

Analysis of Relationship between Characteristics of Driver's Eye Movements and Visual Scene in Driving Events

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Abstract— It has been reported in many papers that the number of eye movements increases and the mean fixation durations on individual objects decreases when the road situation becomes more complex. In this paper eye-movement analysis has been used for understanding the mechanism of visual search of drivers. For the aim, two experiments in which the subjects drove the driving simulators have been conducted. We analyzed the relationship between the eye movement of drivers and the characteristics of their front scenes while driving in driving conditions. In the first experiment it was confirmed that the frequency of saccade became higher and fixation time became shorter in case of the turn event condition among three driving events, where the pixel difference extracted as the visual information from the driver's front scene became larger. In the second experiment the same relationship between the characteristics of eye movements and the driver's front scenes were confirmed by considering the three driving events, running straight, turning corners at a crossing and prediction task of hazard in the urban course. The pixel difference of the driver's front scene influenced the eye movements while driving. These results of experiments about driver's cognitive processing while driving suggested that eye movements depends on the amount of information contained in the front scene defined by the pixel difference.

Keywords—Visual perception of driver, eye movement, useful field of vision, visual attention, safety engineering

I. INTRODUCTION

Driving is such a complex task that the drivers must control steering, accurate level, display of going direction by signals every moment based on the configuration around own car, simultaneously. The driving environment has become more complex as the cars increases on the road and also amount of structures as the traffic signs, the eye-catching shop front and advertising billboards are constructed along the road. Then, the drivers visual environment has become more complex [1][2]. In such the complex and restless driving environment, lack of visual attention to the situation of their own car and the other cars causes traffic accidents or crashes. Therefore, the driver must concentrate on the driving task. Keeping the visual attention for the driving environments high level required the resource of the cognitive perception and recognition for the

visual information processing. For example, the driving performance suffered during cell phone and remote passenger conversations as compared with in-car passenger conversations [3]. Since the conversation by the cell phone makes the driver's driving performance decrease and thereby causes the traffic accident, the use of cell phone while driving is prohibited by the law in Japan. A high complex environment on the road is congested with the cars or pedestrians, demands the more cognitive resources for the visual processing in order to keep the car safe.

The eye movements are generated so as to gather the visual information about the driving environment. Informative regions of a scene are fixated for significantly longer than less informative regions [4]. In general, the frequency of saccade and mean fixation durations provide a good measure of the visual attention. Increasing the complexity of the visual scene (by adding vehicles, road furniture, or irrelevant signing), increases the frequency of eye movements and decreases the mean fixation durations on individual objects while driving[5][6][7][8][9]. However, when the driving situations become more dangerous, the presence of a hazard in the scene causes a focusing of attention such that the fixation duration increase, saccade lengths decrease, the spread of search reduces[10]. The policy of visual information processing while driving is different according to the driving situation in order to avoid the traffic accident or risk[11].

A driver must process much visual information while driving a car. For the driving task they gather the meaning visual information of environment by the eye movement. Since the fixation duration and the frequency of saccade which characterize the eye movement depend on the visual scene of driving situation, the eye movement is function of visual scene. Although a lot of factors to effect the eye movement as experience of driving[12], driving situation, the visual scene cause the eye movement in this paper, therefore, it is assumed that the drivers eye movements was a function of visual stimuli of the driver.

In this paper we investigate the characteristics of the eye movements of driver while driving with regard to the driving events and analyze the relationship between the characteristics of eye movements and the peripheral vision. For the aim of present research the eye movements of drivers are measured



(1) A view of driving simulator



(2) A front image of cabin of driving simulator

Figure 1. Driving simulator((DA-DOO: HONDA Motor Co. Ltd.))

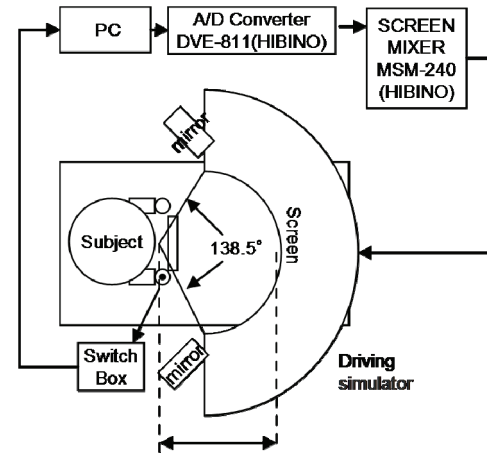


Figure 2. Diagram of DS and devices



Figure 3. Driver wearing eye tracking system in driving simulator

using the driving simulator and the driver's front view on their peripheral vision are recorded. The mean fixation duration and the frequency of saccade of eye movements were summarized as the characteristics in the period of driving events and the difference of the driver's front view were calculated as the index of complexity of the driving task. We attempt to identify the underlying reasons for change of the policy of eye movements according to the driving configuration, such as going straight, turning corner etc., while driving.

