

# Recreating Escape Rooms in Virtual Reality (VR)

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## Abstract

Escape rooms are enjoyable bonding activities amongst many friends, families, and even colleagues. During the COVID-19 pandemic, when many stay indoors to isolate themselves from others for safety, it is important to create methods for people to continue to connect with one another. I create a basic virtual reality escape room game as a potential social group activity during the pandemic. In this paper, we discuss the design and development of a basic 3D Escape Room in Unity.  
**GitHub Code:** [https://github.com/natashasaki/Escape\\_Room](https://github.com/natashasaki/Escape_Room).

## 1 Introduction

An escape room is a game in which a pair or group of team of players cooperatively solve puzzles and accomplish tasks in a limited amount of time. If the group can solve all of the puzzles and ultimately "escape" the room before the time runs out, they win the game.

Escape rooms require teamwork, critical thinking, communication, and delegation, etc. Moreover, escape rooms typically take place in the physical world, creating opportunities for players to engage directly/physically with each other. Thus, they are appealing to a wide portion of the population. About "37% of groups are groups of players over 21, 14% of players are families, with parents and children, while 19% are groups of players under 21. Corporate clients make up about 19% of the customers for escape rooms, and 11% of groups are couples out on a date" [5]. In fact, companies like Google, Microsoft, JPMorgan, and Adobe have used escape rooms as team-building experiences [4].

## 2 Motivation

Currently, during the COVID-19 pandemic, many people around the world are sheltered in their homes. Governments are responding by closing down borders and preventing physical social interaction between people to decrease the number of infected people. Many people are losing their jobs or having to work from home. With social distancing measures in place, we wanted to come up with innovative ways for groups of people to be able to interact with one another in a more natural, physical way (ex. in comparison to just a computer screen).

We felt that recreating a social group experience through virtual reality would be enjoyable and most realistic, given VR's immersive nature. In particular, when done well, VR users feel as though they are their avatar and are transported into another environment. Thus, the versatility of escape rooms in bringing together various groups of people coupled with the immersive nature of VR is effective in achieving our goals.

### 3 Related Work

While utilizing virtual reality gear for general gaming is a quite popular task among students and researchers, narrowing down on escape rooms specifically isn't seen as much. However, groups of students have shown published work of VR escape rooms done using the Unity as well as Unreal engines. One project done by students at Bina Nusantara University in Indonesia tackled the challenge of formulating an interactive puzzle game in virtual reality using Unity game machines [1]. In their game "Locked Out", the user must solve all the puzzles in a room before heading to the next one, going through several processes of user evaluation and maintenance for the final product.

Researchers at Multimedia University in Malaysia also explored escape rooms in virtual reality using Unreal Engine 4, engaging more so with the user's sense of fear and incorporating sound effects and a darker environment [2]. Other researchers at Iowa State University created a collaborative virtual reality escape room game using Unity3D for the HTC Vive, and focused much more on the intractability of a multiplayer VR game by networking the HTC Vives and communicating head/hand position cues to all the teammates [3].

#### 3.1 Escape Rooms for Medical Education

In recent years, many educators and researchers have been searching for more immersive educational experiences for medical students. In particular, many have attempted to create escape room games to study how different types of education impact learning health/medical-related information.

In 2017, faculty members at the North Dakota State University's medical school designed and evaluated a Diabetes-themed Escape Room [6]. They created an escape room gaming environment where the puzzles consisted on topics related to diabetes disease management. In the study, they found that not only did students showed statistically significant increases in knowledge after completion of the game but the students also expressed a positive perceived overall value in the game.

In a similar manner, faculty at the University of Ottawa created escape rooms as an alternative teaching strategy in surgical education [7]. Specifically, the researchers developed a vascular surgery-themed escape room. They found that 83% of medical student participants felt that the experience "motivated them to prepare beforehand and believed that the experience consolidated the knowledge that they had read."

Other studies have been done in pharmacology, radiology, nursing education and more [8][9][10]. Ultimately, escape rooms have been widely studied as an alternative teaching strategy for medical education. The studies do not mention why escape rooms are implemented as opposed to other alternative strategies, but the findings are promising nonetheless. A VR version of the escape rooms for medical education could be interesting in the future given how physically interactive something like surgery is.

## 4 Game Outline

Escape rooms have general rules or guidelines on how they work. As we are attempting to recreate the escape room experience, we attempted to follow these as much as possible, though we had to alter some of the guidelines due to time limitations for this project.

### 4.1 General Escape Room Standards

1. The game begins with a brief introduction to the rules of the game and how to win. This can be delivered in the form of video, audio, or a gamemaster.[1]
2. After this, the clock is started and players have 45 to 60 minutes to complete the game. During this time, players explore, find clues, and solve puzzles that allow them to progress further in the game. Challenges in an escape room lean more to mental than physical, and it is not necessary to be physically fit or dexterous.[6]
3. If the players are unable to solve the game's puzzles within a time limit, the team is typically notified by the game's operator and escorted out of the room.
4. If players achieve the goal within the time limit, they win the game. Sometimes, teams with fast times are placed on a leaderboard.[6] Most escape rooms have clues and codes to unlock other areas.

