SENSING NATURE

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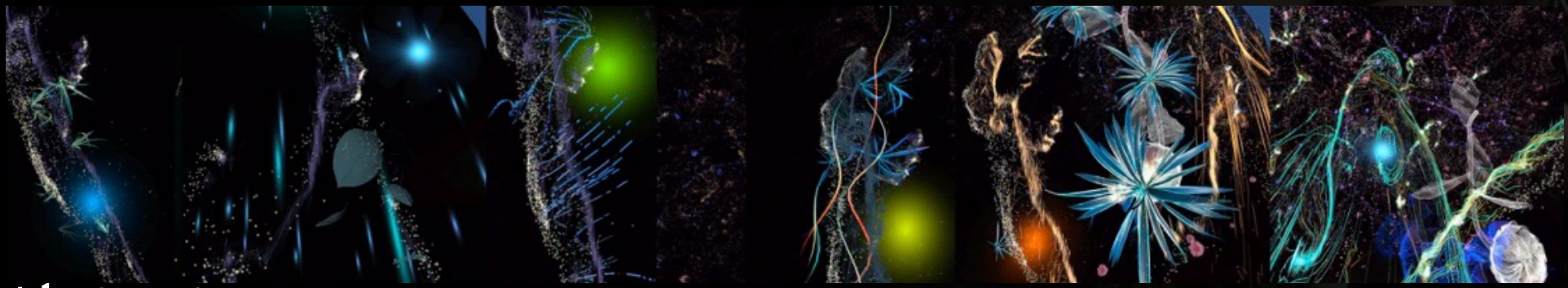

Abstract

The rise of urbanisation has reduced connection with nature and physical interaction, both crucial for well-being and pro-environmental behavior. Sensing Nature is a multisensory virtual reality installation that aims to energize and nourish the spirit by reimagining the natural world as a playful, immersive experience. Users create a sensory journey by interacting with a haptic tree and exploring real-world fabrics and textures. Each touch triggers a transformation of the virtual tree, blending blooming virtual flowers, nature-inspired spatial sounds, and physical vibrations for a unique immersive experience. This project investigated multisensory interaction in virtual reality' s impacts on people's feelings and attitude to nature, addressing the lack of direct touch-based haptic interactions in VR by incorporating active and passive haptic feedback. Qualitative studies shown that multisensory interactions in virtual reality induce healing effects, relaxation and shift attitudes towards nature, demonstrating sensing nature's potential application for relaxation and pro- environmental attitudes.

Authors Keywords

Arts; Nature; Multisensory Interaction; HCI;

Virtual Reality (VR); Wellbeing

CCS Concepts

•Human-centered computing~Human computer interaction (HCI)~Interaction paradigms~Virtual reality

•Human-centered computing~Human computer interaction (HCI)~Interaction devices~Haptic devices

•Human-centered computing~Human computer interaction (HCI)~Empirical studies in HCI

•Applied computing~Arts and humanities~Media arts

Video Link

The video content is available in the Supplementary Materials and at the link: https://youtu.be/CMl8FwpnBQ4

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Introduction

We are in the midst of a twin crisis, a crisis of environmental breakdown and a crisis of human mental health. Morizot [17] defines the former as a crisis of our relationship to nature. There is also evidence that latter, our mental health crisis is in part caused by the breakdown of this relationship, resulting in "nature-deficit disorder", as reduced contact with nature has been linked to psychological costs and diminished awareness and appreciation of the natural world [30].

Research indicates that contact with and connection to nature are strongly associated with improved health, well-being, and pro-environmental behaviors [15]. Physical interaction with plants, such as touch, has been shown to elicit a significant calming response compared to interactions with other materials. Patients exposed to natural stimuli—including viewing plants and flowers of various colors and shapes, smelling pleasant natural fragrances, and hearing sounds of nature—demonstrated enhanced brain activity and emotional responses. In contrast, individuals who lacked such exposure exhibited higher stress levels [37].

The ecological crisis we face is not only a material or scientific problem but also a profound crisis of sensibility [17,39]. While we are increasingly aware of environmental destruction, such awareness often fails to transform our emotional and relational ties with the natural world. Lengieza et al. [13] have shown that mere contact with nature is not enough, as people can lack the required attention and connection to nature to provide the benefits of nature contact.

Zhong Mengual [38,39] argues that art plays a critical role—not as a form of denunciation, but as a medium of reconciliation [24], that helps us learn to truly see the living world. It holds the capacity to rekindle our dulled sensitivity [11] and to reanimate our affective and aesthetic relationships with living beings [27]. Rather than reducing nature to inanimate matter, as modern paradigms have often done [5], art can offer new imaginaries, symbols, and representations that enrich our sensibility and expand our capacity to care [26]. By doing so, art not only enhances individual perception but also acts upon the collective, opening pathways toward more ethical and sustainable engagements with the living world. It is, therefore, not simply what art represents, but what it does—its reconstructive and sensitizing power—that makes it indispensable in times of ecological crisis.

Though visual and sound arts are powerful in this context, virtual reality art has the potential for a stronger sensitising effect due to its immersion and ability create presence, the sense of being in a virtual environment [29]. VR has emerged as a valuable tool in therapeutic contexts, particularly for reducing anxiety [21]. By creating immersive and engaging environments, VR helps distract users from stress, promote relaxation, and support emotional regulation [9].

There have been several investigations into the use of VR, to create "virtual nature". Relaxation is a key function of virtual nature, contributing to both psychological and physiological recovery [23]. Research has highlighted the restorative effects of virtual nature in various settings, particularly workplaces, suggesting it can serve as an effective alternative to real nature in stress-reduction interventions [36]. Furthermore, studies have indicated that virtual nature experiences may promote restorativeness by alleviating attention fatigue [4,16].

However, the aim of our work is not to simply to enhance welling or replace real nature experiences, but to use VR as an artistic medium to enhance people's relationship with nature. A limited but growing body of research also suggests that exposure to virtual nature can enhance nature connectedness and pro-environmental behavior. These effects have been observed across different media formats, including videos, images, and VR experiences [31,33,35].

Another benefit of Virtual Reality is the potential for multi-sensory interaction. Many of life's most enjoyable and meaningful experiences are inherently multisensory [34] and the benefits of nature contact engage all senses [37]. In VR, incorporating multiple sensory modalities significantly enhances immersion and realism by more closely mirroring how we perceive the real world. VR sensory systems support perception through the integration of external inputs (e.g., vision, hearing, touch), internal cues (e.g., balance, proprioception), and efferent feedback such as motor output and attention [18].

Although multisensory experiences have been associated with improved psychological outcomes, research specifically investigating multisensory virtual nature exposure remains limited [7,25]. Among these modalities, olfactory stimuli have received the most attention, with studies showing that natural scents—such as the smell of trees—can reduce stress more effectively than visual cues alone [8]. However, the inclusion of haptic and other sensory modalities is still rare, in part due to the constraints of commercial hardware.

