

A STUDY ON USER SATISFACTION ANALYSIS FOR DEW OCCURRENCE ROAD SIGN

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ABSTRACT

Road signs give instructions or provide information for drivers to select route or destination. However, at the night of season/day with large daily temperature range such as winter, dew occurs on road signs and main place names on the road signs appear black, which can disperse the driver's field of vision to increase the possibility of traffic accidents.

In this study, we performed a preliminary study for the preparation of measures and prevention of traffic accidents that can occur in the severe winter season/day with large daily temperature range. The misreading rate of dew occurrence road signs was investigated, and an ANOVA test was conducted to analyze the satisfaction degree of volunteers by the type of dew appeared on road signs.

The analysis results of the misreading rates showed the average misreading rate for the road sign without dew was 2.8%, and that for the dew occurrence road sign was 21.7%. Also, the satisfaction degree by the type of dew occurrence was 7.12(Spot-Pattern), 4.52(All-Pattern) and 4.14(Line-pattern). The differences in the satisfaction degree by the type of dew occurrence were statistically significant.

1. INTRODUCTION

Road signs give instructions or provide information for drivers to select route or destination. Although navigation systems are installed in many vehicles in recent years and acting as a secondary means of providing information, road signs serve as a primary role of providing information in the field for the original functionality of public infrastructure.

The 'Regulation of Road Sign Installation' describes the installation and functions of road signs, specifying 'Letters, symbols and background should be reflected well to be clearly read at night'[1], and in particular, they also should provide the function of providing information regardless of season, time(day/night) and weather conditions. However, at the night of season/day with large daily temperature range such as winter, dew occurs on road signs and main place names on the road signs appear black, which can disperse the driver's field of vision to increase the possibility of traffic accidents.

In this study, we performed a preliminary study for the preparation of measures and prevention of traffic accidents that can occur in the severe winter season/day with large daily temperature range. The misreading rate of dew occurrence road signs was investigated, and an ANOVA test was conducted to analyze the satisfaction degree of volunteers by the type of dew appeared on road signs, presenting the results of the analysis.

This study reviewed the domestic and abroad studies regarding dew occurrence and legibility. Kum et al.(2005) measured legibility time in order to analyze driver's response in accordance with VMS message using 3D-simulator [1]. Kang and Kim (2010) presented a result that the wind of 6-8m/s pushes down the temperature by 5-10°C through a performance test of anti-dew in window by air blast[2]. Kindron (2005) tested the angle where dew and dew condensation occurred and the influence of contact angle and then presented a result that the lower the angle, the higher the amount of dew condensation [3]. Kindron (2010) measured the amount of dew according to the roughness of surface and the production position. The dew amount was measured by suing CPM (Cloth Plate Method) and it was found that the lower the roughness, the more the amount of dew. In addition, he presented a result that the dew amount increased in proportion of the height and size of specimen [4]. Kim et al.(2007) used driving simulator in order to develop model of legibility-time for VMS Message [5]. No et al.(2008) analyzed reaction of road sign contents for elderly people and difference in generation[7].

2. RESEARCH OVERVIEW

2.1. The Problem of Dew Occurrence on Road Signs

Dew is the phenomenon in which atmospheric moisture condenses into small droplets on the surface of objects. Dew is known to occur mainly at the night of the season or day with large daily temperature range. The analysis results of the average daily temperature range and average dew point performed in this study by using the weather data collected from the ground observation point during four years (2008-2011). Figure 1 showed the average daily temperature range was high and the dew point at which dew started to form was low in the winter seasons including spring/fall

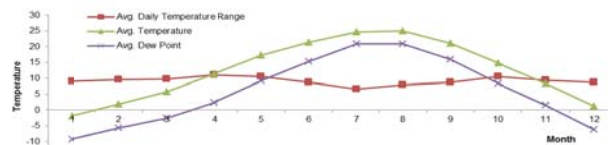


Figure 1 - The average daily temperature range

When dew occurs on road signs, scattered reflection occurs due to the problem of retro-reflection (the phenomenon of the light from the headlights of vehicles being reflected by the reflective surface of road signs and being redirected back to the source). In other words, the light from the headlights of vehicles on the green reflective surface of road signs is not accurately reflected to be scattered causing the problem of signs being looked black, as shown in Figure 2.



