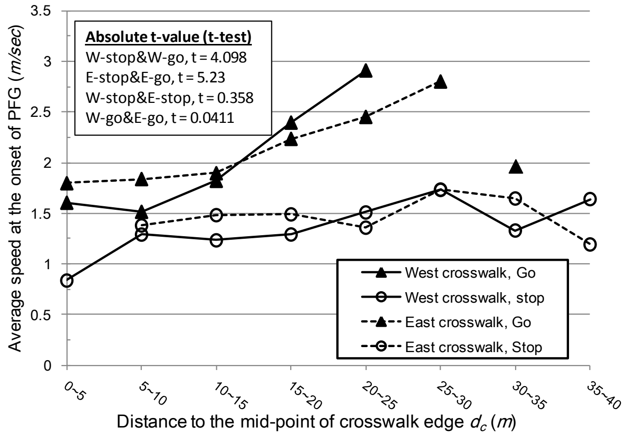

Fig.4 Observed average speed at the onset of PFG

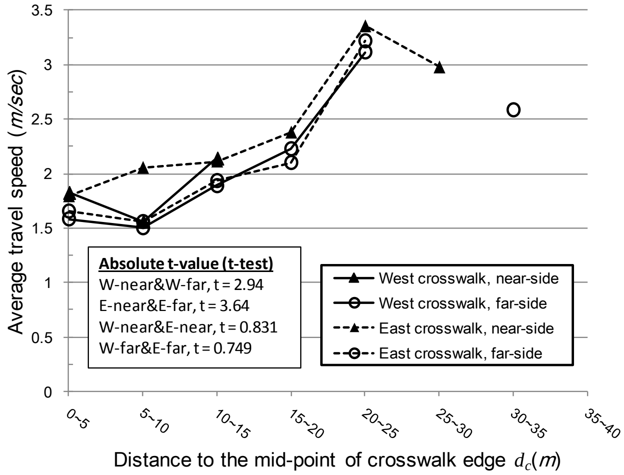

Fig.5 Observed average travel speed v_t

seconds by using image processing system. Table 1 presents the observed number of stop and go pedestrians at the onset of PFG at the observation site.

4. Data Analysis

Fig.3 shows the observed stop probability distributions for near-side and far-side pedestrians at the West and the East crosswalks of Sasashima Intersection. Although the sample size is small, which is the reason why the shapes of the distributions are not smooth; it is clear that the stop probability increases as d_c increases. Furthermore, near-side pedestrians at the West crosswalk have significantly higher (95% confidence level) stop probability compared to far-side pedestrians. This can be attributed to the high opposing pedestrian demand from the far-side and to the high left-turning vehicle demand from the South approach as well, which discourages pedestrian from starting crossing during PFG and results in higher stop probability. The analysis does not show significant impact of crosswalk length on stop probability, which is referred to the insufficient sample size.

Pedestrian average speeds at the onset of PFG for stop and go pedestrians are shown in Fig.4. It is found that pedestrians who choose to stop have significantly lower speeds (95% confidence level) than those who choose to go. In other words, pedestrians who have higher desired speeds tend to have higher probability to go; which is rational.

Fig. 5 shows the average travel speeds v_t for pedestrians who choose to go. Near-side pedestrians have significantly higher v_t than far-side pedestrians. This can be attributed to the effect of left-turning traffic, since near-side pedestrians face turning traffic in the first half of the crosswalk thus they hurry up to clear this part as fast as possible.

5. Conclusions

A preliminary study was conducted to investigate the influencing factors upon pedestrian stop/go behavior at the onset of PFG. The analysis showed that the presence of high left-turning vehicle demand leads to higher stop probability at the onset of PFG for near-side pedestrians compared to far-side pedestrians. Furthermore, it was found that pedestrians who choose to stop have significantly lower speeds at the onset of PFG than those who choose to go. Moreover, near-side pedestrians who choose to go have significantly higher travel speeds than far-side pedestrians which is attributed to the effects of high opposing pedestrian demand and/or high left-turning traffic demand. The analysis did not reveal any significant effect of crosswalk length on stop/go probability or travel speed which is mainly due to the limited sample size. Collecting sufficient data is essential to concrete the conclusion and to proceed with modeling pedestrian stop probability and travel speed.

References

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