

Purpose of Signal Control Regarding Pedestrian Protection and Study Report

Experiments in extending the pedestrian signal time for the protection of elderly people

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Introduction

The death toll from traffic accidents in Japan in 2010 was reduced to 4,863, which is 51 less than the previous year and it was the tenth consecutive year that traffic accident fatalities have declined. Of the above figure, the number of deaths of elderly people 65 years or older is 2,450, which amounts to almost half of the death toll from traffic accidents. When analyzing fatal traffic accidents of elderly people according to situations, in almost half of the cases (50.1%) the accidents occurred while they were walking, in 23.9% of the cases while they were driving a car, and in 16.7% of the cases while they were riding a bicycle. Therefore, measures to ensure the safety of pedestrians are urgently required.

The UTMS Association's Exploratory Work Group regarding protection of pedestrians including elderly people is actively working for the purpose of proposing measures to reduce traffic accidents of pedestrians involving the elderly. This report will introduce field experiments of a new signal control conducted from 2010 as one of the activities.

Background

Pedestrian signals in Japan consist of a green signal (referred to as PG), a flashing green signal (referred to as flashing green, PF), and a red signal (referred to as PR). The green signal means that crossing the road is permitted, and the red signal means that crossing the road is prohibited. The flashing green signal means that crossing the road should not be

attempted and when a pedestrian is in the process of crossing the road, the pedestrian must quickly finish crossing or quit crossing and return.

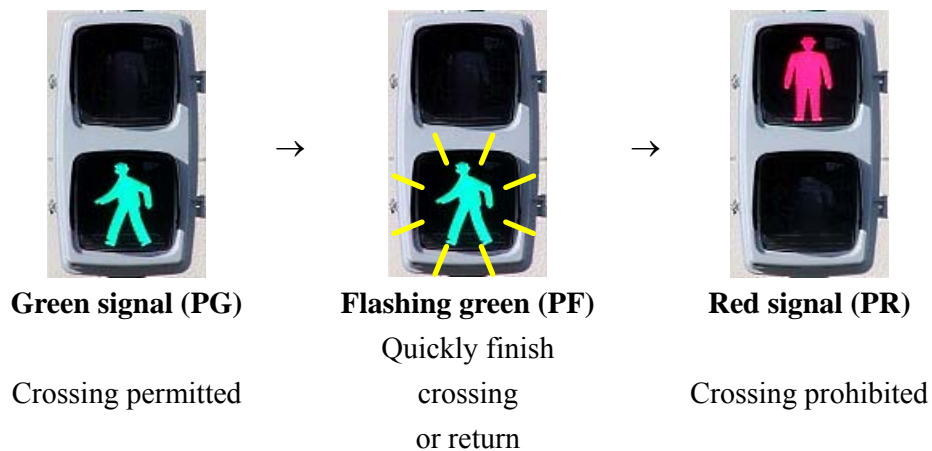


Figure 1. Pedestrian signals in Japan

The number of seconds obtained by dividing the length of the pedestrian crossing by a comparatively slow walking speed (usually 1 m/s) is referred to as the number of seconds for ensuring the completion of crossing. The number of seconds of the green signal time is mostly set greater than the number of seconds for ensuring the completion of crossing, and the number of seconds of the green signal flashing time is usually set at half of the number of seconds for ensuring the completion of crossing so that the pedestrian who has walked across more than half of the length of the pedestrian crossing can finish crossing and the pedestrian who has not walked across half of the length of the pedestrian crossing can return.

However, elderly people and children tend to walk slowly, and when those people start to walk immediately before the green signal stops lighting, they cannot finish crossing the road by the time the green signal finishes flashing and are left in the pedestrian crossing when the signal turns red, which is dangerous.

To avoid the situation, the experiment was conducted by using a video camera to film the pedestrians crossing the road, and when there was a pedestrian who was still crossing the road, the green signal time or the green signal flashing time was extended.

Experiment overview

Intersection used for the experiment

The intersection in Miyazono-cho, Utsunomiya City, Tochigi Prefecture was selected to be used for the experiment.

