

# Haptic Duplicator

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## ABSTRACT

We propose a haptic interface for touching 3DCG models based on the tactile copy & paste technology. In case of conventional systems for providing haptic sensation of touching virtual objects, it is challenging to reproduce realistic surface textures of objects. By scanning vibrotactile stimulation as audio signals, we realized recording of textures of real objects and reproducing of them with a wearable haptic glove with force and vibrotactile feedbacks. In our system, the user can appreciate a number of virtual objects with various scanned textures, and also, change their textures by haptic copy & paste from real objects to virtual 3DCG models.

## Categories and Subject Descriptors

H.5.2 [User Interfaces]: Haptic I/O

## General Terms

Design, Human Factors

## Keywords

haptic display; haptic rendering; haptic sensing;

## 1. INTRODUCTION

In recent years, there are many 3DCG contents. It is mentioned as the background that the general methods for the stereoscopic rendering were established. However, the general technique for haptic rendering on the virtual objects, which can be applied to several systems and devices easily, does not exist.

There are some attempts to provide haptic sensation of touching virtual objects. Haptic workstation [1] provides force feedback from virtual objects on each finger and arm. However, grounded components for kinesthetic feedback restrict the user's movements, so that active and natural behaviors of the user are inhibited. HapticGEAR [2] is a portable force display that allows the user to walk around in an immersive virtual reality environment. However, it imposes a strict limitation on the movements of the user's arm and requires wearing a heavy backpack to touch the virtual object. Then we have developed a wearable haptic glove [3] that provides haptic sensation on the user's fingers using pseudo-haptic based on the pressures

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provided on fingers.

On the other hand, it is also a problem how to generate adequate virtual haptic signals that represent realistic surface textures of real objects. Some research has been conducted on scanning of textures of objects in the real world from a sensor imitating the property of human fingers [4]. The finger-shaped sensor acquires stimulus in stroking objects and the scanned data are transmitted for displaying in real-time. Some other research recorded force and acceleration values to reproduce realistic haptic sensations [5]. These kinds of copy & paste methods save many steps of designing and calculating enormously complex signals of haptic textures.

Our aim is to disseminate the haptic technologies as the third media and extends the conventional multimedia, which is consisted of visual information and auditory information. Based on this motivation, we present a next-generation VR experience with a less-constrained wearable haptic device and highly realistic haptic textures. Our proposed system enables the user to touch 3D virtual objects with his/her hands freely and enjoy their shapes or textures (Figure 1), which are generated based on copy & paste of tactile textures from real objects to virtual objects (Figure 2).



Figure 1. Touching textured virtual object

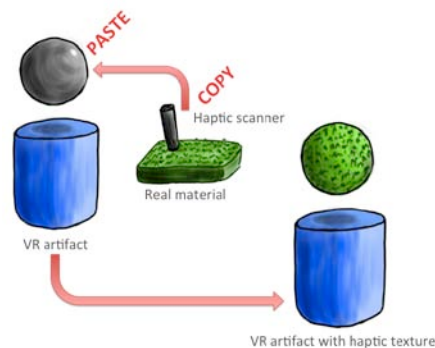


Figure 2. Haptic copy & paste

## 2. Copy and Paste of Tactile Textures

TECHTILE toolkit [6], proposed in 2011, is an easy-to-make and easy-to-use prototyping tool for design and education of haptic media, which is composed of a haptic recorder (a microphone), haptic reactors (small vibrators), and a signal amplifier that is optimized to present not only zone of audibility (20-20000Hz) but also low frequency (1-20Hz) vibration (Figure 3). Tactile stimulations obtained while scanning are recorded based on audio signals. Therefore, the stimulation is editable diversely. We used TECHTILE toolkit for copying of tactile textures from real objects and playback as high-realistic vibrotactile sensations. We applied the recorded vibrotactile signals (Figure 4) on 3DCG models by pasting them as textures.



Figure 3. TECHTILE toolkit

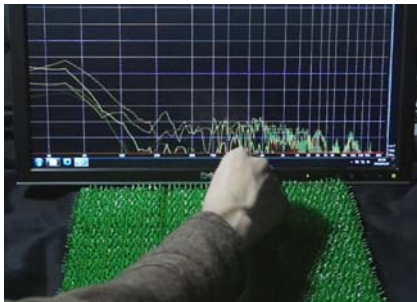


Figure 4. Recorded vibrotactile signal

## 3. System Configuration

Our system for haptic interaction with textured 3D objects is composed of an optical motion capture system (Natural Point Inc., OptiTrack S250e), a 3D projector (Solidray Co.Ltd., Sight3D ) and a wearable haptic glove improved from conventional one ([3]).

The haptic glove consists of a motor and a voice-coil on each finger (Figure 5). From the tracking data on user's head and hand movement, we calculate the force feedback on each finger based on the physical simulation using PhysX (nVidia Corp.) and the visual rendering for stereoscopic image. The calculated contact forces are provided by the use of motors, and voice-coil vibrators reproduce recorded tactile textures based on velocities of fingers' movements.

As a result, the user wearing 3D glasses and the haptic glove can see and touch 3D virtual objects displayed in front of them (Figure 6). Contact forces and tactile textures are provided by the haptic glove, and therefore the user can enjoy realistic haptic interaction with various kinds of textured 3D objects.



Figure 5. The haptic glove (Left) and display mechanism to reproduce pressure and vibrotactile sensation (Right)

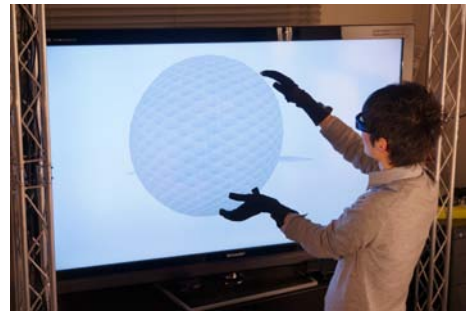


Figure 6. Constructed system

## 4. Conclusion

In this paper, we proposed a wearable haptic interface based on copy & paste of tactile textures from real objects to virtual objects. The system allows the user to touch textured virtual objects actively and to feel a variety of haptic sensation by the combination of force and vibrotactile stimulation. Besides, our proposing method for the haptic rendering on 3D objects is applicable for a variety of existing media simply because we use audio signals as vibrotactile stimulation.

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