This paper is organized as follows: Section 2 describes the experimental methods and equipments, and the configuration of the two experiments. Section 3 describes the results of two experiments about the eye movements and the front view of drivers, and shows the relationship between the eye movement and the front view of drivers. Lastly the final conclusions are presented in Section 4.

II. EXPERIMENTAL METHOD

A. Experimental Equipments

(1) Driving simulator

The automobile driving simulator (DA-D1102: HONDA Motor Co. Ltd.) was used to simulate a driving work. Fig. 1 shows the driving simulator used in this study. This simulator is usually used for driver trainees or novices to learn safe driving techniques. The simulator is implemented on an

advanced 6-axis motion base (sway-motion device) that can simulate closely automobile dynamics in real traffic situations, and visual scenes of driving a road from a viewpoint of the driver is presented on a front screen and three mirror-CRTs. The driver's front view is illustrated in Fig.1 (b). A distance from the front screen to the driver's seat is 1511mm. The front screen is wide and curved so as to surround the driver, and then the driver's visual field is covered by the front screen as shown in Fig.1 (b). The configurations of the driver in the simulator are illustrated in Fig. 2. Using the driving simulator, the driver can drive several kind of driving courses with varying in some kinds of automobile conditions, such as weather and car and human actions (e.g., dashing out in front of a driver's automobile). In this driving simulator two driving modes are selected, the automatic transmission changing mode and the manual transmission changing mode. The automatic mode was used since the driver must concentrate the visual stimuli while driving in the experiments.

(2) Eye movement tracker

During simulated driving, eye movements of the driver and driving road scene were recorded by a head-mounted eye tracking system (EyeLink II: SR Research Ltd., see also Fig. 3). Two eye cameras track right and left eyes respectively. A scene camera on a head band records visual scene that the participant views. In a scene camera either a color or high resolution black and white scene camera is used to generate 30

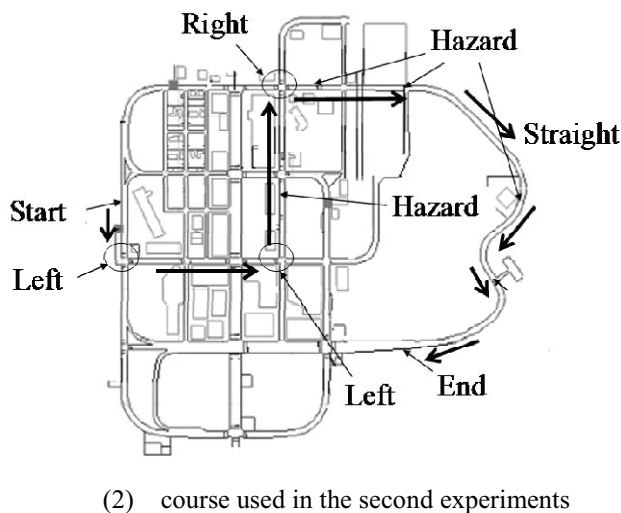
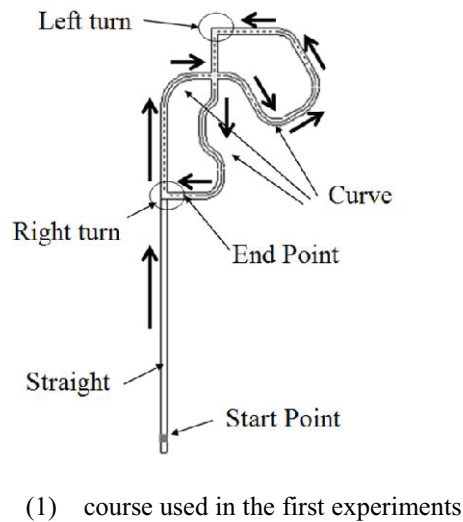


Figure 4 Driving course of driving simulator in first experience.

frames (60 fields) of a scene image per second. The scene image is also streamed to the overlay box, by which participants' gaze position (indicated by a fulfilled circle) is superimposed with the visual scene. The host PC converts gaze position data, obtained by the eye cameras, into position data on the visual scene image captured by the head mounted scene camera. The host PC also analyzes eye movement events in real-time.

