GCIEL Viking Longship Virtual Reality Project: Design Document

Technical Documentation

Megan Bernacchi, Pyait Myat, Brian Sung, Zitan Wang

CSC-324-01 Fall 2023

December 6th, 2023

Table of Contents

1. User Stories

User Story: Tutorial Introduction
- As a VR User, I want to be introduced to the virtual reality experience so that I can understand how to interact with the environment.
- Acceptance Criteria:
  - User can select dominant and non-dominant hand controllers.
  - User receives clear instructions on moving, teleporting, selecting, and dropping objects.
  - Tutorial includes a questionnaire for experience assessment.

User Story: Longship Building
- As a VR User, I want to assemble a Viking Longship model, so that I can learn about Viking shipbuilding.
- Acceptance Criteria:
  - User can pick up and place ship components correctly on the model table.
  - Correct positions for components are highlighted.
  - Assistance is provided if the user struggles to place a component.

User Story: Educational Enhancement
- As a VR User, I want to access educational content about the Viking Longship, so that I can enhance my learning experience.
- Acceptance Criteria:
  - Dictionary and video buttons are functional.
  - Relevant information about each ship component is accessible.
  - User can view videos related to ship components.

2. Design Decisions

Our final product is a design document for the Viking Longship VR experience. The structure of the design document was learned from Nersesian [3].

Experience Structure

This virtual reality experience will be primarily composted by two successive scenes: 1) Tutorial Scene and 2) Building the Viking Longship (Model) Scene.

Tutorial Scene
The Tutorial Scene introduces the user to this virtual reality experience by providing preference selections (e.g., choosing the dominant and non-dominant hand controllers and the heights) and instructions on the experience controls and the experience interactivity (e.g., moving around and picking up and placing objects). Additionally, the Tutorial Scene includes a questionnaire for collecting data for the experience assessment. Once the Tutorial Scene is complete, the user moves to the Building the Viking Longship (Model) Scene.

Building the Viking Longship (Model) Scene
In the Building the Viking Longship (Model) Scene, the user is situated in a room and is tasked to assemble a Viking Longship model by picking up and placing components in the correct positions. This scene helps the user to understand the terminology, structure, and other visual components of the Viking Longship.

Experience Controls

(Trigger)
Teleporting

(Trackpad)
Moving around

(Trigger)
Selecting/dropping
objects

(Trackpad)
45° turn

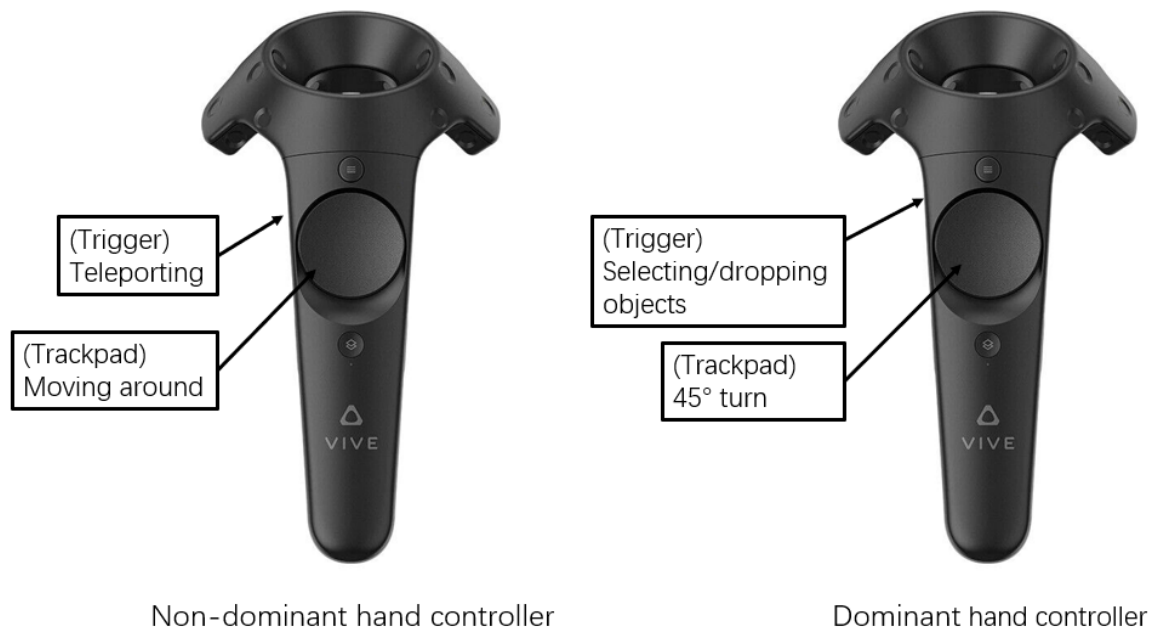Non-dominant hand controller   Dominant hand controller

