Localized Space Display: Combining Gestural Control and Spatial 3D Interactions in a Conventional Computer Monitor

Vincent Chen
Stanford University
vschen@stanford.edu

Jason Ginsberg
Stanford University
jasong2@stanford.edu

1 Introduction

Localized Space Display (LSD) will augment traditional desktop displays with head tracking and gesture recognition to produce a novel 3D computer environment. 2D GUIs have been the primary interaction interface for the current paradigm of computing, but they are limited by screen size and the lack of a depth dimension. Recent advances have been made in 3D computing technologies, in particular commercial virtual reality (VR) applications, that demonstrate the immense benefit of spatial interaction models. We introduce an interface that will allow users to switch between 2D and 3D interactions with ease, without the cognitive load and physical inconvenience of switching between them. As a result, users will be able to take advantage of both paradigms. With our functionality, hand tracking will enable users to intuitively navigate the 3D interface.

While current head-mounted display (HMD) solutions for VR promise the benefits of 3D spatial interactions, they also pose many physical limitations. Users engaged in VR have little sense of the space around them. This may result in simulator sickness, as users are forced to rely on the virtual experience to match cues in their visual and vestibular systems. Furthermore, when ones view is obscured, safety concerns are raised, as they are at risk for hitting or falling over pets, furniture, or friends.

LSD will rely on motion parallax to confer the 3D spatial capabilities of VR to traditional monitors. The focus of our project will be to 1) implement the tracking to introduce the visual parallax effect and 2) experiment with hand-gestural control as a means of manipulating objects in 3D space. Our demo will require a traditional desktop monitor for display, a Microsoft Kinect for head tracking, and a Leap Motion for hand tracking.

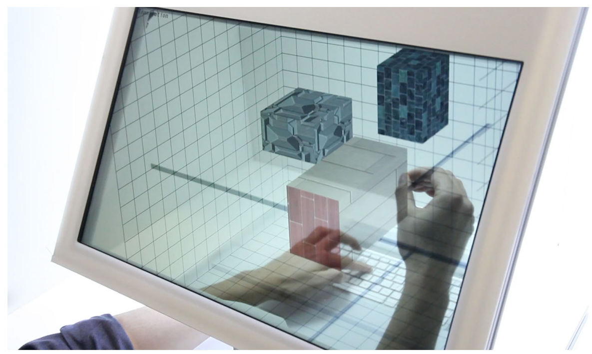


Figure 1: Working with spatial memory. Image from Jinha Lee [1]

2 Related Work

2.1 SpaceTop

SpaceTop [1] is the primary inspiration for our interface. As seen in Figure 1, it features custom hardware, including a transparent screen upon which users can see floating UI elements. SpaceTop's goal was to introduce a means for direct 3D interaction that is 'fused' into a traditional 3D desktop interface [1].

The technology features two Kinect sensors, one for tracking the face and one for tracking hands. We wish to build our own version of this that does not rely on a

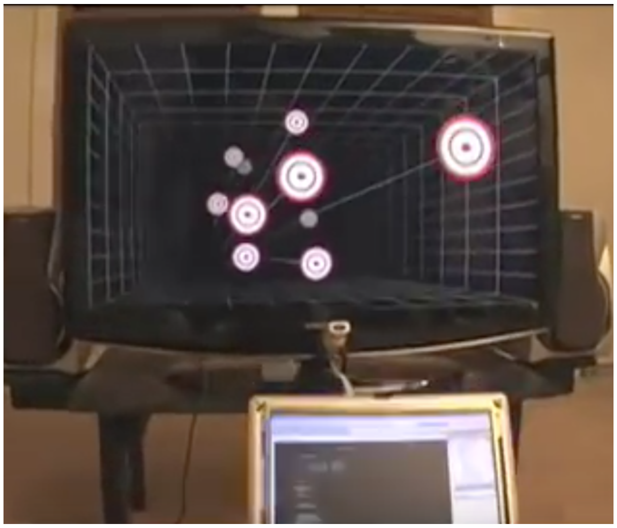


Figure 2: Creating motion parallax using IR emitters and Wii remove. Image from [3]