This intersection is located near the train station at the end of the line and the pedestrian crossing is between two shopping streets. In the district on the other side of the station, there are a lot of hospitals which many elderly people visit and come by train.

Pre-investigation indicates that the number of elderly people accounts for nearly half of the number of pedestrians as shown in Table 1, and some pedestrians could not cross the road before the signal turned red. Therefore, this intersection was considered appropriate for this experiment.

Table 1. Result of pre-investigation

Pre-investigated item	Number of people	Per hour
Number of pedestrians	80	266
Number of elderly people	39(49%)	130
Number of pedestrians who didn't walk across	14(18%)	47



Figure 2. Map of the intersection

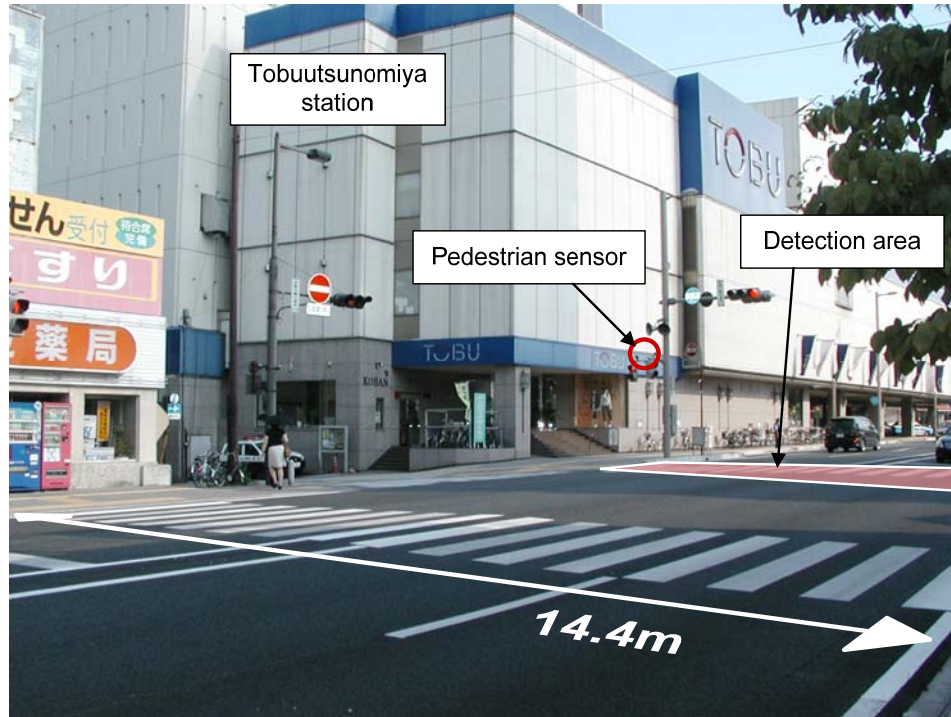


Figure 3. Photo

Configuration of the equipment used for the experiment

The equipment consists of a pedestrian sensor, signal controller, and a lighting apparatus wherein the pedestrian sensor detects pedestrians located in the pedestrian crossing according to the direction of their movement. The presence of a pedestrian crossing the road is transmitted from the pedestrian sensor to the signal controller, and the signal controller extends the green signal time or the green signal flashing time.

Experiment method

There are two possible methods to allow pedestrians to finish crossing the road before the signal turns red: a method to extend the green signal time or a method to extend the green signal flashing time. Of the two, the method to extend the green signal time has been previously conducted at some intersections.

Table 2. Experiment method

Pattern	Extension	Extended signal color	Method
1	No extension	—	Conventional signal
2	Extended	Green signal (PG)	Known extension method
3		Flashing green (PF)	New extension method

In the experiment, the above three patterns were implemented in order to observe behaviors of pedestrians who are crossing the road.

Experiment in extending the green signal time

In this experiment, when a pedestrian is located in the pedestrian crossing, the green signal time is extended until the pedestrian finishes walking across the pedestrian crossing (or up to the extension limit). Since the green signal does not flash while the pedestrian is crossing the road, the pedestrian can continue crossing the road without hurrying. However, another pedestrian may start crossing the road during the extended green signal time; therefore, the green signal time tends to be prolonged.

