Field Experiment of Pedestrian Priority Traffic Signal Control System

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Introduction

In response to the current increasing public demand for pedestrian safety in Japan, various policies are being formulated and implemented including introduction of the Pedestrian Only aspect. The Signal Control Advancement Working Group implemented the experiment "pedestrian priority control" over a period from the fiscal year 2003 through 2004 and has made significant progress. In the fiscal year 2005, the Group implemented the experiment "Signal control and Information for Pedestrian Safety" to verify the effectiveness and adaptability of this control to the society.

Background

In 2005, the number of nationwide traffic accident fatalities for a single year dropped to below 7,000 for the first time in the past 49 years since 1956. The number of fatalities is steadily decreasing towards the Government's target of "annual number of traffic accident fatalities below 5,000". Signal control, to no small extent, contributed to this reduction as well as the vehicle safety measures and progress of emergency medical services. To reduce the number of fatalities further, advanced signal control with the emphasis on safety is necessary.

About one fourth of all traffic accident fatalities are pedestrian traffic accidents, for which the major cause is pedestrians' disregard of the signals. Factors contributing to the disregard of signals include unreasonable signal control, that is, a red light is displayed although there is no vehicular traffic and the failure of the signal to gain the attention of the pedestrians.

The Signal Control Advancement Working System has implemented field experiments for "Signal control and information for pedestrian safety" by controlling these factors that contributed to the disregard of signals, while examining a signal control system that ensures the safety of pedestrians.

Objectives of the experiment

This experiment verifies the effectiveness of this control by applying "Signal control and information for pedestrian safety" to actual intersections. We also verified the

adaptability of this control through the actual experiment that was implemented for one month.

Examination of the control system

The Universal Traffic Management Society of Japan examined the new signal control system to reduce pedestrians' disregard of signals.

One of the locations where frequent disregard of signals occurs is an intersection of a wide primary road and a narrow secondary road. In such an intersection, a longer pedestrian crossing time must be allocated and the current general signal aspect (that is, a red light for pedestrians is displayed first followed by a red light for vehicles) increases the green time for vehicles using the secondary road. This phenomenon readily leads to an unreasonable situation where a red light is maintained for pedestrians of the secondary road although no vehicles are traveling on the secondary road, causing chronic pedestrians' disregard of signals. To reduce such disregard of signals at intersections, we examined the following measures.

Earlier green light for pedestrians crossing secondary roads

The unreasonable situation where a red light is displayed for pedestrians although no vehicles are traveling on the secondary road means that green light is maintained for vehicles on the secondary road needlessly. To reduce this dead green time, the normal signal aspect on the secondary road (red light for pedestrians is displayed first followed by the red light for vehicles) is changed so that the red light for vehicles is displayed first followed by red light for pedestrians. A vehicle sensor is installed near the stop line of the secondary road and if the sensor does not detect any vehicles traveling on the secondary road, the green light for vehicles is discontinued and the green light for pedestrians on the secondary road is displayed before the normal time (the time obtained by discontinuing green light for vehicles is allocated to green light for pedestrians on the secondary road). As a result, dead green time allocated to vehicles traveling on the secondary road decreases, providing longer green time for pedestrians crossing the secondary road (see Figure 1).

We had the following concerns in the implementation of this control.

- Possibility for any risk by discontinuing green time for vehicles traveling on the secondary road.
  Possibility for traveling vehicles remaining on the road due to a traffic conflict between the vehicles turning to the left or right and pedestrians crossing the secondary road.
- Confusion caused for users due to the light sequence being different from the normal.

We focused on these points in the experiment.