B. Participants

Participants were five males, who were 22 aged students of the university. All the participants have regular class automobile licenses in Japan with normal or corrected-to-normal vision. All the participants were given enough explanation for the present experiments and gave informed consents to the experiments before participation. The

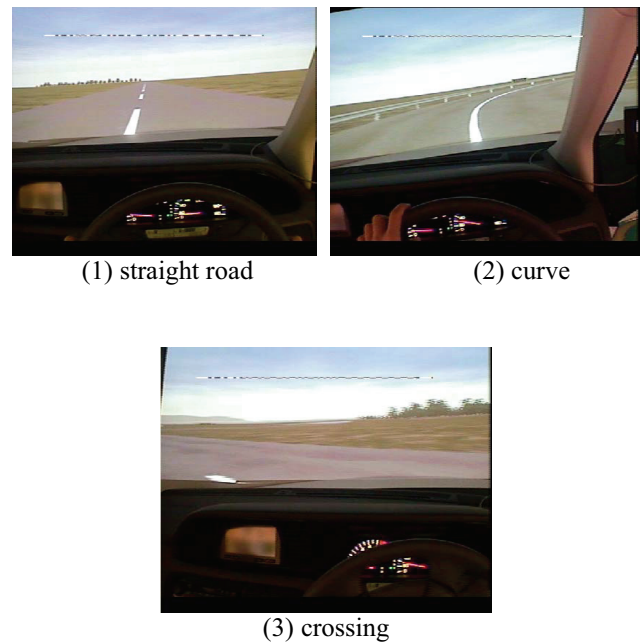


Figure 5 Example screenshot of driving simulator in first experiment.

participants were instructed through a practical lesson and verbal instruction as the driving lessons in the driving simulator.

C. Driving Scene in two experiments

In this paper two experiments with different driving configurations using the driving simulator were conducted in order to investigate the visual information strategy of drivers while driving. The driving configurations of two experiments are changed in the view point of the simplicity of driving scenery and driving velocity so as that the visual task required while driving would be the different level in two experiments.

In the first experiment the driving configuration is set to the situation of driving in a suburb of the city, where there is only road in a wide field without any buildings and traffic facilities, such as shops, traffic equipments and so on. The condition of weather is set to a clear and fine day. The abstract of driving course is shown in Fig. 4(1), in which there are the straight road, curve, and the crossing. The front views in these driving conditions are simple or monotonous sceneries as shown in Fig. 5. In the rural roads situation there are few stationary objects and no moving objects. e.g., no cars and no pedestrians appear on the driving course. In this configuration the drivers see the only road and a distant view as the front scene while driving. Therefore, it is seemed that the cognitive work load of a driver was set relatively lower level in the first experiment since all the driver has to do are only to concentrate the road situation for driving safety.

In the second experiment the driving configuration was set to the situation of driving in the city (urban) on a sunshine day. The visual scenes of drivers on urban roads were more complex or complicated than on the rural ones. The abstract of driving course of the second experiment is shown in Fig.

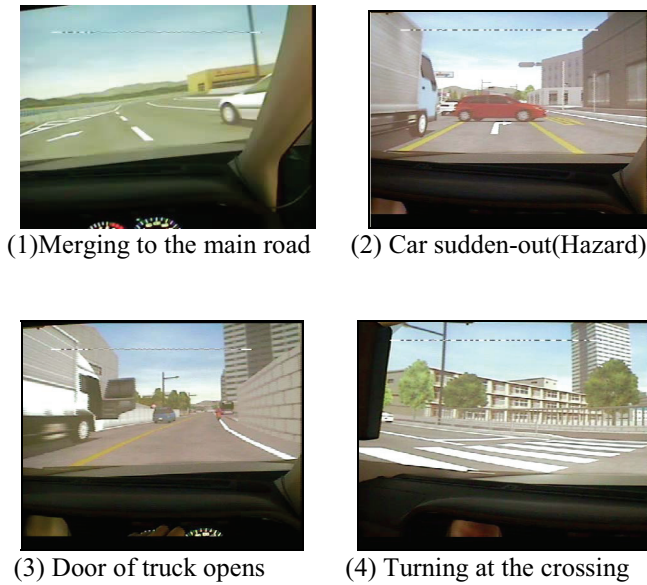


Figure 6 Example screenshot of the front visual scene during second experiment.

