

# Forest Bathing Environments in Virtual Reality: Enhancing Well-being through Immersive Nature Experiences

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*Abstract:* The present study proposes an innovative approach to promote wellbeing by developing forest bathing environments in virtual reality (VR). Forest bathing, a practice rooted in traditional Japanese culture, involves immersing oneself in a forest atmosphere to enhance physical and mental health. VR technology enables the opportunity to recreate and simulate these natural environments, allowing individuals to experience the benefits of forest bathing regardless of their physical location and limitations of physical access to natural environments. This study aims to design and evaluate the effectiveness of a VR forest bathing environment in improving well-being, stress reduction, and overall relaxation.

## 1 Introduction

VR can be used in a wide range of domains, such as medicine, education, arts, entertainment, military, and recently it has been widely used in the health sector (Wang et al., 2019). The advantages of manipulating this technology as a therapeutic tool have been the subject of research. This type of immersive experience is now being used by several studies to complement other treatments, as an adjunctive distraction for both physical symptoms - pain, nausea, blood pressure, heart rate and respiratory rate - and psychological symptoms - anxiety, fear, and stress (Hsieh and Li, 2022). Researchers suggest that relaxation can be achieved, and symptoms of anxiety and depression can be reduced through the use of natural environments in VR (Chan and Qiu, 2021), and as this technology continues to be explored and studied, it may present an alternative to actual natural immersion by creating a simulated environment (Hsieh and Li, 2022). Psychological intervention based on exposure to nature can help alleviate anxiety and other negative emotions in chronically ill patients, supported by fundamentals such as the attention recovery theory that suggests that mental fatigue can be alleviated by exposure to nature (Hsieh and Li, 2022). The control of stimuli produced in the nature environment by VR allows precision in the implementation of therapeutic strategies (Freeman et al., 2017). Current literature shows that VR technology is growing rapidly and proving effective in reproducing natural forests for health and mental health applications (Alyan et al., 2021). The potential benefits of virtual nature are directly related to theories describing the effects of shinrin-yoku - also known as Forest Therapy (FT) (Zhang et al., 2022) - on health, including promoting relaxation, recovery and alertness, improving immune system function, and reducing exposure to air pollution and urbanity (Ross and Jones, 2022). FT is an alternative form of therapy that makes use

of physiological relaxation as a means to boost immunity and improve mental health (Alyan et al., 2021). Numerous studies have proven the effectiveness of FT in improving health, including reducing stress, improving mood, boosting immune function, and lowering blood pressure (Yi et al., 2022). To do this, the person or group travels to forests or nature spaces to participate in treatment activities that connect them to the landscape through sound, smell, touch, sight, and sometimes even taste (Park et al., 2022). Recent studies show that a program lasting one hour and forty-five minutes has a positive impact on the mental health of patients with affective disorders, corroborating the results obtained in previous studies also in other pathologies (Lee et al., 2017), (Poulsen et al., 2016). FT can be an asset in several situations, namely for people with depression, anxiety, hypertension and affective disorders, post-traumatic stress, among others (Lee et al., 2017), (Poulsen et al., 2016), (Song et al., 2016). In addition to the psychological benefits that this population could enjoy if they attended a VR FT program, its relevance is exacerbated due to recent changes in the structure of the hospital. The integration of this VR-based therapy into the healthcare system would compensate for the obstacles caused by the difficulty of access to forests (Jo et al., 2021). Thus, the potential for the transition and applicability of VR FT is promising. Furthermore, exposure to green spaces, which include vegetation in the form of foliage, trees and views, as in the case of FT, improves health outcomes, whether this exposure involves "live" and real nature or virtual nature (Ross and Jones, 2022). Realistic environments have been shown to be more effective in reducing stress levels (Alyan et al., 2021), and VR technology is the most capable of providing this, offering a sense of realism and presence that other devices simply cannot (Maples-Keller et al., 2017). Current findings suggest that virtual nature produces effects similar to those of real nature, making VR a safe alternative to experiencing nature (Chan and Qiu, 2021) and a suitable substitute for people who cannot visit natural areas for whatever reason (Alyan et al., 2021), (Chen et al., 2023). The immediate availability and increased frequency of VR treatments is also noteworthy, reflecting a great advantage and flexibility in service delivery. The increasing accessibility of high-quality VR devices on the market makes it feasible to transfer this technology from the laboratory to other diverse settings (Freeman et al., 2017). Thus, the potential to improve psychological and physiological health through virtual exposure to nature may become a flexible and easy-to-implement intervention method for vulnerable clinical populations (Hsieh and Li, 2022), ensuring that the best possible therapy is available to many more people (Freeman et al., 2017). This study aims to design and evaluate the effectiveness of a VR forest bathing environment in improving well-being, stress reduction, and overall relaxation.

