

# Head Spin: Multisensory Integration of 3D Orientation in VR

Summer 2024

## PURPOSE

The Head Spin project is intended to study how humans process 3D spatial rotations in VR, and how disturbances in different modalities and axes affect how humans perceive and experience orientation perception in a 3D environment. The disturbances that will be added include a rotational chair, galvanic vestibular stimulation (GVS), and spatial audio cues.

## PROJECT DETAILS

This project created a Virtual Reality (VR) interface where participants complete the study, a rotation task, across multiple trials.

### Task Overview

Each trial in the study consists of two phases: phase 1 and phase 2.

- In phase 1, participants see an object rotate across two axes. If active, they will rotate the object to its final orientation. If passive, they will skip to phase 2.
- In phase 2, participants will have to use their controller to rotate the object back to its initial orientation.
  - This phase will later incorporate the disturbances.
- Once participants finish a trial, they are taken to the next trial. For a more detailed look at the overall process, refer to the diagram on the right.

## KEY FEATURES

- Networking and participant session setup
- Interface allows the researcher to customize the task to their study's needs, such as the number of blocks in a session and selecting

a file to contain x number of pre-loaded trials.

- Tutorial
  - An interactive tutorial to orient the user to VR, the controls, and the task, is accessible before the task starts.
- Task
  - Each trial in the task consists of phase 1 and 2, following the task overview.
- Output of user data files
  - Tracked values like the camera position to track head movement, controller position and orientation, and joystick inputs were outputted in BCSV and CSV file format.

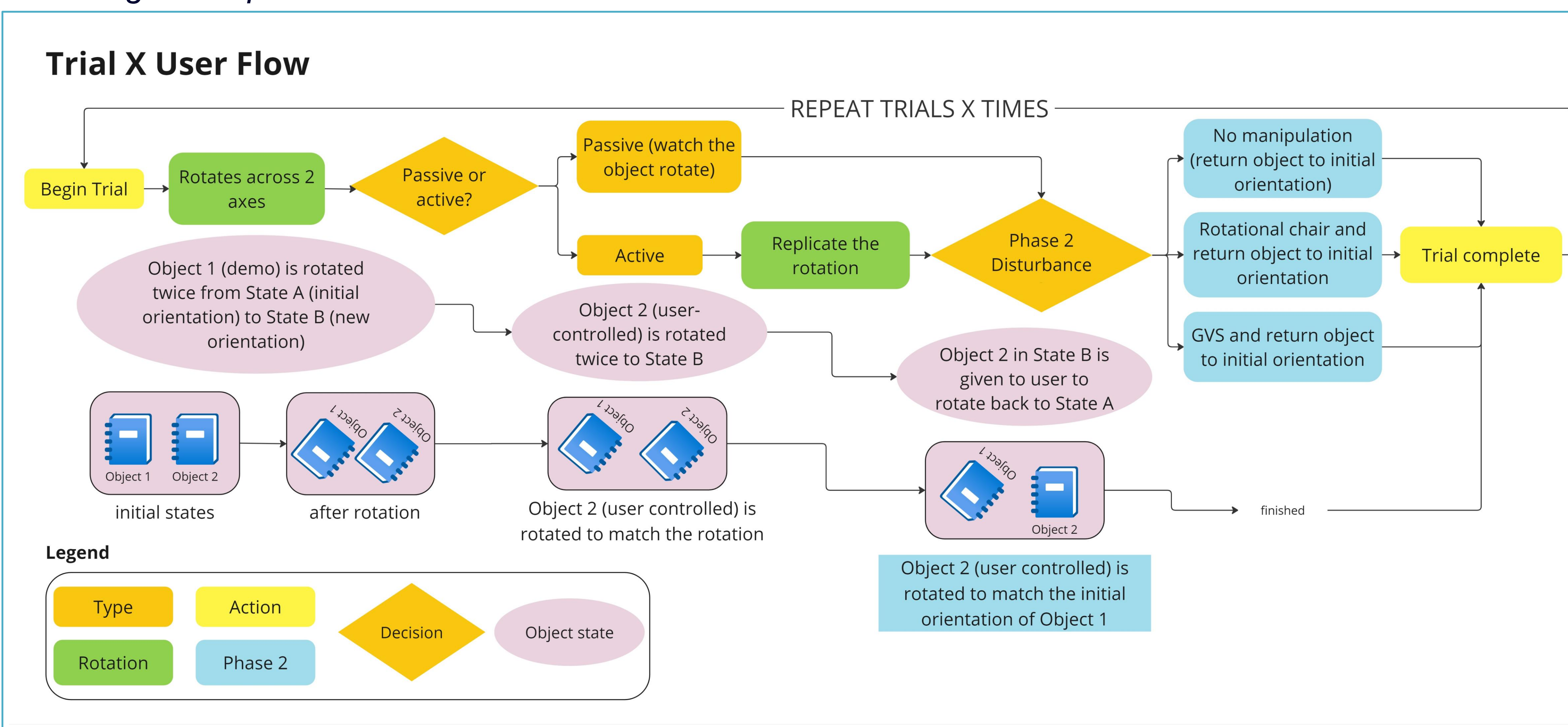
## PROCESS

### Design

It was paramount that we created the VR interface with features and specifications that matched what was needed for the experimental

### Task Overview: Trial User Flow

This diagram depicts the structure of each trial.



study. As such, user flows were created and underwent an intensive iterative process, such as the trial user flow on the bottom of the poster. User personas and journey maps were also created to better understand the needs of researchers and participants using the tool.

