Adjustable Pointer in Virtual Reality for Ergonomic Interaction

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ABSTRACT

In a conventional virtual reality system, the user is provided interaction tools based on the hardware. We propose moving the interaction capability from hard-fixed to the hardware to a virtual one that's loosely-tied to the spatial reference point of the hardware. In our demonstration, we provide two methods for the user to quickly adjust their pointer to interact with objects in atypical situations without the need of additional buttons.

Key Words: 3DUI, Virtual Reality

Index Terms: Human-centered computing~Virtual Reality, Human Computer Interaction.

1 INTRODUCTION

With 6 Degree of Freedom (6DOF) Controllers and Headset, we can naturally interact in a three-dimension virtual reality world. Aside from physically grabbing an object when the controller is close to the object, the other common interaction is to use the 6DOF controller as a pointer, functioning much like a computer mouse in 3D. There are many variations of the pointer such as the pointing metaphors of ray-casting, fishing reel, or image-plane pointing [3]. However, most of them have the pointer fixed in position and orientation based on the hardware used. For example, an upward diagonal pointer for the HTC Vive controllers and a horizontal pointer for the Oculus Quest controllers (Figure 1).

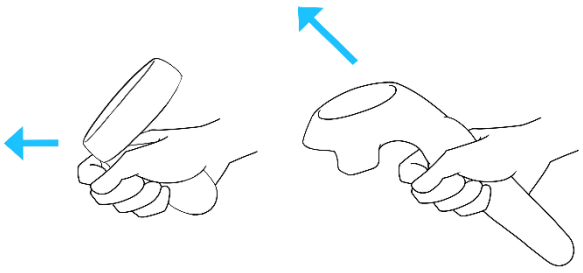

Figure 1: Pointer are typically fixed based on the hardware used. On the left, Oculus Quest with a horizontal pointer. On the right, HTC Vive with a pointer that goes diagonally upward to the left.

With 6 DOF equipment, however, we also get spatial reference points for the user that we can take advantage of. Some experiences and games have utilized the spatial reference point of the controller to provide a portable menu that follows the controller such as Google's Tilt Brush [1], or abilities to quickly transform the tools representing the controller into another tool such as the game Budget Cuts [2]. While these utilizes the spatial reference points, they do not offer users the ability to customize the tool based on their needs.

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The fixed orientation limits the users' ability to engage with content presented in different positions (such as above the user). Users may also be restricted by their own physical ability such as inability to lift their arms above their shoulders. By using the spatial reference points and providing a way to adjust the pointer, users can better interact with the virtual world based on their needs and not the restriction of the hardware.

In this demonstration, we provide an adjustable pointer that utilizes these spatial reference points as well as a test system to measure the improvement to the user's speed in achieving common tasks in a work environment. The user can adjust the orientation of the virtual pointer (Figure 2) that's attached to a controller using another controller. This allows the user to choose the angle that best fit the situation given the user's own body position (standing, sitting, supine) and the position of the objects to interact with (wall, ceiling, or floor).

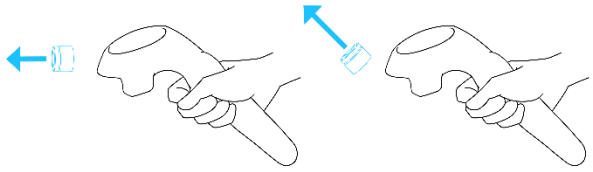

Figure 2: A Virtual Pointer that can be adjusted by the user to face the orientation desired.

2 PROPOSED SYSTEM

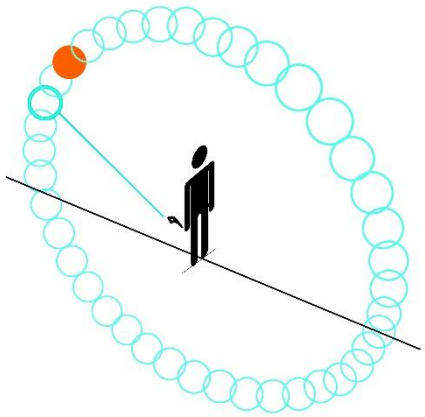

Figure 3: Diagram of user with two 6DOF motion controller and the ring of sphere test environment

Figure 3 shows what the user will be seeing in virtual reality. The user will be wearing a virtual reality headset and have access to two 6DOF motion controllers. One of the controllers will have a virtual pointer floating in front of the controller. The virtual pointer will follow the motion controller as if it's attached physically. It is floating in front to avoid damage to the controller when using another controller to manipulate the virtual pointer's orientation.

