

# VR Rock Climbing for Cerebral Palsy PT

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## Overview

We built a VR application for kids with Cerebral Palsy to help with making physical therapy fun while providing them with exercises that allow the kids to use a full range of upper body motion. We have built a rock climbing game where kids can climb the wall while staying stationary. Our app works with both hands and controllers so that kids can play regardless of any hand mobility issues. We chose to do a rock climbing game as part of the physical therapy. This provides the ability to use many upper body motions while not requiring the user to use any lower body motions, a requirement as we chose to use the Oculus, which lacks lower body tracking.

## Calibration

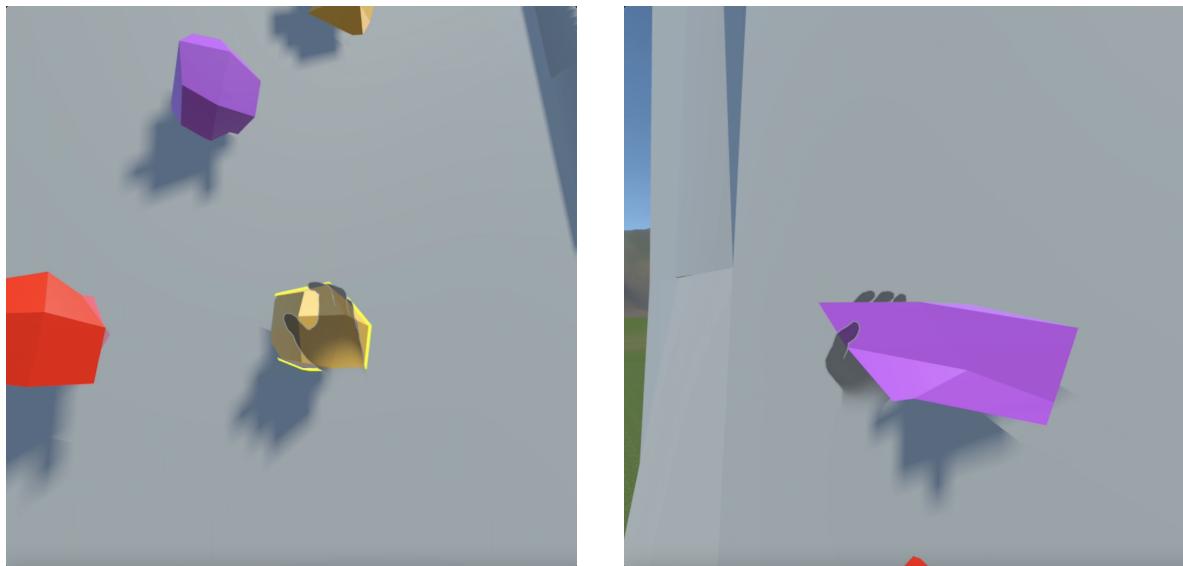
Our rock climbing game has three levels, easy, medium, and hard. In order to scale the difficulty and distance between climbing pegs for different sizes of people with different arm reaches, we have integrated arm-reach calibration as a step for the user. The user reaches out their arms in front of them and above them to gain information about how far they will be able to reach in all four directions. Their arm-reach distance is used to calculate the distance between the pegs, which are procedurally generated for each level. Users calibrate before starting the game and can recalibrate if they cannot reach the created blocks.



Calibration in each of these directions is essential because in children with cerebral palsy, one side of their body may be weaker than the other. Additionally, reaching out to the side isn't indicative of how far they will be able to reach above their head.

## Selection

Users select the pegs they want to climb to by making a fist or 3/4 fist when using their hands or by pressing the grip buttons when using the controllers. The fist action was chosen as the selection method as it seems the most intuitive and natural when asked to climb up a rock. In order to make the selection of a rock look more realistic and follow the usability heuristic of matching the real world, we have added 36 custom peg poses for each shape of a peg that looks like the user is grabbing the peg naturally rather than the fist going through the peg.

