Image Presentation with Smell for Digital Signage and the Effect on Eye Catching

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Abstract: This paper describes the effect on eye catching by digital signage that releases smell from screen and the method of smell presentation to human olfactory receptor. The effect on eye catching is investigated by analyzing movements of eye with and without smell using a detector. Visual image of foods is presented to a viewer, and his or her gazing time on a food object is detected. This experiment reveals advertisement accompanied with smell is more attracted to a viewer. The proposed method for smell presentation is to induce a person inhalation by tactile sensation caused by airflow and released smell at a time of inhalation. This experiment discusses the possibility of inducing subjects to receive smell efficiently.

1 INTRODUCTION

Recently, large digital signage has been prevailing (Burke, 2009). It is far more flexible than the conventional billboard which uses photograph, and it is possible to install it in a passage underground in a city or at an entrance of a store. Various advertised commodities by digital signage have been discussed, and it is believed that cooked foods and other food items can be most effectively displayed by it. As is well known, olfactory sensation has a strong influence on human appetite so that the provision of smells is also an important factor. We often experience to be lured by the smells of food when entering a restaurant. Therefore, if it is possible to provide the smells of food displayed on digital signage, a high advertising effect can be expected (Nakamoto, 2008).

Regarding a display of image with smell, it is common to place an olfactory display device next to an image display device (Sakaino, 2008). However, in the case of a large display like digital signage, the positions of generating images and generating smells are distant away from each other, so it is difficult to express a realistic sensation as if the image of a product is generating the smell, as these two devices are placed side by side as mentioned above. Requirement of a space for an olfactory display device is also a problem.

In order to overcome these problems, we propose the "KANSEI Multi-Media Display" (the term of KANSEI here means sensation, emotion, and mood, in Japanese), a device that can present image with smell at the same time by combining an image display device and an olfactory display device (Tomono, 2011). Holes are created on a thin display panel through which gases can pass, and an airflow discharge device is installed on the back side of the display so that it can present smells to viewers. We create KMMD by using LED and a projector to confirm the basic principles of this device. However, the followings are pointed out for practical uses: (1) Clarification of the effect of discharging smells from the vicinity of the targeted image; (2) Necessity of developing a method where the discharged smells do not linger long because smells tend to spread out into an area and remain for a long period of time.

2 KMMD AND EXPERIMENTAL ENVIRONMENT

KMMD applying a projector shown in Fig. 1 was used for the purpose of discussing the eye catching property of digital signage of several food images through discharging smells. The size of the screen was 1,800mm (width) x 1,200mm (length), on which

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nine panels (400 x 200 mm) at maximum with holes were attached, from which smells were discharged. These panels were 1.5mm in thickness. The diameter of the holes was 2 mm, and the distance between the holes was 3.5 mm.

A smell generating device was installed in the reverse side of the panel. This device consisted of a box to discharge airflow by increasing atmospheric pressure on the reverse side of hole, a mechanism to increase atmospheric pressure, and a duct mechanism to connect them. It discharged a vortex link of gas by instantaneously increasing the atmospheric pressure on the reverse side of the holes. Moreover, it discharged airflow like wind continuously by increasing the atmospheric pressure. If some smells were placed in the box, the smells were carried on airflow and vortex link and presented to the observers.

Subjects were asked to gaze at the screen sitting on a chair at a visual distance of 200 cm. The subjects were separated from the researchers by a curtain so that they could concentrate on the image.

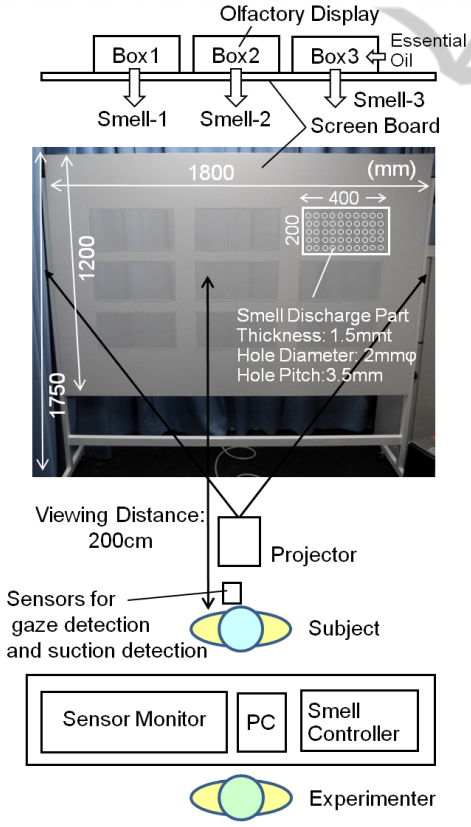


Figure 1: Experimental environment of digital signage where image with smell can be presented.

