Treeam: an Immersive and Collaborative Serious Game About Trees and Forest

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ABSTRACT

The interactions between trees in the forest have raised questions about their potential collaborations and environmental adaptation. Addressing these themes, we introduce `Treeam`, an immersive serious game that simulates the internal functioning of trees through collaborative gameplay. This paper presents the game's mechanics, emphasizing its role in raising environmental awareness. We conclude with a critical analysis of the game's limitations and propose directions for future development and research questions.

Index Terms: Virtual Reality (VR), Collaboration, Environmental Awareness, Gamification, Learning, Sustainable HCI

1 INTRODUCTION

How do trees live? Are they collaborating together in the forest? How do they survive dangers? Do they communicate? This questions have been creating debate in the ecologist research field [10]. In this work, we introduce `Treeam`, an immersive serious game which illustrates the internal functioning of trees. Three players are each linked to a tree and participate in its functioning by activating different bio-mechanisms, collaborating indirectly through signal emissions. This serious game wonders about the way we transpose human behaviour to other living beings, like trees, even when it may not be alike. This game includes a collaborative dimension, albeit an indirect one, given that trees do not "collaborate" strictly speaking. By playing mini-games individually, players communicate, and their success or failure has an impact on the others.

First, we present a quick overview of the concepts of collaboration and environmental awareness with immersive tools. Then, we introduce our design rationale and we describe our game loop. Finally, we take a critical look at our serious game by pointing out limits and ideas for future works.

2 RELATED WORK

2.1 Collaboration in Virtual Reality (VR)

Collaboration balances individual and collective interests, requiring actions like conflict resolution when interests diverge [18]. Virtual reality fosters collaboration through presence, communication, implicit cues, and spatial co-references of the virtual environnement [17]. A shared context enables information sharing and benefits like overhearing [14]. Collaboration in VR could enhance engagement with the material while support long-term retention[7].

2.2 Environmental Awareness with Virtual Reality

A surge in publications of extended reality (XR) applications about environmental subjects occurred over the past years [3], covering topics like education, learning, connection with nature, environmental behavior and environmental awareness. Studies reported a variety of observed benefits, such as improved learning and information retention [12] or an increase commitment to the environment [1]. In their systematic review, Cosio et al. noted that 20% of the XR application of the corpus contained game elements [3].

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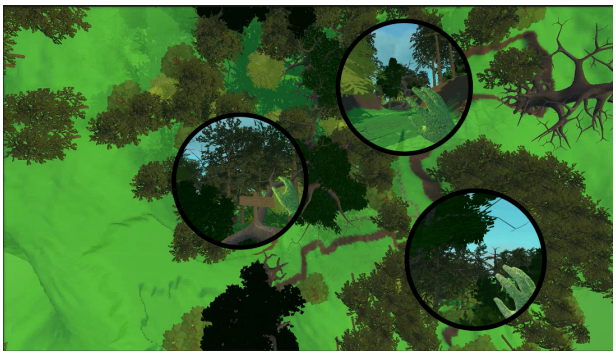

Figure 1: The circles indicate the players' position and viewpoint

2.3 Gamification

Gamification has been used effectively for sustainability education [6]. Adding gamification processes to an educative application can help enhance engagement and motivation [8] while enhancing learning outcomes [2] .

3 DESIGN

The development environment for this project utilizes Unity version 2022.3.19f1 and photon PUN 2 for networking. The virtual reality experience is designed for Oculus Quest 2 and 3 headsets.

3.1 Design Rationale

VR experiences evoke strong emotional [11] and presence responses [4]. Immersing players in a virtual forest, linking them to trees, and embodying biophysical processes aims to trigger higher engagement and foster an emotional connection with nature. `Treeam`'s goal is to combine fun and immersion to raise awareness about trees and forests functioning.

3.2 Game Loop & Mini Games

In `Treeam`, three players are each linked to a tree in an immersive forest. They share a life bar corresponding to the health of the forest. If this bar reaches zero, the game is over. The trees will face different dangers the players will have to solve in order to survive.

Healing: photosynthesis. Photosynthesis is a biological process which changes sunlight into chemical energy and changes water and CO_2 to O_2 and sugar [5]. In `Treeam`, the player has to reproduce the position shown in order to activate photosynthesis, like a plant moving leaves to capture the sun.

Danger: herbivores. When leaves are being eaten by herbivores, trees can react by creating tannins, making the predators stop [15]. In `Treeam`, players create tannins by collecting atoms

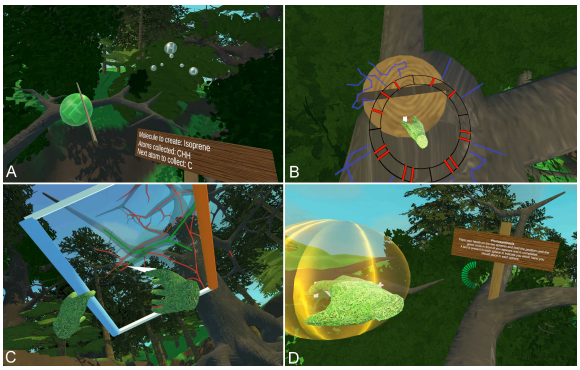

Figure 2: (A) Collect atoms, (B) Mycorrhizal network, (C) Create tyloses, (D) Photosynthesis

in the correct order by touching them as they get closer, in a BeatSaber[1] fashion.

Signaling: mycorrhizal network. Douglas-fir trees are able to emit signals back-and-forth through mycorrihizal networks[2], including defense molecules [16]. In `Treeam`, the players have to reconnect roots of the tree to the mycorrhizal network in order to broadcast the fact their tree is attacked by a herbivore.

Danger: infection. When infected, trees can block their vessels by creating tyloses to prevent the infection to spread [13]. In `Treeam`, players can scan their trees to verify if an infection is spreading, and block it by creating tyloses.

Signaling: BVOCS. Trees can occasionally emit biogenic volatile organic compounds (BVOCs) which can trigger defensive responses in neighboring plants [9]. In `Treeam`, players can compose BVOCs by assembling molecule parts and can send them into the forest, broadcasting that the tree is infected.

Danger: humankind. When the life bar of the forest is close to zero, a cinematic is triggered and lumberjacks come to cut down the trees. It illustrates deforestation and how defenseless trees are when it occurs.

4 Discussion

We acknowledge that this work is perilous. There is a high tension between describing rigorously scientific mechanisms related to trees, including their interactions between living beings in the forest, and illustrating those processes in a understandable and gamified way. Some ecologists are concerned that claims in popular media about communication between trees are disconnected from scientific evidence [10], and might conduct to misinformation. Future works should focus on ways to have those two dimensions coexist better. This includes working more closely with ecologist in a interdisciplinary way. As future work, this prototype could be test on users to measure if non-experts understand better how trees work and if this experience increase positively their attitude toward forest conservation.

5 Conclusion

We developed a collaborative environment where three players, each linked to a tree, activate tree bio-mechanisms to survive dangers. We took advantage of the concept of indirect but synchronous collaboration. Each player carries out mini-games individually, but each is influenced by the success or failure of the others. Through this serious game, we hope to raise awareness of non-expert people toward trees and forest while having fun.

[1] https://www.beatsaber.com/

[2] Mycorrhizas are fungus forming network around roots of trees, eventually connecting them.

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