J-006

Comparison of In-Vehicle Navigation Guidance by Fixed-Spot, Voice and Gazing-Point

Mohammad Abdullah Almogbel*　Pao Sriprasertsuk*　Mutsumi Suganuma*　Wataru Kameyama*

1. Introduction

Recent in-vehicle technologies can provide us with a great deal of comfort and convenience while driving. Satellite navigation systems with GPS devices have seen a huge change in the last decade, in terms of interface, accuracy, processing speed and so on. However, using such devices requires drivers to take their eyes off the roads frequently, especially in unfamiliar places which they have never driven before. Car and GPS manufacturers have developed different ways of displaying navigation guidance information in-vehicle. In our research, we have created a new method of displaying guidance information that utilizes the gazing-point of the drivers, and then we compare it with two already existing methods; voice guidance and fixed-spot guidance.

The goal of our research is to observe and analyze the driver's stress levels and the eye gaze movements under the three mentioned methods, and eventually finding out what is the safest and most efficient method amongst them.

The main elements of our test-bed shown in Fig. 1 are as follows:

1 Driving simulator: "City Car Driving"[1] is a low cost driving simulator game that uses advanced car physics to achieve a realistic car feeling.
2 Logitech G27 steering wheel is one of the most advanced steering wheels available.
3 MiraMetrix S2 eye-tracker[2] whose specifications are shown in Table 1.
4 Magic-mirror (half-mirror): to reproduce the windshield of a real car, we use a magic mirror that is placed on 45° between two monitors on a right angle (90°). Doing so, we can reflect what appears on the monitor underneath on the magic-mirror so it would appear overlaid on the main monitor.

Table 1 MiraMetrix S2 Technical Specifications

Accuracy	0.5 degree range
Drift	< 0.3 degrees
Data rate	60 Hz
Freedom of head movement	25 x 11 x 30 cm (Width x Height x Depth)
Tracking type	Bright pupil

*Waseda University
Global Information and Telecommunications Studies

Fig. 1. Picture of the Test-bed used in the Experiment

2. Experiment

2.1 Preparations

The experiment was conducted on 12 subjects. It was conducted on a span of approximately 6 days, and each experiment lasted for 50 to 60 minutes.

The experiment had three main driving sessions; voice guidance, fixed-spot guidance and gazing-point guidance. The order of the sessions was randomized for each subject so that 2 out of the 12 subjects would have the same order. Just before and after each session, we used a salivary amylase device[3] to monitor the stress levels of each subject.

The gazing-point guidance method displays the navigation information shown in Fig. 3 on the point where the drivers are looking. By doing so, we believe we can reduce distraction and unnecessary eye movements. And the overall procedure of the experiment is shown in Fig. 2.

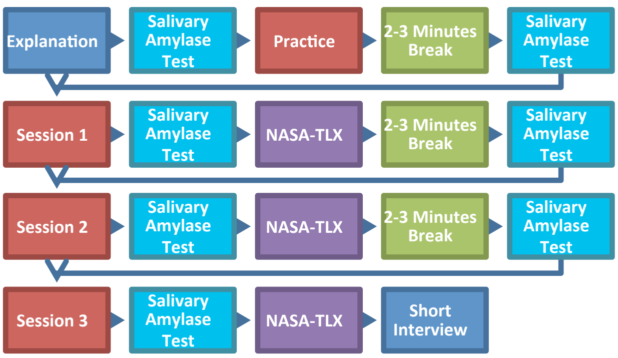

Fig. 2. Procedures of the Experiment

Fig. 3. Examples of the Instructions used in Our Experiment.

2.2 Results & Analysis

Salivary amylase results: As we can see in Table 2, the amount of change between before and after each driving sessions is used to determine whether the used method is stressful or not. 6 subjects (1,5,6,7,8,10) show lower stress levels in the gazing-point method, while 3 subjects show it each for the voice guidance and fixed-spot methods.

Table 2. Amount of Change in Salivary Amylase

		01	02	03	04	05	06	07	08	09	10	11	12
Fixed	Before	44	20	26	16	21	5	28	40	21	1	22	16
	After	55	18	22	18	5	30	26	75	20	1	56	20
Gaze	Before	31	10	16	15	16	19	32	42	22	14	27	8
	After	25	20	19	21	1	2	28	56	19	13	29	19
Voice	Before	28	19	20	17	10	12	23	34	44	8	31	20
	After	23	10	17	23	14	24	33	58	12	16	32	18

Unit: kIU/L

Eye-Movement Results: According to Fig. 4 and 5, the gazing-point method shows slightly less eye movements compared to the other two methods, however, the difference isn't significant.

