CSE 566 Virtual Reality
Spring 2019
Assignment 2: Basic 3D User Interface
Prof. Arie Kaufman
Due date: March 26, 2019, 11:59pm Stony Brook Time

In this assignment, you will be exploring user interfaces for interaction with objects in your virtual world. Similar to Assignment 1, you will have to set up a simple 3D virtual world. Additionally, you are expected to design an interface to allow the user to navigate through your virtual world and to 'pick up' and 'release' 3D objects. We strongly recommend that you meet the following *minimum* hardware requirements for this assignment:

- A Google Cardboard
- A mobile device with either Android version 4.1 or higher or iOS version 8.0 or higher
- A controller connected to your phone using either Bluetooth or USB with 4 menu buttons and directional buttons / joysticks

Unlike the previous assignment, if you own a better controller, you are still restricted to the specifications mentioned in this assignment.

Overview
For this assignment, you will have to design an indoor supermarket experience. The user will have to navigate through a supermarket and buy all the things in a "shopping list" that will be provided to the user. You are free to design the supermarket however you like. The main elements of this assignment are navigating or walking through the aisles / shelves of the supermarket, choosing an item from the aisle / shelf, 'picking' an item and 'dropping' it from the aisle / shelf to the cart, and vice versa. Additionally, you will have to design two menu options: one that triggers a minimap (world in miniature - WIM) that shows where the user is located in the supermarket, and one that triggers how many items are bought from the shopping list.

This assignment is more challenging than assignments 0 and 1 and therefore, we strongly suggest that you start early and spend some time thinking about how you will implement each feature of the assignment.

The supermarket
As mentioned in the overview, you are free to design the supermarket however you like. The supermarket can have several aisles and sections or it may be one long strip market with shelves or baskets on each side. The items on the shelves / in the baskets can either be downloaded 3D models from the Unity Asset store or elsewhere (duly referenced and legally used), 3D models designed by yourself, or 2D representations of the item. The 2D representations can be in the form of text or images, however, when an item is selected by the user, a 3D representation of the item needs to be shown for interaction with the item (described in the later section).
You are free to design a shopping list for the user. The supermarket should have at least 10 distinct items of variable quantities and the shopping list should contain at least 5 distinct items.

At least 2 of the items from the shopping list should be picked up in quantities greater than 2. An example of a shopping list is as follows:

Saeed's grocery list
Apples - x2
Chocolate cake
½ gallon milk box
Cereal with oats and almonds- x3
Loaf of bread

Notice how the shopping list also contains some specific kind of an item, for example "cereal with oats and almonds" instead of "cereal". For at least 3 items from the shopping list, you need to provide different flavors / kinds of the item. As in the case of the cereal, this could be "plain cereal", "cereal with oats and almonds", and "chocolate cereal" or milk could be "whole milk", "reduced fat milk", and "almond milk". These options could either be separate 3D models placed on the shelves / baskets, or they could pop up as a menu once the user selects the general item. A word of caution: please try not to include brands in your assignment, however, if you do wish to include brands, then include a variety of them in order to avoid the advertisement of a single brand.

The camera
The center of the camera should always be fixed on top of the shopping cart, as shown in Fig. 1. You will have to track the user's head rotation and the camera orientations should change as the user rotates his/her head.

Fig. 1: The camera view.
[image source: Waterlander et al., Using a 3D Virtual Supermarket to Measure Food Purchase Behavior: A Validation Study]

Interaction

Since we do not expect you to have the hardware that can track your hands and movement, you will be implementing simple interaction techniques. For navigating through the store, you may use the directional buttons / joystick of your controller. To select an item from the shelf / basket, you will have to implement a gaze-based selection technique.