Figure 2 – Examples of dew occurrence road sign

When such dew occurs at night, the provision of road guidance information to the driver becomes significantly lower than at daytime, resulting in the difficulty in accurate reading of the contents of signs. It means the cognitive processes in the perception-reaction processes (PIEV: Perception-Identification-Emotion-Volition) of the driver is degraded or disabled. The increase in the perception-reaction time due to the degraded cognitive process is highly associated with the risk of traffic accidents and induces high possibility of accidents particularly in highway cross section for road interchange such as highway off-ramp. Therefore, due to the need of the analysis on the dew that can occur in the season (winter, etc.) or day with high daily temperature range, relevant information was dealt in this study.

2.2. Research Outline

Using the photos of dew occurrence road sign, the misreading rate and satisfaction degree were tested on total 82 volunteers. Volunteers consisted of 37 males (45.1%) and 45 females (54.9%), distributed by 20's (n = 26), 30's (n = 26), 40's (n = 15), 50's (n = 9) and 60's (n = 6). The configuration of the volunteers who participated in the study is presented in Figure 3.

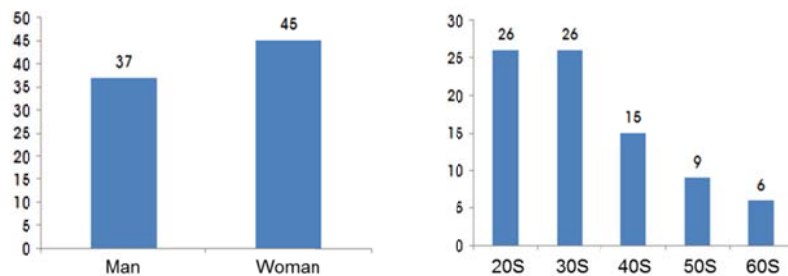


Figure 3 – Configuration of the volunteers

In this study, whether the volunteers can read dew occurrence road signs correctly was defined as a misreading rate. A black region where the disabled zones of retro-reflection appeared due to dew was select as ROI (Region of Interest), and the brightness of the selected region was measured and analyzed. A road sign without dew was presented three times (scenarios 1, 2, 3) to the volunteers and a road sign with dew was presented five times (scenarios 4, 5, 6, 7, 8). Based on the results of previous studies in which the reading time was set to 0.5~1 sec per unit of information, the subject signs were presented for 1 second to the volunteers.

Further, for the satisfaction degree of the volunteers on the type of dew occurrence, the dew occurrence road signs were classified into three types (all-pattern, line-pattern, spot-pattern) according to the type of dew occurrence and each type was presented to the volunteers. The type of all-pattern represents a road sign with most parts appearing black due to the disabled phenomenon of retro-reflection by dew, the type of line-pattern with major place names appearing black, and the type of spot-pattern with part of a road sign appearing black. With the Likert scale set to 10 points, the satisfaction degree for the road signs by the type of dew occurrence was chosen and analyzed using an ANOVA test. In the figure 4 shown are the cases for the three types.

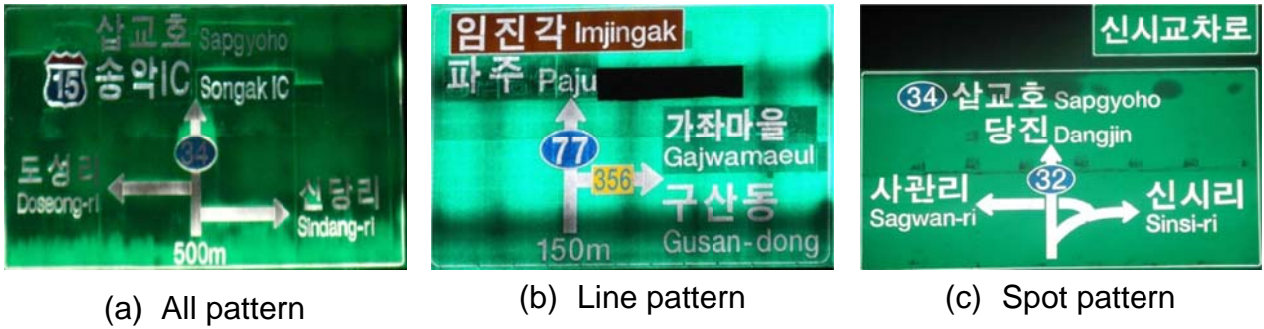


Figure 4 – Road sign type of dew occurrence

3. RESEARCH RESULT

The analysis results of the misreading rates showed the average misreading rate for the road sign without dew was 2.8%, and that for the dew occurrence road sign was 21.7%. In the figure 5 and table 1 presented are the analysis results of the misreading rates for the road signs. The misreading rate in the range of 70-80 brightness was 11-20% and that in the range of 100-110 brightness was approximately 32%. Thus, when a road sign appears black due to the disabled phenomenon of retro-reflection caused by the dew occurred on a road sign, we can conclude that the misreading rate indicating a driver does not recognize the place names on the road sign increases.