Figure 1. How to Use the VR Hand Controllers

This VR experience uses two HTC Vive VR controllers to interact with the scenes (Figure 1). One controller is for the non-dominant hand (defaulted to be the left hand), and another controller is for the dominant hand (defaulted to be the right hand). The user can modify such a selection during the Tutorial Scene. There are four main functions of the hand controllers: 1) moving, 2) turning 45 degrees, 3) teleporting, and 4) selecting and dropping objects.

Moving
The user can move around in each scene by moving a finger around on the trackpad. For example, to move to the left, move—not press—the finger on the trackpad left, and the same for the other directions. Note that moving around using the trackpad does not change the direction the user is facing.

Teleporting
The user can teleport in each scene in a limited range which will be highlighted. Hold the trigger at the back of the non-dominant hand control to choose a destination, then release the trigger to activate the teleport process.

Selecting and Dropping Objects
The user can pick up or drop some objects using the trigger on the dominant hand controller. To pick up an object, approach that object using the dominant hand controller, and press the trigger on that to hold the object. To drop the object on hand, release that trigger.

Turning 45 Degrees
The user can make 45-degree turns by snapping on the trackpad of the dominant hand controller. Snap to the right to turn right for 45°, and snap to the left to turn left for 45°. The snapping should be at least 45° to trigger the turns.

Detecting Motion
Besides using the two hand controllers to interact with this VR experience, this device also supports some types of motion controls for a more immersive experience. Besides using the trackpad to move around, the user can also turn around in the VR experience by making turns physically. The user can also lower their view in the VR experience by crouching down physically. Moreover, as mentioned in "Selecting and Dropping Objects", moving the hand controllers can also be detected in assisting in picking and dropping objects.
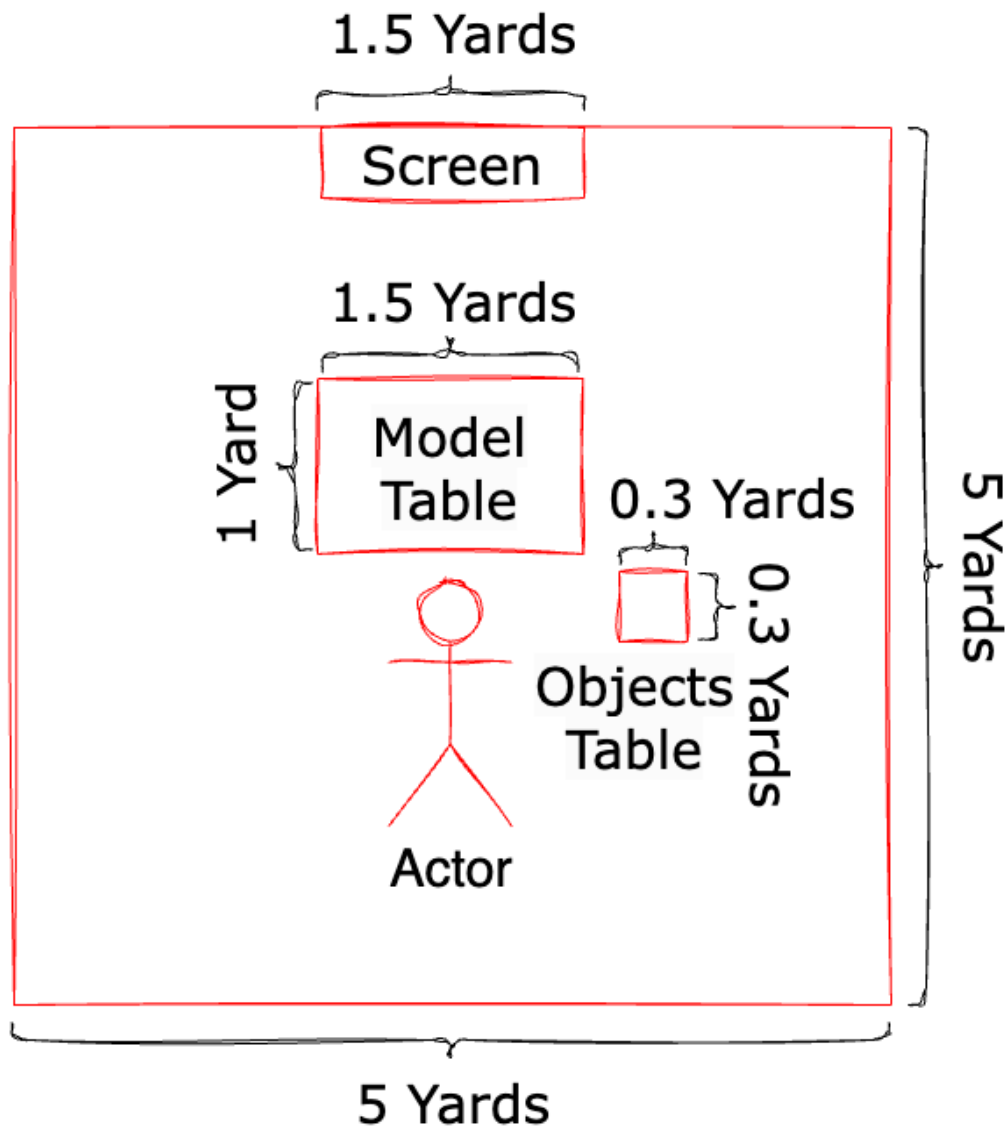
Experience Layout and Design