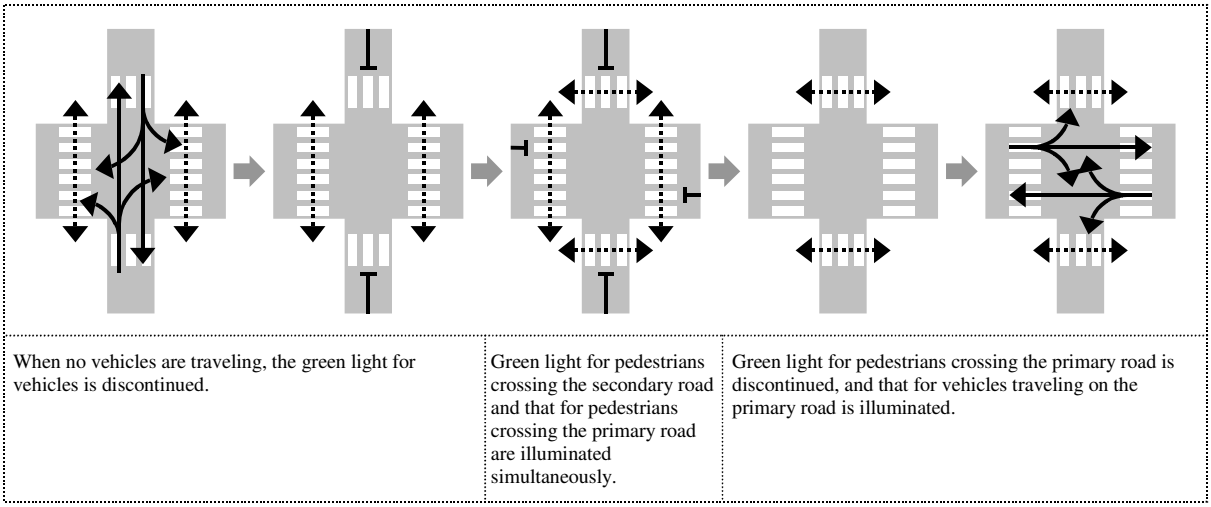

Figure 1. Phase transition diagram under experiment

Extending the green light for pedestrians crossing a primary road

In this experiment, we examined the situation at an intersection of a wide primary road and, in such a situation, a longer time is allocated to green blinking light for pedestrians crossing the primary road. As pedestrians become accustomed to the condition, more often they start crossing after the green light starts blinking and the light turns to red before they finish crossing. In this control, a pedestrian sensor was installed to ensure the safety of pedestrians. When the sensor detects pedestrians who cannot finish crossing before the light turns to red, the green blinking time is extended for a few seconds (2 seconds in this experiment).

Guidance and warning to pedestrians

"Earlier green light for pedestrians crossing secondary roads" enables pedestrians to finish crossing within the green light, which normally turns to red, by increasing the green time for pedestrian crossing. However, the light cannot be kept green because vehicles must travel on the subordinate road and thus pedestrians' disregard of signals cannot be eliminated completely. Therefore, we introduced an audio device to provide a warning on pedestrians' disregard of signals that cannot be prevented simply by introducing an earlier green light.

We also introduced a function that notifies pedestrians that the light turned green for pedestrians crossing the secondary road. "Earlier green light for pedestrians crossing secondary roads" turns the light for pedestrians crossing the secondary road to green earlier than the normal light. This function ensures that pedestrians become aware of

the changing of the light to green.

Since the secondary road is narrow, the warning for disregard of signal was made short so that crossing is not completed while the warning is issued.

Field experiment

Intersection used for the experiment

To achieve an effective experiment, we selected an intersection that satisfies the following conditions within Kanagawa Prefecture.

- Intersection of a wide primary road and a narrow secondary road
- Intersection of a secondary road of comparatively low traffic volume and a primary road of high traffic volume
- Intersection where pedestrians often disregard the signals

Of the intersections that satisfy those conditions, we selected the following intersection that allows for the installation of experimental devices for the experiment after deliberations with the Traffic Regulation Division of the Police Head Quarters of Kanagawa Prefecture.

Intersection of "Tokiwa-cho 3-chome"
3-25, Tokiwa-cho, Naka-ku, Yokohama City, Kanagawa Prefecture

Figure 2 outlines the intersection used for the experiment.

