STELET Display: Tactile Augmentation with Handheld Tool

Shunsuke Yoshimoto* Osaka University
Naritoshi Matsuzaki Osaka University
Yoshihiro Kuroda Osaka University
Masataka Imura Osaka University
Osamu Oshiro Osaka University

Abstract

This research introduced a new concept of a tactile display, "Spatial Transparency", which enables tactile augmentation without mediating a device. We developed Spatially Transparent Electrotactile (STELET) display based on tactile illusion caused by electrical stimulus and the anatomical nerve structure. A simple tactile AR system in which the virtual grip sensation is augmented to the real sensation was provided by using the developed device. In the demonstration, users can interact with the virtual object which is superimposed to the real material by using an instrument.

Keywords: Haptics, Tactile augmentation, Electrotactile display.

1 Concept

This research introduces a new concept of a tactile display, "Spatial Transparency", which is defined as tactile augmentation without mediating a device. A spatially transparent tactile display enables users to feel a real environment augmented with synthetic tactile stimuli. Because grip sensation is related to the physical event caused by handheld tool, to augment grip sensation by using a spatially transparent tactile display has potential to modulate the perception such a texture and stiffness as well as to display a virtual object. This research aims at developing a spatially transparent tactile display and investigating modulation of the perception during a tool manipulation with a virtual object superimposed to the real material. The grip force sensation is augmented to present real environment augmented with synthetic tactile stimuli. Previous tactile displays cannot augment tactile sensation without disturbing real sensation because the tactually augmented position corresponds to the stimulated position. We focused on the tactile illusion caused by electrical stimulus to separate the perceived position from the stimulated position and developed Spatially Transparent Electrotactile (STELET) display [1]. We provide a simple tactile Augmented Reality (AR) system which enables users to feel augmented object by using the developed device. In the demonstration, users can interact with the virtual object which is superimposed inside the real material by using an instrument.

2 Innovation

The principle of STELET display is based on tactile illusion caused by electrical stimulus and the anatomical nerve structure. When the nerve is electrically stimulated, users perceive the sensation at the terminal of the nerve. We investigated the optimal stimulus to apply the phenomenon to the tactile augmentation.

Hardware Design: The strategy to achieve the spatial transparency is to stimulate the afferent nerve rather than mechanoreceptors. The two main afferent nerves which run along with the side of a finger are stimulated. The device consists of an electrical pulse generator, two cathodes and a ground electrode. In order to augment tactile sensation without mediating device, the cathodes are attached on the each sides of the media of a finger. The device

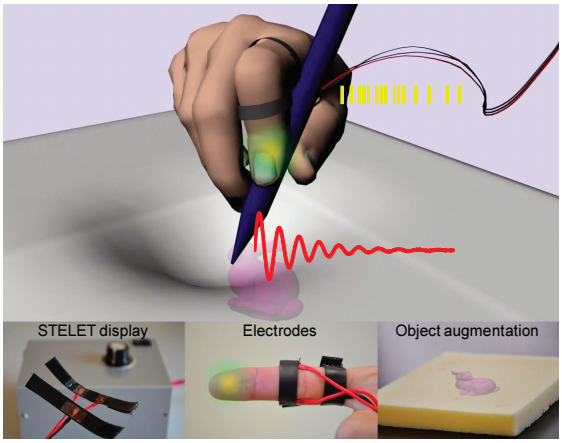

Figure 1: Tactile augmentation with STELET display

can control the pulse rate up to 100 pulses per second (pps) and the pulse height up to 2 mA. The pulse width is fixed at 200 μs.

Stimulus Design: In order to interact with a virtual object, transient acceleration and static force are calculated and displayed. Both acceleration and force are presented by the electrical pulse stimulus and the amounts are linearly controlled by the pulse rate (pulse rate modulation). The acceleration of the instrument according to the physical events such a tapping and dragging are modeled by sinusoidal wave. The static force according to the object deformation is also calculated by using Finite Element Method. The calculated acceleration and force are presented as grip force to integrate with the real sensation.

3 Demonstration

The purpose of demonstration is to investigate a potential of a tactile AR system with the developed spatially transparent tactile display. Especially, modulation of the perception during a tool manipulation with a virtual object superimposed to the real material will be evaluated. The system overview is illustrated in Fig. 1. Users attach the electrodes on their index finger, and calibrate the amount of current. Users touch the real object with holding an instrument and feel both real and virtual object which is visually augmented on the real material. We utilize silicon as a real material and project the virtual object from the back of the material. The position of the instrument is measured by using a camera, and the stimulus is calculated according to the position and velocity of the instrument. The developed tactile display is utilized to present the calculated tactile stimulus. Users feel the integrated grip force according to the physical interaction with an instrument and perceive the augmented virtual object.

References

[1] S. Yoshimoto, Y. Kuroda, M. Imura, and O. Oshiro. Development of a spatially transparent electrotactile display and its performance in grip force control. In *Proceeding of 33rd Annual International Conference of the IEEE Engineering in Medicine and Biology Society*, pages 3463–3466, Boston, August/September 2011.

*e-mail: yoshimoto@bpe.es.osaka-u.ac.jp

The 21st International Conference on Artificial Reality and Telexistence
November 28-30, 2011, Osaka, Japan
ISSN: 1345-1278