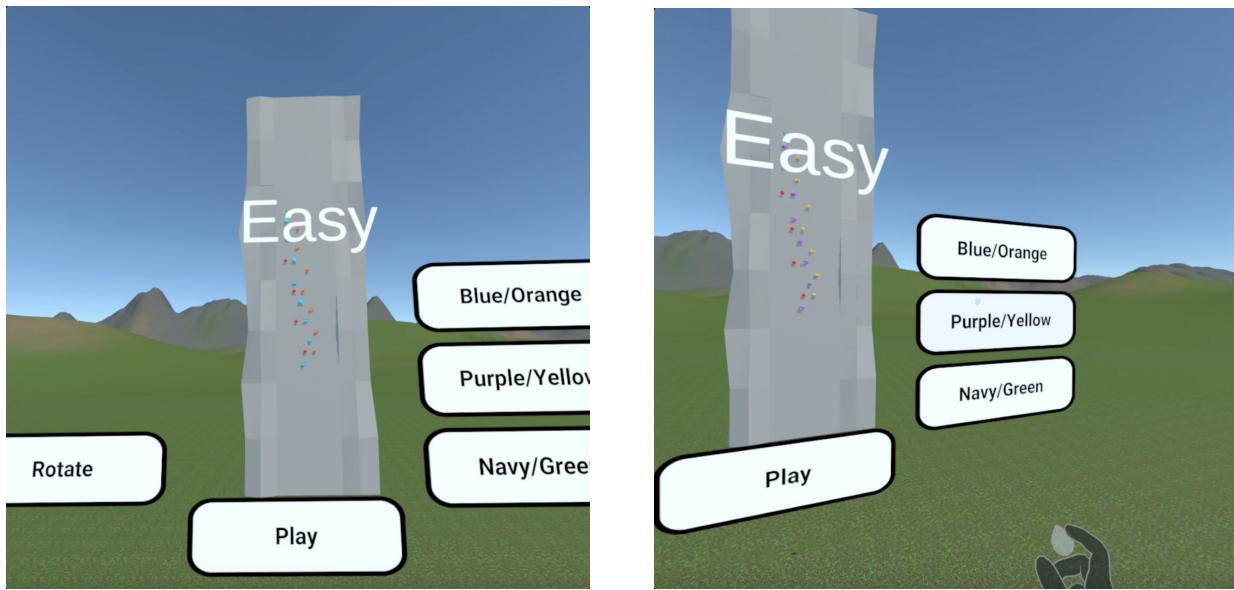


We also have some “danger pegs,” which remain consistently red even if you customize the other peg colors, so we keep visual consistency for the indication of ‘bad’ pegs; these pegs disappear when you attempt to grab/select them. This adds more gameplay variation in addition to a new response (disappearing) on selection.

## Manipulation

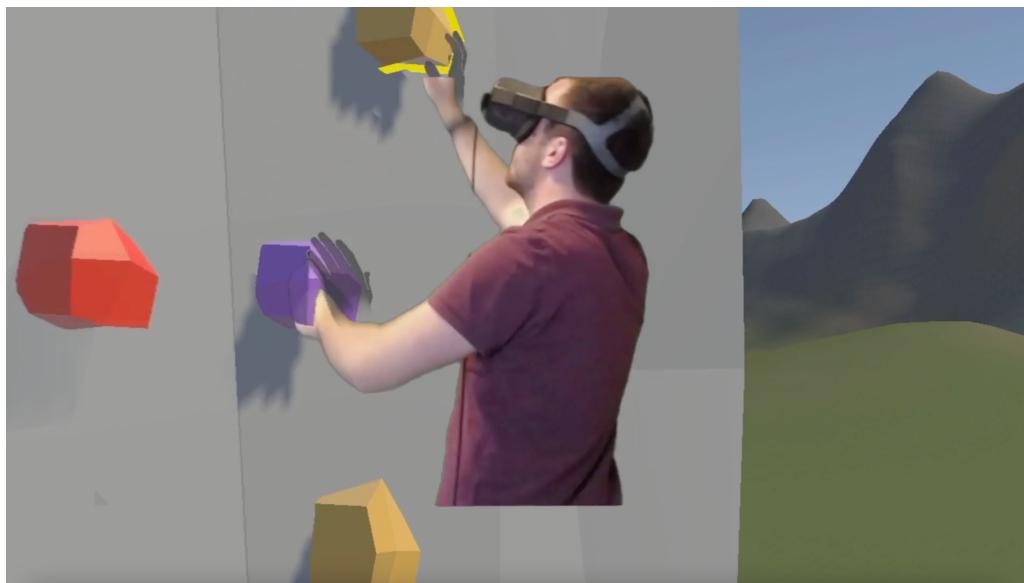
Users have multiple options to customize their climbing wall via object manipulation. One example is that users can change the difficulty level by rotating the wall using buttons. We decided to have the different difficulties on the different sides of the wall so users can decide which difficulty level they want to play with. To fit the user's liking, users can also change the color scheme of the knobs. All the color schemes are color-blind-friendly to cater to a broader audience. The colors for the knobs also correspond to which hand is recommended for the selection of the peg. This functionality is added in the case that the users need specific directions