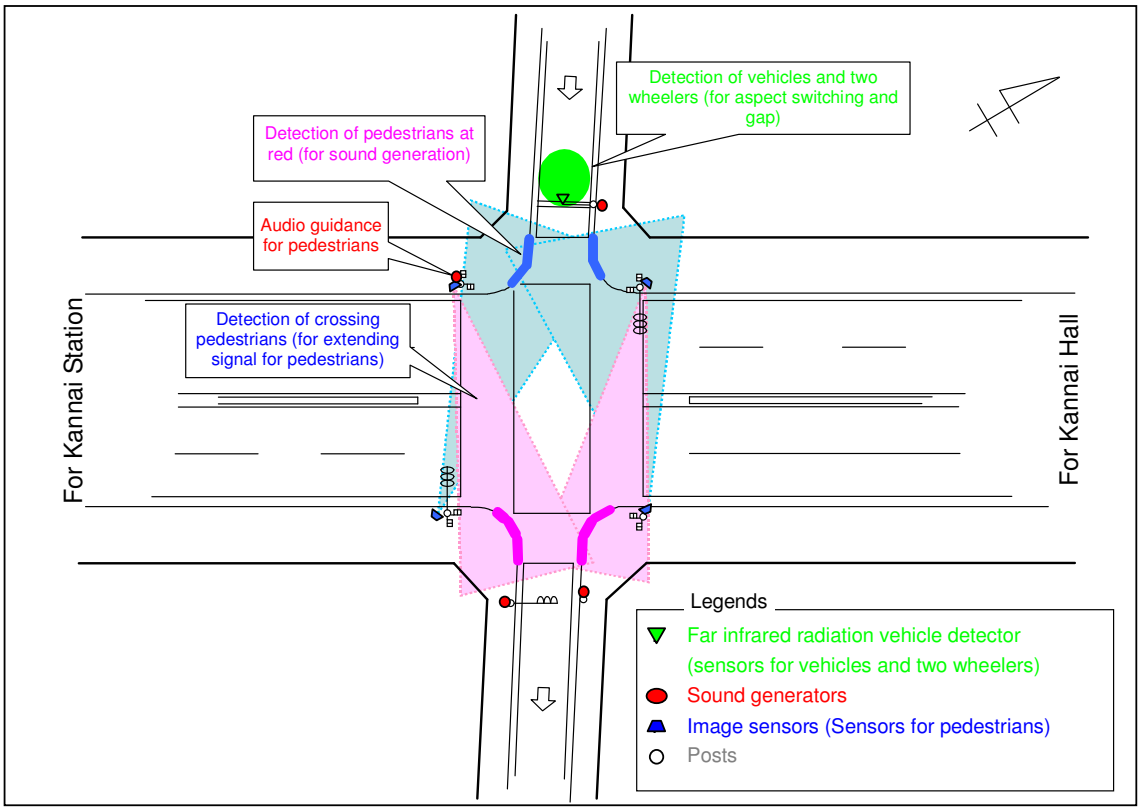

Figure 2. Schematic drawing of the intersection under experiment

Duration of the experiment

The duration of the experiment in the fiscal year 2005 was for one month and measurements of the effects after stabilization of behaviors of pedestrians and vehicles were also enabled.

December 12, 2005 (Monday) to January 18, 2006 (Wednesday)

Examination

The preliminary examination was implemented in the operation condition under the existing control and post examination was implemented in the condition under "Signal control and information for pedestrian safety". Post examination was implemented twice to compare the behaviors of users before and after "accustomed to the condition"; one at immediately after introduction of "Signal control and information for pedestrian safety" and another at one month after the installation. For both the preliminary examination and the post examination, a questionnaire survey was conducted for pedestrians crossing the intersection at morning, noon, and evening time zones to check the responses to " Signal control and information for pedestrian safety". We also took

the location photographs of the intersection for post examination analysis. See below for the examination implementation schedule.

Examination schedule

Preliminary examination: November 1, 2005 (Tuesday)
1st post examination: December 13, 2005 (Tuesday)
2nd post examination: January 17, 2006 (Tuesday)

Examination time zone

Morning: 8:50 to 10:50
Noon: 11:30 to 13:30
Evening: 17:00 to 19:00

Results of the experiment

Change of green times

Table 1 shows the total green times in seconds for each of the primary and secondary roads during the examination period on the second day of post examination based on the control execution history. The green times without application indicate the values calculated based on the assumption that preliminary control was performed with the same cycle length and split.

Table 1. Change of green times

Time zone	Without application				2nd post examination			
	Primary road		Secondary road		Primary road		Secondary road	
	Vehicle	Pedestrian	Vehicle	Pedestrian	Vehicle	Pedestrian	Vehicle	Pedestrian
8:50 to 10:50	3,965	3,551	2,352	1,731	3,853 (-112)	4,559 (1,008)	1,286 (-1,066)	2,123 (392)
11:30 to 13:30	3,946	3,514	2,448	1,800	3,821 (-125)	4,799 (1,285)	1,173 (-1,275)	2,219 (419)
17:00 to 19:00	3,996	3,558	2,482	1,825	3,876 (-120)	4,541 (983)	1,376 (-1,106)	2,237 (412)

(Unit: seconds, figures in parentheses indicate the amount of increase or decrease)

This table shows that the green time allocated to vehicles traveling on the secondary road under the conventional system is reduced and the time is mainly redistributed to pedestrians on the primary road.

The green time for vehicles traveling on the secondary road is reduced, however, hardly any vehicles traveling on the secondary road are remaining (see Table 2), indicating implementation of proper green time allocation.

