GhostGlove: Haptic Existence of the Virtual World

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Figure 1: *The categorized behaviors and perceptions that are represented by our proposed method.*

1. Introduction

In the real world, we usually do not perceive haptic sensations consciously. However, if the haptic sensations are absent or if they are not of the desired quality, it would result in discomfort, and the existence of the world would be degraded. In order to eliminate the feelings of discomfort and represent genuine feelings of the existence of objects in virtual reality interactions, as shown in figure 2, we show that haptic sensations play a decisive role in inciting cognitive functions in a virtual environment. There are many researches on haptic displays for virtual reality interactions with the hand, such as CyberTouch and CyberGrasp [Immersion Corp.]. However, the represented sensation is still inadequate to provide us with the experience of feeling the definite existence of virtual objects or virtual creatures. Generally, it is considered that a complex and expensive device is required to provide realistic haptic sensations; many attempts to simplify the device would result in poor sensations, for example, simple vibrations. To merge the simplicity of the device and realistic sensation of existence, we propose a novel wearable haptic interface named "GhostGlove." This device generates natural and realistic haptic sensations over the entire hand—on each finger and the palm—and integrates the perceptions on the entire hand along with the visual sensations to enables us to recognize the existence of the virtual world.

2. Method

Usually, the palm is used for a rough and quick recognition of the size and shape of an object, while the fingers are used for dexterous manipulations. We found that the interactive combination of the cutaneous perceptions on the palm and fingers is effective in the haptic recognition of the objects. Based on the study on exploratory procedures [Lederman and Klatzky 1987], we categorized the behavior in human-object interactions by focusing on the relative motion of the palm and the object as shown in figure 1. The direction of the motions represented by Encounter and Pressure are perpendicular to the object surface, while those represented by Contour following and Stroke are lateral to the surface. Bimanual enclosure, grasping, and unsupported holding are examples of static contact. We then implemented the prototype device shown in figure 3 to reproduce the corresponding cutaneous perceptions in each relative motion.

The mechanism for the reproduction of the sensation on each finger and the palm is based on our unique technology to provide significantly realistic sensations of touch and the dynamics of virtual objects [Minamizawa et al. 2007]. By reproducing the vertical and shearing forces on the fingerpad by this simple mechanism, the device could generate high-responsive and precise haptic interactions of the dynamic motion of the virtual objects. We extended this method to the entire hand including the palm, and also confirmed the effectiveness of bimanual coordination particularly in the perception of volume and surface.

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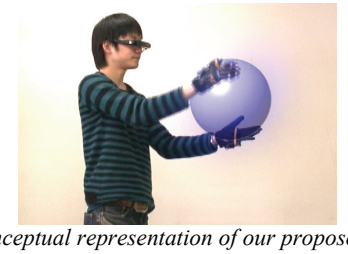

Figure 2: *Conceptual representation of our proposed system. The user with HMD and the devices on both hands can see and touch the VR object. The haptic sensation is represented interactively corresponding to the user's motion.*

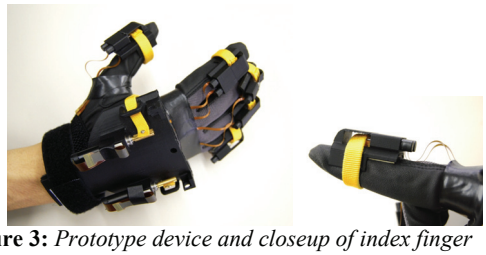

Figure 3: *Prototype device and closeup of index finger*

3. Summary

We proposed a novel haptic interface to be worn over the entire hand. This interface allows realistic and responsive haptic interactions in virtual reality environments via a simple method that considers the importance of the unconscious perception of haptic sensations for recognizing the existence of the external world. GhostGlove provides an unprecedented feeling of the dynamics of virtual objects and the vitality of virtual creatures.

References

LEDERMAN, S. J. AND KLATZKY, R. L. 1987. Hand-movements: A window into haptic object recognition. *Cognitive Psychology*, 22, 421-459.

MINAMIZAWA, S. FUKAMACHI, K., KAJIMOTO, H., KAWAKAMI, N. AND TACHI, S. 2007. Gravity Grabber: Wearable Haptic Display to Present Virtual Mass Sensation, In *Proceedings of ACM SIGGRAPH 2007*, Emerging Technologies.

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