

Scentery: A Calming Multisensory Environment By Mixing Virtual Reality, Sound, and Scent

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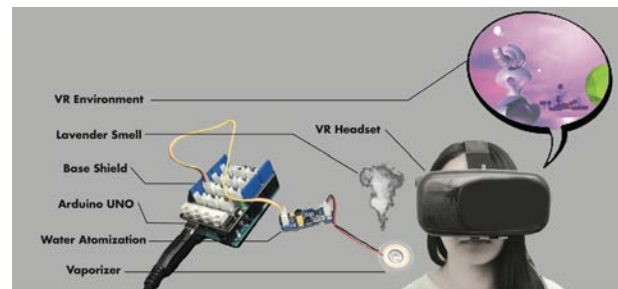


Figure 1: Scentery proposes calming multisensory environments by VR, sound and scent.

Abstract

Scentery proposes a novel approach to create calming multisensory environments by displaying visualizations, reproducing audios and activating olfactory sensations. By the use of recent literature, we introduce an initial Emotive Design Taxonomy that intersects emotions, and colors, sounds and scents. Scentery's users switch between different multisensory scenarios that promote calm sensation. The first VR scenario immerses the user into the scenery of lavender field, which bursts into a carnival of purple, a lavender scent and ambient instrumental sound. The other scenario is the scenery of raining forest, a ylang-ylang scent and nature sound. Scentery was developed with Unity 3D for creating the 3D scenarios, Unity Remote for the camera control and viewer's perspectives, and a microcontroller for triggering the scents in the vaporizer.

Author Keywords

Virtual Reality; olfactory; auditory; stress, multisensory.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

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Introduction

Nowadays stress levels continue to increase throughout the general population and the ability to find coping mechanisms becomes more essential to reach a healthy mental condition. A study from the National Institute of Mental Health [29] states that people who go through or experience a long-term source of stress could have health problems, and this source can affect them chronically if the stress they respond to is constant or goes on for too long. McEwen has suggested that our biological set points at which a variable physiological stabilize state changes when chronic stressors occur across the lifespan, and as the stressors accumulate the biological cost of these changes are linked to chronic illness [17]. Due to its impact on human health, scientists target the potential causes of stress and the influences in humans' health. A version of the Stressful and Traumatic Events Questionnaire (STEQ) exposes the most stressful life events in different age periods. In the questionnaire, it consisted of six clusters of traumatic life events: (1) Abandonment by a significant other; (2) Sexual Abuse; (3) Physical maltreatment; (4) Emotional maltreatment; (5) Death of a significant other; (6) Suicide attempt of a significant other [5].

Environmental factors, calming environment could psychologically reduce stress levels and increase an emotional sense of engagement. Virtual Reality (VR) is a computer-generated environment that can simulate a calming, relaxing environment to help cope with stress. We investigate the psychological potential of VR with the senses of hearing and smell to promote a calm environment. Our design goals proposes an Emotive Design Taxonomy that focus on the analysis of recent research on emotions, and its relationship to colors, scents, and sounds for multisensory environments.

Scentery focuses on the calm emotion to create an experience of VR displays integrated with sound and generates the olfactory stimulation for augmented sensation. In this paper, we explain the technology and implementation of two scenarios that promotes this multisensory environment for the calm emotion.

Background

Virtual Reality Therapy

Studies indicate that VR can be an effective environment for emotional therapy. A study shows that the immersive VR experience can be an exposure therapy for users to cope with flying phobia [23]. Users after experiencing the VR exposure therapy were reported of having a significant improvement on the willingness to fly on the airplane.

Another study of VR exposure therapy proposed a theory for helping patients cope with extreme stressful memory after the World Trade Center attack [7]. The theory suggests that in order to help patients reduce fear and stressful memory, patients need to establish a deep level of emotional engagement to their fear related memory through the use of VR therapy.

