

## Study on Stimulation Effects for Driver Based on Fragrance Presentation

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### Abstract

*Drowsy driving is one of the factors that leads to a fatal car accident and also a serious problem we combat for extermination. Caution-advisory indicators and alarm sounds are the most general approached to prevent drowsy driving. However these visual and auditory information are excessive enough to alert drivers. This study aims to focus on olfactory stimuli, which do not provoke interference with driving actions, and examines the effectiveness in combating drowsiness. Using four types of fragrance such as peppermint, rosemary, eucalyptus and lemon, we performed investigations on the effectiveness of each fragrance while changing presentation method in order to remain alert against drowsy driving.*

### 1. Introduction

Traffic accidents caused by drowsy driving never disappear and lead to fatal crashes when heavy vehicle is involved. General countermeasures to prevent drowsy driving are using caution-advisory indicators and alarm sounds. However visual and auditory information, which has been provided by interfaces such as meters and audio, seems excessive enough to alert drivers.

This study is designed to focus on olfactory stimulation, which does not provoke interference with driving actions, and examine the effectiveness to revive drivers by fragrance presentation.

Utilizing several kinds of fragrance that have alerting influences, we performed investigations on the effectiveness based on driving performance while changing the type and the intervals of fragrance presentation.

### 2. Purpose

In this study, we provide drowsy drivers with fragrance and evaluate the influence and the stability. In validation, we analyzed driving performances of drivers using a driving simulator and compared them before and after fragrance was provided to evaluate how the effect works.

Besides, when restoring drowsy driver to an alert state, the strength of effect and the stability are important. Thus, requisite minimum of fragrance should be presented to the driver's nose to avoid olfactory adaptation caused by filling car cabin with the scent. Besides, we needed to consider practical structure that allows us to install it on an actual vehicle. Thus, we tested and developed fragrance presentation system that meets those requirements.

### 3. Fragrance presentation system

#### 3.1 Configuration

Fig.1 shows our fragrance presentation system. This experimental system was composed of image processing part and fragrance projecting part.

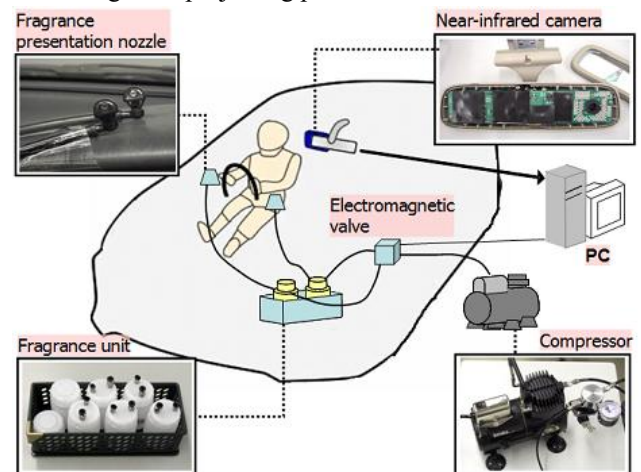


Figure1. Composition of fragrance presentation system

#### 3.2 Image processing system

Image processing system recognizes and measures eye blink that is considerably important to judge wakefulness (Fig.2). First, it captures a face image by Near-infrared light projection method that reduces influence of disturbance caused by road travel, and picks up eye area to follow. Then, it proceeds to search abstracted eye area to detect blinking action of top and bottom lids [2].

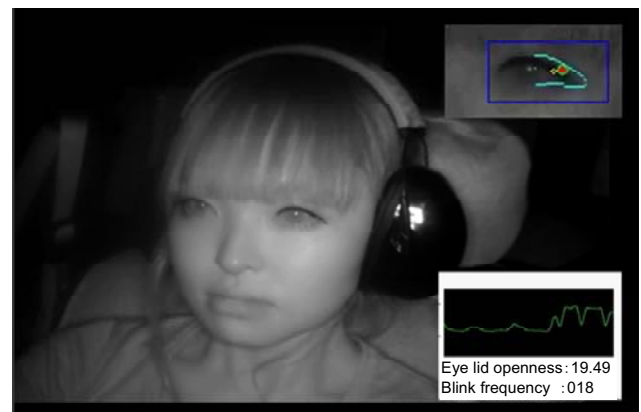


Figure2. Eye Recognition by Image Processing

### 3.3 Fragrance Projecting System

Fragrance projecting system was composed of compressor, high speed magnetic valve and 1.0mm pinhole nozzle. Pulse controlled magnetic valve could provide fragrance through pinhole nozzle, enabling pinpoint projection to driver.