Table 2. Number of traveling vehicles remaining

Time zone	2nd post examination			
	Cycle count	Count of cycles with traveling vehicles remaining	Total number of traveling vehicles remaining	Number of traveling vehicles remaining per cycle
8:50 to 10:50	72	5	19	0.26
11:30 to 13:30	76	1	1	0.01
17:00 to 19:00	79	2	3	0.04

Rate of disregard of signals

Table 3 shows the numbers of occasions of disregard of signals in preliminary examination and on the second day of post examination that are summarized for each of the directions shown in Figure 3.

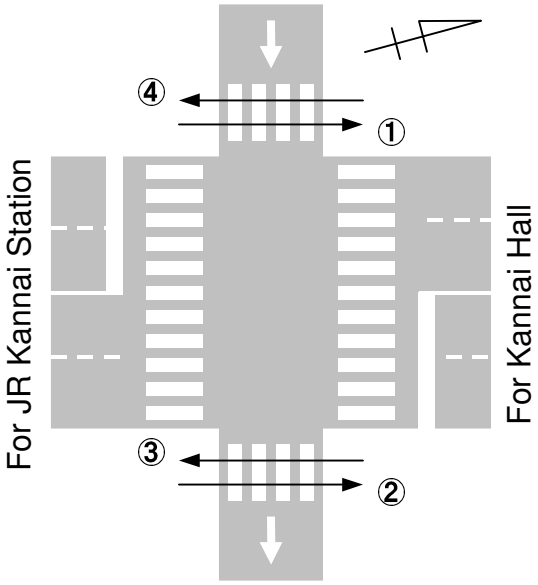

Figure 3. Crossing directions used for summary

Table 3. Change of rate of disregard of signals

Crossing direction	Preliminary examination			2nd post examination		
	Number of pedestrians	Number of pedestrians who disregarded signals	Rate of disregard of signals (%)	Number of pedestrians	Number of pedestrians who disregarded signals	Rate of disregard of signals (%)
②→③	2,921	1,475	50.5	3,143	725	23.1
③→②	3,071	1,010	32.9	2,902	440	15.2
④→①	1,534	625	40.7	1,400	217	15.5
①→④	1,087	351	32.3	1,072	158	14.7

(Rate of disregard signals = Pedestrians crossing who are detected in the infrared aspect/all the pedestrians × 100)

This result indicates that there are hardly any differences in the numbers of pedestrians between preliminary examination and post examination. However, the number of pedestrians disregarding the signals and the rate of disregard of signals have been reduced to a half. The pedestrian green time for the target direction has increased, enabling safer crossing.

Extension of pedestrian green time

Figure 4 shows the summary of the number of times the pedestrian green time was extended in one day of post examination based on the control execution history.

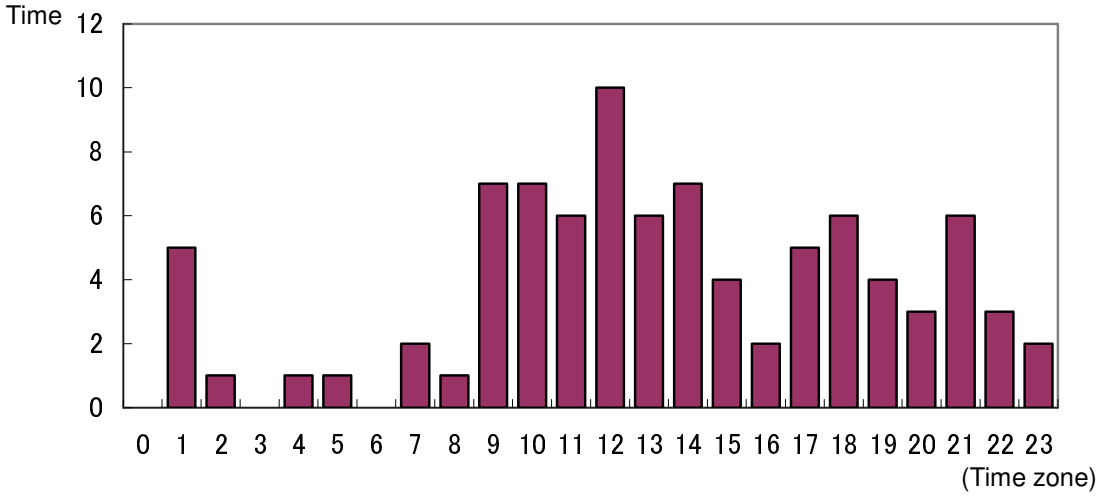

Figure 4. Number of times pedestrian green time was extended

This graph shows that green times are often extended in the time zones (7:00 to 23:00) where an increase of the number of pedestrians occurs, proving that pedestrian green time is increased effectively as required, ensuring safer crossing.

