Facilitating Collaborative Gameplay Within an Immersive Virtual Reality Environment

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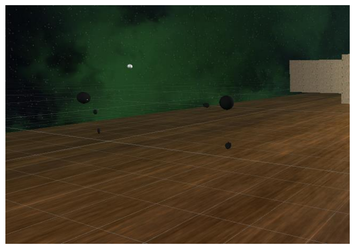
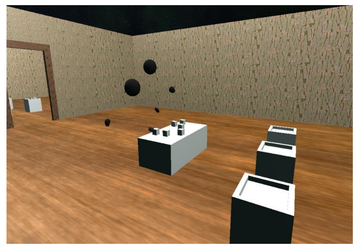
Overview

I created a two-player VR collaborative puzzle game in Unity. The game has three distinct puzzles to solve, totaling to about an hour of content on average. This game was built to the Meta Quest 2 headset and created for standalone use.

Figures 1-2. Photos depicting collaborative gameplay in the game. Left: The players tossing a ball to each other. Right: The players figuring out where each object should be placed.

Standalone Tracking

Standalone tracking uses a series of algorithms to function. The Perspective-n-Point problem is meant to find the position of a camera given known 3D points and is mainly what is used to determine the position of the headset. The controllers are different, using an inverse method called LED matching based on the infrared lights which appear on the outer ring of the controller. LED matching uses a flipped version of the PnP problem, where it knows the position of the cameras, and needs to find the position of the 3D points. [1]

Figure 3. An example of how the Meta Quest 2 uses LED matching to track the position of the controllers. [1]

Collaborative Gaming

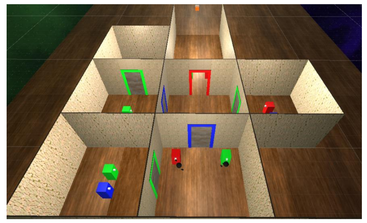
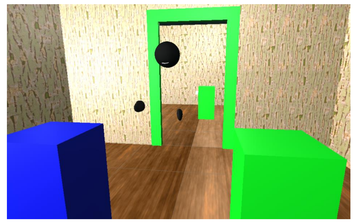
There are three distinct types of multiplayer games, competitive, cooperative, and collaborative. How each type differs is based on the ultimate goals of each player, and how it causes them to interact. Competitive games, the most common type, have the goals of players directly clashing with each other, cooperative has each player have different goals but temporarily work together for mutual benefit. Finally, in collaborative games, all players have the same goal and work towards it together [2]. This project is collaborative due to the goal of the two players being the same – to finish the puzzles together.

Puzzle 1: The Maze of Doors

The players are thrust into a maze of colored doors which open and closed based on the color of the button they pressed. When a button is pressed, each door that shares that color will open, and all other doors will close. To solve this puzzle, players must use good communication, special awareness, and memory to make their way out.

Design Choices:

- First two rooms split players up.
- Dead-end room buttons give partial control.
- Two main solutions.
- Small by design.

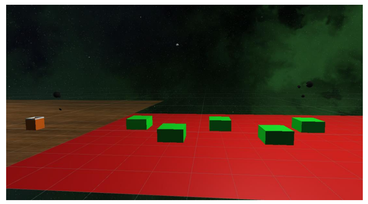
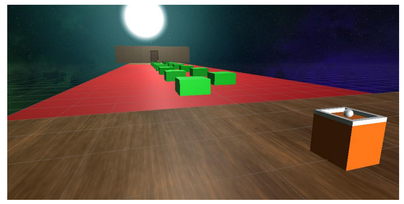
Figures 4-5. Left: A top-down view of the Maze of Doors. Right: A player in a room figuring out which button to press.

Puzzle 2: The River of Lava

The players need to transport an object from one side of the dangerous lava river to the other. They will quickly learn that they are not able to teleport to the platforms while holding the ball, meaning the only way to get it across is by tossing it back and forth while traversing the platforms.

Design Choices:

- Easy to understand, hard to master.
- Platform distance too far to hand off, must throw.
- Risky or safe throws – no required path.
- Hardest for experienced players.
- Players are always together.

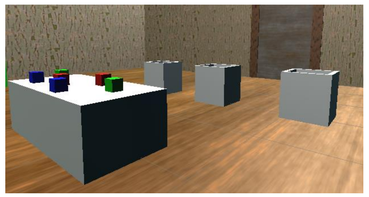
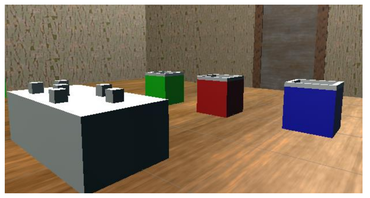
Figures 6-7. Left: One player throwing the object to another. Right: A view of the River of Lava from the starting zone.

Puzzle 3: Gauntlet of Knowledge

Puzzle 3 is split into three rooms, each with similar feel but different solutions. In the first room, the players will each press a button, which will reveal the colors of either the grabbable cubes or the platforms. Once they figure out where to put each one by combining their information, they will be able to move on to the second room. That room is similar, but one person can see all the colors, while the other can not. The catch is that the person with color vision can not interact with the objects, which will force them to instruct the other player on where to put each one. Finally, the last room is different than the first two, where both players are given the platform colors and a colorless object. Through trial and error, the cube's color will eventually reveal itself once both players have interacted with it at least once.

Design Choices:

- Familiar situations with different solutions.
- Team is together, but do not have the same information.
- Heavy emphasis on communication and information transfer in rooms 1 and 2.
- Room 3 encourages both players to participate.

Figures 8-9. Left: Room 1 view by player with color vision of cubes. Right: Room 1 view by player with color vision of platforms.

Unity Libraries Used

- XR Interaction Toolkit – Enables full VR support in Unity and allows for object interaction.
- Normcore – Adds multiplayer functionality and a server syncing system for variables.

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References
[1] Andrew Melim. Tracking Technology Explained: LED Matching. Nov. 2019. url: https://developer.oculus.com/blog/tracking-technology-explainedled-matching/
[2] Amy Voida, Sheelagh Carpendale, and Saul Greenberg. "The individual and the group in console gaming". In: Proceedings of the 2010 ACM conference on Computer supported cooperative work - CSCW '10 (2010). doi: 10.1145/1718918. 1718983