There is growing interest in how multisensory VR might influence pro-environmental behavior [1,14]. Yet, active multisensory interaction in VR—where users influence or respond to sensory input in real time—remains largely unexplored. In a recent study, Spangenberger et al. [32] explored the impact of visual, auditory, tactile, and olfactory stimuli in a VR experience where participants embodied a tree. While the additional sensory channels did not significantly enhance nature connectedness beyond audiovisual VR, they did promote greater pro-environmental intentions and reflective thinking [32]. Crucially, their approach was limited to passive multisensory presentation, with no interactive feedback mechanisms. Further research is needed to identify effective technological designs, interaction strategies, and psychological frameworks that can foster environmental engagement and deepen emotional connections to nature in immersive contexts [2,19,20,22]

Our project, Sensing Nature, overcomes this by integrating touch, vision, and sound without requiring wearable devices, offering a more "Natural Interaction"[6], immersive sensory experience. We aim to deepen emotional connections to nature, reduce anxiety, and promote well-being. Our qualitative research aims to investigate how multisensory interaction in virtual reality affects people's emotions and attitudes towards nature. This pictorial is divided into four parts: physical world, virtual world, multisensory interaction and qualitative research.

Concept

Virtual Reality For Wellbeing

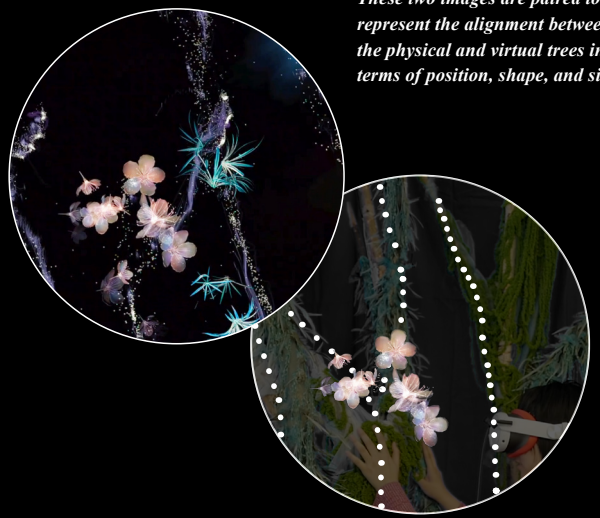
Sensing Nature is a healing, immersive experience designed to reconnect people with their senses and nature. By engaging in the virtual world, participants momentarily disconnect from the anxieties of real life, finding relaxation, empathy, and a renewed sense of connection with the natural world. Through multisensory interactions in virtual reality—including visuals, audio, haptics (textiles, vibrations)—this project transforms a virtual tree into a dynamic, responsive being. Participants report a flow of energy, a sense of emotional healing, and a deeper appreciation for nature, even though the tree is not alive. They feel a closer relationship even though the tree is not human-like. Many describe the tree as a musical instrument, a maternal figure, or an old friend, highlighting the emotional depth of the connection.

The Power Of Touch

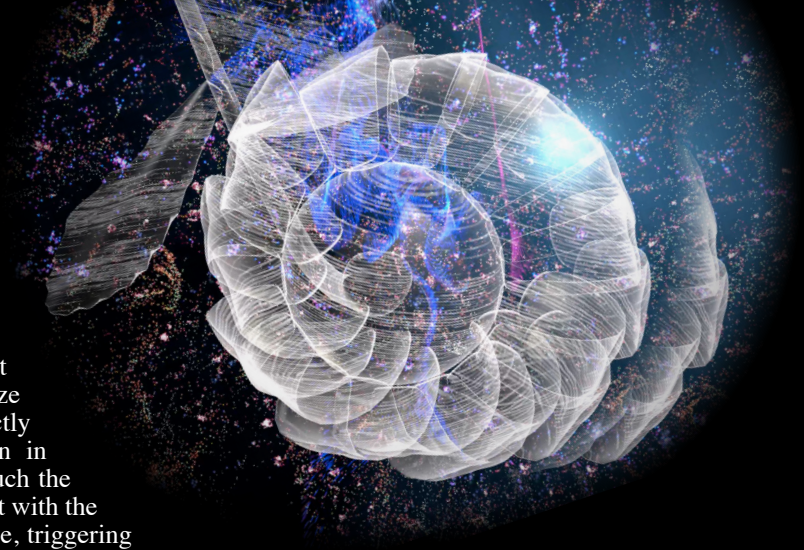
In the physical world, a haptic tree integrates diverse fabrics with a multisensory interactive system. In parallel, the virtual world features a 3D-scanned installation tree that mirrors the physical tree's exact size and shape. These two trees are perfectly aligned, occupying the same location in both worlds. Wherever participants touch the haptic tree, they simultaneously interact with the corresponding branch of the virtual tree, triggering dynamic visuals, spatial audio, and vibrations. Through these interactions, participants create their own virtual environment while exploring the textures and fabrics of the physical tree. This seamless connection between the physical and virtual worlds fosters an immersive and tactile experience.

You see - and feel – the tree grow and transform.

Every touch unlocks cascades of flowers and vibration, interwoven with the sound of nature, and each individual's sensory experience is beautifully unique.



These two images are paired to represent the alignment between the physical and virtual trees in terms of position, shape, and size.



Walk-Through Text

Imagine a dying tree, adorned with diverse fabrics in the physical world. In the virtual realm, this fabric tree transforms into a magical, responsive being. By touching it, you unlock a unique interplay of effects—joyful and deeply connected, as if nature itself responds to your presence. Each interaction mirrors the intimacy of human connection, where every touch invites a vibrant reaction.

Unlike in the real world, here the flowers bloom because of you, the mother tree grows taller through your contributions, and spatial nature sounds embrace your mind. Vibrational energy flows through your body, inviting you to fully immerse yourself in this multisensory experience—your interactivity fuels it all.

You are the creator and the heart of this world, free to disconnect from daily distractions and lose yourself in its magic. Through haptic feedback, you forge a personal bond with the tree, crafting your own emotional journey—a unique story within an enchanted forest. Every visual, sound, and vibration is distinct, shaped entirely by when, where, and how you touch. Each texture reveals a different response, guiding you deeper into this magical encounter.

Embrace your emotions, free yourself, and discover a world where your touch brings nature to life.

Physical World

In the physical space, there is a seat and a haptic installation. On the haptic installation, diverse fabrics with different textures are sewn onto a tree. Beneath the tree is a black box that houses all the Electrical Sensors and the Micro controller. All wires are plugged into a socket, which is connected to the wall socket. The tree is fixed to a wooden board supported by several pillars and secured with nails, all of which are covered in a grass texture. In addition to the haptic installation, a laptop running the interactive program Sensing Nature is connected to a virtual reality headset via a link cable. Participants are also provided with headphones.

Core Components

Vibration System

We compared 12V and 5V vibration motors and used parametric modeling with 3D-printed shells to protect users from direct contact. Vibration frequency was controlled via a driver, with different PWM amplitudes set through the Arduino program. Vibrations could be turned on or off, and frequencies adjusted using Open Sound Control (OSC) connections between VR Unity and Arduino programs.