Figure 2. Layout of the Room

In the VR setting, there is a room with a screen in front of a model table (Figure 2). The model table in the center is 1.5 x 1 yards in dimensions, and the user will interact with various components by placing them on the Viking Longship here. There is also an objects table in the center of the room with dimensions of 0.3 x 0.3 yards where the user picks up a ship component and uses that to construct the ship in the model table by dropping the component in the designated location. The entire room's dimensions are 5 x 5 yards.

Experience Interactivity

This section describes how the user interacts with the experience. This section helps formulate goals for the experience interactivity which assists in understanding the development needs and programming the experience. Please note that these goals **are not set in stone** and can be modified as the project develops.
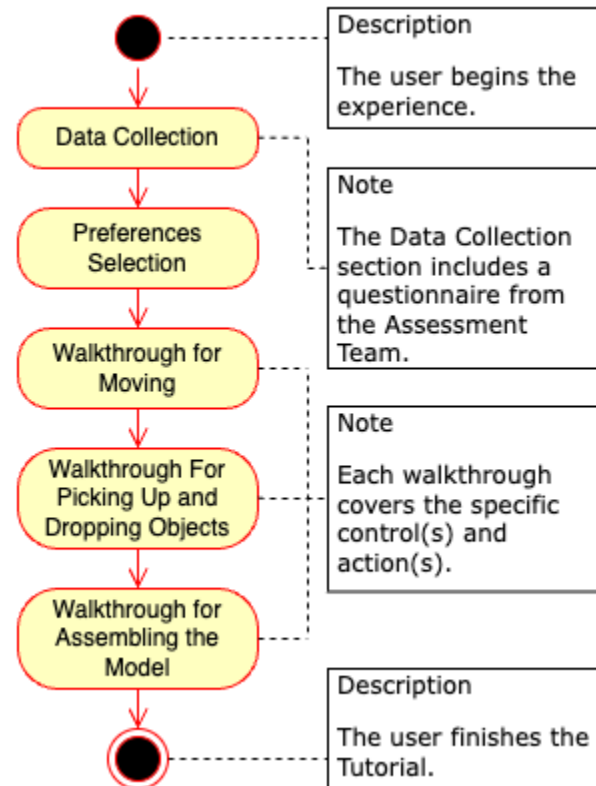
Tutorial Scene

Figure 3. UML of The General Flow of the Tutorial Scene [4]

The experience begins with the Tutorial Scene. The Tutorial Scene includes successive activities (Figure 3):

1) The Data Collection activity consists of a questionnaire from the Experience Assessment Team collecting information on the user's sex, age, and other characteristics important for analysis of experience;

2) The Preferences Selection activity allows the user to modify certain features of the experience to promote accessibility; and

3) The Walkthrough activities for the different features detail the controls and performances of actions.

After completing the Tutorial Scene, the user moves on to the next scene.