Experiment in extending the green signal flashing time

In this experiment, when a pedestrian is located in the pedestrian crossing, the green signal flashing time is extended. Of the pedestrians who are crossing the road, pedestrians, such as elderly people, who walk slowly can finish crossing the road while the green signal is flashing.

In those experiments, since the pedestrian crossing is 14.4 meters long, the green signal time was set at 17 seconds, the green signal flashing time was set at 7 seconds, and the extended time for each was set at 3 seconds so as not to affect the smooth traffic flow.

Results of the experiments

Experiment date and investigated items

To verify the effectiveness of the extension of the green signal time and the extension of the green signal flashing time, pedestrians' road crossing situations were investigated from the photos taken by a video camera. Experiment date and investigated items are shown in Table 3.

Table 3. Experiment date and investigated items

Experiment	Date	Time zone	Investigated item
No extension	02/18-21/2011	10:00-14:00	* Pedestrians' beginning and completion of crossing
Extension of PG	03/04-07/2011	10:00-14:00	* Attribute of pedestrians (by age and gender)
Extension of PF	04/15-18/2011	10:00-14:00	* Number of seconds of pedestrian signal time (PG, PF)

Number of samples

Table 4 shows the number of pedestrians according to their age group, gender, and the timing of their beginning and completion of crossing as determined by the video taken.

Table 4. Number of samples

No extension	Gender			Age group					
	Male	Female	Total	Infant	Elementary	Junior & senior high	Adult	Elderly	Total
2/18	226	213	439	0	0	22	353	64	439
2/19	180	226	406	0	5	2	329	70	406
2/20	178	198	376	0	0	3	338	35	376
2/21	151	177	328	0	0	5	269	54	328
Total	735	814	1549	0	5	32	1289	223	1549

Extension of PG	Gender			Age group					
	Male	Female	Total	Infant	Elementary	Junior & senior high	Adult	Elderly	Total
3/4	175	170	345	0	0	0	290	55	345
3/5	162	286	448	0	0	14	346	88	448
3/6	122	162	283	0	0	1	241	41	283
3/7	118	157	275	0	0	5	232	38	275
Total	577	774	1351	0	0	20	1109	222	1351

Extension of PF	Gender			Age group					
	Male	Female	Total	Infant	Elementary	Junior & senior high	Adult	Elderly	Total
4/15	111	285	396	3	0	0	314	79	396
4/16	157	351	508	7	18	53	372	58	508
4/17	447	533	980	38	22	11	818	91	980
4/18	97	230	327	1	0	0	224	102	327
Total	812	1399	2211	49	40	64	1728	330	2211

Implementation status of the green signal time extension and the green signal flashing time extension

Table 5 shows the number of seconds of extension and the number of times (number of cycles).

The implementation percentage of three-second extension (maximum extension) of the green signal time and the green signal flashing time was 87.5% and 55.1%, respectively. With regard to the extension of the green signal time, another pedestrian is considered to be crossing the road during the extended green signal time. The number of seconds of average extended signal time obtained from the following table is 2.7 seconds for the extension of the green signal time and 2.0 seconds for the extension of the green signal flashing time. The extension of the green signal flashing time seems to have less impact on other phases including vehicles.

Table 5. Extension situation by experiment (unit: cycle)

	No extension	1 second	2 seconds	3 seconds	Total
Extension of PG	104	26	38	1180	1348
Extension of PF	580	156	254	1214	2204

Situation of beginning of crossing according to age group

Signal colors at which pedestrians started crossing the road during the experiment period are classified according to age group and shown in Table 6 and Figure 4.

The results indicate that the beginning of crossing at the red signal has been reduced by 3 points for age groups other than the elderly. This seems to be because opportunities to cross the road at the red signal have been reduced due to the extension of the green signal time or the extension of the green signal flashing time.

On the other hand, since elderly people tend to start crossing the road only at the green signal, extension of signal time may not have much impact.

