Physically-based Direct Object Manipulation by Hand and Fingertip Force Display in Fish Tank Virtual Reality

Yunxiu Xu, Siyu Wang, and Shoichi Hasegawa✉

Tokyo Institute of Technology, Tokyo, Japan {yunxiu, siw131, hase}@haselab.net

Abstract. This paper explores creating an interactive system combining 3D interactive surfaces with physics-based hand interaction methods. The system works in Fish Tank Virtual Reality(FTVR) environment, the user can manipulate the projected virtual objects when looking at their real hand. To achieve dexterous manipulation, we designed methods to visualize contact points between fingertips and rigid bodies without adding force feedback. Vibration is used to enhance collision perception. This system can help to break the border between the virtual and real world.

Keywords: Dexterous manipulation· Virtual coupling

1 Introduction

Augmented Reality (AR) is a variation of Virtual Environments (VE). It allows the user to see the real world and the virtual world simultaneously. Projected-based Fish Tank Virtual Reality(FTVR) is a kind of large and stable AR device that can create three-dimensional (3D) interactive VE. The physics based manipulation[4] can be used in this VE. Some research realized bare hand manipulation[3].In the hand-based interaction between humans and VE, users need to use their real hands to control the corresponding agent in VE. The agent can be a virtual hand or some tool. But in AR environments, real hands and virtual hands will both appear at the human viewpoint, so it is important to create physical-based manipulable environments that only show real hands like [1]. But they cannot show the contact point and force of finger accurately. Therefore, we need to propose methods to provide fingertips contact information without occlude the hand and disturb the user.

2 Proposal: Visual Effect and Vibration for Direct Manipulation

Figure 1 (a) shows the overview of the system. We use a 6-dof tracker and a binocular camera to obtain posture information of the user's head and hands.Figure 1(b) shows an example of our visual grasping effect, We use round cone to represent the fingertip. A hologram-style effect was used when the user's finger made contact or penetrated the virtual objects, and we got the contact force then used it to adjust the brightness of the effect. The force was displayed through the position and color of the effect. Since we want users to look at their real hands and operate like figure 1(c), the extra hardware may affect the hand pose recognition and occlude the image. Some devices present haptic sensations on the wrist[2], we installed bone conduction headphones on the user's wrist, We modulate the contact force into a vibration signal and send it to the user to enhance the manipulation experience.

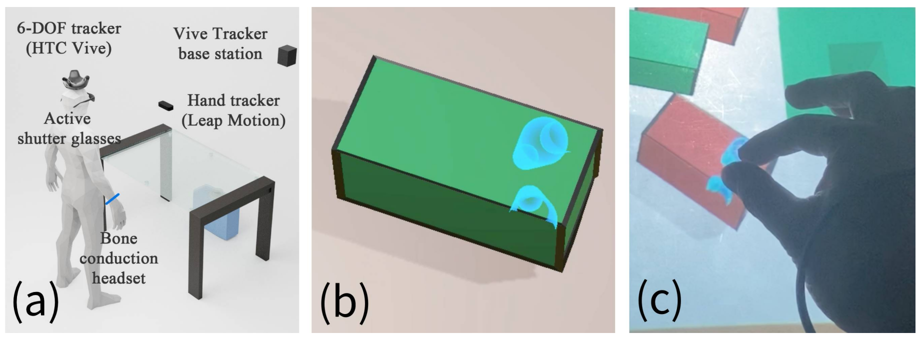

Fig. 1. (a)System hardware overview; (b)The visual effect; (c)The example of manipulation in real world.

3 Conclusion

The current paper describes a projection-based FTVR system with a dexterous direct manipulation method. To support dexterous manipulation, we visualized the penetration and feedback force of the user's hand when grasping in FTVR. While we are still very far from implementation of a system that can realize similar effect to reality grasping, we will improve the haptic feedback and manipulation experience in future.

References

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