	Searching	Hiding a clue or an object is a common tactic.
	Observation and Discernment	Rooms can hide clues via obfuscation. Knowing what is important and what is not is key.
	Correlation	The ability to relate clues to the correct puzzle. Sometimes requires a leap in logic. Also good for the meta puzzle.
	Memorization	For remembering sequences of numbers or symbols.
	Math	Sometimes with no paper. Shape algebra is common.
	Words	Anagrams, cryptograms, anything with letters
	Pattern Recognition	Clues can form of a pattern: i.e. sequence of numbers. Inductive reasoning is useful here.
	Compartmentalization	Helpful for Open Path Rooms. Needed to break up and visualize a room into individual parts.

Figure 1: Most common types of skills and categories of puzzles that appear in escape rooms

### 4.2 Alterations for Our Project

The main alterations that had to be made are as follows:

1. Shorter time for completion
2. Fewer and less complex tasks
3. Single Player implementation

## 5 Methods

### 5.1 Tracking and Implementation

The VR game was developed with Unity and is adapted for the View-Master Deluxe VR Viewer. We track users' heads with an IMU mounted on the VR headset, specifically tracking orientation using the VRduino. The VRduino is a custom hardware for position tracking, which incorporates an IMU and Teensy. Teensy provides the proper support circuitry for the photodiodes used with the HTC Vive Lighthouses.

Our game is implemented with stereo rendering for the HMD using an inter-pupillary distance of 64mm. Moreover, I implemented a reticle that detects clickable objects. The player is able to click these objects by gazing at them with the reticle for about 2 seconds. This functionality enables the player to engage in the game without having to use a keyboard. Moreover, since only the head was tracked as opposed to additionally tracking player position, I designed the game so that the player can walk by tilting the head downwards around 30 degrees.

### 5.2 Game Design

Our game is set in the woods with two barns, a well, and a broken down car. The game begins with the player being lost in the woods and finding a recently abandoned property. Our game involves a partially outdoor escape room, where the user is "trapped" in the woods and the only way to escape is to find the car keys within the 15 minute time limit.

I decided to include an outdoor forest area to induce the somewhat calming effect that nature has on people. This was a particularly important design decision since this time is very stressful between COVID-19 and the protests against systemic racism and the unjust murder of George Floyd.

### 5.3 Game Outline

1. Player is lost in the woods and stumbles upon a property. This property includes a well, 2 barns, and a car deep in the woods. The 15 minute timer starts.
2. One of the barn doors is locked, and the key is located at the bottom of the well. The player must collect both the rope and bucket which are found somewhere on the property in order to retrieve the key from the well
3. After opening the locked barn, the player will notice a safe, which requires a 4-digit combination.
4. Notes are scattered in the two barns along with other objects that provide hints towards what the combination may be.
5. Inside the safe is the key to the car, which ultimately allows the player to leave the woods.

## 6 Sample Scene Images

Attached are various images that include what the player sees during different periods of the game.

