CSCI 49383 Final Project - VR Development in Unity

Sharron Qian*

Final Demo: https://youtu.be/4tihEIkhnAI

GitHub: https://github.com/sharronq/csci49383$_{final}$

Figure 1: Top down screenshot of Unity scene.

ABSTRACT

Virtual reality has become increasingly important within many spheres, being both capable of technological breakthroughs and simultaneously having practical uses for everyday activities. This project, which renders a study room with several interactive functions, investigates VR immersion, and how a simulation of a realistic environment can provide mental refuge for users stressed by the weight of reality. Throughout this paper, various design and implementation decisions made throughout the development of the project, as well as the inspiration and rationale behind the initial idea, will be outlined. Tests were conducted using the virtual room developed in Unity and input from an HTC Vive VR system that supports head and hand tracking, in addition to SteamVR. Results showed that even a simple room simulation could improve one's stress and well-being by acting as a source of escapism. These results imply that if this project is developed further with more complicated features, a virtual room could become immersive enough to provide therapeutic benefits.

1 INTRODUCTION

The immersion of a user in virtual reality is defined by audio, visuals, and realistic tracking, and is highly important to a user's experience of virtual reality. One's perception of reality greatly affects any interactions they may make with their environment, meaning the immersion of a virtual reality program is important in determining how a user is able to interact and benefit from a program that simulates reality.

This project attempts to use immersive tactics to imitate reality and provide a user with a study room that allows for a mental break and an escape from external stressors. By using a combination of virtual reality technologies, the features in this program culminate to form a starting point of a fully immersive simulation of reality that is tailored to one's preferences for aesthetic and design.

1.1 Rationale

The purpose of this project was to focus on one of the most important aspects of virtual reality - immersion - while providing a safe space for those who need it. A program that simulated a room could act as an immersive atmosphere in which users could transport themselves to an environment that was ideal to their personal preferences for studying, relaxing, or working. As one's actual studying environment such as one's own room or living space, may not provide the level of comfort needed for them to focus effectively on what they are working on, a customizable simulation of an environment for studying may benefit one's workflow or mental fortitude instead. In addition, a simulated room has the possibility of including features that are unavailable to users in reality (for example, one might not have access to words of affirmation, a clean space, feelings of security, etc.) that may help them feel more comfortable than they do in real life. Being comfortable in one's environment not only enables a person to work more efficiently, but may draw attention away from stressors or distractions that one is experiencing in real life that may be hindering their mental health or productiveness. Even if not working, a user may be able to use this virtual space to simply relax or take a break from reality.

*e-mail: sharronsq@gmail.com

Furthermore, this project was inspired by the indie game Virtual Cottage [1], developed by DU&I, which allows users to bring a relaxing atmosphere to their working environment and start or finish daunting tasks. This project expands on key ideas defined by DU&I into virtual reality by furthering customization elements and interactivity.

1.2 Objectives and Goals

The initial goal of this project was to implement a myriad of interactive and immersive features to bring the simulated environment closer to reality, for example:

- Day and night cycle: The room would have multiple windows and light sources implemented to create the illusion of a day and night cycle contingent on the actual passage of time in reality. Any time-keeping objects would be accurate to the user's local time. This would allow the user to adjust the ambience as they please while still being able to keep track of time.

- Avatar customization: The user would be able to experience the program as a first-person avatar, which they could customize in front of a mirror. The purpose of this would be to provide users with affirmation in their appearance or gender, as having avatar customization would allow a user to look exactly how they would like.

- File upload and download: The user would be able to upload document files to a virtual laptop and work on assignments or projects within the program. The user would also be able to upload their own music or audio files to listen to within the program.

- Room customization: The user would be able to change the design of room from a variety of choices, once again for the purpose of adjusting the ambience of the room as one pleases.

- Quality of life features: More interactable furniture, screen-break reminders, and an affirmation button that reassures the user, in order to make the room feel safer and more welcoming.

These features would provide complexity to the room on such a level that is comparable to reality, and facilitate an environment within the virtual space that would allow a user to immerse themselves in a relaxing atmosphere with the ambience that suits their preferences. The purpose of having this much customization would be to simulate an ideal environment in which every aspect of the world can be altered to one's comfort, as opposed to what one might experience in reality.

2 Related Works

This project was inspired by the indie game Virtual Cottage [2], developed by DU&I, which allows users to bring a relaxing atmosphere to their working environment and start or finish daunting tasks (see Figure 2). The creators investigated the impact of ambience in the form of audio on one's productivity, and found that thousands of users were able to work more efficiently, reduce stress, and improve their mental health by creating an ideal environment suited to their own sensory preferences.

Adopting this concept, this project essentially attempts to translate Virtual Cottage into virtual reality by offering users not only a simulated room where one could relax, but an expansion of customizable assets such as a larger library of music, a personable avatar and room design, and an immersive illusion of reality that allowed users to stay grounded while still getting an escape from their real life environment.

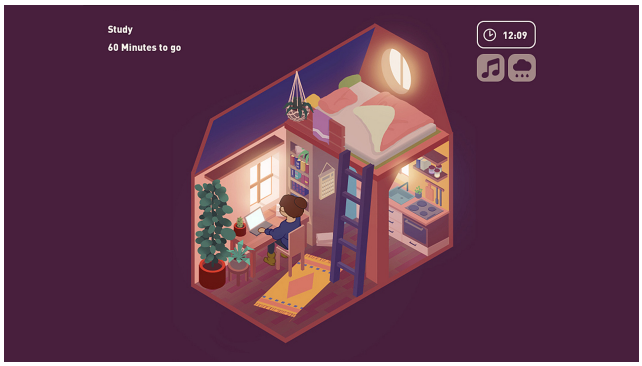

Figure 2: In-game screenshot of Virtual Cottage.