There were various measurement instruments installed behind the subjects, which were operated by the researchers.

3 EYE CATCHING PROPERTY OF A SCENE WITH SMELL

In the field of advertisement, it is important that pedestrians are attracted to a signboard and watch it carefully. Our research group previously simulated that a digital signage accompanied with smell particularly increased attractiveness to viewers though there were many non-smelled signboards (Tomono, 2010). In this paper, the method of presenting the smell for the person who had stood in front of one advertisement to gaze at the target commodity at long time was examined. Therefore, an experiment was conducted on how eye catching property and psychology were affected by discharging smell from the vicinity of a food image, by arranging smells in that way. In this experiment, the gaze movements of subjects over real dishes on a table and their picture images of various dishes with and without smell and on a screen were measured, and a questionnaire for KANSEI evaluation was implemented. Fig. 2 shows the experimental environment of investigating the eye-catching property using a gaze detection device and the condition of experiment scene. Table 1 shows 20 adjective-pairs used for KANSEI evaluation based on a semantic differential method (Heise, 1970).

Six or ten students participated into the experiment.

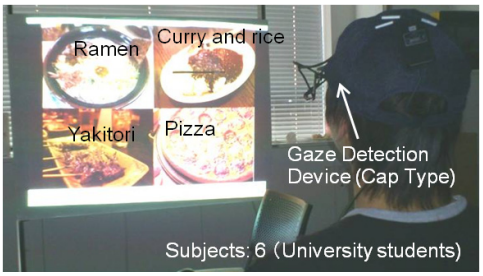


Figure 2: Experimental method of eye catching evaluation.

3.1 Scene of Rows of Food Images

(1) Experimental Method. An image simulating a billboard where several food photos seen in a restaurant area were arranged was projected onto a large screen, and pedestrians' gaze movements were analyzed (Fig.2). The foods presented there were four foods of noodle, curry, yakitori, and pizza, all of which had relatively strong smell. As the gaze tendency was considered to be influenced by the

display position, the positions of the four food images were rotated. The display time was 20 seconds. The gaze detection device was an NAC Eye Mark Recorder EMR-9. A gaze point was measured in the image captured by a view camera. The detection accuracy was approximately one deg. Furthermore, because gaze tendency was considered to be influenced by personal likes or dislikes, a questionnaire about tastes of food was conducted.

Table 1: Adjective-pairs used for sensibility evaluation.

No	Adjective-Pairs	No	Adjective-Pairs
1	Delicious - Unpalatable	11	Progressive - Traditional
2	Artificial - Natural	12	Splendid - Simplicity
3	Sharp - Blunt	13	Hot - Cool
4	Hard - Soft	14	Favorite - Dislike
5	Refined - Vulgar	15	High-grade - Low-grade
6	Sweet - Bitter	16	Beautiful - Ugly
7	Bright - Dark	17	Big - Small
8	Fresh - Old	18	Fully - Fed hunger
9	Gaudy - Sober	19	Heavily - Weak
10	Strong - Frankness	20	Orderly - Disorder

(2) Experimental Results. Fig. 3 (A) is an analysis of the gaze-stationary point of Subject C. The gaze-stationary point is defined as the area where the gaze point stays more than 0.1 second within a range of 2 degrees of the viewing angle. From this figure, the gaze point stayed on the object on the bottom-left of the screen (yakitori) for a long period of time, and it almost evenly stayed on other three objects. Referring to the result of questionnaire for the favorite tastes, it was known that the subject was looking at the image of yakitori for a long period of time because he/she was interested in it. Furthermore, as for the rotation of images, there was a tendency that the gaze time on the food shown on the left side was longer.

(B) shows the average gaze time of the six subjects for each object. In the questionnaire about tastes of food, three subjects chose yakitori, and the other three subjects chose three different foods. The gaze time on yakitori was the longest, and it was more or less similar among the other objects.

(C) shows the comparison of gaze time on the objects which the subjects answered as their favorite food and those on other objects. The result was the same as the daily experience that the gaze-stationary point is concentrated on one's favorite food.