A study about the impact of VR therapy for public speaking anxiety in the university scenario investigated the effectiveness of VR therapy [10]. In this study, eight university students completed the individual emotional therapy. The individual therapy sessions are hosted weekly with 15 min approximation each week and lasted four weeks long. The measurements appear to be effective for university students in reducing their public speaking anxiety by using VR display.

Sound

Sound also contributes to an immersive experience in the audio environment. Sound plays an important role in influencing our mood and emotions. A study states that sound can create an immersive atmosphere or ambience that triggers the emotion of fear by using nature sound [27, 2]. However, the auditory sensation can also improve mood and help increase levels of happiness. Many studies have shown that pleasant sounds, like instrumental music, can effectively lift our mood state and reduce depressed emotions [18]. English [9] also stated that sound is the stimulus of both the physical and psychological responses. In Scentery, we use the ambient instrumental music and nature sounds that promotes a calm environment [27, 2] and engages at a deeper level during the VR experience.

Scent

Smell is an olfactory reception that is essential in our everyday lives. It affects our mood, emotion, thoughts, and behaviors. Many researchers have implemented smell in their applications. The research done by Amores and Maes used scent to promote human health and wellbeing. They created Essence, an olfactory wearable computational device, which can release peppermint scent which promotes a general arousal of attention in a pattern based on the analysis of the biological data from users to enhance learning and cognitive performance [1]. Brewster's research states also that smell has a strong link to memory [3]. They use different smell, such as floral, ozone, grass etc., as a searching tool for people to recall digital photos. Participants of the research describe that the smell of the object reminds them of the time and place when they perceived the smell [3]. A similar research project

that used smell to recall the memory of a person or event is inScent, a wearable olfactory display that uses artificial emitted scents to notify the user in everyday scenarios [8]. This mobile olfactory device is also used to emphasize messages from loved ones by emitting pleasant scented notifications which link the relationship between the user and their emotional partners.

Moreover, olfactory sensations have also been utilized and integrated with VR therapy in research. A study conducted by Chen incorporates olfaction to VR applications [6]. In her research project, she selected scents, such as burning rubber, smoke, garbage, body odor etc., and introduced a potential application of the ubiquitous olfactory display to be integrated into the virtual reality exposure therapy which uses computer vision-based face tracking technology to detect the position of user's nose and emits the odor [6]. Chen also introduces another possible application of the ubiquitous display device into the VR display system, CAVE, which is considered the most immersive VR display system [19]. Chen's project inspires us to capitalize on our sense of smell in our VR scenarios. By utilizing smell as a way of memory calling and integrating the VR therapy technique, patients may recall or link themselves directly back to the calming state.

Multisensory Experience

Researchers, Lifton and Paradiso also presented a related study that demonstrates the potential to interplay the real world and the virtual world. Insofar, they propose Dual Reality, an environment which is mediated by the network of sensors and actuators to interact between the virtual environment and the

reality [13]. They developed "Plug" sensor network consisted in 35 nodes modeled on a electrical power outlet strip and this sensor network is designed specifically for ubiquitous computing environments. Lopes, et al. used electrical muscle stimulation to provide the feeling of counter force in VR scenarios that include walls, gates, sliders, boxes, and projectiles [16]. The TREE project from MIT Media Lab [20] designed sensory-enhanced VR film that includes smell (dirt, rain forest and fire), vibration, heat, and body haptics, in order to create an immersive experience of being a tree throughout its life cycle.

EMOTIVE DESIGN TAXONOMY WITH COLOR, SCENT, AND SOUND

Even the vast research on emotions and their relationship with color, scent or sound, we focus in specific references that could be applied for VR environments. We investigate the representations of these factors and create a summary that reflects their emotional effects. We also summarize their combinations that potentially can be the most effective design choice for creating a calm multisensory environment (Figure 2).