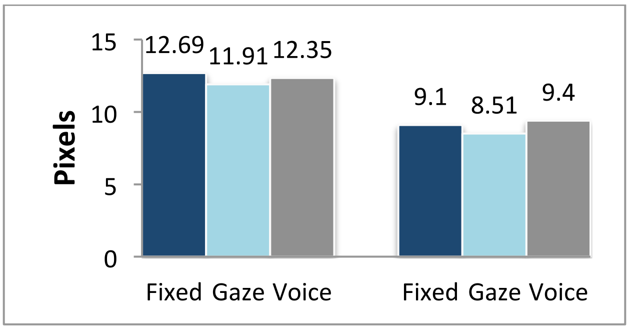

Fig. 4. Total Average of Eye-Movements in Pixels (X–Y)

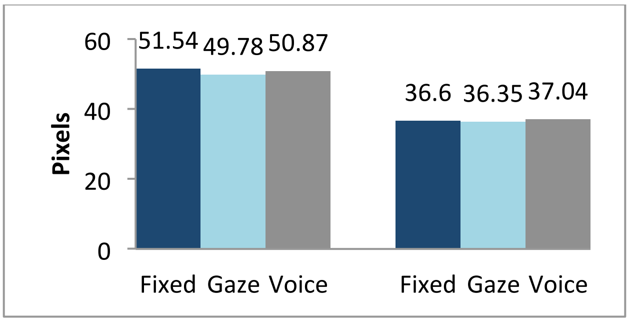

Fig. 5 Total Standard Deviation of Eye-Movements in Pixels (X – Y)

Gazing-point analysis: We have categorized the gazing-points as follows: left & right mirrors, back mirror, speedometer, road and others. In the voice guidance method, subjects are able to keep their eyes most on the road with the percentage of 83% compared to the other two methods. However, like the eye-movement analysis, the difference isn't significant.

NASA-TLX: To analyze NASA-TLX results, we have applied the AWWL (Adaptive Weighted Workload) method[4,5]. Analysis shows that 6 subjects have lower task workload under the gazing-point method, and 6 subjects under the voice-guidance method. But on the other hand, the fixed-spot guidance has the highest task workload amongst all of the subjects.

3. Discussion

According to the salivary amylase analysis, NASA-TLX and the eye-movements analysis, we can say that the gazing-point method is very potent compared to the other two methods. But on the other hand, in the voice-guidance method, subjects are able to keep their eyes more on the road but that's due to the disappearance of visible navigation instructions, which allows the drivers to focus more on the road.

4. Conclusion & Future Work

According to the feedback from the subjects, the instruction signs that were used in our experiment are relatively huge and caused vision obstruction in some cases, which will be amended by creating new instructions that consist of easy-to-understand signs instead of words. Further work will also include personalizing of the navigation instructions showed to the subjects depending on what kind of information are needed and what are not.

References

[1] City Car Driving, http://citycardriving.com (Last Visited: 24 June 2013)
[2] Eye Tracker System for Eye Tracking, MiraMetrix S2, http://mirametrix.com/products/eye-tracker/ (Last Visited: 24 June 2013)
[3] M. Yamaguchi, T. Kanemori, M. Kanemaru, Y. Mizuno, H. Yoshida, "Correlation of Stress and Salivary Amylase Activity," in Japanese Journal of Medical Electronics and Biological Engineering, Vol. 39, (3) pp. 234-239, 2001.
[4] S. Miyake, M. Kumashiro, "Subjective Mental Workload Assessment Technique: An Introduction to NASA-TLX and SWAT and a Proposal of Simple Scoring Methods," in The Japanese Journal of Ergonomics, Vol. 29, (6) pp. 399-408, 1993.
[5] S. Haga, N. Mizukami, "Japanese Version of NASA Task Load Index Sensitivity of its Workload Score to Difficulty of Three Different Laboratory Tasks," in The Japanese Journal of Ergonomics, Vol. 32, (2) pp. 71-79, 1996.