(D) shows a radar chart presenting KANSEI evaluation. As for the impression when looking at the billboard, the scores of the adjectives of "delicious" and "favorite" were high.

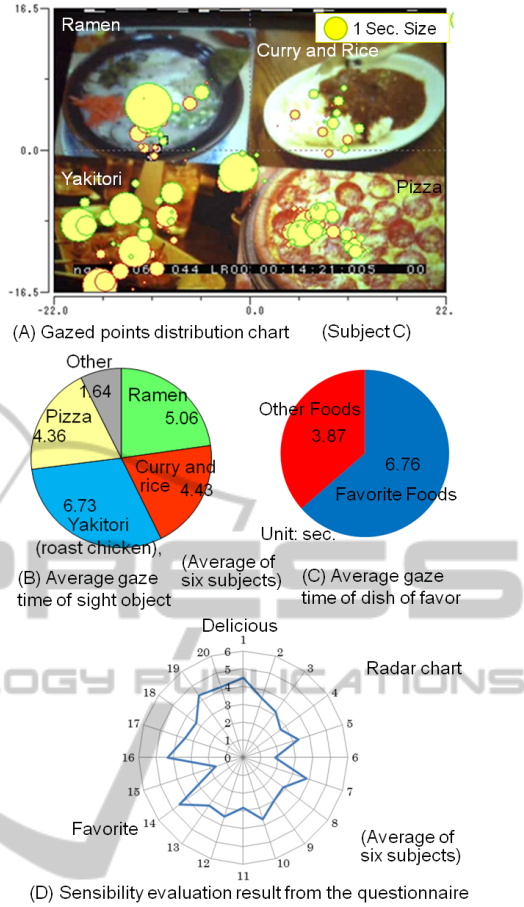


Figure 3: Experimental results of foods image without smell.

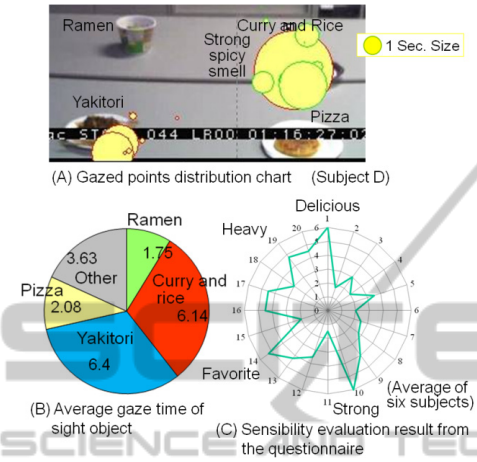
3.2 Scene of a Row of Real Foods on a Table

(1) Experimental Method. Real foods were arranged on a table to produce the scene similar to the experiment on 3.1, the blindfold was removed from the state of the blindfold, and the subject was made to gaze on the table for 20 seconds. The temporal variation of the gaze-stationary point was investigated.

(2) Experimental Results. Fig. 4(A) shows a result of Subject D. Because the subjects stood beside the table, the foods arranged in lower part of this figure were nearer the subject's position, it seemed that yakitori and pizza were seen easily. However, the gaze time of an upper right curry and rice was long. The subject answered that the concern was high because the smell of the spice of the curry and rice was strong.

(B) is average gaze time of six subjects to each food. The gaze time of the curry and the yakitori was

longer than that of the noodle and the pizza. From this experiment, it has been understood that the existence of an impressive smell in addition to the favor greatly influences the eye catching. Moreover, it has been understood that the scores to the adjectives such as "Strong" and "Heavy" in addition to "Delicious" and "Favor" were high.



(A) Gazed points distribution chart (Subject D)

(B) Average gaze time of sight object

(C) Sensibility evaluation result from the questionnaire

Figure 4: Experimental results of real foods scene.

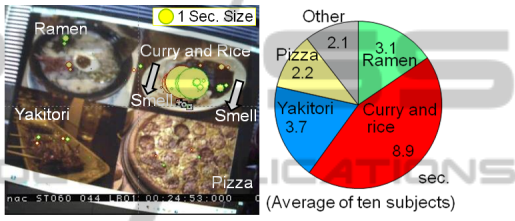
3.3 Scene of Food Images from Which Smells Are Being Discharged

(1) Experimental Method. A smell of food was discharged from the place where the food image was displayed by using the system of Fig. 1. Because it was a purpose to examine the relation between the smell presentation and the eye catching property in this experiment, the smell was discharged only from the upper right corner of the screen. The food image positions had been gradually changed. Condition 1 of discharging the same smell as the food image and condition 2 of discharging the smell different from the food image were examined.