4(2) and the front views in these driving conditions are shown in Fig. 6. In this configuration, the pedestrians, the buildings and shop front located along the road and the traffic equipments such as the traffic signs and signal. The moves of other cars and the pedestrians keep step based on the driving scenario in the driving scenes. This driving simulator contains a risk awareness program that is designed to take participants through a route containing several hazards such as children crossing the road and unexpected door open of a parking car. The driving course used in the second experiment contains two hazards, unexpected door open of a parking trailer and sudden crossing of a car as shown in Fig. 4(2). The front view scenes of the second experiment are shown in Fig. 7. The driving environments of the second experiment fall into three categories, normal (driving on a straight road), turn event (turning at crossing and joining to the main road), and hazard event (door open and car sudden-out).

Mentioned above, it was seemed that the cognitive visual resources were required more in the second experiment than in the first experiment since the driver's visual tasks while driving were loaded more in the second experiment. For keeping safety drivers not only have to pay attention the other cars and pedestrians movement consciously, but also have to predict the likely driving events as the pedestrians rush out into the road and the front car suddenly stop every time. In the second experiment the objects and the driving events to be particularly concerned are set as a driving scenario.

D. Procedure

Participants drove the predetermined courses on the DA-D1102 driving simulator wearing the eye tracking camera (see Fig. 3). After calibration of the eye tracking system they were

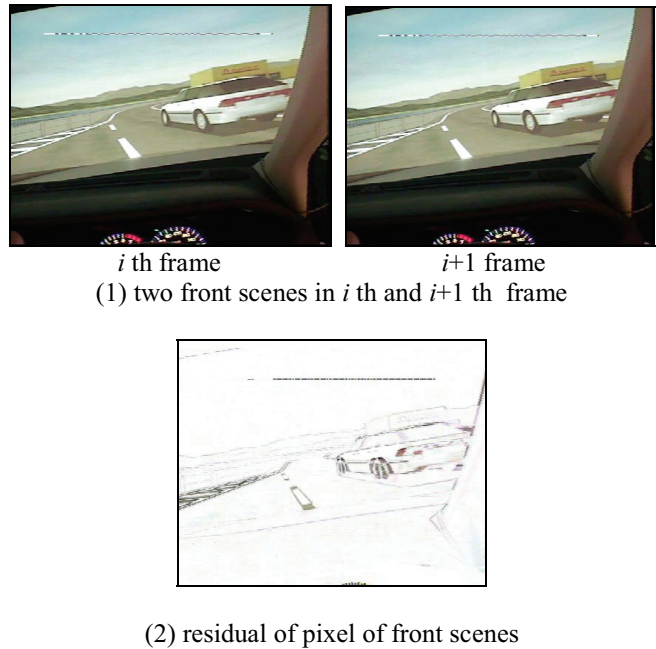


Figure 7. Residual picture of driver's front scene while driving

seated at the simulator and asked to adjust the seat. The participants were instructed to drive the predetermined course as they would do normally and follow the traffic regulations.

In the first experiment the participants drove the course in a suburb of the city at the predetermined speeds, 30 km/h or 60 km/h. Since it was difficult to turn the corner in the crossing at the predetermined speed, they were instructed to reduce the car speed so as to turn the corner well in the crossing. Although the driving speed was not kept at predetermined speed, the driver had to be encouraged to speed up the car to the predetermined speed 30 km/h or 60 km/h in the driving course. Therefore, it was seemed that the driver's cognitive mental workload while driving at 60 km/h is larger than at 30 km/h.

The iteration number of trials was three in each speed condition for each participant. In a trial at the predetermined speed a driver drove the course three times. After calibration of the eye tracker the participants drove the predetermined course three times at 30km/h speed condition, and then did it three times at 60km/h speed condition. The next trial was performed after the intervals of several minutes as a rest and last trial was done with same procedure. While the driving experiments using the driving simulator eye movements of the participants were measured and the front view of them were recorded in digital video. The characteristics of eye movement such as the saccade and fixation were extracted from the recorded eye movement data after the all trials were completed.