## 2 Methods

The research will be conducted using a mixed-methods approach, integrating qualitative and quantitative data collection and analysis methods. To develop the environment, a multidisciplinary team of experts in psychology, multimedia, and nature sciences will collaborate. They will apply state-of-the-art VR technology and design principles to create realistic and interactive immersive forest environments, incorporating elements such as visual cues, sounds, scents, and interactive features. User-centered design methodologies will be employed, involving user feedback and iterative design iterations to ensure the authenticity and effectiveness of the virtual environments. The evaluation of the VR forest bathing environments will involve a sample of participants, who will be randomly assigned to either the VR forest bathing group or a control group. The VR forest bathing group will engage in immersive experiences within the virtual environments, while the control group will engage in non-immersive digital nature experiences. Pre and post-intervention assessments will be conducted using standardized measures to assess subjective well-being, stress levels, and relaxation. Additionally, qualitative interviews will be conducted to gather in-depth insights into participants' experiences and perceptions of the VR forest bathing environments. The variables we propose to assess and study are divided into psychological, physical and physiological symptomatology. As previously mentioned, VR FT

sessions have the potential to improve psychological symptomatology, namely reducing anxiety and stress levels. Therefore, we propose the use of the Depression, Anxiety and Stress scale - DASS 21. The 21-item version is quick to apply, making it feasible to assess before and after each session. The DASS is composed of a set of three self-completion scales, which are intended to measure clinically significant symptoms of emotional states of depression, anxiety and stress (Ross and Jones, 2022). It is also considered relevant to assess well-being and, thus, we propose the use of the Portuguese version of the Warwick-Edinburgh Mental Well-Being Scale (WEMWBS) (Figueiredo et al., 2022). The WEMWBS is aimed at assessing subjective and psychological mental well-being for the Portuguese population (Figueiredo et al., 2022). In order to monitor relaxation throughout the session and the activities performed, we propose the use of an EEG device for the purpose of recording heart rate (Ahn et al., 2019).

### 3 Results

The findings of this study have the potential to revolutionize the field of well-being interventions by harnessing the immersive capabilities of virtual reality technology. If successful, the development of VR forest bathing environments can address the limitations of physical access to natural environments, particularly for individuals residing in urban areas or those with mobility constraints. This research can also inform the design of future VR applications for health and well-being promotion, highlighting the importance of incorporating natural elements in virtual experiences.

### 4 Discussion

An example of how cutting-edge technology and ancient practices can coexist harmoniously is the use of virtual reality to reproduce the feeling of woodland bathing (Murtiyoso et al., 2023). Through this integration, people are able to utilize the advantages of a practice that is deeply ingrained in Japanese culture while overcoming physical and geographical constraints. This confluence highlights how adaptable time-honored methods are in a digital environment that is continuously changing. The VR forest bathing environments also tackle the problem of access to outdoor areas. This novel approach offers a democratization of well-being by offering a practical substitute for those who might otherwise be excluded from the advantages of forest bathing (McEwan et al., 2023). Many people may not be able to access physical forests due to factors like urbanization, physical disabilities, or time constraints. The success of the VR forest bathing setting should be compared to conventional, real forest habitats, nevertheless (Reese et al., 2022). Are the results similar? Are there any subtle distinctions between the two experiences' well-being improvements? More research is required to fully understand the psychological and physiological factors at work during a VR forest bathing session, therefore highlighting the potential benefits and drawbacks of each strategy would help. How do these reactions compare to or differ from those had while actually taking a woodland bath? Investigating how both experiences affect brain activity, heart rate variability, and cortisol levels can provide insight into the underlying mechanisms behind the reported gains in wellbeing. There are undoubtedly individual variations in the VR forest bathing environment's effectiveness. Some people could find the virtual experience to be just as restorative, while others might be more drawn to the actual, physical feelings of a forest. By examining these preferences, individualized interventions will be developed and improve the design of next VR wellness applications. But as VR technology develops, moral concerns about the possible disconnection from reality and the natural world can surface. Researchers should examine the ecological effects of lessening the need for physical travel to natural settings, potentially aiding in conservation efforts, and address ethical issues associated to creating a connection with nature through a virtual environment.

## 5 Conclusion

Forest therapy is an alternative form of therapy that makes use of physiological relaxation with proven benefits for mental health and well-being. FT can be applied in several situations such as depression, anxiety, hypertension and affective disorders, post-traumatic stress, among others. Forest bathing involves immersing oneself in a forest atmosphere to enhance physical and mental health. VR technology is capable to produce a sense of realism and presence and can simulate interactive and immersive natural environments, allowing individuals to experience the benefits of forest bathing, regardless of their physical location and limitations of physical access to natural environments. Several studies demonstrate that the use of immersive environments has been effective in complementing the results obtained by conventional therapies. The control of stimuli produced in the nature environment by VR allows precision in the implementation of therapeutic strategies.