Accessibility - Choosing the Dominant and Non-Dominant Hand Controllers and Adjusting Table Heights
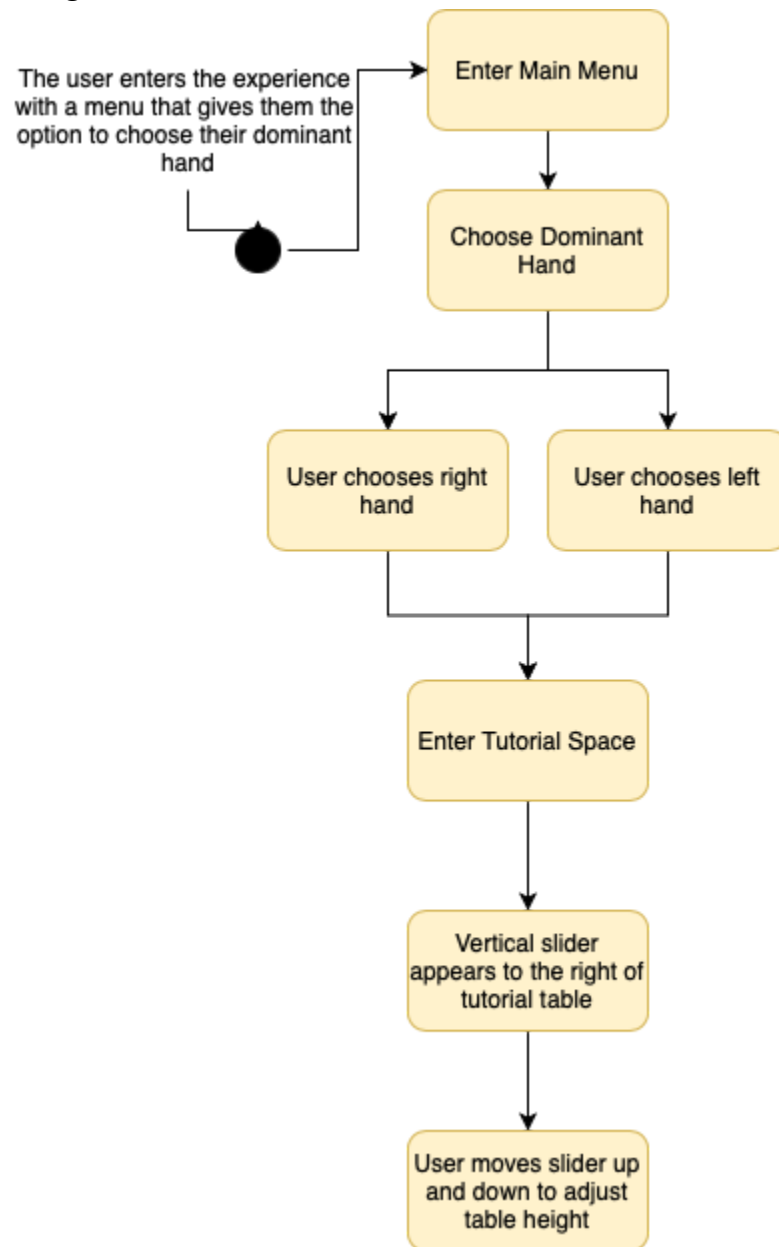

Figure 4. UML of Accessibility - Choosing the Dominant and Non-Dominant Hand Controllers & Adjusting Table Heights [4]

Within what will eventually be the main menu, the user will be prompted to choose their dominant hand (Figure 4). No matter their answer, as it does not affect the experience itself, they will then go on to the tutorial space. Within the tutorial space, there will be tables where the user builds the model longship and where the pieces for it are located.