Haptic Data Flow

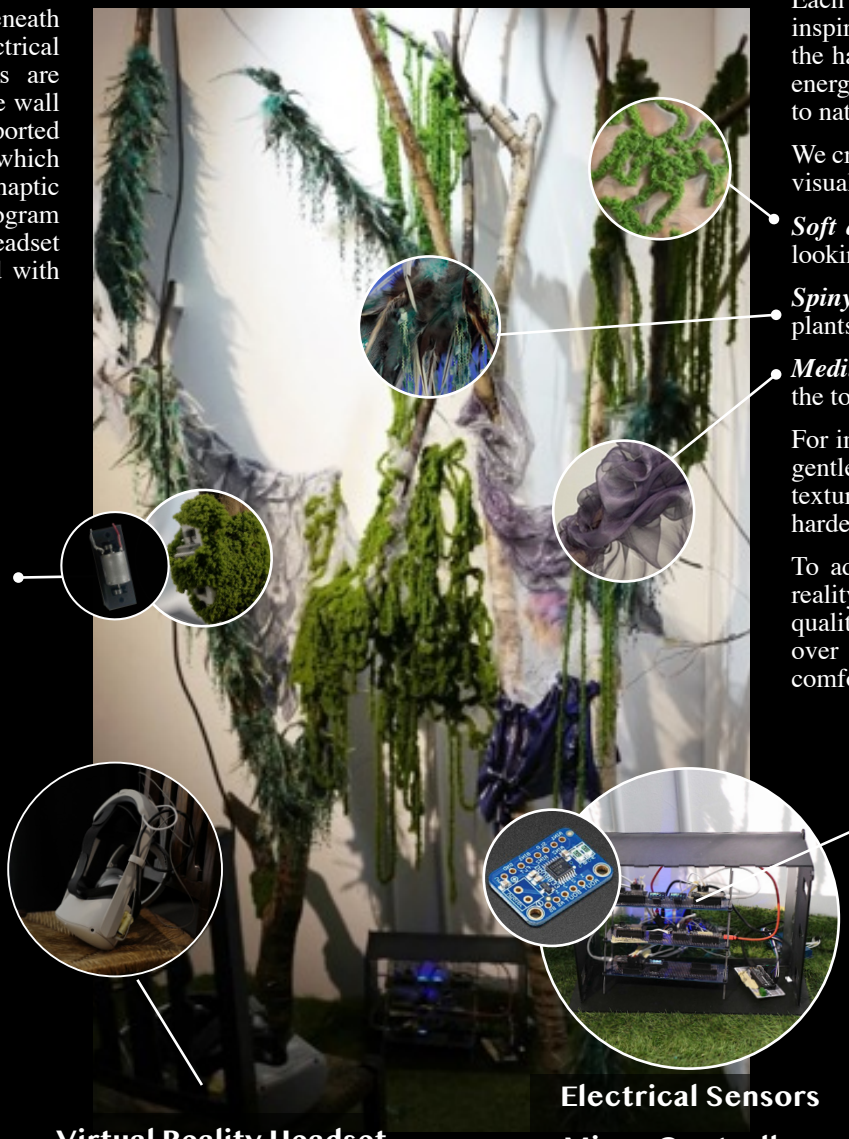
When participants touch different physical fabrics, while at the same time in the virtual world, the virtual hand triggers different box colliders in Unity and then send different data to ESP32.

Getting the Audience Onboard

Before the experience begins, we provide a brief introduction to Sensing Nature, encouraging participants to touch and familiarize themselves with the different fabrics. People often have unique ways of interacting through touch, and each distinct touch produces a specific effect.

Haptic Tree (Branch)

We picked up a dying branch that had been blown down by the wind to give it a second life in the virtual world.



Virtual Reality Headset

Electrical Sensors

Micro Controller

Fabric Collection

We collected various fabrics and selected three distinct textiles.

Each type of fabric reflects a distinct sense of touch, inspiring corresponding visual designs. By engaging with the haptic tree, participants become aware of a spiritual energy deeply rooted in their subconscious connection to nature.

We created three types of fabric, each paired with unique visual, musical, and vibration effects:

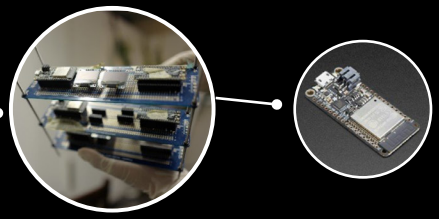
Soft and low-bump fabrics correspond to gentle, soft-looking flowers.

Spiny and highly bumpy fabrics evoke visuals of spiny plants.

Medium-softness and medium-bumpy fabrics simulate the touch of various flowers.

For instance, wool was chosen as a soft, low-bump, and gentle fabric. Silk, treated with folds, created a medium-textured fabric, while feathers were selected for their harder texture to represent spiny plants.

To address potential hesitations about touch in virtual reality, all fabrics were selected for their skin-friendly qualities. This consideration led us to choose fabrics over rough textures like tree bark, ensuring a more comfortable and inviting tactile experience.



Esp32 Huzzah Microcontroller

The ESP32 Huzzah microcontroller, with built-in Wi-Fi, connects physical devices like vibration motors to the Unity platform. It enables seamless communication by transmitting data between these components and Unity.

Virtual World

Visual Design And Technology

In the virtual world, a 3D scan of the physical tree mirrors its size and shape, occupying the same space, referred to as the "virtual installation tree," Participants to interact with it using their virtual hands: when touching the physical haptic tree they also touch the virtual tree. This dual interaction enables participants to create personal narratives, fostering unique sensory experiences and emotional responses across both worlds.

We have designed both interactive and non-interactive effects. Interactive effects include small petals, flowers, leaves, energy dots, energy lines, energy flower flows and more, appearing as participants touch the tree. Energy lines flow along the tree, representing the flows of nuturients and neurotransmitters within and between trees [28]. Non-interactive elements include the title sequence, the rising blue moon, falling rain, groundwater flowers growing, the big particle tree transforming into a line tree, energy leaves becoming colorful, warm, and bright, and the sunrise These ensure that the storyline progresses smoothly and key moments unfold seamlessly.

Combined with these non-interactive visuals, participants feel that their touch drives the story, creating their unique forest. The story's progression is designed to bring positive energy, with the color tone evolving from cool to warm hues. Inspired by color spectroscopy, these visual elements guide participants and enhance the immersive emotional experience.

The journey spans from night to day, inviting participants to leave behind the anxieties of the physical world and immerse themselves in the virtual realm. In this space, they build their own natural world, absorbing warmth and positive energy to carry back into their daily lives.

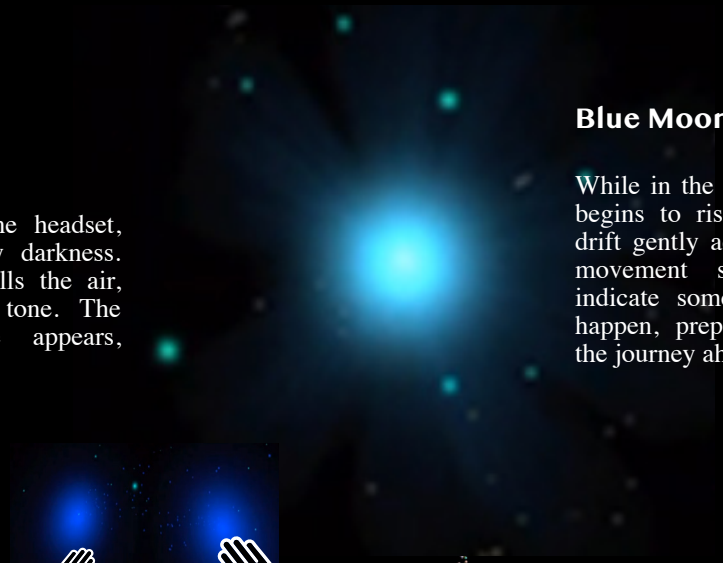
We used Unity's Visual Effect and Shader Graph tools, along with C# scripting, to create and integrate interactive visuals. As previously mentioned, when participants touch different branches and fabrics, they immediately trigger synchronized visual effects, spatial sounds, and vibrations.