Table 6. Signal color at the beginning of crossing according to age group

Age group	Details of experiment	Signal color at the beginning of crossing			Total
		PG	PF	PR	
All ages	No extension	1420(92%)	69(4%)	60(4%)	1549
	Extension of PG	1294(96%)	49(4%)	8(1%)	1351
	Extension of PF	2094(95%)	88(4%)	29(1%)	2211
Elderly people	No extension	217(97%)	4(2%)	2(1%)	223
	Extension of PG	216(97%)	6(3%)	0(0%)	222
	Extension of PF	319(97%)	9(3%)	2(1%)	330
People other than the elderly	No extension	1203(91%)	65(5%)	58(4%)	1326
	Extension of PG	1078(95%)	43(4%)	8(1%)	1129
	Extension of PF	1775(94%)	79(4%)	27(1%)	1881

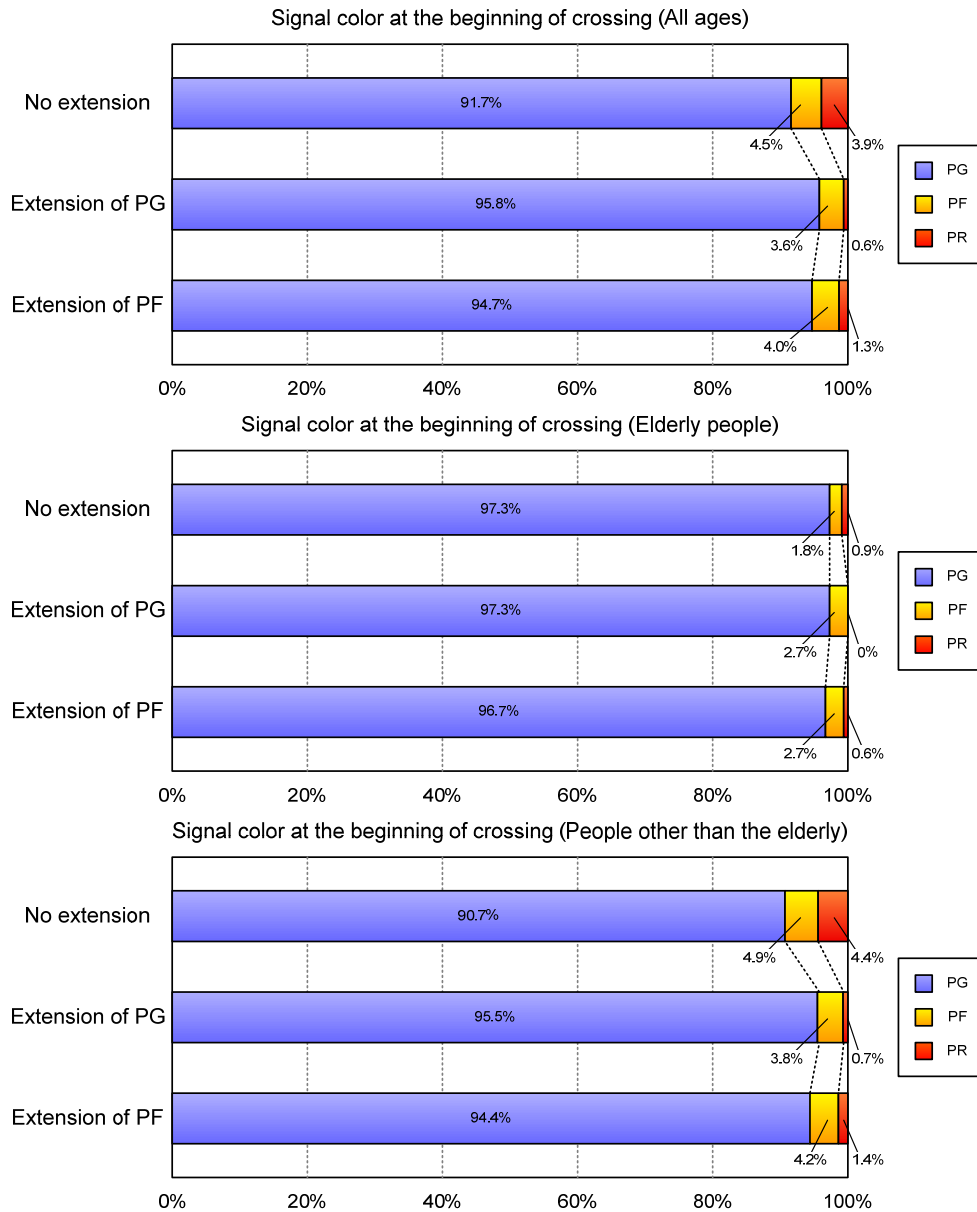


Figure 4. Signal color at the beginning of crossing according to age group

Situation of completion of crossing according to age group

Situation of elderly people finishing crossing the road

Figure 5 shows the time difference between the time at which a crossing is completed and the time at which the signal turns red with regard to elderly people. This graph indicates that the extension of signal time allows elderly people to cross the road at ease.