(2) Experimental Results. Fig. 5(A) shows the result of subject E in condition 1. It is understood that the image of the curry in the upper right corner into which the smell was discharged was seen long. In this experiment, we calculated the average gazing time from ten subjects. As the result from Picture (B) describes, the picture of curry was gazed longer than the pictures of any other foods, regardless of orders of the pictures. In the case of replacing the picture of curry with pizza and teriyaki chicken, and presenting the smell related to the picture, these upper right pictures were gazed at long as well as the case of the curry by subjects.

On condition 2, if the food image that related to the smell was in the screen, the image was searched and seen for a long time. That is, the person tends to be induced to the olfactory stimulus, and to see the sight object that doesn't contradict the smell. However, at this time, the half of the subject had noticed contradiction (irrationality) into which the smell was discharged from a place different from the place where food image was displayed. In the case of that the foods images displayed on the screen were not corresponded to emitted smell, subjects seemed to feel weirdness because they could not find the visual which matched with the smell. On the questionnaire, some of them answered “the smell was more memorized than the foods images.”

The result of the sensibility evaluation radar chart was near the above-mentioned result when real foods were seen.



(A) Gazing points distribution chart (Subject E)

(B) Average gaze time of sight object

Figure 5: Experimental results of foods image with smell.

3.4 Discussion

A large difference in the distribution of gaze-stationary points was observed between food images only and food images with smell. It was confirmed that the image with smell attracted attention to the food and gave a strong impression. In this point, it is close to looking at real food.

Regarding the influence of the weirdness sense given by the difference between the positions where food image is presented and smell is discharged, the number of subjects who realized it was not negligible, so it seems that the place and direction of emitting smell are important factors to improve the reality of visual. Our previous researches suggested that emitted smell made one to initiatively look for the visual matched with it on the screen (Tomono, 2011). In this experiment, it was successful to emit smell corresponded to the visual from the vicinity of the food image because of using KMMD. Providing smell from the displayed point enabled people to naturally feel comfortable. This occurred because they do not need to search for the visual and the smell is strongly connected to corresponded visual in his or her mind. The only matter was not to evaluate on enough number of subject.

4 SMELL PRESENTATION VIA INDUCED INHALATION BY TACTILE SENSATION OF AIR

4.1 Aim of the Experiment

Since one of the characteristics of smell is once it emits it diffuses quickly, it is desirable to use small amount of smell as much as possible. It was easily guessed that if subjects know the place and direction of emitted smell by using KMMD prior to the emission even small amount of smell would make it possible to increase the effectiveness of olfaction, since they can initiatively activate their inhalations.

Since smell is delivered by airflow, in real-life situation, we often perceive smell in the wind. For example, when gentle breeze strokes the cheeks, people tend to take a breath to sense a smell in the wind. As the wind contains the information of the surrounding environment, sniffing allows people to effectively grasp the surrounding situation (Sawada, 2008). This suggests the possibility that people learn to do sniffing for the purpose of comprehension of their situation.

If this proposition is experimentally verified, as shown in Fig.6, it will be possible to present a smell to the user at the time of inhalation by inducing inhalation using an air-cannon with the function to release a vortex ring. Note that behind the screen are two types of air cannons in the same figure. Air-cannon 1 ejects a vortex ring for tactile sensation. Then, air-cannon 2 ejects a vortex ring containing smell. As is indicated in (A), human inhalation normally repeats itself at an interval of once per 5~7 sec. However, when a tactile sensation is given, sniffing is induced, as is indicated in (B), and so if smell is delivered at this time, it will be effectively received.

4.2 Experimental Method

In order to demonstrate that smell is perceived more effectively by giving tactile sensation to the face and causing sniffing to occur, the system illustrated in Fig.6 was used to present smell under two conditions, shown in Fig.7, and the rate of successful perception of smell was investigated. The first part of this experiment was to present smell at a constant time interval of inhalation under normal conditions. The second part was to present smell one second after tactile sensation based on a model predicting such induction of sniffing. The duration of smell presentation was 5s in both parts of the experiment. Bergamot (PalmTree Co., Ltd.) was used in this experiment. In both parts, a subject was asked to hold a counter by his or her right hand and press the counter when he or she sensed a smell. Smell was presented 20 times during the experiments. The experiments took 1min and 40s. The number of the subjects was eleven (eight men and three women).

