Demo

Demonstration of an Olfactory VR Game to Improve Cognitive Function

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Abstract

Olfaction has a deep connection with cognitive function and it is expected to be applied in cognitive rehabilitation. Using an olfactory display, a device to present odors controlled by a computer, enables a virtual reality experience with added olfactory information called "olfactory VR". Our research aims to apply olfactory VR to cognitive enhancement, and we have developed an olfactory VR game to improve cognitive function. This is currently being tested by elderly people and focuses on sensory memory of odors. Players are required to memorize odors without linguistic information and select the odor memorized from a choice of three odors encountered in the game. Odors in our virtual world are also represented visually in the game landscape thorough the head-mounted display with the odors generated by the connected olfactory display as the player interacts with the game.

CCS Concepts
*• **Human-centered computing** → Interaction design; • **Applied computing** → Life and medical sciences;*

1. Introduction

There is a deep connection between olfaction and cognitive function, including memory and sensation recollection and detecting olfactory abnormalities as an early symptom of cognitive impairment. Olfaction is expected to be used in cognitive rehabilitation.

An olfactory display is a device that presents odors, by controlling the timing of presentation, the type and concentration of odors, and their mixing ratio [NM07]. This can be applied to gaming, especially using Virtual Reality (VR), that combines odor presentation with virtual reality, creating a new player experience [OCN21].

Our research also applies olfactory VR to cognitive enhancement in elderly people. To achieve this, we have developed an olfactory VR game that focuses on cognitive training through sensory memory of smell. A player wears a head-mounted display incorporating the odor output nozzle of the olfactory display, and plays the game while seated in a swivel chair.

2. Methods

2.1. Device

For the olfactory VR game we used 4 devices: a computer, a head-mounted display for VR (Meta Quest 3), a controller (Meta Quest Touch Plus Controller), and an olfactory display machine housing the odor samples [NM07]. (Figure 1)

The player wears a head-mounted display, connected to the olfactory display machine by approximately 3 meters of Teflon tubing, with controllers in both hands. The left thumb stick enables walking in the game landscape and the right hand held controls are used for other interactive content. The olfactory VR game content is processed by a computer, with the sound, images and odors presented through the head-mounted display in response to players' actions in the virtual landscape.

2.2. Olfactory VR Game Content

The olfactory VR game content requires players to memorize specific odors through sensory information without linguistic or visual information describing the odor.

The olfactory VR game contents proceeds as follows:

1. Presentation of the reference odor to be memorized. The odor is presented in a timed way to enable the player to perceive and memorize it. (Figure 2)
2. Searching for the odor source in the virtual landscape while keeping the odor in mind. The player is required to proceed with parallel tasks, memorizing the odor and searching for its
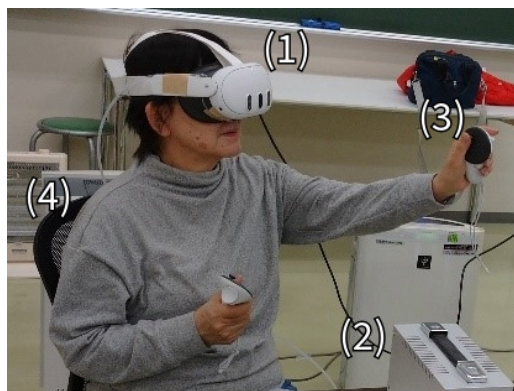
Figure 1: *A player wearing the head-mounted devices. Players experience the content while (1) wearing the Meta Quest 3 that is (2) connected to the olfactory display, (3) holding Meta Quest Touch Plus controllers in both hands and (4) sitting in the swivel chair.*

Figure 2: *First scene of the game. Odor to be memorized is presented with visual information as a white cloud.*

Figure 3: *Second scene of the game. Odor source is represented as a Japanese lantern "Toro".*

Figure 4: *Final scene of the game. Each of three colored clouds has each smell and one of them has same smell as memorized one.*

source. Using an isotropic diffusion model, the odor intensity distributed by the olfactory display is calculated in relation to the distance and direction between the player and the odor source. (Figure 3)

3. Matching the memorized odor from a choice of 3 odors. When the player has located the odor source in the landscape they are presented with 3 odors represented by different colored clouds. They then select the correct odor to match the one they memorized at the start of the game. The odor intensity is calculated relative to distance and direction between the player and each cloud. (Figure 4)

3. Conclusion

Our research aims to enhance cognitive function through the use of olfactory VR, with the olfactory game content we have created focused on sensory memorization.

The player is required to memorize smell only with the olfactory sensory information presented by each odor, carry out parallel tasks, and compare and select a memorized odor from a choice of three.

Although we are currently testing the olfactory VR game with elderly people, it should be of use to everyone. Participants can enjoy the experience of odor detection and comparison, hence its demonstration at ICAT 2024.

4. Acknowledgement

References

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