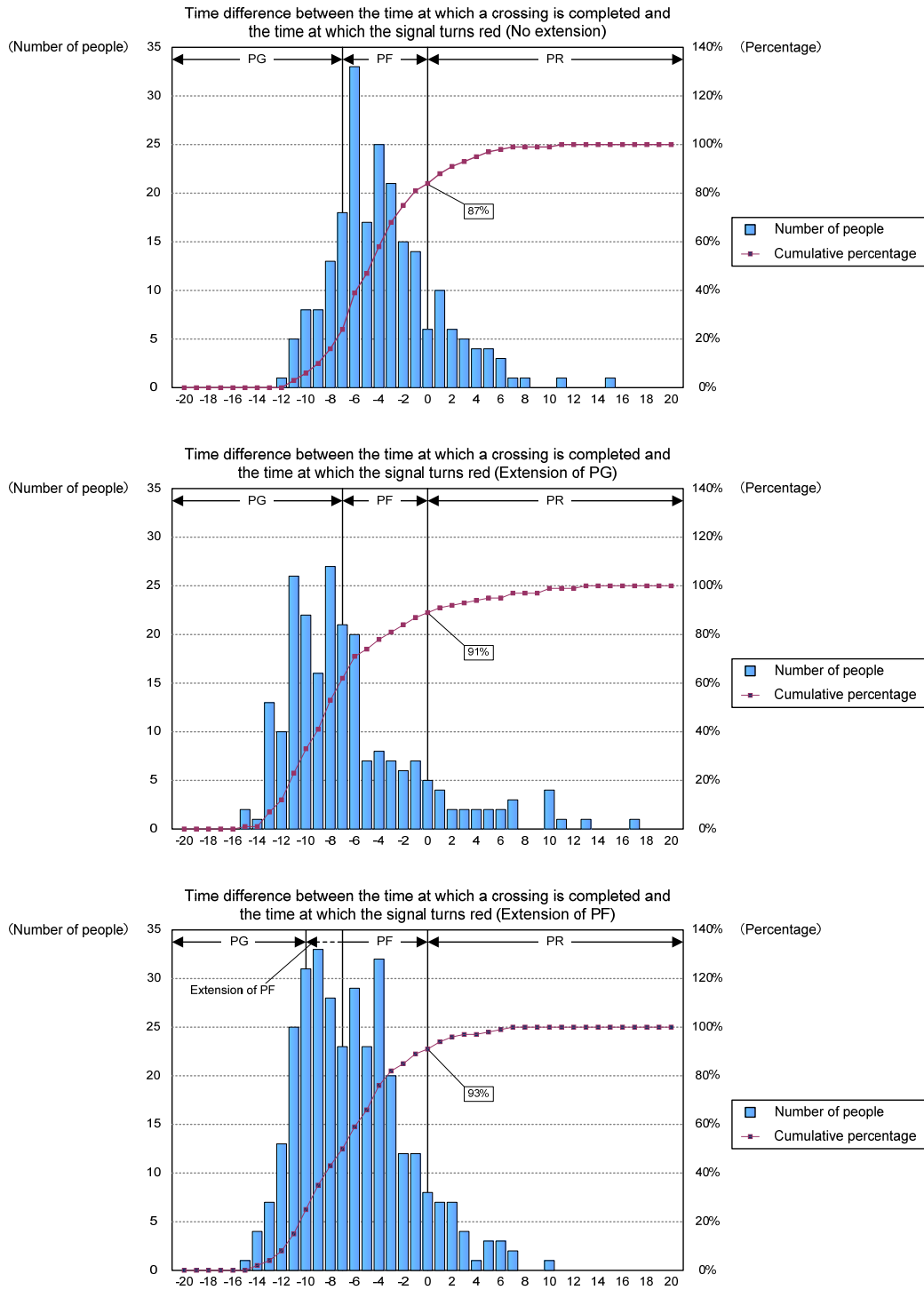


Figure 5. Time difference between the time at which a crossing is completed and the time at which the signal turns red (elderly people)

Situation of people other than the elderly finishing crossing the road

Figure 6 shows the time difference between the time at which a crossing is completed and the time at which the signal turns red with regard to people other than the elderly. By extending the pedestrian green signal time and the green signal flashing time, the peak value was changed from -9 seconds to -11 seconds, which indicates that pedestrians were able to cross the road without rushing.