Next to both tables will be a vertical adjustable slider that the user can move up and down which corresponds to the height of the tables.
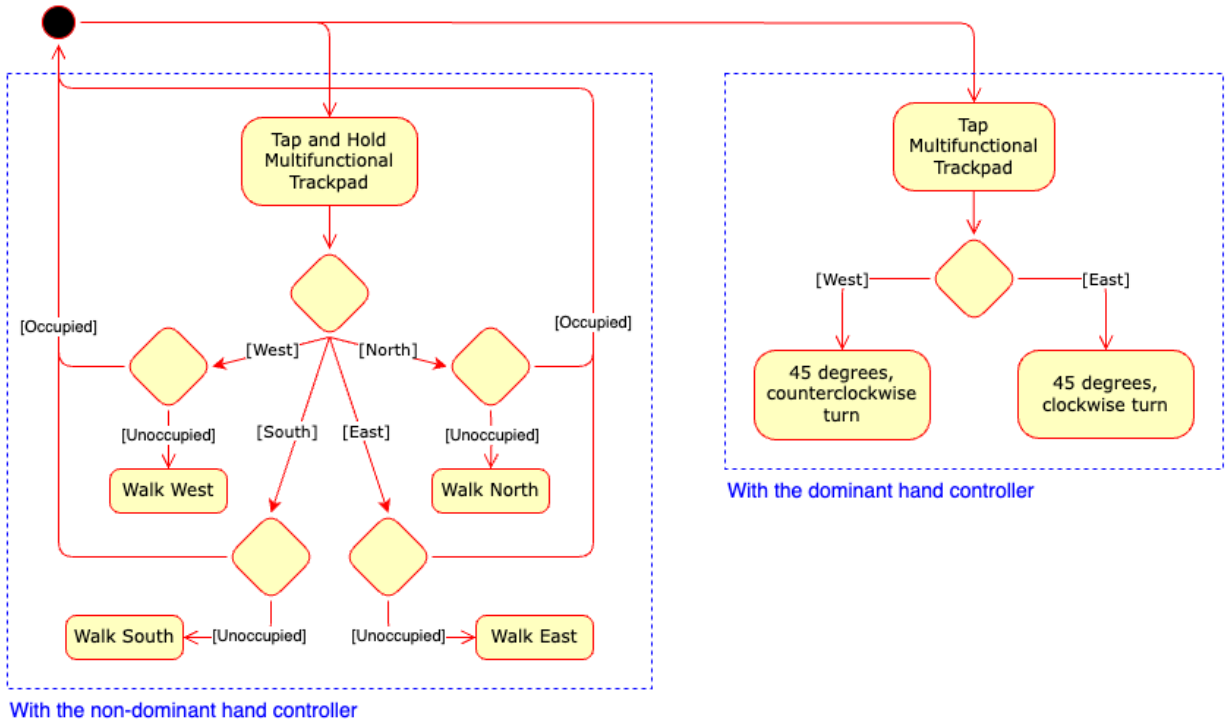
Moving - Walking and Turning [1][2]

Figure 5. UML of Moving - Walking and Turning [4]

The user moves by walking and turning (Figure 5). The user taps and holds the North, East, South, and West directions of the Multifunctional Trackpad on the non-dominant hand controller to take a step in the North, East, South, and West directions respectively. If the user's collider, however, overlaps with an object's collider, the display shows a sign: "You cannot walk in this direction." On the other hand, the user taps the East and West directions of the Multifunctional Trackpad on the dominant hand controller to turn 45 degrees clockwise and counterclockwise respectively.
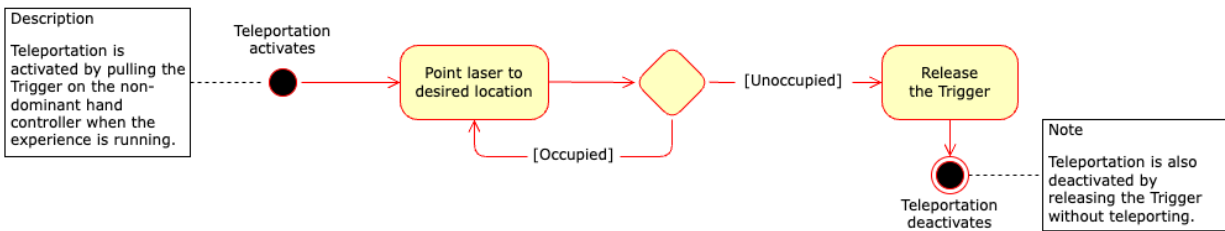
Moving - Teleporting [1][2]

Figure 6. UML of Moving - Teleporting [4]