A variety of fragrance presentation methods may be expected such as providing through air conditioning equipment, wearing a personal device and installing an isolated scent projector [3]. The use of air conditioning system fills vehicle with full of fragrance and easily leads to unsuccessful alert effect resulting from stimulus adaptation. Wearing a personal device is likely to interfere driving actions. Although a scent projector can solve these problems, it seems to be rather difficult to mount on vehicle.

As compared to these approaches, our experimental system can produce spot and non-contact fragrance presentation immediately. Moreover, since a compressor, which is used as a major device in this system, can easily be shared with existing air conditioning system on vehicle, technical feasibility is highly expected (Table 1). Fig.3 shows the picture of experimental fragrance presentation system.

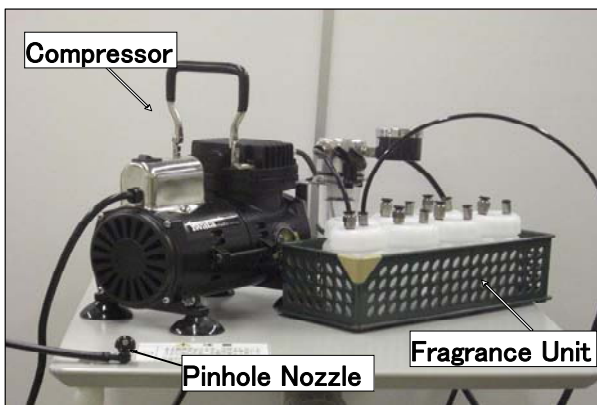


Fig.3 Fragrance Presentation System

Table 1 Comparison of effectiveness

Method	Certainty	Interference	Adaptability	Feasibility
Air Conditioning	○	○	×	○
Wearing Device	○	×	○	△
Scent Projector	△	○	○	△
Experimental System	△	○	○	○

## 4. Alerting Effect of Fragrance Presentation

### 4.1 Verification Method

Verification experiment was performed in a fixed driving simulator (Fig.4) with which fragrance presentation system (Fig.1) was equipped. All the subjects were in their 20s and licensed drivers who had sufficient sleep in the previous night. Eight males and two females participated. The subjects were required to drive right along centerline on expressway with straight and curved sec-

tions at the velocity of 100km/h. When drowsy driving is recognized, fragrance starts to be delivered and the presentation is repeated every 60 seconds.

We judged driver's attention level based on the results of eye blink frequency measured by image processing part and eye-lid observational judgment method assessed in reference[2]. Then driver's wakefulness were divided into three levels such as 1: Normal Alert, 2:Less Alert, 3:Non Alert.

Besides, alerting effect was evaluated based on wobble from centerline caused by low conscious level and calculated its deviation by comparing the dispersions of offset distance. Specifically, referring to the distance between vehicle and centerline recorded by driving simulator, standard deviation was calculated every 30 seconds. When this parameter was lower than threshold (value 0.4 was a border value that preliminary experiment had proved lane departure occurred), driver was considered to be in full attention state. We used pepper mint, eucalyptus, rosemary and lemon as fragrance that supposedly have a certain level of effect for this test [1].

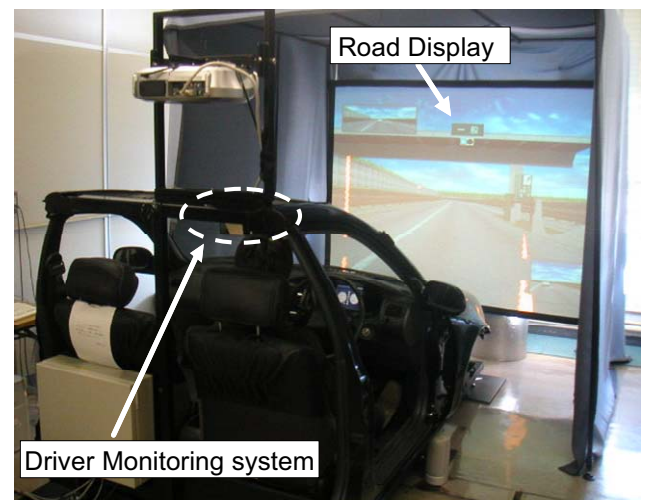


Fig.4 Driving Simulator

### 4.2 Verification Result

Records of Fig.5 to fig.8 indicated the effects of fragrance presented to subject A, a drowsy driver. Four types of Fragrance were supplied at the interval of 60 seconds when drowsiness was recognized. On the figures, solid line represents standard deviation of departure range towards lateral direction calculated every 30 seconds. Dash line is arousal level of the subject.

From the results of fig.5 to 8, although the influences in sustainability differ in degree, alerting effectiveness in every fragrance was confirmed. Fig.9 shows average sustainability of an alert state in 10 subjects affected by four types of fragrance.