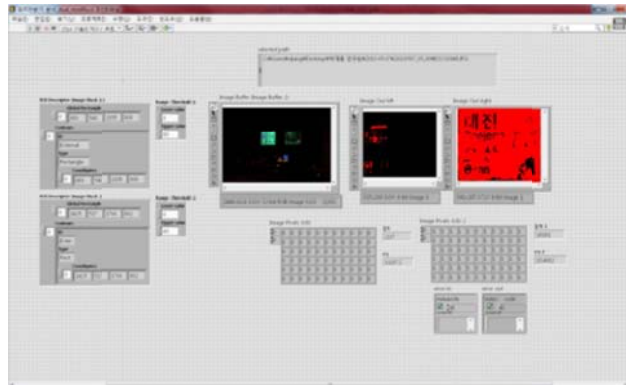


Figure 5 – Result screen of dew occurrence region extraction

Table 1. Result of the misreading rates for the road signs

Scenario	Brightness	Misreading rate (%)
# 1	-	2.5
# 2	-	3.7
# 3	-	2.5
# 4	77	19.8
# 5	76	14.8
# 6	70	11.1
# 7	100	32.1
# 8	109	32.1

The analysis results of the satisfaction degree by the type of dew occurrence showed demonstrated the satisfaction degree on the type of spot-pattern was average 7.12 points and those on the types of all-pattern and line-pattern were 4.5 and 4.14 points, respectively. Also, as the results from the ANOVA test, the differences in the satisfaction degree by the type of dew occurrence were statistically demonstrated with a p-value of 0.00. Further, the Post Hoc Analysis was conducted and the results were represented by each type of the group (spot, all and line). In the table 2 shown were the results from the ANOVA test and Post Hoc Analysis.

Table 2. Result of ANOVA test

	S.S.	D.F.	M.S.	F	Sig.
Between	431.47	2	215.74	77.34	0.00
Within	677.87	243	2.79	-	-
Total	1109.34	245	-	-	-

Table 3. Result of Post Hoc Analysis

	N	Tukey HSD		Duncan	
		Group 1	Group 2	Group 1	Group 2
Line pattern	82	4.14	-	4.14	-
All pattern	82	4.52	-	4.52	-
Spot pattern	82	-	7.12	-	7.12
P-value	-	0.31	1.00	0.14	1.00

From the results above, we can conclude the satisfaction degree of the volunteers is low, regardless of dew occurrence area, in the road signs with, especially the road signs of which dew occurred on major place names, which implies that dew occurrence road signs act as a negative impact on the visibility and satisfaction degree of drivers.

4. CONCLUSIONS AND FURTHER STUDY

Road signs give instructions or provide information for drivers to select route or destination. However, at the night of season/day with large daily temperature range such as winter, dew occurs on road signs and main place names on the road signs appear black, which can disperse the driver's field of vision to increase the possibility of traffic accidents. In this study, we performed a preliminary study for the preparation of measures and prevention of traffic accidents that can occur in the severe winter season/day with large daily temperature range. The misreading rate of dew occurrence road signs was investigated, and an ANOVA test was conducted to analyze the satisfaction degree of volunteers by the type of dew appeared on road signs.

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road signs of which dew occurred on major place names, which implies that dew occurrence road signs have a negative impact on drivers.

For the ongoing development of the study, following further studies are needed. In this study, we analyzed the misreading rates of volunteers using the photos of dew occurrence road signs, not in actual driving conditions. Therefore, future research is needed for the comparison of the results of this study and the time taken to recognize road signs and to react by drivers under actual on-road driving conditions. Further, we considered only age and the brightness of photos as the conditions that affect in recognizing the contents of road signs. However, in future research, with further consideration of the conditions including personal characteristics, information and stimulus quality, the reading time and misreading rate are to be analyzed. The results obtained from this study are expected to be utilized in future studies which deal with the preventive measures for the problems occurred in the case of dew occurrence on road signs.

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