The user also moves by teleporting (Figure 7). The user activates teleportation by pulling the Trigger on the non-dominant hand controller. When teleportation is activated, the non-dominant hand controller displays a sign: "Holding the Trigger, point the laser to the desired location. Release the Trigger to teleport." If the laser overlaps with an object's collider (i.e., the laser points at an occupied space), the non-dominant hand controller displays a sign: "The laser must point at an unoccupied space to teleport." If the laser does not overlap with an object's collider (i.e., the laser points at an unoccupied space) and the user releases the Trigger on the non-dominant hand controller, the user teleports to the desired location, and teleportation is deactivated. Additionally, teleportation can be deactivated without teleporting by releasing the Trigger on the non-dominant hand controller.
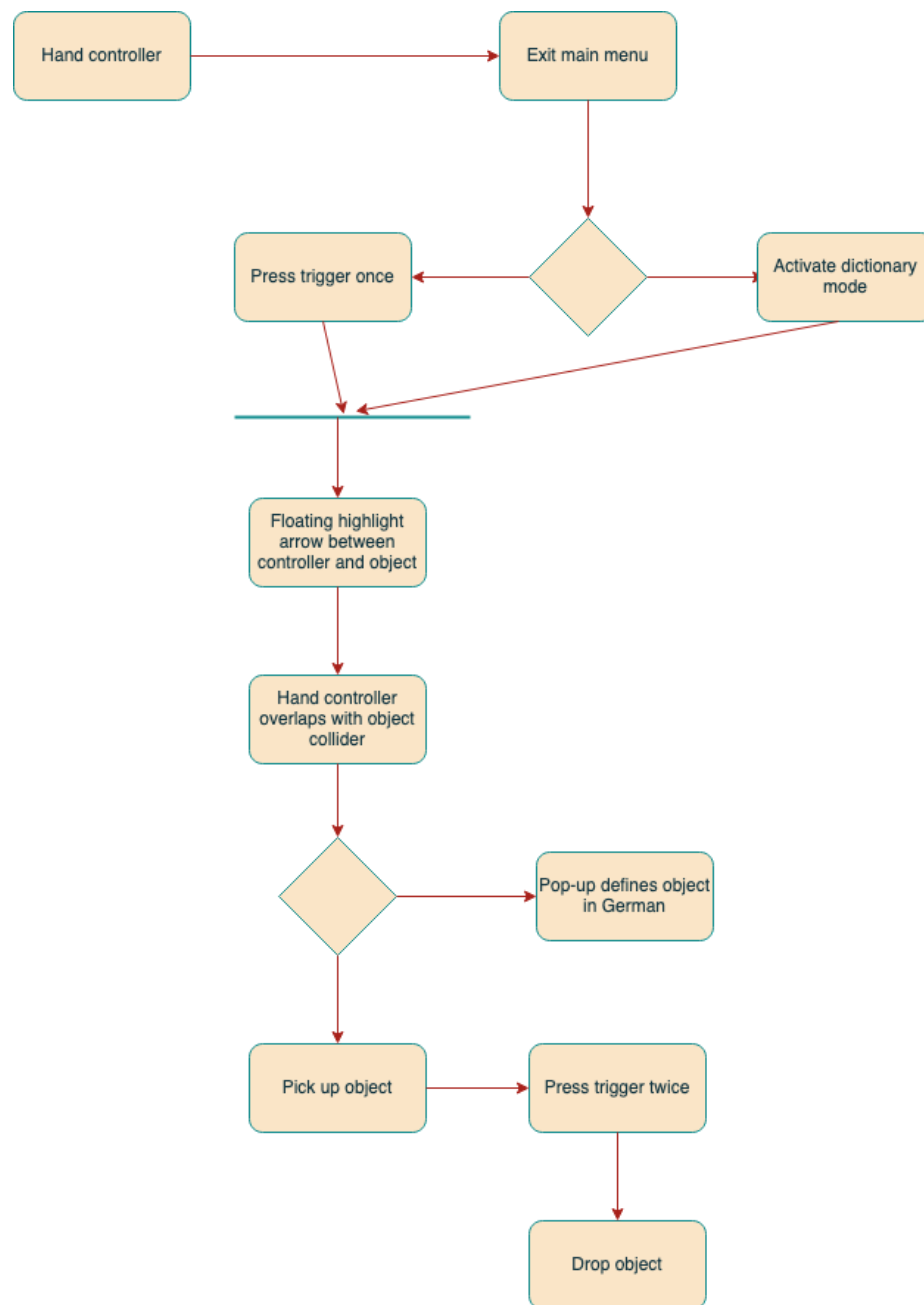
Picking Up and Dropping Objects

Figure 7. UML of Picking Up and Dropping Objects [4]

