Multiple Multi-Touch Touchpads for 3D Selection

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ABSTRACT

We propose a 3D selection method with multiple multi-touch touchpads. The method enables 3D region selection requiring fewer actions assuming some constraints, such as that the 3D region is defined by a rectangular parallelepiped. Our method uses an asymmetric bimanual technique to define a 3D region which in the best case requires only a single action. We employ two touchpads, each recognizing input from up to two fingers, and all actions can be executed while the user is resting her arms on the table, reducing fatigue caused when interacting with multi-touch displays. The technique also supports other typical manipulations, such as object and camera translation and rotation. The 3D region selection technique can be applied to define visualization regions in volumetric rendering or objects within a scene.

Keywords: 3D user interfaces, Bimanual interaction, Multi-touch, 3D selection

Index Terms: H.5.2 [User Interfaces]: Input devices and strategies—;

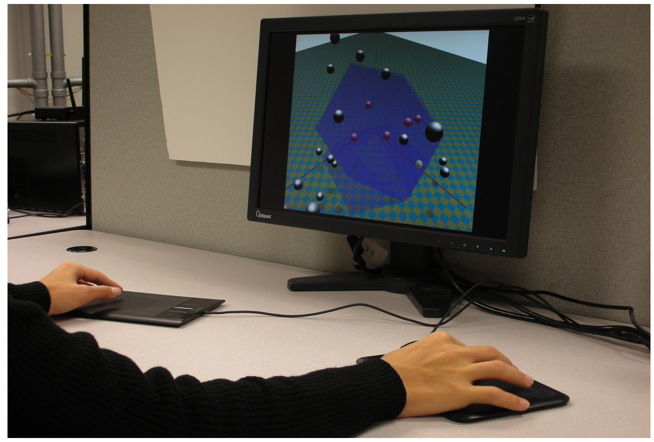

Figure 1: User interacting with the proposed system with multiple multi-touch touchpads

1 INTRODUCTION

3D region selection can play an important role in some tasks, such as defining a visualization region for volumetric rendering, selecting vertices of complicated 3D polygon models, or selecting multiple objects in a scene. In volumetric rendering, it is very hard to select and manipulate all the data in the visualization due to common issues such as occlusion. Therefore, users are often required to manipulate the visualization part with a method indicating a region in a 3D virtual world.

In this poster we focus on a multi-touch system that allows the user to define several points in 2D coordinates effectively. We employ two touchpads, each of which reports information of up to two fingers and users can interact with them while resting their arms comfortably on the desk during a task (Figure 1).

The proposed method is an asymmetric, bimanual interface. Because we employ two touchpads, it is possible to detect which hand a given finger touch comes from while usual touchscreen cannot. Also, since touchpads measure absolute 2D positions on the pad, users can indicate a 3D region with just one two-handed action, in the best case. This is not the case when using mice, which report relative values. We describe our approach to 3D region selection with multiple multi-touch touchpads.

2 RELATED WORK

Many bimanual interaction methods have been proposed. For example, several 3D region selection methods were presented by Ulinski et al. [2]. Although the methods allow one to define 3D regions, we consider that they are accompanied by high fatigue when compared to other instruments such as a mouse, because the manipulation is usually done by holding 6DOF sensors and moving them in the air. Input devices that rest on a work surface provide comparatively less fatigue, since users receive support from the input surface during manipulation.

There are various touch devices and interface systems. Multi-touch devices are promising and they have been used for 3DUI [1] as they can handle multiple DOFs at one time. Touch devices can provide direct or indirect manipulation. For large touchscreen or tabletop surfaces with large input areas and the same size of display area compared to the user's body, it is difficult to reach the corner points. Even if it is possible, it might force the user to use both hands to touch only two places. In this case, the user cannot touch more than two arbitrary points. Also, with direct touch devices, occlusion can be a problem especially if the display area is small.

3 DESIGN OF THE INTERFACE

3.1 Multiple Touchpads

We employ two multi-touch touchpads from Wacom, the Bamboo Touch. The devices are small enough to cover the whole input area with fingers of only one hand. Each device supports up to two touch-points in a 2D coordinate system and allows the user to rest his arms during manipulation. Each touchpad is placed on the work table where the user feels comfortable placing their fingers. Typically this is near the places where the user simply lays his arms on the table as shown in Figure 1.

Combining information from several fingers, it is possible to map the input into a 3D coordinate system. One important point about this is that the touchpad reports absolute touch-point values. Therefore unlike mouse manipulation, some of the definition of a 3D region can be done using a single action with mapping. However, since the proposed method is an indirect technique (input space is separate from display space), to define a 3D region with few actions requires user training.

One of the main advantages of using two touchpads is that the system can tell very precisely which touch-point belongs to which hand, and can use this information to support a much richer set of gestures, some starting with the left hand, and some with the

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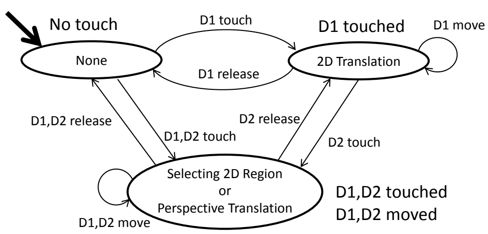
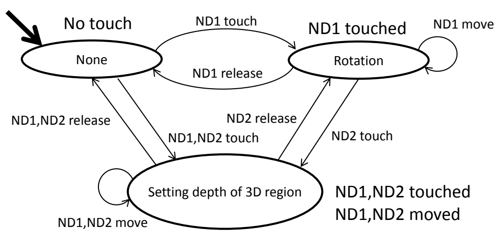
right. A typical multi-touch screen cannot tell which touch-point is coming from which hand. As for accessibility, touchpads are now commonly available and users do not need to purchase specialty hardware, such as 6 DOF sensors or touchscreen displays. Also, it is easy to carry touchpads, which means it is easy to set up in a new environment.