In the second experiment the participants were asked to drive the simulator on the predetermined course with the current of the other car. The iteration number of trials was three. In a trial they drove once around the course as shown in Fig. 4(b). The task to keep the predetermined speed was not imposed to them since it is difficult to keep the fixed velocity due to a lot of

TABLE I. SAMPLES OF TIME SEQUENT OF EVENT PERIOD (SUBJECT A)

(1) Time sequence of an event period in an experiment 1.
(sec)

Event	period		Event	period	
	30km/h	60km/h		30km/h	60km/h
Straight	45.69	24.12	Straight	11.74	6.90
Curve	11.98	5.67	Curve	10.85	5.61
Straight	3.91	2.54	Straight	4.30	2.53
Curve	5.44	2.80	Curve	6.27	2.70
Straight	3.48	2.40	Straight	4.37	2.34
Curve	18.09	10.27	Curve	21.19	10.31
Straight	4.12	2.71	Straight	4.94	3.01
Curve	5.80	2.30	Curve	5.91	2.50
Straight	9.08	4.90	Straight	8.91	5.51
Turn(Left)	2.94	6.59	Turn(Left)	4.44	3.95
Straight	9.51	4.22	Straight	9.32	4.06
Curve	24.83	15.38	Curve	25.85	14.85
Straight	3.67	2.81	Straight	3.40	2.54
Turn(Right)	3.74	3.87	Total	273.77	157.39

(2) Time sequence of an event period in an experiment 2.
(sec)

Event		Event	
Straight	15.42	Straight	5.85
Turn(Right)	6.00	Hazard	6.00
Straight	12.85	Straight	6.71
Turn(Right)	6.00	Hazard	6.00
Straight	13.59	Turn(Right)	6.00
Turn(Left)	6.00	Straight	14.63
		Total	105.05

events. In the second experiment the driving. The participants were same with ones of the first experiment, but the second experiments were carried out on the different day with the first experiment because of the fatigue of participants.

E. Extract of characteristics of eye movement and front view while driving

In these experiments eye movements of drivers were measured while driving in two road conditions. For considering the relationship between the eye movements and the peripheral vision, the characteristics of eye movements and peripheral vision should be extracted from the eye movement data and driver's frontal scene during the experiments. Generally speaking, the frequency of saccade and mean fixation durations provide a good measure of the visual attention. The frequency of saccade and mean fixation duration were extracted as an eye movement property in each period according to the driving events.

The difference of gray levels between two pictures represents the edge of objects. In Fig.7 shows the two consecutive frame images and the picture representing the gray level difference of them. The increase of the gray level

difference means that the number of objects in the visual scene increases and the complexity of the visual scene for the driver becomes higher level. This index for the complexity of the front scene of a driver was defined using the difference of the front picture, and the relationship between this index and driver's eye movements are discussed through the results of experiments. The visual information of the front scene was quantified based on the pixel change of them. The i -th quantity of the pixel change of the picture is defined by the difference of pixel-value between i -th frame image and $(i+1)$ -th frame image included in the front view. In the total quantity of the difference of each frame included in a period of driving event is calculated by summation of the difference value in each frame. This total gray level difference of frame image was defined as the characteristics of the front scene in the period according to the driving task.

In the first experiment three categories of driving events, running straightly on the course, running curve along course and turning the corner at the crossing, were considered as the task seemed to be required the different cognitive level. The characteristics of the eye movements and the front scene of drivers were calculated in case of the periods according to the three categories about driving tasks in two speed condition, 30 km/h and 60 km/h. In the second experiment, the periods of three driving categories, operation of running straightly, operation of turning the corner in the crossing and hazard prediction event, were determined in the driving course. The driving task periods of the turning operation and hazard prediction were set to 6 sec, 3sec before the event and 3sec after the event. The start time and end time of period was determined so as to center the driving event on the middle of the period.

III. EXPERIMENTAL RESULTS

A. Time period of driving events

The frequency of saccades and mean fixation duration were recorded as the characteristics of eye movements of drivers while driving. For the aim to investigate the eye movement while driving in relation to the front scene, the driving scenes were categorized into three driving events. Thus, the segments of the driving were determined so that these measures were summarized in three kinds of driving events according to the three road situations. The examples of time sequent of the events and the period time are shown in TABLE I. The time sequence of driving events was different between the subjects because of the difference of the car speed of each subject, and also the driving event periods were different with ones of other subjects.