Entry

As participants don the headset, they are enveloped by darkness. Soft, calming music fills the air, gradually setting the tone. The title Sensing Nature appears, shimmering and fading.

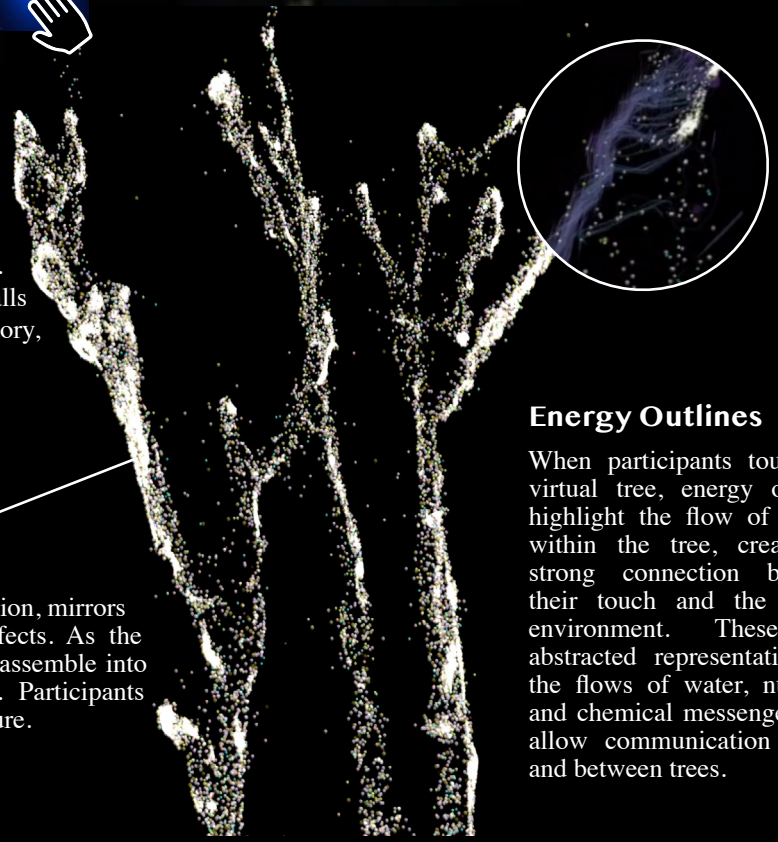
Blue Moon

While in the distance, a blue moon begins to rise. Floating blue dots drift gently across the screen, their movement slow and rhythmic, indicate something important will happen, preparing participants for the journey ahead.



Virtual Hand (Energy Ball)

To ease the transition and prevent disorientation in the emptiness, two glowing blue energy balls slowly materialize in the palms of the participants' hands, subtly reminding them of their presence in the virtual space. Representing their hands, the energy balls change color over the course of the story, using color spectroscopy.



Virtual Installation Tree

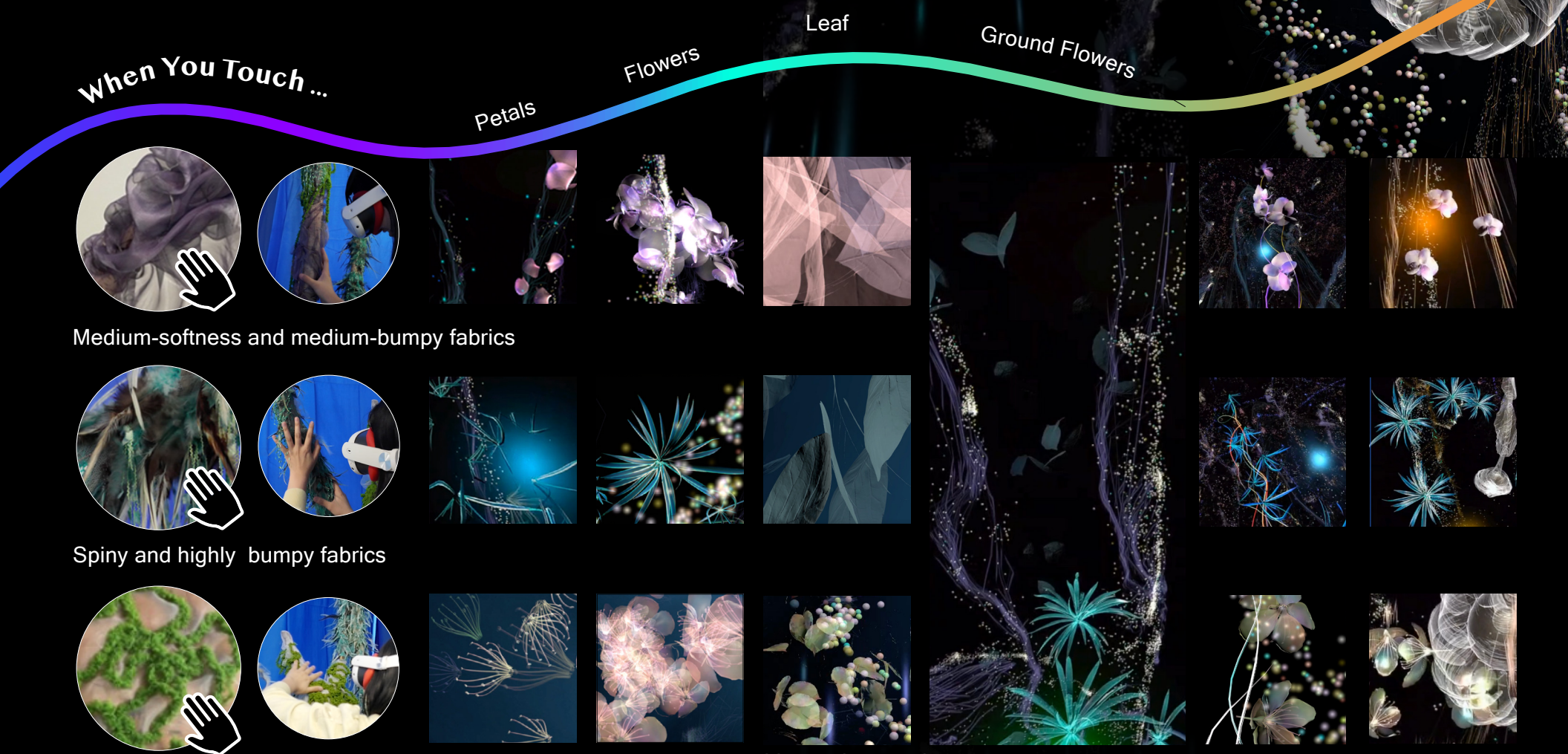
The virtual installation tree, created from a 3D scan of the physical installation, mirrors its size and shape through visual effects. As the experience begins, particles gradually assemble into the tree, with colors shifting over time. Participants are invited to touch it and embrace nature.