3.2 Allocation of Manipulation

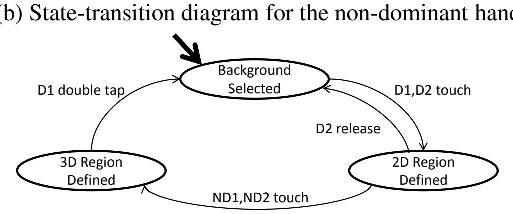
We assigned some tasks to be initiated by each hand thanks to the availability of two different touchpads. In this subsection, we discuss our implementation regarding handedness, so the described system can be swapped with user's handedness. Each hand has its role depending on whether it is the dominant or non-dominant hand. Generally, the dominant hand manipulates 3D translation and 2D region selection, while the non-dominant hand manipulates 3D rotation and defines the depth of the 3D region (Figure 2). Note that these types of gestures can be changed to the user's liking.



(a) State-transition diagram for the dominant hand



(b) State-transition diagram for the non-dominant hand



(c) State-transition diagram of the system

D1, D2: first and second finger of dominant hand
ND1, ND2: first and second finger of non-dominant hand

Figure 2: State-transition diagrams for each hand

The proposed method supports 3D region selection, as well as 3D translation and rotation. The 3D region selection can include 2D selection assuming the depth of the 3D region is zero. In our system, we assign 2D region (3D region with depth zero) selection to the user's dominant hand. The 3D region is defined by an axis-aligned rectangular parallelepiped.

Two touch-points on the touch pad for the user's dominant hand correspond to the viewport of the application window. The correspondence between input on the touchpads is shown in Figure 3. 2D regions are defined within the screen by the two finger positions of the dominant hand on the touchpad. Note that a 3D region is defined by an axis-aligned rectangular parallelepiped, which means the 2D regions are defined with the constraint that the region should form an axis-aligned rectangle. After a 2D region is defined, and once the non-dominant hand's two fingers touch the corresponding

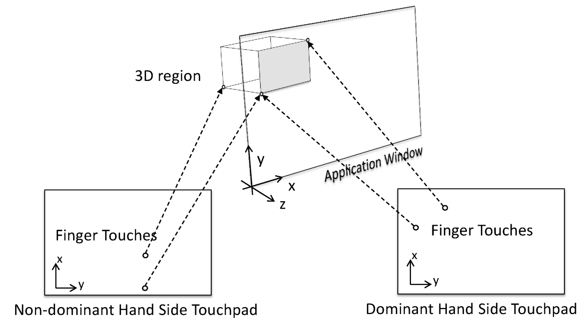


Figure 3: Correspondence between touchpads, the application window, and the 3D region

touchpad, the 3D region will be defined according to the distance and position of the touch-points. This parameter adds depth to the 2D region defined by the dominant hand, forming a 3D rectangular parallelepiped.

Once the 3D region has been defined, all objects in the region will be selected. After a 3D region is defined, users can manipulate the region simply by using a single finger.

The 3D translation gesture is divided into 2D translation and perspective translation. With a single finger, 2D movement on the touchpad corresponds to 2D translation. Two Horizontally aligned fingers, which cannot define a 2D region because of zero height, are used as an additional gesture. Sliding two horizontally aligned fingers provides perspective translation. 3D rotation is done with the Virtual Trackball metaphor. Because we assume a single touch should smoothly invoke 3D translation or rotation manipulation, single object selection is supported with a double-touch gesture (Figure 2 (a)).

We support interaction using the order of touchpad selection. For example, if the user starts with the dominant hand, then manipulation should be 3D region or object manipulation. If the user starts with the non-dominant hand, then manipulation should change the camera viewpoint. With this concept, users can manipulate any objects or the camera in the 3D coordinate system.

4 Conclusion

We proposed a 3D region selection method using two multi-touch touchpads. The interface does not suffer from arm occlusions or collisions between fingers on different hands, and incurs less fatigue. The proposed method is an asymmetric, bimanual interface using hand information (dominant or non-dominant). 3D selection and 3D manipulations are allocated to different hands.

Also, using absolute 2D positions on the touchpad, 3D region definition can be accomplished with a single action in the best case. Use of the techniques allows users to rest their arms during the tasks. Multiple multi-touch touchpads have the possibility to support expressive 3D region selection and manipulations using common devices.

Future work would be a comparison between the proposed system and two mice or a two 6DOF sensors configuration especially in terms of fatigue, intuitiveness, and learnability.

References

[1] A. Martinet, G. Casiez, and L. Grisoni. 3d positioning techniques for multi-touch displays. In *Proceedings of the 16th ACM Symposium on Virtual Reality Software and Technology (VRST)*, VRST '09, pages 227–228. ACM, 2009.

[2] A. Ulinski, C. Zanbaka, Z. Wartell, P. Goolkasian, and L. Hodges. Two handed selection techniques for volumetric data. In *Proceedings of the 2nd IEEE Symposium on 3D User Interfaces (3DUI)*, 2007.