of motion, like cross-body motion, and therapists can guide the user to use the corresponding hand based on the color.



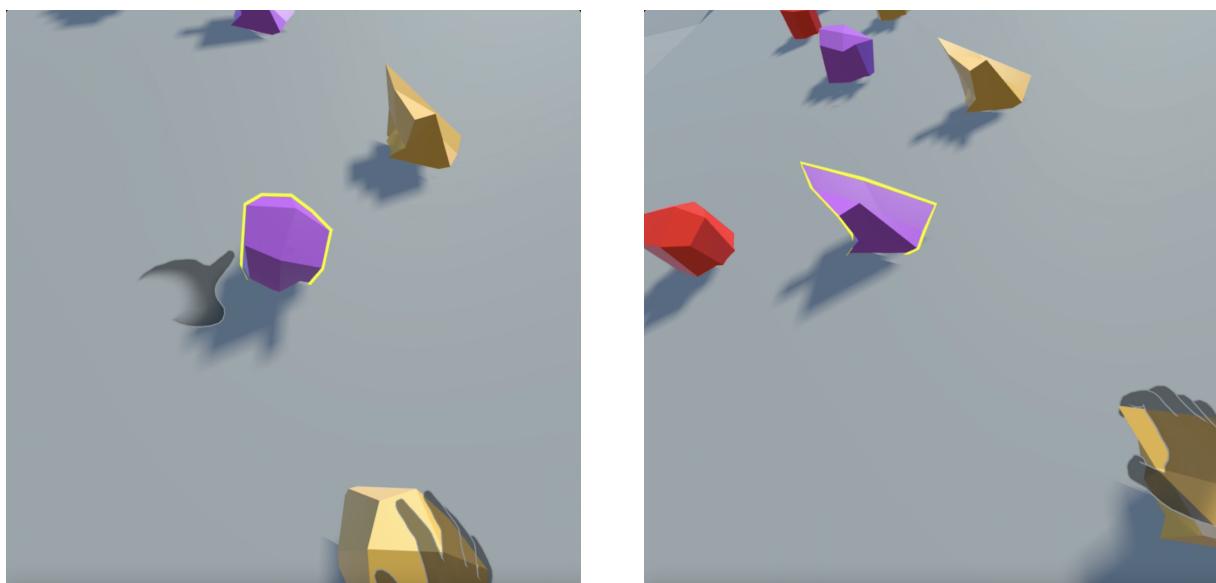
## Traveling

Before gameplay of climbing, users are transported to different areas by changing the position of the wall, which reduces the risk of simulation sickness. When users select a peg to climb the wall, they “pull” themselves closer to the peg, like in the real world. Since our game puts the user very close to the wall for climbing, it provides a view similar to “tunnel vision,” overall providing more accessible travel mechanics that are intuitive to learn as well as virtually eliminating motion sickness.