User awareness

Figure 5 and Figure 6 show the summary of the pros and cons of the new signal control system and audio guidance that were implemented in this experiment. These results were obtained from the questionnaire survey conducted for the pedestrians who crossed the intersection in the time zones during the post examination.

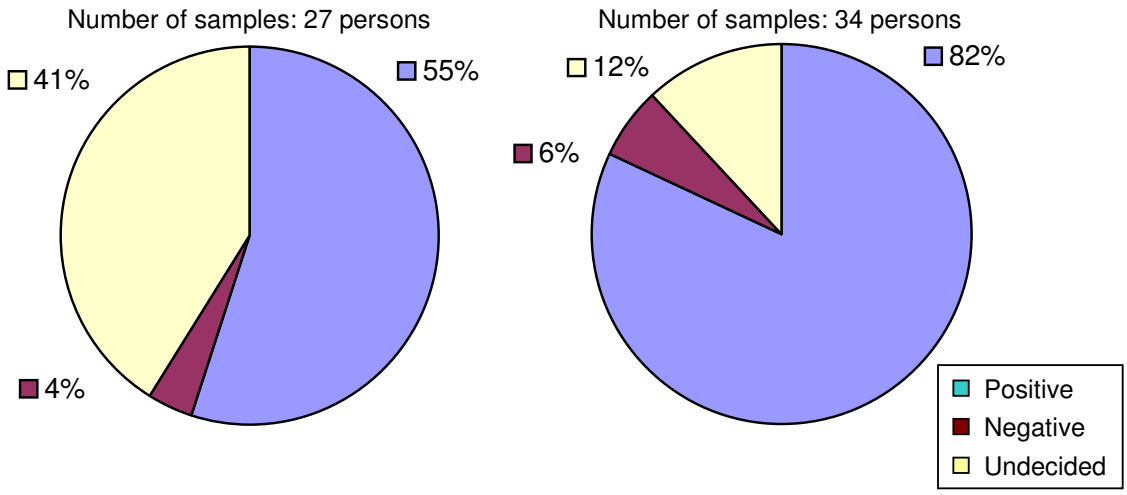

Figure 5. Ratio of pros and cons on the control

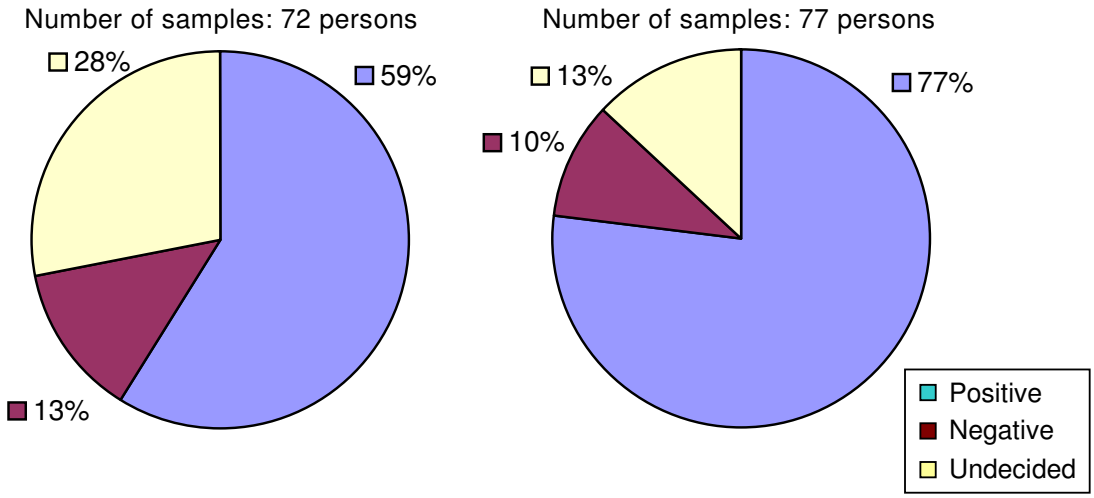

Figure 6. Ratio of pros and cons on audio guidance

These graphs indicate that generally both the control and audio guidance received a positive assessment, and more pedestrians assessed positively after a certain period from installation than immediately after the installation.

Conclusion

This experiment verified that the application of "Signal control and information for pedestrian safety" improved the pedestrian services in the form of an increase of green time and at the same time reduced the number of pedestrians disregarding the signals. We also verified that our initial concerns regarding vehicles still remaining at the intersection or user errant behaviors did not occur.

Acknowledgment

Finally, we would like to express our gratitude to the Police Headquarters of Kanagawa Prefecture for their generous cooperation and guidance in the implementation of this field experiment.