Creating Near-Field VR Using Stop Motion Characters and a Touch of Light-Field Rendering

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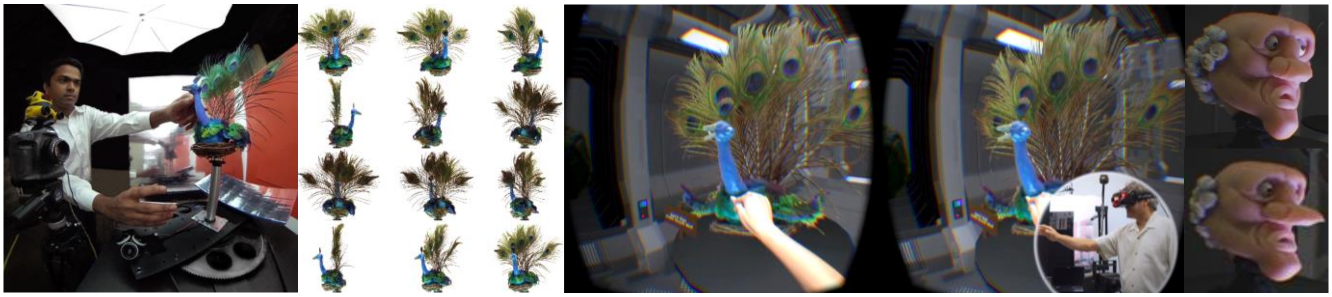

Figure 1: *(a) C*apture system. *(b) Sequenced images. (c) Animation reacting to hand interaction. (d) Effect of rebinning.*

1 Introduction and Motivation

There is rapidly growing interest in the creation of rendered environments and content for tracked head-mounted stereoscopic displays for virtual reality. Currently, the most popular approaches include polygonal environments created with game engines, as well as 360 degree spherical cameras used to capture live action video. These tools were not originally designed to leverage the more complex visual cues available in VR when users laterally shift viewpoints, manually interact with models, and employ stereoscopic vision. There is a need for a fresh look at graphics techniques that can capitalize upon the unique affordances that make VR so compelling.

We have created a new type of VR experience and pipeline by using image-based rendering techniques to capture and render hand-crafted stop motion puppets that are rich with micro geometry and detailed surfaces and materials. Our pipeline is computationally lightweight and integrated within the Unity3D game engine, thus allowing artists to quickly create lush models that can be plugged into a traditional virtual environment running in real time. Experientially, we found that these rich renderings create a magical place with a strong and immediate feeling of presence, which we call Near-Field VR. In particular, our ability to represent specular reflections, iridescence, sub-surface scattering, transparency, and fine geometric details correlates with findings in perceptual psychology regarding the hierarchy of cues that users employ to make sense of the Near-Field space [Cutting and Vishton 1995].

2 Approach

A custom-designed turntable captures a ring of images at 1° increments for each frame of an animated sequence of a stop motion puppet. Because the animator must now consider depth when manipulating poses, check images at 0 and 90 degrees are sent to Dragonframe, allowing time scrubbing and transparency. Primatte was used to matte images. As the user moves, we compute each eye's view angle and project the nearest captured view onto two co-axial billboarded polygons. Bounded by loading time, we only load and cache as-needed images in the DXT5 format from an SSD using 1K textures to match the HMD's resolution.

We also explored horizontally rebinned pixels to correct perspective from close viewpoints; projection onto proxy geometry derived from stereo correspondence for better stereoscopy; and flowed fields with 5⅝° spacing for rebinned animation.

Interestingly, the perception of organic shapes proved quite tolerant of the geometric errors of our simplest billboarding technique, which we preferred due to its fast performance. We leveraged the game engine to minimize artifacts by setting default height to that of the user, placing geometry to control model proximity, and matching captured lighting. Our artists used complex materials to leverage the near-field cues retained by our image-based approach, for example, glints move from eye to eye with head translation.

While we will more fully implement vertical parallax, flowed fields, projection onto geometry, and relighting, it is important to pause and present our current results. Our research proves that Near-Field VR is a viscerally engaging type of VR that needs to be further developed; that the Near-Field region must transcend typical polygonal techniques and move toward the image-based cues the human perceptual system demands; and that VR greatly benefits when it finds ways to leverage traditional craft.

References

CUTTING, J.E., AND VISHTON, P.M. 1995. Perceiving layout: The integration, relative dominance, and contextual use of different information about depth. In *Epstein, W., & S. Rogers (Eds.), Handbook of Perception and Cognition*, vol. 5, Perception of Space and Motion, NY: Academic Press.

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