Colors are closely associated with our emotions [15, 21]. Red is a warm and highly saturated color which is highly noticeable, compared to other colors, and gives people a strong attention and also make them feel alert. Orange is also a warm and saturated color which can activate positive emotions and state of mind. Yellow represents happiness and sunshine. It also gives people inner energy. Blue is a cool and calming color that represents peacefulness and gives people a calming effect. Green represents life and nature that brings us to a healthy emotional state. Purple provides calming

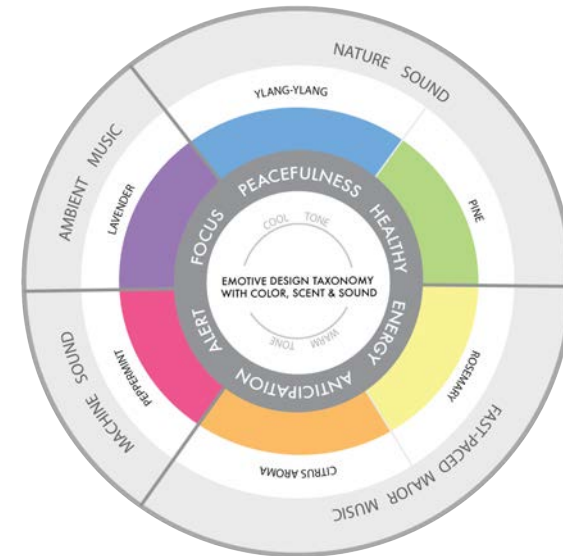


Figure 2: Emotive Design Taxonomy with Color, Scent, and Sound

effects as well; it also helps people be more productive and remain focused.

We also identify a variety of scents to meet each emotion. For example, peppermint has an awakening effect that enhances memory and alertness [24]. Citrus aroma and lavender are both pleasant, but the former one is more stimulating and have a high arousal effect, and the latter has a more active, fresher, relaxed effect [28,24]. Rosemary, on the other hand, is a spicy scent that rates high on confusion and bewilderment and create more tension [4]. Pine scents give a natural and active impression that boost mood

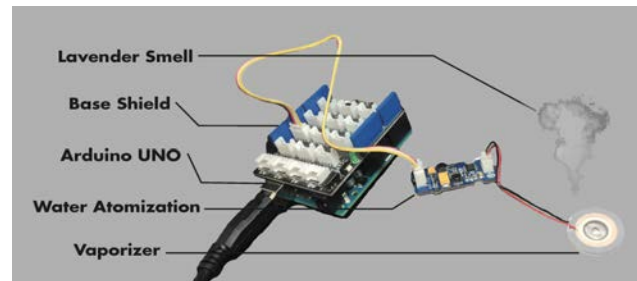


Figure 3: Design structure; lavender smell; base shield; arduino uno, water atomization; vaporizer.

state and reduce in blood pressure due to contact with nature [12]. Moreover, ylang-ylang can significantly decrease blood pressure and increase skin temperature that creates a calming effect [24].

Sounds have different representations in human emotions. For example, fast-paced major music is more associated with light, highly saturated, and warm colors and creates the emotion of happiness and energy [22]. Ambient music is pleasant, can energize people, and make them more productive and focused [26]. Machine sound can be distractive and increase alertness [25]. Also, nature sound can decrease in heart rate that results people in a calming emotional state and is also related to nature that brings them a healthy emotional state [2]. By focusing in emotions for the VR and physical objects that activate scent, emit sound and other sensory experiences, we aim to design experiences that could focus in the intention of the VR environment (Figure 5). Using this taxonomy, we propose Scentery, a multisensory calming environment. Thus, the colors of purple, blue, or green in combination to nature sounds or ambient instrumental music and the scents, such as lavender, ylang-ylang, or

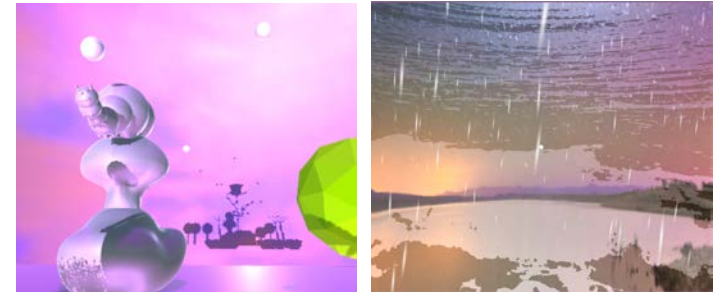


Figure 4: Scentery's VR Scenarios: Carnival of Purple and Rainforest.

pine, are our design choices for creating a calm environment.