Features like a pause and settings menu and various tooltip UI were designed. A style guide for branding consistency was developed. User testing was conducted to inform the design, especially concerning the ease of use of the controls and ease of learning of the task.

### Development

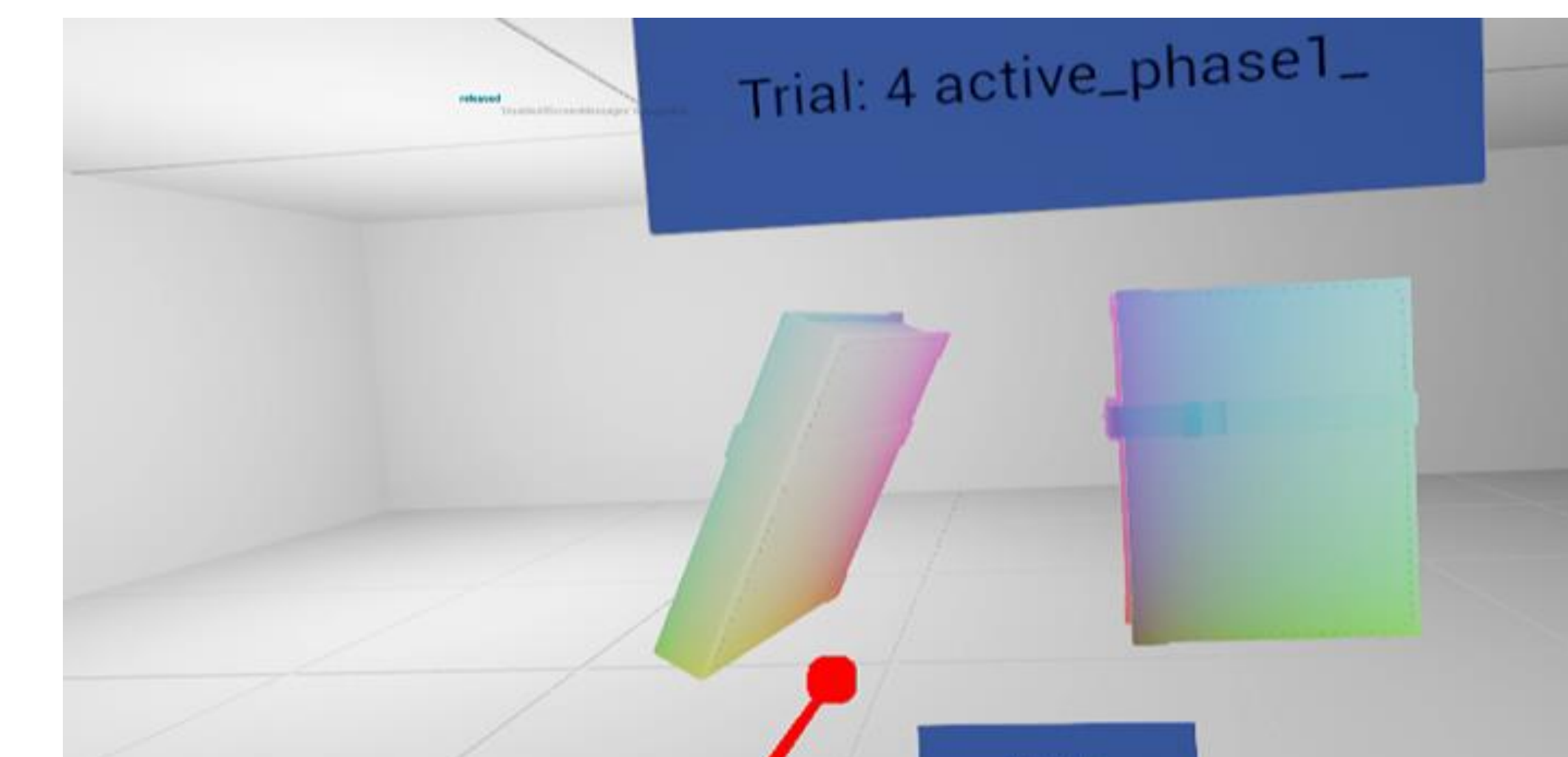
Implementation of the task, tutorial, and environment in virtual reality was created using Unreal Engine 5.3.2, and the project was designed for usage with Meta Quest headsets and controllers. Blender was utilized to create the 3D model of the rotational object, a book.

Additionally, we utilized an in-house built server

to simulate the rotational chair and sent messages to it to check if the connection between our system and the disturbance works.

### Head Spin VR Interface in Unreal Engine

Screenshot of the task in action in VR.



## NEXT STEPS

- Incorporating the disturbances (GVS, rotational chair, spatial audio cues, etc.) into phase 2 and reflecting the changed experience within the VR task and interface.
- Implementing the full user experience such as controller tooltips, pause and settings menus.
- Implementing different mechanisms for controls for greater ease of use.

## ACKNOWLEDGEMENT

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