The user first selects the hand controller and exits the main menu, then uses the controller to select an object by pressing a trigger once.(Figure 7) When the resulting floating arrow appears, the user then uses the controller to overlap with the object collider to pick up an object. When the trigger is pressed twice, the object is then dropped.
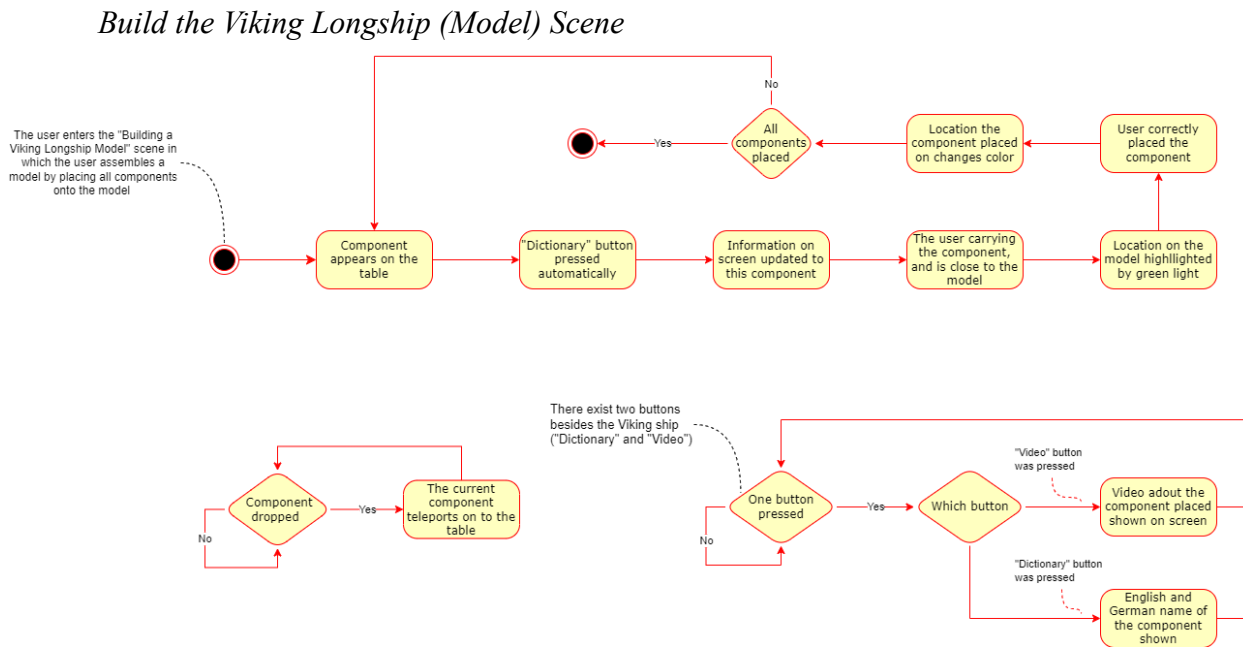
Build the Viking Longship (Model) Scene

Figure 8. UML of Build the Viking Longship (Model) Scene [4]

The UML diagram above shows the general flow of the "Build the Viking Longship (Model) Scene" which is after the user completes the Tutorial Scene.(Figure 8) The main objective of this scene is to familiarize users with the structure and various components of the Viking Longship.

Assembling
The user will enter this scene facing the model table with the Viking Longship on it, and the first component of the ship will appear at the center of the objects table on the right-hand side of the user. The user will be able to move around, pick up different components, and place them onto the Viking Longship model. As the user approaches the model table with one component on hand, the correct position of that component in the Viking Longship will be highlighted in green color. If the user cannot place the component correctly in 10 seconds, a dashed line that connects the user's right-hand control and the destination will appear to assist the user. This entire process described above repeats until the user can place all the components onto the model.

Name/Video Buttons
There will be two buttons located on the left front corner of the table with Vikingship on it. One is for the name of the component and the other one is a video. When the user

picks up one component, the "Dictionary" button will be pressed automatically, displaying the name of that component in English and German, which is projected on a screen at the far end of this scene. Then the user can press the other button by placing the hand control above it, and then press it to display a video related to that component on the same screen. The user can press the button repetitively for as many times as they want.