Gaze-based selection

In Assignment 1, you may have implemented the teleportation by 'looking' at the object for an interval of time. This technique is called selection by gaze. To select an item, you have to track the direction in which a user is looking in and check if a ray from the center of the mobile device's display, in the direction of the gaze, intersects with the item. The selection of an item needs to be clearly visible. For this assignment, you have to enlarge and change the color of the item to show that it is selected. For better experience you may even show a semi-transparent narrow "pipe" that represents the ray that traces the direction of gaze. The user should be able to select an item from the shelves / baskets as well as the cart. Of course, the cart can get busy and not everything may be in the user's view. In that case, you may either select the entire cart whenever the user looks inside the cart and use a pop-up menu to show the contents of the cart to the user, or you may use a button to rearrange the items in the cart such that every time you press the button, items in the front will go behind and the items that were previously behind will be shown in the front. Once an item is selected, the user should be able to click a button on the controller to confirm the selection.

If you plan to design a pop-up menu for content browsing, you can either use the directional buttons on your controller or you may list the items in front of the user and use gaze to select the menu option.

Once an item is *selected* from a shelf/basket or from the cart, using a select button, the goal now will be to transfer the item to the cart or back to the shelf, respectively. To do this, simply make sure that the user's cart and the location of the shelf/basket where the user would like to pick or put back the item, should be in some close proximity with each other. Within the defined proximity, when a user *selects* an item from the shelf/basket, a path should be drawn from the position on the shelf/basket into the cart. Then, using a *release* button, the item should be animated along the path, to show that the item is being put in the cart. This process should be similar when a user wishes to select an item from the cart to return back to the shelf/basket, however, in this case, the user and the cart should be in proximity of the location on the shelf/basket where the item belongs. If the user and the location of the shelf/basket are not in the defined proximity, then the selected item should be highlighted in red to show that the cart and shelf/basket are not in close proximity to each other.

Menus

Your assignment should have at least two menu options: one that triggers a minimap (WIM) that shows where the user is located in the supermarket, and one that triggers how many items are bought from the shopping list.

There should always be a minimap at a corner of your view. A minimap is a miniature map that is often placed at a screen corner in video games and VR applications to aid players/users in orienting themselves within the game/virtual world (see Fig.2). You may have a button that triggers to enlarge the minimap.

Fig. 2: Example of a minimap shown in the red dotted circle

Secondly, you should have a button to show and hide your shopping list. Any item(s) that has/have been put into the cart should be crossed out from the list and any item(s) that has/have been replaced on the shelf/basket should show that the item(s) has/have not been bought.

Some guidelines
You are only supposed to program a maximum of 4 buttons on your game controller in addition to the directional buttons / joystick. Since you have limited buttons, configure them wisely. For example, you may use the same button to select / release and also use the same button to trigger one of the menu options: require the user to not gaze at an item and look straight down the aisle or instead to use the button for triggering a menu option. It would be really useful if you implement a 'return' button - this could be used to quit the menu.

Submission
-   The submission should be done on Blackboard. You are allowed multiple submissions, however, the submission closes strictly on March 26, 2019, 11:59pm, Stony Brook time and your latest submission will be considered for grading.
-   Blackboard max size for submission is 250MB. If your zip file for submission is larger, please upload before the deadline your zip file to Google Drive and submit a shared link as the assignment submission on Blackboard.
-   All your submission should be in a zipped folder. The zip folder should include the following for full credit: your Unity project folder, a report, and a video.

- Your Unity project folder should contain your Unity saved scene and all your Scripts and Assets that will be required to re-build your project. Please do not include your project executable in the folder.
- For your report, you should include *at least* the following:
    - A title: "CSE 566 Virtual Reality, Spring 2019, Assignment 2: Basic 3D User Interface"
    - Your name and Stony Brook ID
    - Unity version
    - Hardware used
    - Directory hierarchy
    - Any extra functionalities/ features that you implemented for this assignment
    - Details on implementation: references to the downloaded 3D models or how did you design your own model;
- The video should be the recording of the stereo view (example: https://drive.google.com/open?id=1rAlSyb07uAHQ7wN3S4Y7Jxui-9yjIpti or here). The video should demonstrate all the features of your assignments, including the head rotations, menu interaction, and grocery item pick and drop interaction.