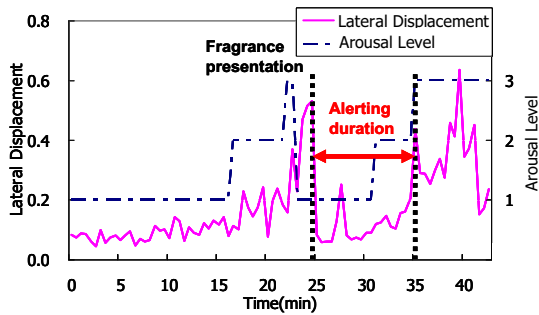


Figure5. Pepper mint at 60 second intervals  
(Subject A)

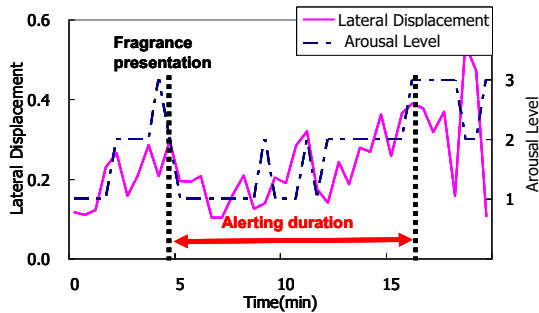


Figure5. Rosemary at 60 second intervals  
(Subject A)

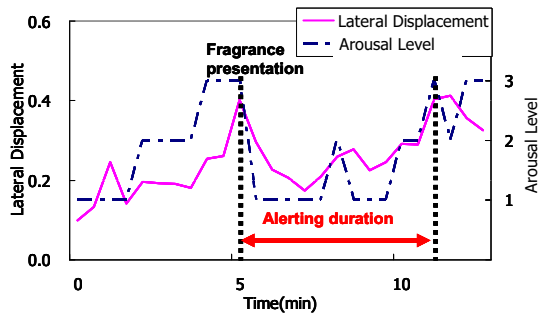


Figure7. Eucalyptus at 60 second intervals  
(Subject A)

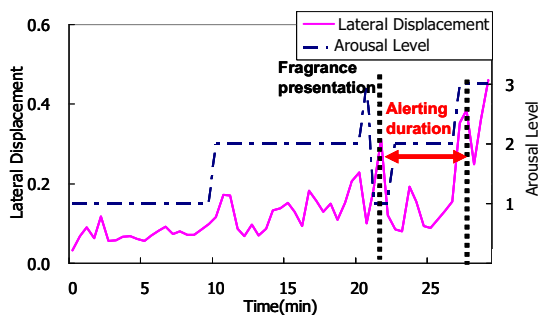


Figure8. Lemon at 60 second intervals  
(Subject A)

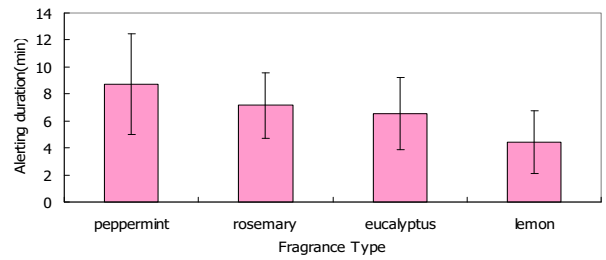


Figure9. Averaged sustainability of wakefulness in 10 subjects

## 5. Estimate of enhancing sustainability

### 5.1 Sustainability of Wakefulness

As examined in the previous chapter, alerting effect of fragrance presentation on drowsy driving was proven to be valid. Furthermore, pepper mint has the strongest effect which enables driver to be in full alert state for 9 minutes on average.

However, rest areas and service areas on expressway are generally located in every 15 kilometers, and it corresponds to around 15 minute drive. Thus 9 minutes duration is insufficient to restore drowsy driving and approximately 20 minute sustainability is considered desirable. Further investigation on prolonging alerting effect will be necessary.

### 5.2 Study on Proper Interval of Presentation

In addition to olfactory stimulus strength (types of fragrance), which was stated in the previous chapter, olfactory adaptation is also expected to take a major role in sustainability of wakefulness.

Therefore, changing presentation intervals (frequency and time), we investigated the method that could control olfactory adaptation in order to maintain longer sustainability of an alert state.

In this verification, interval of fragrance presentation was shortened to 30 seconds, which is only half of that used in the previous test. The rest of the other conditions remained the same as that used in section 4-1.

Fig.10 to Fig.13 are experimental results of wakefulness sustainability of subject C who was provided with fragrance at the interval of 30 seconds. (Fig.10 : Peppermint, Fig.11 : Rosemary, Fig.12 : Eucalyptus, Fig.13 : Lemon). Solid lines represent standard deviation of lateral departure recorded at 30 second intervals and dash lines show the level of wakefulness.