Energy Outlines

When participants touch the virtual tree, energy outlines highlight the flow of energy within the tree, creating a strong connection between their touch and the virtual environment. These are abstracted representations of the flows of water, nutriants and chemical messengers that allow communication within and between trees.

Interactively Touching Fabric

Interactive effects bring nature's growth to life, beginning with the virtual tree's energy blossoming into petals and flowers, deepening participants' connection to the virtual world. As rain falls and leaves respond to touch, groundwater flowers emerge, marking a transition. The big tree then grows as participants interact with the virtual tree, transforming energy dots into glowing lines and vibrant flows that rise to the big tree and reach for the sky. Touches unleash floating and singing flowers, bursting with energy. The story concludes on a warm, uplifting note as colors shift from cool blues to radiant oranges, guided by color spectroscopy.



Medium-softness and medium-bumpy fabrics

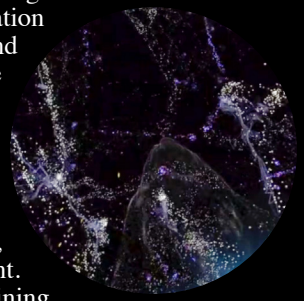
Spiny and highly bumpy fabrics

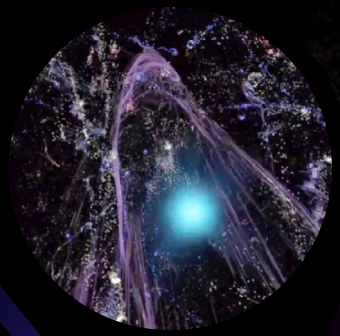
Soft and low-bump fabrics

It's starting to rain.
After rainfall, ground flowers emerge.

Highlight - *Big Tree Growing*

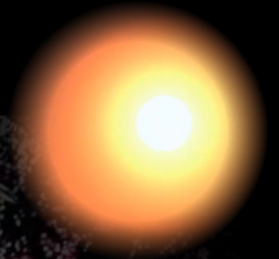
After the rain falls, life flourishes, from groundwater flowers to the majestic big tree. Participants touch the virtual installation tree, activating energy dots, lines, and flowing energy flowers that shape the big tree's growth. These energy flowers rise from the virtual haptic tree to the big tree, bridging the connection between them. As interactive energy builds, the big tree evolves from dots to lines, becoming warmer and more vibrant. Multiple layers of glowing, shining leaves gradually appear, stretching skyward, with colors shifting beautifully from cold to warm. The haptic, dying tree springs to life, thriving through the participants' touch.

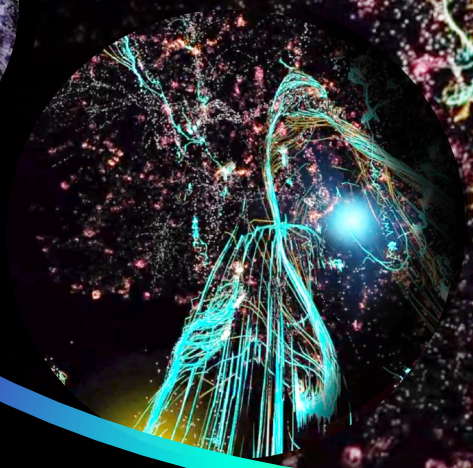




Sun Rise

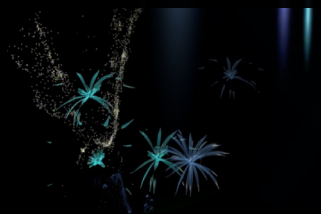
Transitioning from pink to orange as ink flowers begin to appear—symbolizing the arrival of daylight. The environment gradually brightens, evoking feelings of warmth, happiness, and relaxation. If participants are ready, they can feel free to remove their headset and return to the physical world.





Rain

Rain gently ushers in a shift in emotional tone, its soft descent accompanied by an ethereal voice that wraps participants in a soothing embrace. As they touch, interactive leaves float down, harmonizing with the blossoming of groundwater flowers and the gentle hum of nature's growth. The big tree stirs, poised to rise and flourish.



Energy outlines

The interactive energy flow changes colors throughout the experience, becoming warmer and brighter as the story progresses, symbolizing renewal and growth. The lines represent the flows of nutrients that enable to tree to grow and eventually communicate with other plants and fungi.

Multisensory Interaction

Participants receive synchronous multisensory feedback based on when, where, and how they touch. This feedback includes visual effects, spatial sounds, and haptic responses—both passive tactile sensations and active vibrations. These interactions aim to encourage exploration and evoke varied emotional experiences. Their movements trigger different multisensory feedback, which, in turn, induces emotional responses. These emotional responses prompt new movements, creating a continuous loop where motion and multisensory feedback influence each other.

Haptic Images

Haptic images, composed of tactile and kinesthetic information from multiple sensory channels, are often more complex than visual or auditory information [10]. To manage this complexity, our Sensing Nature system detects variations in participants' touch and movement, generating tailored multisensory feedback. By combining both passtive and active tactile and kinesthetic data, the system creates unique haptic images for each participant.

