Chapter 4
Interaction of Olfaction with Vision or Other Senses using Olfactory Display

Tomohiro Tanikawa  
University of Tokyo, Japan

Michitaka Hirose  
University of Tokyo, Japan

ABSTRACT

In this chapter, the authors introduce interaction of olfaction with other senses by showing two different types of case studies based on this interaction. Olfactory sensation is based on chemical signals whereas the visual sensation and auditory sensation are based on physical signals. By using this cross-modal effect between olfaction and vision, olfactory display can present various “pseudo olfactory experiences.” One can produce an olfactory sensation different from the presented smell. In addition, by using cross-modal effect among olfaction, gustation, and vision, one can present various “pseudo gustatory experiences” with the same food via visual-olfactory displays. By utilizing the interaction of olfaction with other senses, it is possible to augment the capability of olfactory displays and achieve a high quality olfaction and gustation experience.

INTRODUCTION

Olfactory sensation is based on chemical signal, such as smell molecules, whereas the visual sensation and auditory sensation are based on physical signal, such as light, air vibration. Basic principle of information processing on olfactory sense has not yet been clarified. Therefore, most olfactory displays which exist now have very limited functions. For example, most of the displays can only present the set of scents which was prepared beforehand because a set of “primary odors” has not been found. In order to implement olfactory displays for practical use, we have to improve them to present much more smells. For this purpose, we may need to find out a novel technology to synthesize wide range of smells from few element odors.
By using instability and variability of olfaction, there would be a possibility that we can make such a technology. If we are able to present user smell other than the actual, we may be able to define several “element” odors or “primary odors,” and we can generate various olfactory experiences by them.

Also, we may think about inter-sensory instability. For example, gustatory sensation has similar instability and variability with olfaction. Thus, we can change user’s perceived taste of a food substance by changing appearance and scent with augmented reality technology.

In this chapter, the authors want to introduce display technology based on this kind of principle, that is, cross-sensory effect. This technology consists of very important part of “next generation VR technology.”

**OLFACTORY AND GUSTATORY DISPLAYS**

Both olfactory and gustatory senses have instability different from the other senses. The new concept mentioned above can be applicable when implementing olfactory and gustatory displays.

Among five senses, it is said that olfaction activates our emotion most vividly. Therefore, it would be effective to use olfactory system as communication media. Olfaction is more unstable and variable than vision and audition. It is known that we can identify scents of daily materials only fifty percent of the time. For example, only half can answer “apple” when they sniff apples (Cain, 1979; Sugiyama, Kanamura, & Kikuchi, 2006).

Although olfactory displays are uncommon, many researchers are working to develop ways to display scents (e.g., Nakamoto & Minh, 2007; Yamada, Yokoyama, Tanikawa, Hirota, & Hirose, 2006; Nakaizumi, Yanagida, Noma, & Hosaka, 2006; Sato, Ohtsu, Bannai, & Okada, 2008). Moreover, some olfactory displays using vaporizers have already been commercialized (e.g., ScentAir; AromaJet; Trisenx; Scentcommunication; Osmooze; air aroma; Air/Q Whole Room Air Freshener). These display systems are used for appreciations with combination of other sensory displays (Heilig, 1992; Zybra & Eskeland, 1999; Mochizuki, Amada, Sawa, Takeda, Motoyashiki, Kohyama, … Chihara, 2004). For example, “Let’s cook curry” developed by Nakamoto, Otaguro, Kinoshita, Nagahama, Ohinishi, and Ishida (2008) is an olfactory display with interactive aroma contents, “a cooking game with smells.” It presents smells of curry, meat, onion and so on by player’s control. “Wearable olfactory display” developed by Yamada, Yokoyama, Tanikawa, Hirota, and Hirose (2006) generates olfactory field by changing concentration of some kinds of aroma chemicals using position information.

However, both of them produced only combination of prepared element odors, they are, selected aroma chemicals, in each preceding studies. It is still difficult to generate infinite numbers of smells for current olfactory displays.

A gustatory display would be one of the last frontiers in the area of computer human interaction. Even comparing with the olfactory displays, very few studies are conducted regarding as this area.

Beidler (1971) provided a compendium of knowledge of the basis for the sense of taste as a pioneering work. More recently, Maynes-Aminzade offered a suggestion for “edible user interfaces” (Maynes-Aminzade, 2005) and developed some low-resolution gustatory displays. Iwata et al. have developed the “Food Simulator” (Iwata, Yano, Uemura, & Moriya, 2004) by integrating an interface that displays the biting force, auditory information, and the chemical sensation of taste. In the “Food Simulator,” chemical sensation of taste was displayed by releasing prepared taste components using a micro injector. However, these studies have not focused on presenting various synthesized tastes.

There are several reasons why gustatory displays which can synthesize various tastes are so few. One of the most serious factor is that its basic
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