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## Bibliography

- J. W. Ahn, Y. Ku, and H. C. Kim. A novel wearable eeg and ecg recording system for stress assessment. *Sensors (Switzerland)*, 9(19), 2019.
- E. Alyan, T. Combe, D. R. Awang Rambli, S. Sulaiman, F. Merienne, and N. Diyana. The influence of virtual forest walk on physiological and psychological responses. *International journal of environmental research and public health*, 21(18):11420, 2021.
- S. H. M. Chan and L. Qiu. Nature in virtual reality improves mood and reduces stress: evidence from young adults and senior citizens. *Virtual Reality*, 1(April), 2021.
- R. Chen, Y. Gao, R. Zhang, Z. Zhang, W. Zhang, H. Meng, and T. Zhang. How does the experience of forest recreation spaces in different seasons affect the physical and mental recovery of users? *International Journal of Environmental Research and Public Health*, 3(20), 2023.
- S. Figueiredo, M. J. Trigueiro, V. Simões-Silva, T. Coelho, R. S. d. Almeida, P. Portugal, S. Sousa, F. Campos, and A. Marques. Tradução, adaptação e contributo para a validação da escala warwick-edinburgh mental well-being scale para a população portuguesa. *RevSALUS - Revista Científica Internacional Da Rede Académica Das Ciências Da Saúde Da Lusofonia*, 2(4):2, 2022.
- D. Freeman, S. Reeve, A. Robinson, A. Ehlers, D. Clark, B. Spanlang, and M. Slater. Virtual reality in the assessment, understanding, and treatment of mental health disorders. *Psychological Medicine*, 14(47):2393–2400, 2017.
- C. H. Hsieh and D. Li. Understanding how virtual reality forest experience promote physiological and psychological health for patients undergoing hemodialysis. *Frontiers in Psychiatry*, 13(13):1–17, 2022.
- S. H. Jo, J. S. Park, and P. S. Yeon. The effect of forest video using virtual reality on the stress reduction of university students focused on c university in korea. *International Journal of Environmental Research and Public Health*, 23(18), 2021.

- I. Lee, H. Choi, K. S. Bang, S. Kim, M. K. Song, and B. Lee. Effects of forest therapy on depressive symptoms among adults: A systematic review. *International Journal of Environmental Research and Public Health*, 3(14), 2017.
- J. L. Maples-Keller, B. E. Bunnell, S. J. Kim, and B. O. Rothbaum. The use of virtual reality technology in the treatment of anxiety and other psychiatric disorders. *Harvard Review of Psychiatry*, 3(25), 2017.
- K. McEwan, K. Krogh, K. Dunlop, M. Khan, and A. Krogh. Virtual forest bathing programming as experienced by disabled adults with mobility impairments and/or low energy: A qualitative study. *Forests*, 5(14):1033, 2023.
- A. Murtiyoso, S. Holm, H. Riihimäki, A. Krucher, H. Griess, V. Christiane Griess, and J. Schweier. Virtual forests: a review on emerging questions in the use and application of 3d data in forestry. *International Journal of Forest Engineering*, 2023.
- B. J. Park, W. S. Shin, C. S. Shin, P. S. Yeon, C. Y. Chung, S. H. Lee, D. J. Kim, Y. H. Kim, and C. E. Park. Effects of forest therapy on psychological improvement in middle-aged women in korea. *Journal of Preventive Medicine and Public Health*, 5(55):492–497, 2022.
- D. V. Poulsen, U. K. Stigsdotter, D. Djernis, and U. Sidenius. ‘everything just seems much more right in nature’: How veterans with post-traumatic stress disorder experience nature-based activities in a forest therapy garden. *Health Psychology Open*, 1(3), 2016.
- G. Reese, J. Stahlberg, and C. Menzel. Digital shinrin-yoku: do nature experiences in virtual reality reduce stress and increase well-being as strongly as similar experiences in a physical forest? *Virtual Reality*, 26(26):1245–1255, 2022.
- A. M. Ross and R. J. F. Jones. Simulated forest immersion therapy: Methods development. *International Journal of Environmental Research and Public Health*, 9(19), 2022.
- C. Song, H. Ikei, and Y. Miyazaki. Physiological effects of nature therapy: A review of the research in japan. *International Journal of Environmental Research and Public Health*, 8(13), 2016.
- X. Wang, Y. Shi, B. Zhang, and Y. Chiang. The influence of forest resting environments on stress using virtual reality. *International Journal of Environmental Research and Public Health*, 18(16), 2019.
- Y. Yi, E. Seo, and J. An. Does forest therapy have physio-psychological benefits? a systematic review and meta-analysis of randomized controlled trials. *International Journal of Environmental Research and Public Health*, 17(19), 2022.
- S. Zhang, J. Teng, Y. Zeng, H. Song, and Z. Gu. The effects of forest therapy on public mental health and circular economy: A policy support model in japan. *Frontiers in Public Health*, 10(10):1–14, 2022.