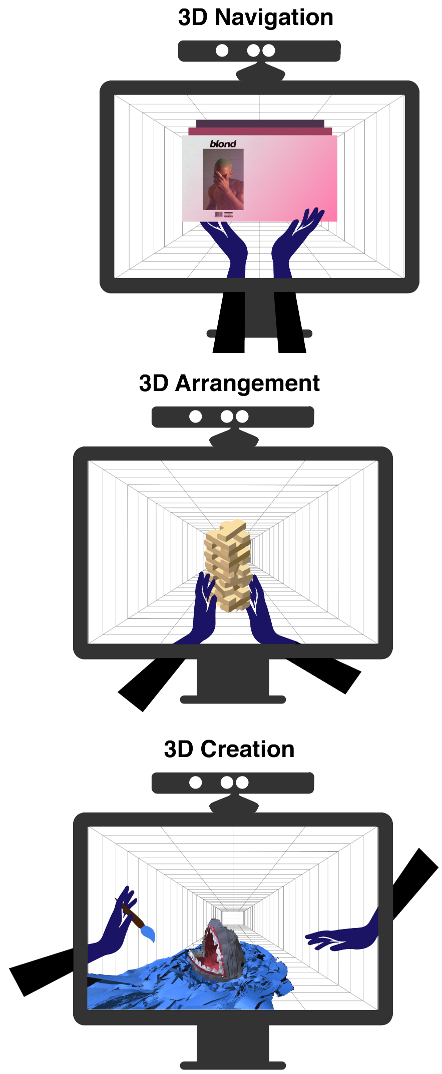
see-through display but may work on any monitor. In our implementation, we intend to obfuscate the hands behind the monitor so that body-transfer effects will mitigate the perceived lag between the virtual and real hands of the user.

2.2 Head Tracking using the Wii Remote

In 2008, Johnny Lee hacked a Nintendo Wii IR controller to update a screen relative to the location of a users head. This created a 3D parallax effect using only a traditional TV monitor, which resembles the 3D effect we seek to produce in any computer monitor. As Lee suggested, the resulting effect was like looking through your screen as a ”window” into another world [3]. Our project will go further by allowing interactions with objects in this ”window” through hand tracking.

3 Timeline

Over the next few weeks, we have a concrete plan to implement LSD. Below are a few concept images describing the interaction model under specific use cases for the display.



3.1 Face Tracking (5/27/2017)

Our goal is to accurately keep track of a single face, its distance and height from monitor to roughly approximate the position and angle of the users eyes so that we may update the screen for parallax. In order to do this we need to interface with the Kinect SDK (and read the documentation), place markers to keep track of relative placement between the camera, monitor, and the user. Afterwards, we will implement the parallax effect due to head orientation (updating the displayed objects) in Unity3D.

3.2 Hand Tracking/Rendering (5/31/2017)

Hand motion will provide the main interaction for the 3D experience. We wish to track both hands, over the range of a 20-inch display, with accurate in translational and rotational tracking. A user may touch or grasps objects to move them. These interactions will depend on the demo (e.g. 3D navigation will simply tracking the z-depth of the user's hands). Similar to the Kinect, we will have to interface the Leap Motion with Unity, render the output, and recognize hand-object interactions.

3.3 User Interface Environment (6/2/2017)

We will use Unity to build our demonstrations of files browsing, 3D object manipulation, and 3D object creation (see figures). This step is the most flexible, and dependent on the final capabilities of the display. It will require building and coding interactive environments (as one example a scrollable page viewer) that behave as expected regardless of the display on interaction.

3.4 Potential Issues

Even if fully implemented, our proposed display will be limited. Notably, it will only be able to render 3D for one user at a time. Additionally, the hand tracking is range-limited and will not be able to fully handle occlusions. LSD will also produce a 3D parallax effect that is weaker in immersion than the stereoscopic effect of a HMD. And our greatest difficulty will be in defining the interaction behavior from an HCI perspective. In particular defining when a user motion registers as an object selection and, in turn, that object's responsive behavior may require experimental study.

References

[1] J. Lee, A. Olwal, H. Ishii, and C. Boulanger. *SpaceTop: integrating 2D and spatial 3D interactions in a see-through desktop environment.* In Proc. of CHI 2013, pages 189192

[2] J. C. Lee, ”Hacking the Nintendo Wii Remote,” in IEEE Pervasive Computing, vol. 7, no. 3, pp. 39-45, July-Sept. 2008.

[3] [Johnny Lee]. (2007, Dec 21). Head Tracking for Desktop VR Displays using the WiiRemote [Video File]. Retrieved from https://www.youtube.com/watch?v=Jd3-eiid-Uw