NatureBlendVR: A Hybrid Space Experience for Enhancing Emotional Regulation and Cognitive Performance

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Figure 1: (a) Bio-responsive environment (b) User interacting with haptic flower sphere (c) Additional elements (deer) reacting to user heart beat

Abstract

NatureBlendVR is an immersive experience designed to enhance well-being through forest bathing. This system integrates XR technology with interactive, bio-responsive physical elements. Through the experience, participants find themselves in a blended environment where physical components of nature are integrated into their immediate surroundings. The experience gradually transitions from the real world to a designed virtual forest, where digital elements align perfectly with the physical environment. This fosters a deep sense of presence, allowing users to feel fully immersed as their embodied sensations align with the virtual interactions they encounter.

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1 Introduction

Nature has long been recognized for its beneficial effects on well-being. The Japanese practice of Shinrin-yoku, also known as forest bathing, has been demonstrated to enhance both psychological

and physical health [Wen et al. 2019]. Previous research has investigated the use of virtual reality (VR) technologies to make nature more accessible. Comparative studies indicate that VR nature experiences can yield benefits similar to traditional forest bathing, although there are limitations due to the purely digital nature of the experience [Reese et al. 2022]. Recently, researchers have started exploring the integration of haptic and somatosensory stimuli in VR nature experiences. However, these stimuli are typically system-generated and not the result of active user engagement, despite the collection of physiological data from participants [Lopes et al. 2022]. Additionally, research on VR biofeedback experiences has shown that dynamic visualizations can reduce stress and enhance empathy [Armstrong et al. 2023; Skiers et al. 2022]. We introduce NatureBlendVR, an immersive hybrid forest bathing experience that combines physical and virtual elements for active multi-sensory engagement. By incorporating responsive biofeedback components—such as a touchable flower sphere that pulsates and glows in sync with the user's heartbeat—we aim to enhance reflective, embodied sensations and deepen the connection with the hybrid natural environment, overcoming previous limitations.

2 System Design

For the physical setting, we created an interactive environment that incorporates simulated natural elements, such as artificial grass, trees, flowers, and ambient lighting. The Virtual Reality system was developed using the Meta Quest 3 headset and the Unity3D framework. Inside this immersive digital environment, users find themselves in a forest clearing beneath a starry sky. The placement of the nearest trees and plants in the virtual environment aligns with the positions of their counterparts in the physical space. The experience is further enhanced by nature sounds, delivered through Bose 700 noise-canceling headphones. A haptic flower sphere, present in both the physical and virtual forests, features pulsating lights and haptic modules that respond to the user's heartbeat. To collect the user's biosignals, we use the EmotiBit wearable sensor, which transmits data via TouchDesigner to an Arduino module. This module is connected to LED strips and 20 haptic actuators in the physical flower sphere, which glows and pulses in sync with its digital counterpart.

3 Preliminary study

During our preliminary study, eight participants experienced a multi-sensory forest environment combining physical and virtual elements, enhanced by biofeedback. Seated in a forest-like setup with artificial grass, trees, and flowers, participants were equipped with an EmotiBit sensor and engaged with a haptic flower sphere that responded to their heartbeat through pulsating vibrations and changes in light intensity. The experience lasted from two to seven minutes, and participants shared valuable feedback that influenced the system's development.

Key insights included:

- **"Magical" Experience:** Many participants described the experience as having a magical quality, highlighting the emotional and sensory impact.
- **Connection with Nature:** The integration of real and virtual elements, including the trembling leaves and haptic feedback, made participants feel immersed and connected to the forest.
- **Immersive Biofeedback:** The pulsating sphere, synchronized with their heartbeat, provided an engaging and meaningful interaction, enhancing the overall immersion.
- **Real and Virtual Interaction:** The ability to interact with elements in both the real and virtual worlds deepened the sense of presence.
- **Emotional Support:** Some participants expressed feelings of loneliness in the nighttime forest setting and suggested adding animals like cats or deer to create a more comforting and emotionally supportive environment.
- **Enhanced Audio Experience:** Improved soundscapes through headphones contributed significantly to the immersive atmosphere.

Overall, the feedback guided the system's expansion, helping to create a more memorable and engaging experience for future users.

4 Conclusion

NatureBlendVR is a multi-sensory forest bathing experience that blends physical and virtual elements with biofeedback technology. This system is designed to help users reconnect with nature, enhancing their psychological and social well-being. By immersing users in an environment where they can engage with both real and virtual representations of nature, NatureBlendVR strengthens the feeling of presence and connection with the natural world. The inclusion of biofeedback elements creates a uniquely personal experience, promoting mindfulness and relaxation.

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