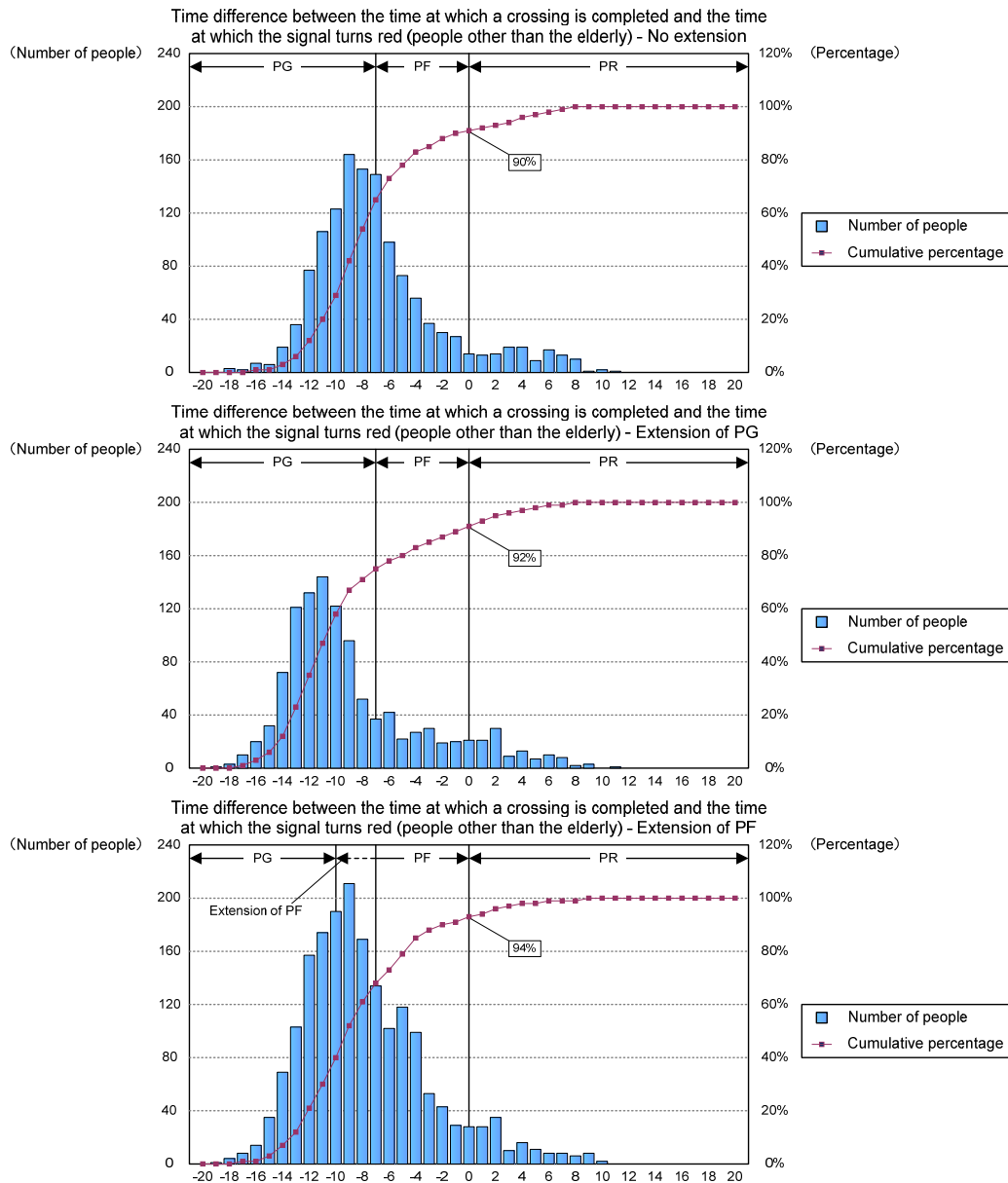


Figure 6. Time difference between the time at which a crossing is completed and the time at which the signal turns red (people other than the elderly)

Pedestrian phase at the completion of crossing according to age group

Signal colors at which time pedestrians finished crossing the road during the experiment period are classified according to age group and shown in Table 7 and Figure 7.

When the signal time was not extended, 13% of elderly people had finished crossing the road at the time the signal turned red. Since the results in the previous section indicate that 97% of elderly people started crossing the road at the green signal, 10% of elderly people could not finish crossing the road by the time the green signal stops flashing although they followed the traffic signal.

In the experiment to extend the green signal time, the percentage of elderly people who finished crossing at the red signal has been reduced by 4 points, from 13% to 9%. In the experiment to extend the green signal flashing time, the percentage of those elderly people has been reduced by 6 points, from 13% to 7%.

This indicates that the reduction rate is greater than that in the case of people other than the elderly, and extending the green signal time or the green signal flashing time is more effective for elderly people.

Furthermore, extension of the green signal flashing time reduces the number of pedestrians who finish crossing the road during the green signal when compared with the extension of the green signal time; however, the results are the opposite when pedestrians who finish crossing the road during the green signal flashing time are included. Consequently, the data indicates that the extension of the green signal flashing time can more effectively prevent pedestrians from crossing the road at the red signal (disregard of signal).

Table 7. Signal color at the completion of crossing according to age group

Age group	Details of experiment	Signal color at the completion of crossing			Total
		PG	PF	PR	
All ages	No extension	1029(66%)	358(23%)	162(4%)	1549
	Extension of PG	1042(77%)	204(15%)	105(1%)	1351
	Extension of PF	1313(59%)	768(35%)	130(1%)	2211
Elderly people	No extension	86(39%)	108(48%)	29(1%)	223
	Extension of PG	158(71%)	44(20%)	20(0%)	222
	Extension of PF	159(48%)	149(45%)	22(1%)	330
People other than the elderly	No extension	943(71%)	250(19%)	133(4%)	1326
	Extension of PG	884(78%)	160(14%)	85(1%)	1129
	Extension of PF	1154(61%)	619(33%)	108(1%)	1881

