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Demo of an olfactory game using paired odors to increase the odor range, enabling immersive olfactory experience in VR environments

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Abstract

Olfaction is a key human sense, but olfactory human interface technologies are not yet so common compared to visual and auditory devices. Recently, the utilization of olfactory stimuli in digital contexts has been attracting wider attention especially in the VR field. Although those trials aim at enhancing the quality of the virtual environment, many of them have limitations in the range and precise control of odor types. This research focuses on creating virtual environments incorporating olfactory display technology with a wide range of odor types and precise temporal control of scent emissions. In our scented virtual game, users navigate landscapes to collect the scents. The 3D environments include multiple scent sources enhancing interaction, providing additional sensory experience encountered through the head-mount display (HMD), enabling user engagement and developing experience with scent detection.

CCS Concepts

• ***Human-centered computing*** → ***Interaction design;***

1. Introduction

Olfaction is a key human sense, with smells capable of inducing strong emotions and memory associations. However, olfactory human interface technologies are not yet so common compared to visual and auditory devices. Recently, the utilization of olfactory stimuli in digital contexts has been attracting wider attention especially by VR users and developers. Thus, there has been research oriented to olfactory VR [YKN*04] [RKT*19], although earlier trials to introduce scents to digital environments have been limited in the range of odor types and their precise control.This research focuses on creating virtual environments incorporating olfactory display technology with a wide range of odor types and precise temporal control of scent emissions. In our scented virtual game, users navigate landscapes to collect the scents. The 3D environments include multiple scent sources enhancing interaction, providing additional sensory experience encountered through the head-mount display (HMD), enabling user engagement and developing experience with scent detection. Our study on the virtual experience with realistic and intuitive olfactory stimuli will lead to further development such as olfactory training and well being.

2. Method

2.1. Implementation of the virtual environment

We have created a 3D olfactory virtual environment, incorporating a program for simulating more realistic scent presentation, enhancing the user experience compared with the 2D game. As shown in Figure 1, we use a computer (1), an Oculus Rift head-mount display (2) with corresponding Oculus Touch left and right hand controllers (3) and the olfactory display device (4), which is a key element for the scent distribution [NM07], and the tube connecting the olfactory display to the headset worn by the participant (5). The olfactory display runs in conjunction with the virtual interactive 3D environment, programmed using Unity.

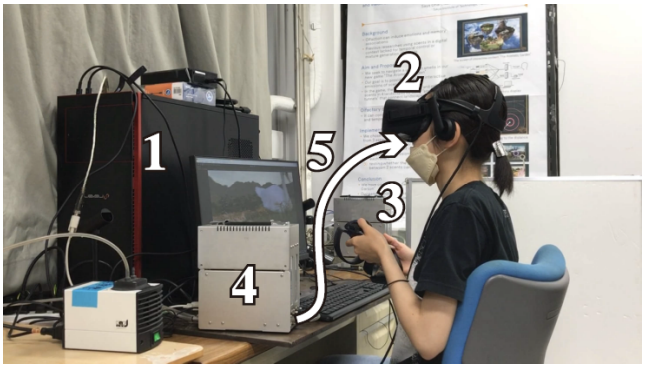

Figure 1: *The equipment used for the 3D virtual olfactory display*

2.2. Consideration of the scents

From the viewpoint of designing olfactory stimuli distinguishable from each other, we chose the scents for our game from a wide

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range of odor types, including unpleasant smells. These include: more pleasant - geranium, orange, mint, apple, strawberry, blended floral scents; less pleasant - smoke, sulfur, moldy earth, camphor, acetaldehyde and acetic acid. The set of odors were selected taking toxicity into consideration, and by a questionnaire and sensory tests. We also investigated pairs of odors that generate an impression different from both of the single odors before blending when they are presented as mixtures, with sensory tests conducted on two approaches; antagonism and essential oils. Antagonism is the phenomenon that occurs between a pair of odor compounds, where an odorant A prevents an olfactory receptor from receiving a second odor B. As limonene and camphor showed the potential to have an antagonistic effect, the orange scent including limonene and the camphor scent are in the list of odors used in our virtual environment. For the essential oils, relationships of similarity among groups of oils can be utilized to provide an unexpected impression.

3. Construction of the virtual environment incorporating related olfactory and visual stimuli

Our 3D scented virtual environment has 2 imaginary landscapes containing 12 scented items with several tunnel links between them. The players wander the landscape to search for and collect scents, so the imagery and the odors need to relate meaningfully to be effective in helping them to do this. A wider range of odors and precisely controlled scent emissions enrich the experience we are creating, and better enable users to undertake specific olfactory tasks. Also, in the new 3D space, it is possible to dispel with the tessellated covering used in the 2D version [OCN21] as players can navigate around and behind objects in search of the smell source. Consequently, this allows for greater play with the imagery used and allows us to build an olfactory space that can relate more closely to navigating in a real-world environment.Olfactory stimuli are basically presented with changing intensity in relation to the distance of various smell sources embedded in the virtual environment, so as the player moves their head and advances into the virtual landscapes using the Oculus Controllers, they can also encounter a 3-dimensional sense of smell.As players navigate the landscape, certain odor sources are designated as links to the alternative landscape through 'scent tunnels'. Each of the several tunnels has a pair of scents, one at its entrance and exit, and players experience their mixture while traveling through the tunnel. For instance, the limonen scent that can be found in the scene as shown in Figure 2 leads to a tunnel that ends with the camphor smell in the alternate landscape, creating a third smell sensation while traveling in the tunnel that derives from the mixing of, but is different to, the entrance and exit smells (Figure 3).

4. Conclusion

We created a 3D scented virtual environment with enhanced interactiveness using olfactory display technology. The wide range of odor types and the precise temporal control of the emission enable players of the game to search for scented items with a more realistic olfactory experience. The shift of the game environment from 2D to 3D also enhances the immersive experience. We are now developing the game to be used for olfactory training and the creation of health and well being.

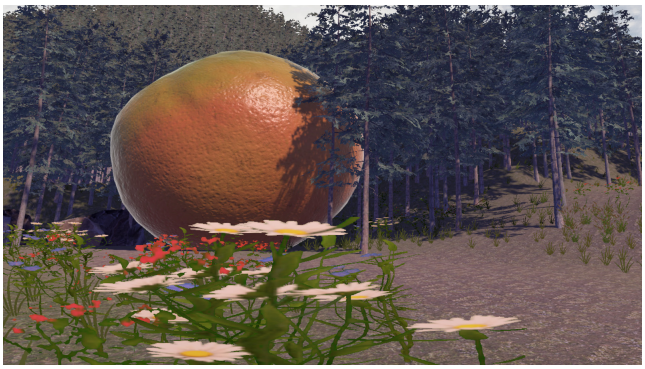

Figure 2: *Screenshot from the latest 3D version of the olfactory game showing the limonen smell source hidden within the virtual garden landscape.*

Figure 3: *Screenshot of crystals in the volcanic landscape emitting a camphor smell*

Acknowledgement

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