These results suggest that every fragrance have certain effect on alerting the state of the subjects. Fig.14 shows the comparison of averaged alerting state obtained by two different intervals. We confirmed that 30 second interval can provide much more strong effect on sustainability of wakefulness and especially peppermint can enhance the duration up to 16 minutes on average.

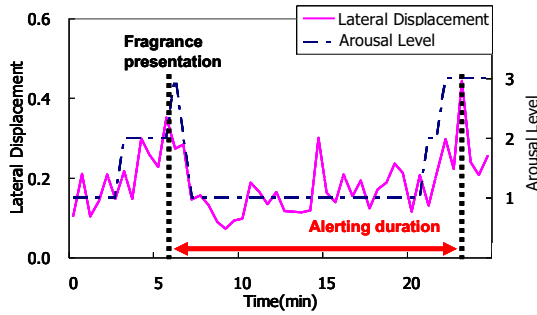


Figure10. Peppermint at 30 second intervals  
(Subject A)

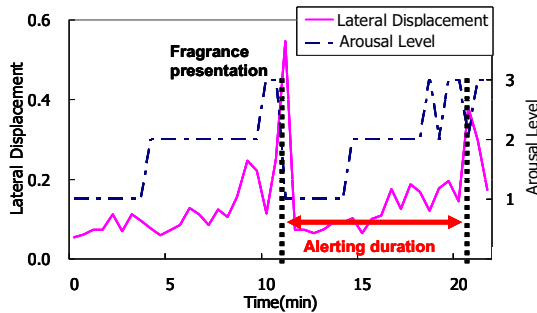


Figure11. Rosemary at 30 second intervals  
(Subject A)

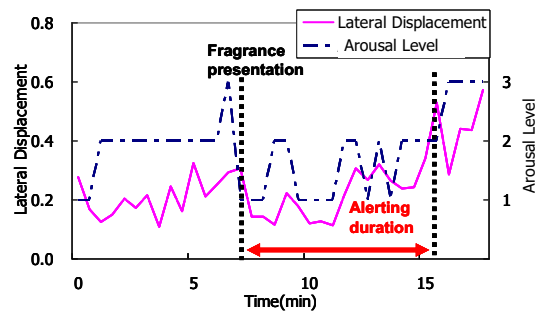


Figure12. Eucalyptus at 30 second intervals  
(Subject A)

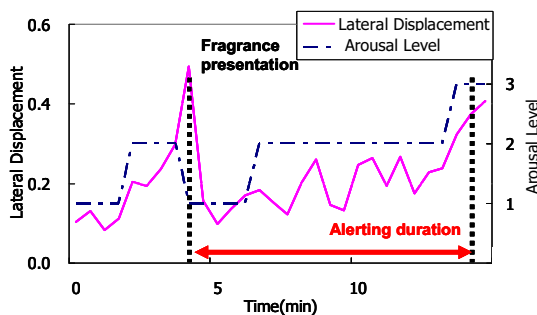


Figure13. Lemon at 30 second intervals  
(Subject A)

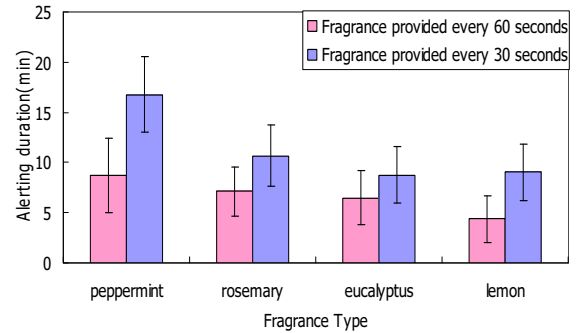


Figure14. Average duration of wakefulness

## 6. Conclusion

This study verified fragrance presentation technique to alert drowsy driving. In addition, we experimentally developed a fragrance presentation system which can be practically installed on actual vehicle and assessed the effectiveness using a driving simulator.

From this experiment, fragrance presentation to drivers at the wheel can induce wakefulness and peppermint presentation is suggested to be the most effective. 30 second interval presentation ensured 16 minute wakefulness.

Compared to 60 second interval, 30 second interval can provide longer alertness level because repeated fragrance presentation revived wakefulness before sleepiness came back to drivers. However, shortened presentation interval likely causes olfactory adaptation. Examination on effective presentation frequency should be considered.

Likewise, although presentation intervals remained fixed in this study, effectiveness of irregular presentation frequency and even real-time change of fragrance type need to be examined in order to put olfactory adaptation under better control. Our future work includes finding more effective sequence in fragrance presentation techniques.

## References

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- [2] Suzuki, M: An estimate of Driver's Drowsiness used change of Blink and Steerage Characteristic, *ViEW2007 Vision Engineering Workshop2007*, I-14, pp141-144, 2007.
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