Dropped Objects
If an object is accidentally dropped onto the ground or the table, it will automatically be teleported back to its original position, which is on the object table.
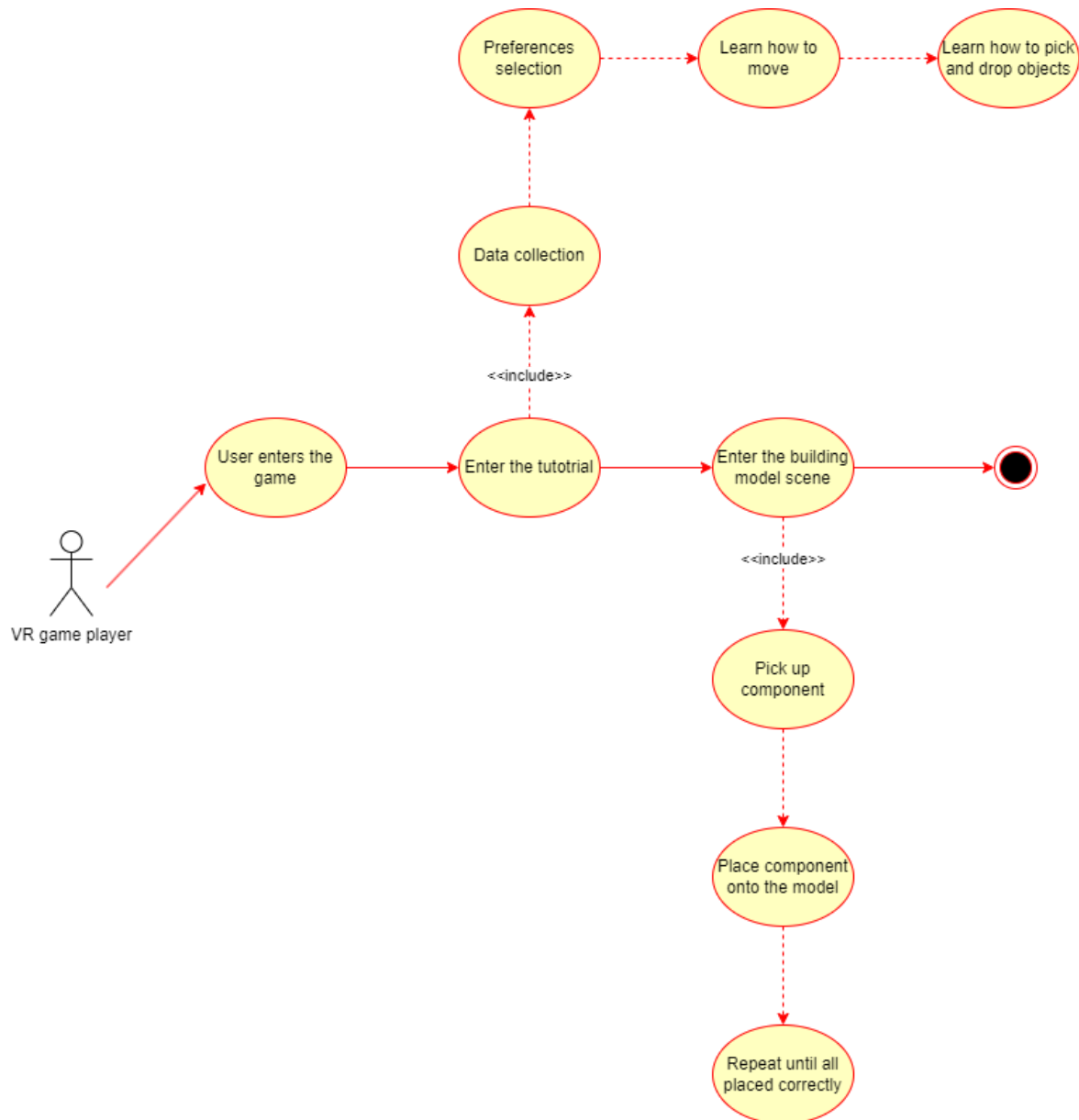
Use Case Diagram

Figure 9. Use Case Diagram [4]

The use case diagram shows how a typical user would play this VR game. (Figure 9) The user will first enter the tutorial scene which includes subsections including data collection, preferences selection, learning how to move, and learning how to pick and drop objects. After completion, the user will enter the Building Viking Longship Model Scene in which the user will place components onto the model until the ship is built.

3. Sources

[1] Smithsonian American Art Museum, "Beyond The Walls," [Virtual Reality Experience], Steam, 2019.

[2] Valve, "The Lab," [Virtual Reality Experience], Steam, 2016.

[3] E. Nersesian, "VR Design Doc," artncoding.com, 2023. [Online]. Available: https://artncoding.com/vrcsapp-vr-design-doc. [Accessed: 11-12-2023].

[4] S. Sundaramoorthy, "UML Diagramming: A Case Study Approach," [New York: Auerbach Publications], 2022.