In the first experiment the whole course was divided into three categories and the start and end times of the period corresponding to the three driving events were identified in each trial by analyzing the recorded front scene video. An example of the event period was one in the first trial driving of subject A which was shown in TABLE I (a). The total time for driving the course in 30km/h and 60km/h was 273.77sec and 157.39sec, respectively. 7 straight road events, 10 curvature events and 3 turning events were contained in the one driving trial. The driving trials were repeated three times. The average

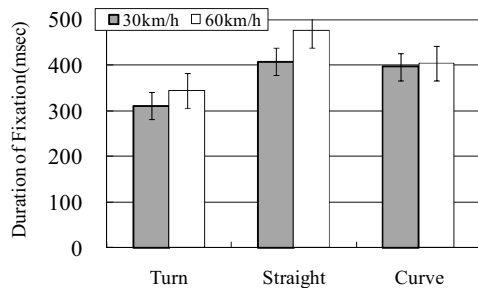


Figure 8. Mean fixation duration in first experiment.

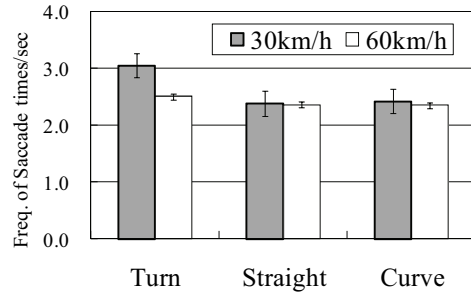


Figure 9. Frequency of saccade in first experiment.

of the frequency of saccades and mean fixation duration during the same events were summarized in each subject.

In the second experiment the driving event periods were also identified by analyzing the scene video, running straight, turning at a crossing, and prediction of hazard. The period time of the turning operation and prediction of hazard was fixed as 6sec. The example of the driving task period in the second experiment is shown in TABLE I (b).

B. Results of first experiment

(1) Eye movement while driving events

The eye movements of five subjects were recorded while driving in the suburb course in the first experiment. The characteristics of eye movements in three driving events, straight event, curve event and turn event, were summarized as the results of eye movements. The mean fixation duration and the frequency of the saccade in each driving event are illustrated in Fig.8 and Fig.9, respectively. The mean fixation duration in left or right turning at a crossing was shortest among the three events, and the one in driving on the straight road was longest in both 30km/h and 60 km/h conditions. While, the frequency of saccade in left or right turning at a crossing is highest and one while driving at a straight road is lowest. The same tendency of eye movements while the driving events was similar to the result of the subjects.

The results of one way ANOVA with respect to the traffic event conditions are shown in TABLE II (1) and (2). For the mean fixation duration, the significant main effects of the driving events were detected in four subjects except "subject E" in 60km/h speed condition. For the frequency of saccade, the significant main effects of the traffic events were detected in four subjects except "subject E" in both speed conditions.

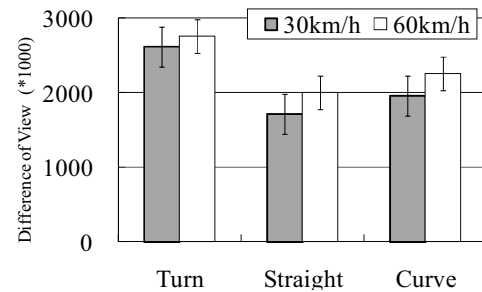


Figure 10. Difference of front view of drivers in first experiment.

TABLE II. RESULTS OF ANOVA FOR EYE MOVEMENT WITH RESPECT TO TRAFFIC EVENTS.

(1) Results of ANOVA for the duration of fixation.

subject	30km/h		60km/h	
	<i>F</i> (2,78) value	<i>p</i> value	<i>F</i> (2,78) value	<i>p</i> value
A	4.84	0.01*	3.99	0.022*
B	1.83	0.16	4.54	0.013*
C	2.69	0.074	4.05	0.002*
D	1.95	0.14	4.95	0.009*
E	0.22	0.79	0.17	0.83

note : * means that the significant effect is detected

(2) Results of ANOVA for the frequency of saccade.

subject	30km/h		60km/h	
	<i>F</i> (2,78) value	<i>p</i> value	<i>F</i> (2,78) value	<i>p</i> value
A	21.5	<0.0001*	3.99	0.018*
B	5.53	0.0056*	4.54	<0.001*
C	6.9	0.0017*	4.05	0.0069*
D	5.65	0.005*	4.95	0.0057*
E	1.33	0.26	0.17	0.28

note : * means that the significant effect is detected

(2) Pixel difference of front scene as index of complexity

In this paper the complexity of the visual scene were defined by the ever-changing front view of driver as shown in Fig. 7. The increase of the gray level difference means that the number of objects in the visual scene increases and the complexity of the visual scene for the driver became higher level. The gray level difference of the front scene of subjects during the experiment were calculated and summarized in each traffic event as shown in Fig. 10. The average of the gray level difference of the front scene during the period of each traffic event is illustrated. The gray level difference in turning at the crossing is larger than one in the other events, driving on the straight road or curvature. The same tendency of front scene while the driving events as each other is confirmed in each result of the subjects.