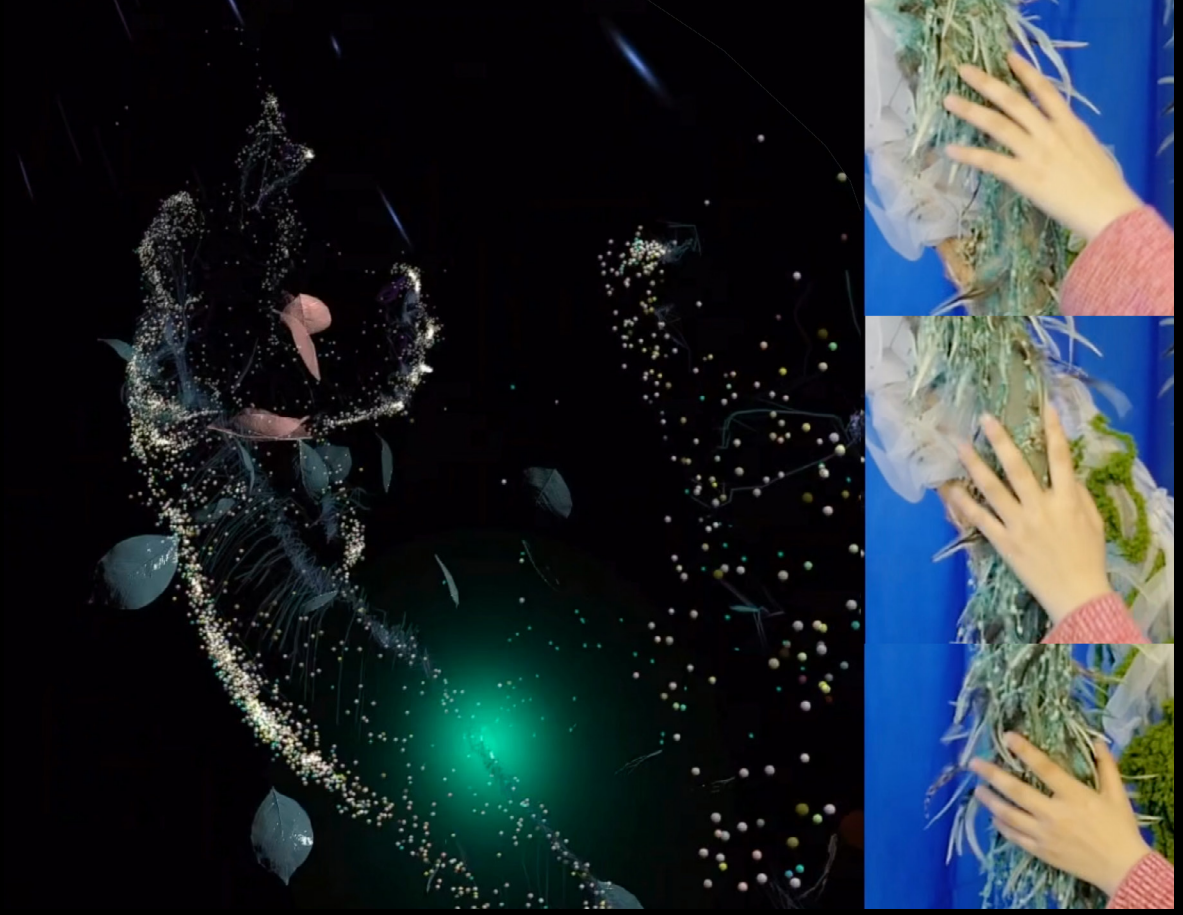
Tactile Information

Passive Tactile Sensations

When participants touch textiles of different textures and shapes, they trigger various visual effects. These visual effects are designed to correspond to the tactile sensations associated with touching the fabrics. At different points in time, participants trigger new visual effects that build upon the natural growth of flowers from the previous timeline while still reflecting the tactile qualities of the fabric in virtual reality.

Active Vibration Design

Vibration motors trigger motion in the tree's trunk upon touch. The simulation occasionally mimics the rhythmic heartbeat of a tree as the motors operate intermittently. Different positions on the tree trigger distinct vibration effects, enhancing tactile feedback. We installed two vibration motors—one at the top and one at the bottom of the tree. Touching the fabric on the upper half activates vibrations in the upper branches, and vice versa for the lower half. However, we noticed that vibrations from distant sources could be distracting. The lack of vibration dampening also made it difficult for some participants to identify where the vibrations originated. Despite these challenges, our tests confirmed that multisensory interactions significantly influence participants' emotions and their attitudes toward nature.



Kinematic Information

To convince participants of the connection between touch and multisensory feedback, we ensured that visual, auditory, and vibrational responses always appear around the hand, just as in the real world. If the visual feedback appears far from the hand, it would raise doubts about whether it was triggered by the participant themselves. However, since we can't predict how people will touch, we place multiple colliders in the virtual branch, each set to the size of an average palm. When a collision is triggered by the virtual hands in Unity, which resemble real hand movements, the visual effect appears at the collision point.

Even if a person touches the same fabric repeatedly, if their hand moves beyond the palm's length, a new particle effect is triggered at the new position. This approach ensures accurate and timely touch feedback, similar to how water flows in a shower or body scans work in meditation—feedback appears exactly where the person touches. As shown in the image above, from up to down, if a person moves their hand back and forth along the same trunk, the flower visuals will form a trailing line that closely follows the movement of the hand, while different pitches of music reverberate in response, as if in a concert.

As shown in the image below, from left to right, if participants touch for a longer duration, the number of visual effects increases. This ensures that the visual effects respond not only to tactile details but also to kinetic perception, closely mimicking real-world responses to human interaction.

Touch Detection Technology

To detect touch, we implemented two methods: conductive sensors (hardware) and box colliders. (software) For conductive sensors, we tested pressure sheets, fabric, and threads. For box colliders, we added multiple Unity colliders on the virtual tree, using hand tracking in virtual reality to detect touch.

Among the conductive sensors tested, threads allowed participants to better explore and enjoy the original textures compared to pressure sheets or fabric. However, segmenting touch areas wasn't possible, as sensors stream when too close, so we used box colliders for the final installation.

As shown in the picture, we placed box colliders at each palm size with some overlap, to enable more precise recognition of touch locations. When participants touch and move beyond the size of a palm, a new box collider is triggered, which, in turn, activates new multisensory feedback. This design enabled detailed interactions with both tactile and kinesthetic information, which play a key role in shaping the experience. In addition, this design helped save time and effort during exhibition setup, as opposed to managing and testing multiple wires before and during the exhibition.

Sound Design And Technology

We designed three to five different pitches of music for each fabric and visual element. Each interaction triggers a corresponding piece of music, visual effect, and vibration. In Unity, we spatialize the music so that, wherever participants touch, they always feel sound surrounding them. At each stage of the experience, the musical responses are adjusted with different instruments to reflect the changing emotional tone. For example, with spiny and highly bumpy fabrics:

- In the petal stage, we designed shorter, more active music.
- In the flower stage, as the flowers grow, the music expands in length.
- As the big tree matures, the emotional tone shifts, resulting in richer instrumentation, higher pitch, and increased volume.

As mentioned earlier, we aimed to shape haptic images composed of both tactile and kinesthetic information. To achieve kinesthetic feedback, we designed three to five different pitches for each fabric. When participants touch different parts of spiny or bumpy fabrics—for example, by moving their hands beyond the size of a palm—they trigger a new pitch that matches the rhythm, and is tailored specifically to that fabric and its current stage of growth. To achieve tactile feedback, different fabrics are associated with different pieces of music that correspond to their tactile qualities. For instance, spiny and highly bumpy fabrics trigger different pieces of music compared to soft, low-bump fabrics. Meanwhile, all of these are designed to match the visual effects and story progression.

So far, we have synchronized music with touch, visuals, spatial positioning, and left-right audio channels. Whenever, however, and wherever participants touch and move differently, the multisensory interaction detects these differences and responds accordingly. Tactile and kinesthetic information work together to shape different haptic images.

We integrated the music using FMOD, with each instrument's rhythm originally recorded by our musicians. Initially, we explored using MAX/MSP in conjunction with Unity connected through Open Sound Control (OSC). However, we ultimately chose FMOD due to its ability to directly modify and manage music within its interface while coding triggers in Unity.

Future Development

In this version, the system randomly selects different pitches when participants move their hands beyond the size of a palm on the branch. However, we are uncertain whether participants would feel a stronger connection between the interactive music and their touch if the music's pitch consistently rose as their hand moved upward and fell as their hand moved downward. In the next phase, we plan to analyze and refine the music interaction with touch in greater depth, exploring how motion-based interactions influence emotions and attitudes toward nature.

Qualitative Research

We conduct a thematic analysis of data collected through semi-structured interviews with 10 participants after experiencing Sensing Nature. Participants were recruited from the student body at Goldsmiths, University of London. The study was conducted in the virtual reality (VR) lab at Goldsmiths, University of London, where a nature view was visible through a large window.