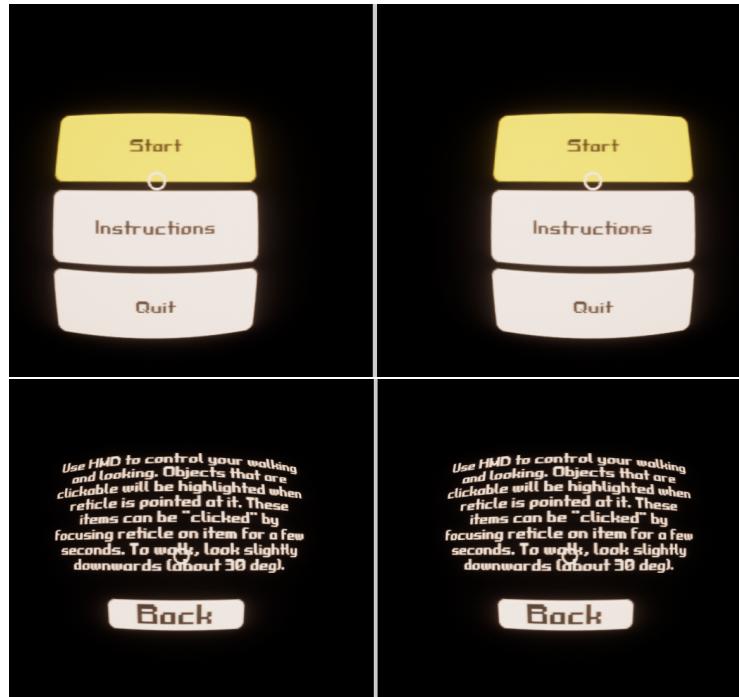


Figure 2: Start menu screen and instructions page

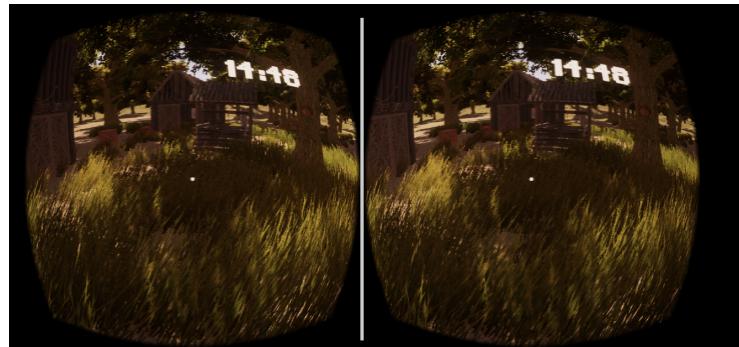


Figure 3: Main game scene with count down timer in top right corner



Figure 4: Message after putting objects into inventory

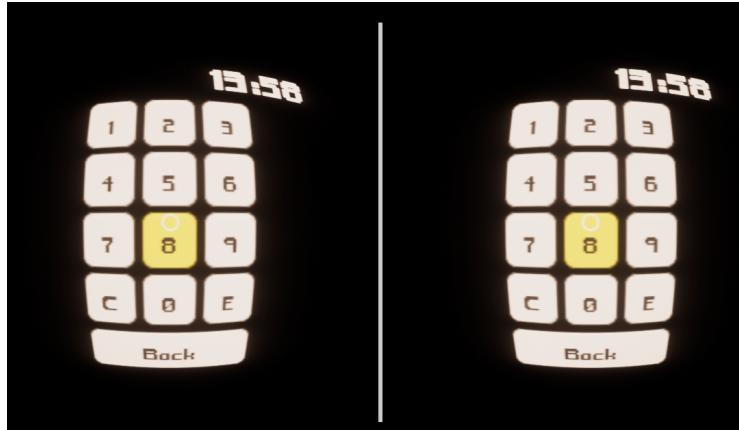


Figure 5: Safe combination scene

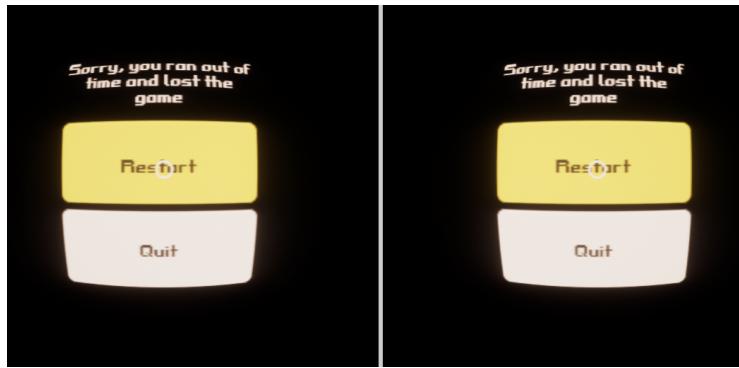


Figure 6: A basic game over scene which players see if they run out of time. Allows player to either restart the game or quit

## 7 Future directions

As mentioned in earlier sections, some alterations had to be made for this project due to time restraints. Nevertheless, the creation of this game provided a proof of concept of the ability to create an immersive and enjoyable VR escape game.

Below, I have compiled a list with ideas for the most important improvements and extensions to my project. In particular, the improvements are the following:

### 1. Multi-player functionality

Escape rooms are ultimately multi-player bonding activities. This basic escape room provided a proof of concept of our ability to recreate escape rooms more generally. To make the escape room VR game as enjoyable as possible, we will need to implement multi-player functionality so people can collaborate with each other.

### 2. Haptic Feedback

Currently we implement the escape room event handling with the mouse and keyboard. This was mainly due to not having access to hand controllers and therefore the ability to track hand movements. Implementing haptic feedback will help make this game more immersive, realistic, and potentially enjoyable. An even greater improvement would be to network the

HMD and hand controllers so as to provide head and hand position cues to teammates.

### 3. Variety of Scenes and Puzzle Complexity

One limitation of Escape Rooms is that each room can only be experienced once since the novelty of the puzzle and challenge diminishes afterwards. Thus, to make the game more enjoyable, it is crucial to create different scenes or escape rooms. Moreover, as shown in Figure 1, above, escape rooms have a variety categories and complexities. Part of the fun of escape rooms comes from the problem-solving aspect of the game, so it would be beneficial to create more variety in our puzzles and their difficulties.

### 4. Longer Game Experience

With our current implementation, the game is not particularly hard so we have not allotted much time for the player to escape the room. With the above improvement of scenes and puzzles, we should increase the time that users have to escape the room. Ideally, we would have enough content and challenges to use the typical time limit of 45 to 60 minutes. Nevertheless, changing the time allotment will be a very simple fix.

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