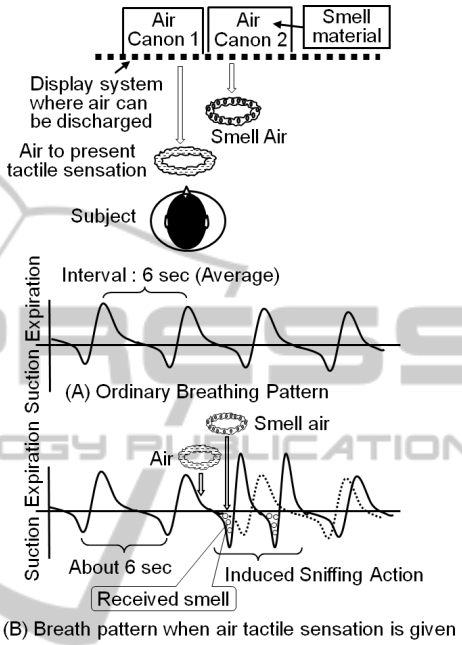


Figure 6: Smell presenting method.

4.3 Experimental Results and Discussion

The rate of successful smell perception increased significantly for eight subjects among eleven in the second part of the experiment. For the remaining three, the difference in the rate in the first part and the one in the second part was small. Fig.8 shows the average number of successful smell perceptions over the subjects and the standard deviation. When a statistical test procedure was carried out using the null hypothesis that there was no difference in the rate in the first and second part, the hypothesis was rejected at the significance level of 5%. Thus, the rate of successful smell perception was higher in the second part.

After the experiment, the subjects were asked to fill out a questionnaire. There are many answers that they unintentionally sniffed because they thought that there was a change in the surrounding environment. In this experiment, the subjects were blindfolded so that they need to use the senses other than vision to learn about the environment, and this

might lead people to check what happened when tactile sensation was given by using the olfactory organ. Thus, there is a high possibility that inhalation can be induced by tactile presentation. In addition, the results also suggest the possibility that induction of inhalation is stronger for images containing steam such as cooking-scene of steaming dishes with the tactile sensation.

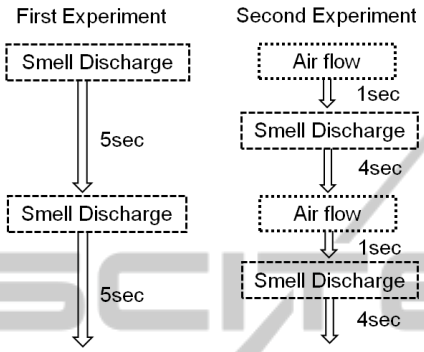


Figure 7: Experimental method.

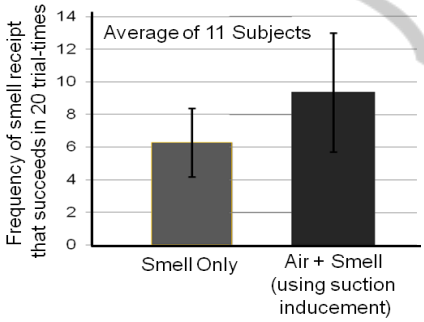


Figure 8: Experimental Results.

5 SUMMARY

For application to digital signage that can release smells from several locations on its screen, we compared the eye movement over a visual image of foods, over real foods, and a visual image of foods with smell. Also, we considered the method to release subtle smells at the time of inhalation. As a result, we revealed the following:

1) The taste of the subject and location of the presented image on the screen has great influence on the gaze time of the subject looking at visual images of food. When the subject was looking at the real food or the visual image with smell, in addition to the aforementioned factors, the intensity of the smell had an impact on the gaze time.

2) Visual accompanied by smell was tended to be gazed longer. It seems like subjects feel comfortable only when the point of emitting smell on the screen is exactly matched with the one of displaying visual, since they do not need to look for where smell is coming from. Sensory evaluation when presented with scented visual images of food is similar to the one when presented with real foods.

3) The rate of successful scent perception of smell increased after tactile sensation was given. This suggests that tactile sensation induces inhalation. Using this, it will be possible to make effective olfactory reception.

In this experiment, the number of subject was not enough to evaluate the data analytically. However, by repeating the experiment with larger population of subject, more accurate result will be obtained in the future. We would like to improve a sense of reality of digital signage by releasing smells from the image of the products.

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