Participants were seated, and curtains were drawn to block the nature view. They were introduced to the setup and invited to explore the fabrics. After adjustments, they wore the VR HMD and headphones. Participants immersed themselves in the virtual environment and completed the full sensing nature experience. After the experience, the curtains were opened to reveal the nature view, and an interview was conducted immediately. Participants were encouraged to use their native language for better expression, with translations provided for transcription. The interview aimed to explore participants' experiences, feelings, and the impact of multisensory interactions on their emotions and attitudes toward nature. Questions addressed their general experience, sensory interactions, and relationship with nature.

The data was analysed using a thematic analysis procedure that followed steps: transcription, familiarization, coding, searching for themes and reviewing themes [3]. Interviews were first transcribed, including supplementary details about participants' movements and behaviors (e.g., "touched grass texture repeatedly"). Non-English responses were translated into English. As part of familiarisation, transcriptions were reviewed multiple times to note items of interest. The transcripts were then coded line-by-line using the NVIVO software package. Similar data excerpts were grouped to create comprehensive codes, titled clearly for easier identification (e.g., "Distracted from anxiety in the real world"). Codes were then analyzed for similarities and overlaps to form central organizing concepts for themes. The themes were then reviewed and revised multiple time, each time returning to the original codes and text to better understand the themes. Four final themes were identified: Immersion, Multi-Sensory Interaction, Nature and Emotion.

Findings

Theme 1: Immersion

Participants reported a strong sense of being present in nature, feeling deeply immersed and momentarily detached from real-world stress. The haptic feedback contributed significantly to the realism, making the experience more believable and grounding them in the virtual environment.

Participants experienced being in nature: "I feel like I went to nature even though I'm in the open area (VR lab)." Participants felt immersed and lost track of time: "I cannot feel the time passing; I feel like I was very immersed in this environment with all my senses."

Participants emphasized the importance of haptic feedback in making the experience more immersive and credible: "Visual is cool, but haptic makes it what it is, makes me engrossed in the virtual world, which is more convincing." The result was a feeling of being in two worlds: : "In the physical world, I can feel my hand touching, but in the virtual world, it is a kind of round shape. I feel like magic; it seems that touch and vision make me have kind of two experiences in two worlds."

Theme 2: Multisensory Interaction

Participants emphasized that the integration of multiple senses—visual, tactile, and auditory—set this experience apart from both real nature and non-interactive virtual reality. The multisensory design offered a greater sense of agency and presence, and although individuals perceived different dominant senses, they highlighted how the combined effect shaped their emotions subconsciously.

Participants highlighted how the multisensory interactions responded instantly to their actions, creating a sense of personal agency: "When I touch different textures, I get different feedback immediately; it felt like my own agency." People can feel different multisensory interactions responding to them when they touch different textiles, and they change over time: "I found different interactivity when I touch different places, different amounts of particles change over time." Participants also felt that the longer they touched, the more they experienced: "Touch longer to see how I can vary it, look at the little different things and feel a subtle variable feeling."

Immersion in the virtual world led to sensory dissociation, where participants reported different senses being engrossed while others faded or felt altered. This phenomenon occurred with varying sensory inputs, such as time, touch, body awareness, and interactivity. The haptic focus on fabric contributed to the dissociation between touch in the virtual and real world, leading to a lower sense of body awareness: "I don't feel my body because my feedback is focused on these fabrics, so any of my sense of touch will give me feedback in vision in another reality." Participants reported that they often did not notice the interactive sound elements while immersed in the experience: "I didn't realize sound was interactive; I just immersed myself in the environment." This was primarily due to the overwhelming dominance of visual stimuli: "To be honest, at that time, when I felt most immersed, I did not hear much music. I felt that I was completely immersed in the ups and downs of the whole particle, and touching the flower would appear. I had been looking at the appearance of those flowers, so I feel that vision may be the most important sense for me."

Some participants shared that they didn't consciously think about triggering interactions during the experience. Instead, they naturally enjoyed them as part of the environment, taking them for granted: "I don't feel like I know what interaction will be triggered here and then I deliberately trigger it; it's more like a feeling of naturally enjoying them." This suggests that, even though participants were unaware of some interactive elements, multisensory interactions still shaped their emotions and experiences. Participants emphasized the value of integrating multiple senses rather than isolating their effects: "The strongest feeling must be vision, but I don't think feeling can separate these three senses."

Theme 3: Emotion

Participants described feeling relaxed, peaceful and happy after the experience. The most powerful and enchanting moments emerged when all three senses worked in harmony. No motion sickness was reported; while one participant noted the headset was heavy, they still felt more comfortable after the experience.

Participants overwhelmingly felt positive and happy after the experience: “I feel happy, and there is a feeling of being naturally healed by this virtual environment.” The experience also evoked pleasant memories: “I can recall some memories of such warm moments in the past, which bring me into contact with some of the most beautiful things that people may have, such as the original intention or the beautiful people and things.” A few participants felt sadness when everything disappeared at the end: “I feel a little bit sad because at the end, life is over (sunset), but at the beginning, your effects were so beautiful.” they were still deeply moved by the experience.

Participants felt that touching the tree established an emotional dialogue, as with an elderly figure, symbolizing wisdom or care: “I am talking with old people.” They found emotional healing through haptic interaction, as the responsive feedback created a sense of mutual communication, akin to conversing with someone who listens and responds. This was as healing as a social connection with people: “When I touch a place, there is a response, it feels healing, feels like I’m communicating with the world, a feeling of connection with this virtual world like communicating with people. If someone can respond if I say anything, I would be happy.”

Touch played a profound role in participants’ experiences, offering a range of emotional and interactive impacts that emphasized healing (“It seemed that I brought a little bit of light into the dark world with the feeling of touch.”), connection (“It feels healing, feels like I’m communicating with the world, a feeling of connection with this virtual world like communicating with people.”), and a sense of achievement: (“It’s actually quite a sense of achievement to watch it grow by my touch”).

Participants described how their interactions with the virtual tree transferred energy: “Energy was transferred between the tree and myself.” This suggested a reciprocal relationship between their touch and the tree’s growth, where participants felt their energy contributed to the tree’s positive transformation: “The big tree was the most important part, and I feel there is something flowing from myself; my touch builds the tree based on my energy, the tree transfers the negative energy from my body to positive energy to build the positive tree.” They also saw the haptic installation as a medium for energy flow: “This installation is a medium for me to interact with the virtual world; it creates a flow.” This connection with the natural flow of life, allowed them to forget their social identities: “It feels like stripping away all the social attributes of the world; people return to the experience of the most original level of life.”

Participants were amazed by the large tree’s growth and described a positive connection to the tree: “Like a benign force between me and the tree, it’s a beautiful, magnificent, deep, and good thing.” They described this connection as healing and calming: “A healing experience that made me feel calm, and I felt the flow of life from the tree and myself.” Participants often described feeling calm, relaxed, and peaceful during the experience: “I feel calm, like an empty plane, it’s calm and relaxing” and “I feel calm, and it transfers everything to positive.” Another participant shared that it helped them forget their anxiety: “It makes me feel very peaceful, calm, and I forgot those anxieties.”