In the virtual world, the user will also see a ring of spheres that emulate different objects that the user may interact within a work environment. We have chosen a ring to focus on comparing the effect of different pitch angle and avoid time differences caused by different yaw angle. The spheres will be outlined when the pointer is pointing at it.

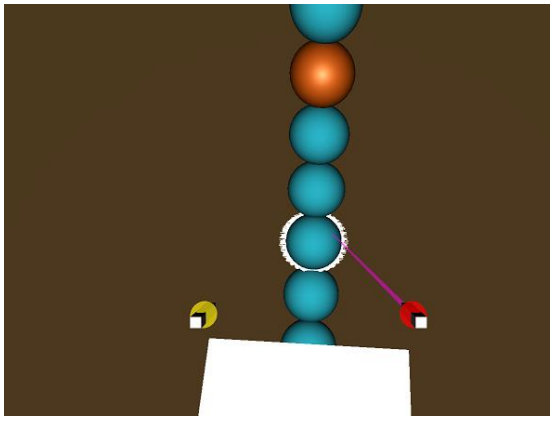

Figure 4: Image of what the user will see in the virtual reality demo. Orange sphere is the target to be selected. The white outline shows which sphere the user's pointer is currently pointing at.

One of the spheres will be highlighted orange as the target and the user will be asked to select it as quickly and accurately as possible. The time it takes will be recorded and aggregated so we can compare the effects of different pointer pitch angles.

2.1 Pointer Adjustment by User via Controller

With the use of one controller, the user will be able to rotate and change the orientation of the pointer on the other controller. This is done by pulling the trigger of the first controller to simulate grab and releasing the trigger when the pointer is at the desired orientation.

2.2 Pointer Adjustment by Adjustment Node

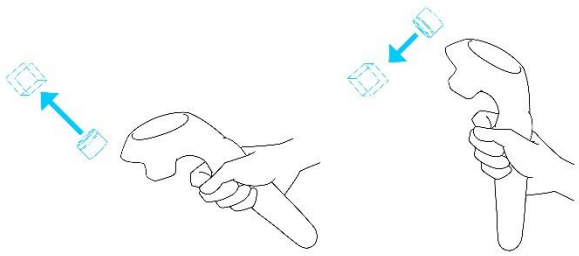

Figure 5: On the left, user selecting an adjustment node. On the right, the orientation of the pointer when the user let go of the trigger after selecting the adjustment node.

An adjustment node is an object that the user can select with their pointer to adjust the pointer angle. The user will start by selecting the adjustment node using the pointer and by holding down the trigger button. Once selected, the user can reorient the controller in any way and upon release, the pointer will be in an orientation that faces the adjustment node as shown in Figure 4. This allows the user to adjust the orientation without the need of a second controller.

2.3 Testing Procedure

The system will adjust the pointer pitch angle based on the experiment setup as needed. The default configurations are 45-degree, 0 degree, and -45-degree with respect to the horizontal axis.

There are three zones of interaction we are interested in: The wall (area in front of the user), the ceiling (area above the user) and the floor (area below the user).

The system will first ask the user to select a sphere straight ahead of the user. This is the calibration sphere and provide a base line for comparison. Starting with the wall zone, the system will then randomly select a sphere in the current zone. After the user has selected the sphere, it will ask the user to select the calibration sphere and repeat the process. After collecting enough data, it will then repeat the process with the ceiling zone and then repeat again with the floor zone. The system will also provide message to let the user know which zone they should be looking at.

Once the user has finished all three zones, this process will repeat with a different pointer orientation until all three pointer orientations (45-degree, 0 degree, and -45-degree) have been tested.

3 Demonstration and Experiences

In our demonstration, the user has the option to go through a trial where the user will be asked to quickly and accurately choose the highlighted spheres in three different zones using 3 different pointer orientations. At the end of the trial, the user will be provided with statistics on how they performed using different pointer orientation and selecting targets from different zones.

The user will also be able to do the trial where they change the pointer orientation using either controller or adjustment node

Our demonstration system will be an Oculus Quest virtual reality headset. User will need to wear the Oculus Quest headset and use its two controllers to experience the demonstration.

4 Conclusion

In this paper, we proposed a demo showing our concept of an adjustable pointer system without the use of additional physical buttons. The system allows for user to quickly adjust the pointer to point in a different orientation in two ways. The first is using another controller to directly manipulate the pointer. The second is through interacting with a special virtual object. This allows the user to adjust the pointer based on the user's needs, which can be external and based on the environment or internal and based on the user's physical status. In the future, we will expand the work to explore other ways to utilize spatial reference points for other interactions as well as the potential for pointers that will auto-adjust when facing content designated for a different orientation

References

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