IMPLEMENTATION

VR Scenarios

Scentery was developed with Unity 3D that creates 3D scenarios that immerse the user into the computer-generated sceneries in the virtual environment. We have developed two different scenarios that could potentially help users with stress. One of the scenarios we have developed is the lavender garden (Figure 4). Integrating the smell of lavender with ambient instrumental sound and a purple environment, we propose this flower garden scenario to help user relax and de-stress.

The other scenario that we developed is the scenario where the user is surrounded by the rain in the virtual environment. With the immersive experience of the raining auditory effects and the visual effects, we aim to help users to emotionally engage in the scenario and to find the feelings of relaxation (Figure 4) .

Technology Description

To execute the working prototype, we use a smart phone inserted in a VR headset as the viewer to display the scenarios in the virtual reality environment (Figure 5). In order to continuously track the changes of the user's head rotation, we programmed a script and attached it to the camera in the building environment. The script modified camera in the building scene constantly rotates along with the position changes of the accelerometer inside the smartphone while connected to Unity 3D. To create the stereoscopic view on the smartphone, we rendered the view with two cameras which are placed at slightly different angles to create an illusion of depth and perspective view. We also use Arduino Uno, a microcontroller board, along with the VR program to activate triggers programmed in the VR environment.

Scent Release

The scent is released by the triggers programmed in the microcontroller connected with Unity 3D. For the mechanics of the olfactory device, the water vaporizer collides the oil-based scents at high pressures to produce atomized water or the vaporized water. Two vaporizer are connected to the microcontroller. The vaporizer converts water into vapor and emit the scents for 10 seconds.

Audio Display

We create raining sound effect stimulation in the rainforest scenario, calming nature sounds effect [14], and the scenario of the lavender garden that has a relaxing ambient instrumental effect that makes people feel relaxed and calm [11].



Figure 5: Example of user engaged in the VR scenario.

CONCLUSION AND FUTURE WORK

The value of color, sound and olfactory information and its relationship with emotions has been widely recognized in many academic studies, artistic performances and therapies. This paper proposes an initial exploration of the intertwine between emotions, and color, sound, scent for creating VR environments by our Emotional Design Taxonomy. By using this taxonomy, Scentery implemented in two multisensory experiences that focused on calming emotional states. Carnival of Lavender presented a predominant purple color 3D scenario with lavender smell and instrumental sound. The raining forest used a ylang-ylang scent and nature sounds.

VR experiences are mainly created using a 3D environment and sound. To augment these experiences and its, we envision that olfactory interfaces could be incorporated. This incorporation would not only enhance the realism of the virtual experience, but they would also serve as a stimuli in the process of therapy.

Moreover, mobile devices play an important role in today's society. They also benefit the technology of VR in a number of ways. We decided to use a mobile device as the highlight of this project due to its convenience of downloading apps, availability to the users, and portability. Mobile devices are also easy to access and are less expensive than other VR gadgets that can help people develop new technology in a more approachable way.

In future work, we will conduct workshops with psychologists to find feedback on the use of this technology in their practices. We will also evaluate the efficacy of the working prototype based on user studies of participants with traumatic experiences and expand the wider options of functioning scenarios for discovery. By experiencing the sensations of visual, auditory, and smell, we aim to help patients with traumatic experiences to combat traumatic stress by reimagining the stressful life events in a more comfortable setting under the exposure of VR therapy.

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