Participants highlighted how multisensory interactions enhanced their relaxation: “Interactive music with touch was relaxing, and the visuals made me feel peaceful for sure.” The experience was also compared to walking in nature: “It makes me feel relaxed, just like I’m walking in nature.” Some suggested the leisure moments might help with anxiety, describing the environment as ideal for complete relaxation: “It makes people not think too much, to really relax, and have a state of complete leisure; in this environment, it’s really good for helping with anxiety disorders or just relaxing.”

In addition to the calmness, a few participants mentioned feeling a sense of whimsy: “Except calm, I also feel a little bit light-headed, like very whimsical.” However, some participants reported discomfort caused by the heaviness of the headset: “I feel more comfortable, the effects are amazing, but the headset is heavy and uncomfortable.”

Participants expressed that the most powerful and enchanting moments occurred when the three senses—visual, tactile, and auditory—worked in unison. This synchronized experience brought positive energy and enhanced the overall feeling: “I like the feeling when I sense touch, audio, and visuals at the same time, which feels so magical, and they bring positive energy to my hands; multiple senses together are the strongest sense.” The harmonious integration of these senses contributed to feelings of peace and tranquility, often evoking a calm, balanced emotional state: “When multiple senses happened together, it makes me feel the peace and harmony.”

Theme 4: Nature

Rather than reducing interest in real nature, the virtual experience deepened participants’ emotional connection to it. They expressed increased attentiveness to natural beauty, a stronger desire to care for the environment, and greater motivation to physically engage with nature after the experience.

Immersion shifts participants’ body awareness and fosters a deep connection with the virtual tree: “I feel like it’s growing from my body.” Participants reported feeling as though they shared a symbiotic relationship with the virtual tree: “I feel like the symbiotic relationship with the big virtual tree; I seem to be closer to the installation tree because I feel as if we are experiencing the feeling of the four seasons together. I participate in its growth every time, and it is triggered by me.” Touch further deepened this symbiotic relationship: “The two of us exist together; I am touching this little tree and then looking at some changes in the particles on the big tree.”

Participants viewed the virtual tree as an extension of real nature: “This tree is one of [real nature]; it represents [real nature], and I interact with [the virtual tree], but my interaction won’t affect the real nature.” They also highlighted the sense that the virtual tree could transcend the limitations of real nature: “In the virtual world, flowers can move, and flowers from different seasons can appear at the same time. It’s surreal.”

Participants felt they were communicating with the tree by touch: “It was like when I was a child, I always touched the tree, and I think it can talk with me, this experience is like this.” They likened it to talking with elderly people: “I am talking with old people.”

Although the virtual tree is not human and does not resemble one, participants described feeling a distinct personality: “After the experience, the installation feels very kind.” They also felt a sense of identity within the

tree, developing a closer relationship with it over time, such as a maternal connection: “I truly feel they’re becoming my mom.” Or a friendship: “I saw the tree grow up with my own hands, which makes me feel I have the heart of an old mother, but I don’t feel I am his mother, I feel I am his friend who grows up with him.”

The multisensory interactions in the installation not only allowed participants to feel connected to and giving toward the virtual tree: “I’m a part, based on its power, through our interaction, I give him strength that he produces this effect.” but also fostered a sense of empathy toward nature: “After the experience, when I watch real nature, I feel they are also growing well; they are working very hard to live, the plants are alive.”

Participants also expressed heightened awareness of nature: “I love plants, which are better than machines. I didn’t pay more attention before on the plants outside, but now I found more details of them.” And a desire for continued interaction with real nature: “After the experience, I would more like to touch (interact with) the real nature, like lie on the grass or go out to touch it.” These findings suggest that the virtual interaction with nature helped participants not only appreciate nature more but also led to a greater willingness to interact with and care for nature in their real lives: “I feel more like to care about nature.”

One key distinction that participants noticed was the active role they played in shaping the virtual nature, which contrasted with the passive experience of observing real nature: “The real nature is moved by wind, it’s not moved by me, but this virtual nature is moved by me.” This suggests that the Sensing Nature experience is a more idealized, human-centered interaction with nature, where the participant felt like an active agent in the environment. The virtual nature responded to their actions in ways that real nature does not, making the experience feel more emotionally engaging. The instant multisensory feedback participants received from their actions in the virtual world was another key factor that made the experience feel more immediate and emotionally rewarding compared to real nature: “I think this work has some relationships with real nature, but this virtual one can give me feedback immediately, but in nature, I could only see the real tree.”

Discussion

Our qualitative analysis has shown a number of key themes that can inform future design and research. Firstly, Sensing nature was found to be a highly immersive experience. Secondly, multisensory interaction was considered by participants to greatly enhance immersion, presence and agency. Thirdly, this resulted in an emotional impact which was primarily a sense of calm, but also a strong sense of connection. The integration of multiple sense, and particularly touch was key to this emotional effect. These three themes taken together show the value of multi-sensory, immersive experience. In particular, it is important for VR designers to consider how to integrate multiple senses, and particularly haptics, within their experiences. Though real world haptics are not possible in all experience, our participants were clear how much they valued it, and out results indicate that touch might have an important impact on wellness, and, in particular, on the sense of connection.

The fourth theme is the most fundamental to Sensing Nature. The core of the experience for participants was the sense of connection to the virtual tree and to nature in general. This sense of connection was particularly heighted by touching the tree. This connection to nature was both a key contributor to the positive emotional impact of the piece and also a mechanism that increased participants reported desire to interact and care for real nature. This shows that multi-sensory virtual reality has the potential to help address both our mental health crisis and the crisis of sensetivity to nature.

A particularly interesting aspect of our results is that many particicpants described their relationship to the tree by analogy to human relationships (“a friend”) or even family relationships (“a mother”). Lengieza [12,13] identifies human relationships as a key metaphor for understanding human-nature relationships and Morizot [17] identifies the importance of building relationships with our “alien kin” of other living beings that are both very different to us but also our family (in a very literal, Darwinian sense that we share common ancestors).

This was a small, qualitative study that cannot be used to derive generalisations and is certainly no proof of clinical effectiveness for mental health and well being. However, the results are intriguing and Sensing Nature itself demonstrate a multi-sensory language through which connection to nature can be enhanced.

But at this point we must address a key potential objection: surely technology drags us away from the natural world rather than connecting us to it. Should we not simply encourage more contact with real nature.

Here we return to Zhong Mengual’s [38,39] and Morizot’s [17] idea of the crisis of sensibility. Zhong Mengual highlights the importance of art in overcoming this crisis. Classical western art has built a separation from nature, treating it as a mere symbol or mirror of human emotions. However, Zhong Mengual describes how the 19th Century Hudson River School developed a new art that displayed living this as and for themselves, informed by the new, Darwian sciences. It should be noted that, though our participants described human-like relations to the tree, at no point does Sensing Nature anthropomorphise the tree. We interact with it as a tree (as suggested by Zhong Manguel), via abstract representations of chemical flows, that are informed by recent science.

Sensing Nature focuses on a tree, a much more difficult being to relate to than an animal. It’s immobility and the long time scales of it’s actions make it seem solitary and inert to us. However, Simard [28] has shown that trees have complex patterns of communication via mycorhizal networks that even include nurturing and kinship. These are precisely the relations described by our participants after interacting with Sensing Nature, but they would be unlikely to discover them simply by touching a real tree without the interactive visualiations of invisible flows..

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