(3) Comparison between characteristics of eye movement and the complexity of front view

For considering the relationship between eye movement and the front scene, the correlation coefficients between the

TABLE III. CORRELATION BETWEEN CARACTORISTICS OF EYE MOVEMENTS AND DIFFERENCE OF PICTU IN FIRST EXPERIMENT.

Subject	trial	30km/h		60km/h	
		Fixation duration.	Frequency Sac.	Fixation duration.	Frequency Sac.
Sub-A	1	-0.376	0.762	-0.359	0.579
	2	-0.445	0.689	-0.224	0.403
	3	-0.506	0.39	-0.240	0.18
Sub-B	1	-0.230	0.291	-0.205	0.359
	2	-0.205	0.224	-0.461	0.633
	3	-0.323	0.427	-0.385	0.515
Sub-C	1	-0.137	0.057	-0.273	0.389
	2	-0.438	0.655	-0.096	0.216
	3	-0.260	0.292	-0.128	0.087
Sub-D	1	-0.397	0.548	-0.491	0.682
	2	-0.202	0.346	-0.462	0.669
	3	-0.227	0.402	-0.076	0.155
Sub-E	1	-0.174	0.066	-0.523	0.512
	2	-0.009	0.235	-0.471	0.607
	3	-0.303	0.141	-0.130	0.041

difference of pictures and gazing time, times of saccade were calculated as shown in TABLE III. Even though there exists the variance the positive correlation between the frequency of saccade and the difference of front scene and the negative correlation between the mean fixation duration and the difference were detected for all subjects. These results suggest that the change of peripheral vision influences the visual information processing while driving and consequently causes the quick and instantaneous eye movements, and also, this busy eye movements were required to compensate the lack of visual information to keep the vehicle safe.

C. Results of second experiment

(1) Eye movement while driving events

In the second experiment the eye movements of five subjects were recorded while driving in the city course, in which several events were prepared containing the two hazard events provided by the risk awareness program of the driving simulator. The analyzing periods were defined with three categories, normal (driving on a straight road), turn event (turning at a crossing and merging to the main road), and prediction event of hazard (door open and car sudden-out). The characteristics of eye movements in three driving events were summarized as the results of eye movements. The mean fixation duration and the frequency of the saccade while each driving event are illustrated in Fig.11 and Fig.12, respectively. The ANOVA of frequency of saccadic eye movement and fixation time while the driving with respect to the driving events were conducted and significant effect were confirmed as shown in TABLE VI.

(2) Pixel difference of front scene as index of complexity

The gray level difference of the front view of subjects during the experiment were calculated and summarized in each traffic event as shown in Fig. 13. The average of the gray level difference of the front view during the period of each traffic event is illustrated. The mean fixation duration became longer in order to "Straight", "Turn", and "Hazard". The frequency of

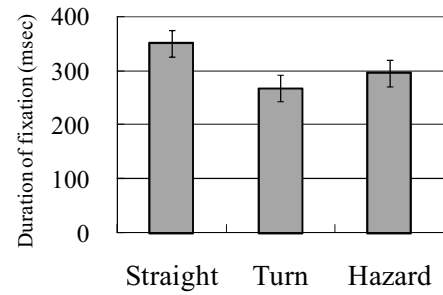


Figure 11. Mean fixation duration in second experiment.

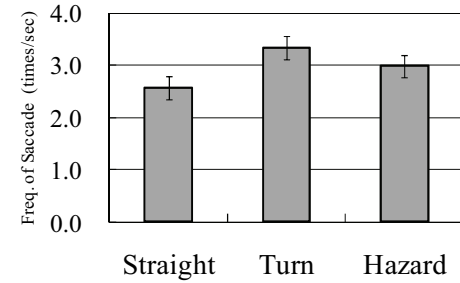


Figure 12. Frequency of saccade in second experiment.