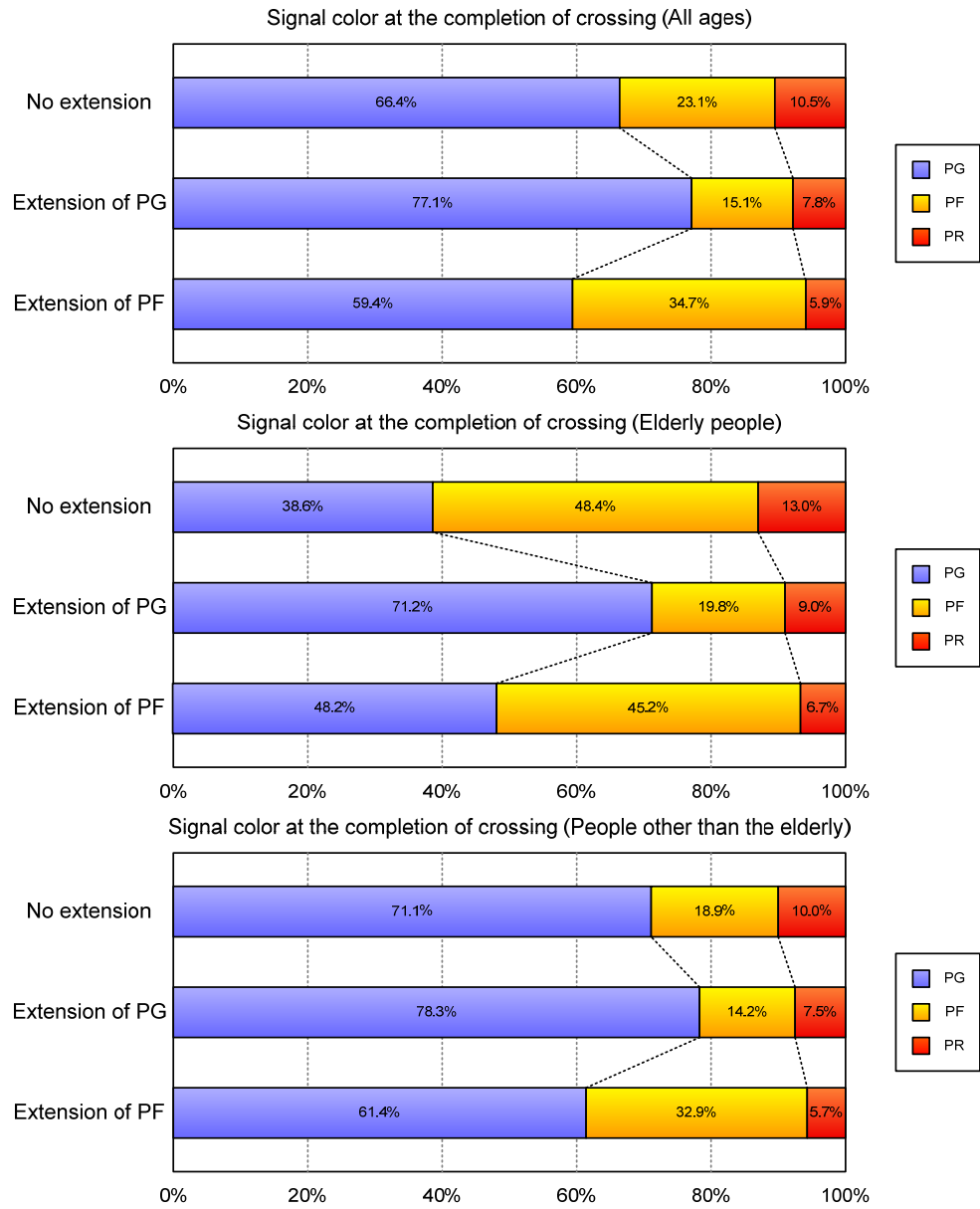


Figure 7. Signal color at the completion of crossing according to age group

Future issues

The above experiments verified that the extension of the green signal time and the extension of the green signal flashing time are effective for protecting elderly people when crossing the road. Although the number of seconds of signal time extension was short, up to three seconds, the number of pedestrians who were left in the pedestrian crossing when the signal turned red was reduced. Since possibility of interference with vehicles is eliminated, reduction of traffic accidents can be expected.

Specifically, when comparing with the extension of the green signal time, the extension of the green signal flashing time is more effective in a short amount of extended time. There is a concern about the extension of the green signal time that has been previously implemented because the extension may affect the smooth traffic flow. However, the extension of the green signal flashing time is expected to inhibit the adverse effect.

Moreover, experiments of the green signal time extension or the green signal flashing time extension were conducted in terms of pedestrian protection; however, it is possible to expand the function so as to reduce the green signal time. When there are no pedestrians detected, reduction of the green signal time may improve the smooth traffic flow. However, more accurate detection of pedestrians is required, and future studies including study of sensor technology are essential.

Future issues involve studies of new signal control methods that can improve smooth traffic flow while ensuring the safety of pedestrians including elderly people.