3 Method

This program was built with the intention of being used with an HTC Vive VR headset and controllers, in addition to SteamVR. Controller input is scripted specifically for Vive and SteamVR.

3.1 Interaction

There are several features implemented for interactivity, including (lowest to highest):

- Walking: In order to enable user movement with the Vive controller, a script, VRController.cs, was added to the project as a component under the main camera rig. The script calculates the user's movement based on touchpad input and adjusts the height of the camera based on where the user's headset is positioned. To determine movement direction and speed, the script calculates the direction that the user is currently facing before applying movement in that direction. In addition, the script also implements a snap rotation function, which snap rotates the direction the user is facing by ninety degrees each time the grip buttons on a controller are squeezed. The direction the snap rotation occurs in is determined based on which controller the input is taken from.

- Object interaction: In order to enable object interaction with the Vive controllers (picking up and dropping interactable objects), two scripts (Hand.cs and Interactable.cs) were written manually to define the behaviors that allowed the player to pick up an object with the controller prefab. Based on the position of the player's controller in relation to the objects around it, the script calculates the nearest object and connects it to the hand on collision if the trigger is squeezed. On release, the script disconnects the joint connection and allows the object to fall.

- Mirror: A mirror was placed in the room using a mirror prefab [4] that had a camera and a render texture on it. The camera, which was facing the room's interior, output to the render texture. The render texture was then placed onto the mirror, making it so that the mirror prefab rendered the camera's output in such a way that would imitate the reflection of a mirror.

- Music player: The music player is a game object in the scene comprised of a vintage radio prefab [3] and a button that toggles audio and an animation. Two scripts - Button.cs, which implements the button animation and calls a function to toggle on button press, and PlayMusic.cs, which implements the function used to start playing the music and animation. By interacting with the button on top of the radio, the user can toggle an audio source to begin playing a song if it is not already

playing. In addition to the music, the mouse avatar next to the radio activates its animation and begins dancing. If music is playing and the user interacts with the button again, both the music and animation will cease.

- Basketball Game: Using a trash can prefab [4] and a script, BasketballGame.cs, a game was implemented in which the user was provided a ball, and the goal was to throw the ball into the trash can. The trash can was given a collider with a script that checked for collisions with the ball, and on collision would respawn the ball and increase score count by one. Two buttons were also added - one, which on press reset the score to zero, and another which on press respawned the ball at its original position.

- Whiteboard: A white plane with a script, Whiteboard.cs, that implements a texture renderer was attached to a wall to appear as a whiteboard that the user could draw on. In addition to the plane, a marker game object with a script, WhiteboardMarker.cs, that detects collision with the whiteboard and renders texture, is given to the player on load to draw on the whiteboard. The tip of the marker is rendered as a separate game object, meaning that the script is able to determine whether or not the user can draw on the whiteboard based on the position of the tip of the marker on the whiteboard. The color of the pen is also determined based on the color of the tip game object.

3.2 Input Device

The program was designed to be built with an HTC Vive VR headset and controllers. The usage of SteamVR allowed for head tracking with the Vive headset, and the SteamVR plugin [1] on Unity was used to read input from the Vive controllers into Unity. The SteamVR Input interfaced can be accessed from Unity through the Window tab, through which the touchpad touch interaction has to be added manually. After adding touchpad touch as an action, it then must be added to the controller bindings through the binding UI.

Each time a controller input action is needed, the script that needs the action imports the Valve.VR namespace and uses the appropriate class declarations from the namespace to assign input actions to script variables. Currently, the methods that require some sort of input from the user are:

- Walking: Gets the user's finger position on the touchpad to determine which direction to move and how fast. Also uses the player's tracked head position to determine movement and orientation.

- Object interaction: Gets the user's controller's trigger output - uses trigger down to pick up objects, and trigger up to drop objects.

4 User Study, Results, Analysis

Although the project was not tested with any third-party participants, if developed further with fewer time constraints, it could possibly evolve into a more immersive environment that users are able to rely on for relaxation. Despite the fact that many features initially planned were unable to be implemented, the project was sufficiently developed within a period of six weeks to constitute a solid starting point. Additionally, many features that were implemented, although functional, are not entirely optimized and suffer a few problems because of this. Some of the grabbable interactables, for example, are prone to jittering when grabbed and brought too close to the camera rig. The scale of the entire room also appears to be larger than life.

5 Discussions and Conclusion

This paper discussed the topic of immersion in terms of virtual reality, and investigated the impact of different forms immersion on one's perception of a space. In outlining the various design and implementation decisions made throughout the development of this project, this paper analyzes the timeline of the project's development from its initial goal and rationale to its conclusion and results, thus determining how different immersive functionalities contribute to the realism of a VR project. The project attempts to accomplish a similar goal to its inspiration, Virtual Cottage, by creating an ambient environment similar to a safe space for its users. Though the initial intent of the build was to allow for high levels of customization and interaction, the final results allow for enough interaction to be immersive on a surface-level. In conclusion, the impacts of immersion on a simulated space are integral to how a user interacts with that space. By creating high levels of immersion in a project such as this, it is possible for a user to experience escapism and seek refuge from stressful situations by using virtual reality.

5.1 Future work

Further implementations of the project may expand on the base room implemented in the project's current build by adding more furniture, music, dynamic lighting, or other functionalities such as those mentioned in the Objectives section. The most crucial functions that may be implemented in future builds would involve customization of the character and the room.

References

[1] V. Corporation. Steamvr, April 2015.
[2] DUI. Virtual cottage, October 2020.
[3] PolyLabs. Vintage style radio, December 2019.
[4] B. P. Studio. Apartment kit, August 2018.