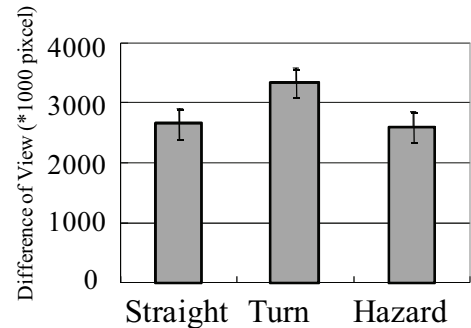


Figure 13. Difference of front view of drivers in second experiment.

saccade and the difference of the view became larger in the reverse order. The gray level difference in the turn event is larger than one in the other events.

(3) Comparison between characteristics of eye movement and the complexity of front view

It was confirmed that the relationship between the eye movements and background view also existed in case of the drive of the city course except the hazard situation. In the hazard situation the relationship between them were different with one in the normal driving situation since the eye movement was caused by the different mechanism. The correlation coefficient between the two kinds of characteristics of eye movements and the front scenes were shown in TABLE V. In a lot of driving trials the correlation between them were confirmed.

D. Discussion

In general, the frequency of saccade becomes higher and the duration of fixation became longer in the more complicated

situation so as to get more information from environment. However, the saccadic movements are required frequently so as to get the information around own car for avoiding the accidents, therefore, the fixation duration of drivers became shorter [5][6][8]. Considering these results about characteristics of eye movements while driving in the first experiment, the results of the first experiments suggested that the complexity of the front views in the three traffic events were different, and the traffic events effected the eye movement of drivers. In other words, the results of the first experimented that the driving operation on the straight or curve road was an easier task for the driver than the one on the turning operation at the crossing since the frequency of saccade became smaller and the duration of fixation became longer.

In the second experiment, the differences of the properties of eye movements among the driving events were not detected significantly by the ANOVA as shown in TABLE IV. The correlation between the characteristics of eye movements and the front scene was confirmed as shown in TABLE V. It was reported as “focusing of attention” that the mean fixation duration became longer than the normal situation in the hazard situation [3]. Thus, since the hazard situation required the more visual resources to keep safe or occupied the visual attention, the relationship between eye movements and the front scene was not detected in the hazard situation.

IV. CONCLUSION AND FUTUREWORK

In this paper, the two driving experiments were conducted on the course in rural area and urban area, in which the driving events, such as running straightly or turning at the crossing, were contained. The different amount of cognitive resources of drivers was required according to the driving events to keep the car safe in these experiments. After driving experiments, the characteristics of eye movements and the driver's front scene corresponding to the driving events were extracted from the eye movement data and the recorded video. The present study illustrated the relationship between the characteristics of eye movements and the front scene. The larger became the frequency of eye movements, the larger became the extracted characteristics of the scene video in two experiments. These results suggested that when the index defined by the difference of pixel in the front scene became larger, the eye movement might be generated more frequently.

In this paper the characteristics of the front scene were simply defined by the difference of pixel contained in it. It is the future work to consider the index of their attention in relation to the eye movements.

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TABLE IV. RESULTS OF ANOVA FOR EYE MOVEMENT TO DRIVING EVENTS.

subject	Duration of Fixation		Frequency of Saccade	
	F(2,78) value	p value	F(2,78) value	p value
A	2.93	0.060	5.62	0.008*
B	2.41	0.100	2.28	0.110
C	4.56	0.093	6.65	0.004*
D	2.55	0.38	4.49	0.013*
E	0.97	0.0001*	2.01	0.140

note : * means that the significant effect is detected

TABLE V. CORRELATION BETWEEN CHARACTERISTICS OF EYE MOVEMENTS AND DIFFERENCE OF PICTU IN SECOND FIRST EXPERIMENT.

Subject	trial	Fixation duration	Frequency Saccade
Sub-A	1	-0.544	0.549
	2	-0.623	0.731
	3	-0.579	0.57
Sub-B	1	-0.370	0.229
	2	-0.508	0.61
	3	-0.238	0.119
Sub-C	1	0.306	-0.255
	2	-0.605	0.674
	3	-0.458	0.537
Sub-D	1	-0.568	0.554
	2	-0.503	0.571
	3	-0.617	0.692
Sub-E	1	-0.466	0.524
	2	-0.842	0.887
	3	-0.585	0.705

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