## Wayfinding

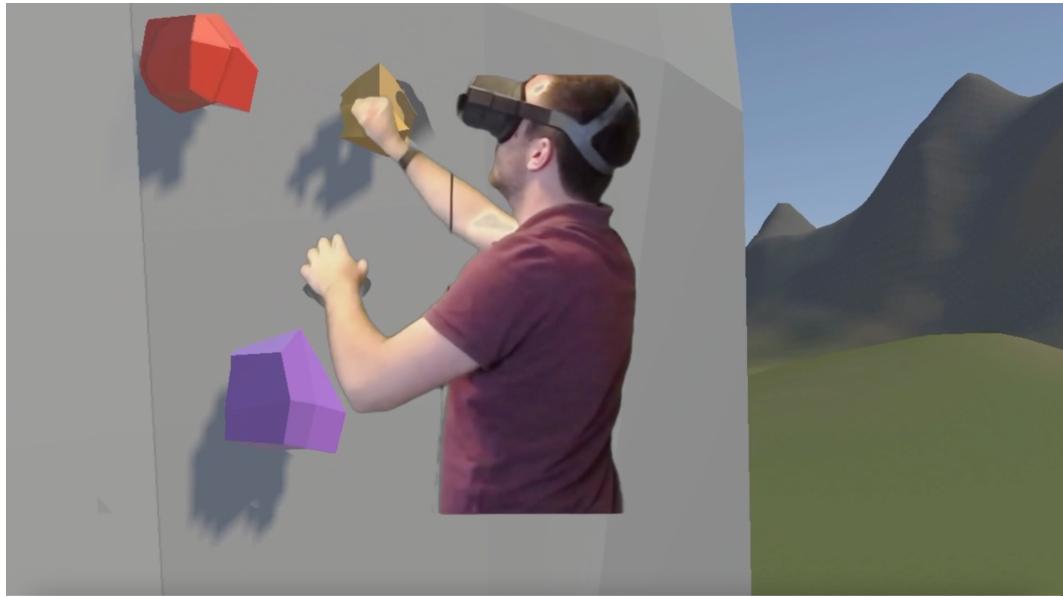
Wayfinding is incorporated into the game by outlining the easiest path to the top using outlines around the pegs. This was incorporated to help the younger target audience who may need guidance on how to navigate to the top. This feature can also provide specific guidance for the users in order to help their physical therapy and target specific movements. We decided to outline the pegs rather than change the colors to keep the color as a factor of which hand the user must use to climb, in case this restriction is part of their therapy.



## AR Support

In order to better serve the physical therapists, we have incorporated an AR component that provides the therapists with a real-time view of where the user is relative to the scene in the VR game. The therapists can use this to guide the users during the game and provide assistance. To record the AR portion, you'll require a Windows computer with "[LIV](#)" installed on Steam or a newer mobile device (this feature is still in alpha and requires a strong wifi connection). Please refer to the LIV documentation on how to get it working on your device:  
<https://www.liv.tv/mixedreality>.

This also addresses an issue in the current collaboration project between the CGUI lab and the CUIMC PT school. They have separate videos of the children playing the games taken from GoPros and videos of the VR gameplay taken from within the headset, but no good way to overlay those videos. This AR/MR solution lets physical therapists and patients directly see what gameplay motion corresponds to a particular movement.



## Menus and Instructions

Following the heuristic of user control and freedom, users can pause during gameplay of climbing the wall by making a thumbs up. The user can then either resume or restart the game. There are also many instructions throughout the game to help the user navigate more easily.



## Future Steps

In the future, we want to add the functionality of recalibrating if users cannot reach once the pegs are generated. We also want to add more manipulation movements during the gameplay of climbing the wall. Some ideas are to have obstacles where users need to push or change the

obstacle in order to continue. This game can also incorporate milestone-based excitement by using scores and timers so children are more motivated to play the game. Finally, another stretch goal we had was to add a custom wall where users can create their own path that they can climb.

## How to Play the Game

In order to play the game, you will go through the following steps:

- 1) Press “Start Game” on the initial menu
  - a) We recommend using just hands for a more immersive experience; you’ll need to enable hand tracking on your VR headset for this functionality if you haven’t done so already
- 2) Calibrate your arm reach by making a thumbs up with each hand, out to the sides first and then above your head for each arm afterwards; you’ll follow instructions on the screen for this
- 3) Check to see that you can reach all the boxes that have been generated at the various calibration points
  - a) At this stage, you can choose to recalibrate or move on to game play
- 4) When you move on to play the game, you will first be brought to the customization menu; here you can “Rotate” the wall to play a different difficulty level, and can also change the colors of the pegs. After you’ve made your customizations, press “Play”
- 5) Use your hands to reach up for the various pegs to get to the top
  - a) You’ll see outlines on the pegs that are the best to reach for next
- 6) When you get to the top, press the green button with your hand and you’ll have the option of restarting the game
- 7) At any time during climbing the mountain, you can use a thumbs up hand gesture to pause your climb and then either resume or restart