Enhanced Electrotactile Sensation: Tapping and Sliding*

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I. Introduction

Haptic is the sensation that human senses throughout the finger. To give artificial haptic sensation, we stimulated electrically to finger skin. As like human behavior, a tapping and a sliding mode were reproduced by electrical stimulation. We studied an electrotactile actuating system that provides tactile stimulation and visual information at the same time, as well.

II. Conventional studies of electrotactile display

The electrotactile display generates sensation by stimulating tactile receptors with an electric current. Kajimoto et al. [1] suggested a "Tactile Primary Colors" approach that can activate mechanoreceptors separately and merge these stimuli to make general tactile stimulation. They coin their approach as "Tactile Primary Colors" because the principle of generating sensation is similar to that of making colors. Based on this approach, Sato and Tachi [2] try to represent the distribution of force vector utilizing an electrotactile display.

III. Tapping diagram

For 'tapping diagram' experiment, we stimulated electrically to skin of finger by 4x4 electrode array(gap between electrode: 11mm) with test shapes. We designed the experiment to evaluate differences in shape perception due to visual differences. Table 1 shows the results of tapping diagram experiments. We use several diagrams such as rectangle(12mm), circle(12mm) and triangle(12mm). Except for rectangles, the width of all shapes is 1, which is similar to the size of the electrode array. These results indicate that visual information contributes to recognizing diagram shapes.

TABLE I. Shape perception rate of Tapping Diagram experiments

	Rectangle (oblong)	***Circle***	***Triangle***	***Rectangle***
w/o Diagram	22.22%	44.44%	33.33%	11.11%
w/ Diagram	77.78%	55.56%	44.44%	55.56%

IV. Sliding diagram

To recognize a height of object, human slides a finger on the object. By scanning a selection of stimulation electrodes , we tried to give a similar perception. First approach was the optimization of electrical stimulation wave form for height perception. The wave consisted of three regions, slop1(up), top, and slop2(down). As shown in Fig 1 (a). 'no stimulation' in top region gave a best perception of height without vision information, whereas, the conditions of B&C were better with vision information. The other experiment was the perception of different height depended on driving voltage and frequency. Figure 1 (b) shows that the frequency change of wave (Ex.F) can induce height sensation in more than 89% of people. Results of Exp. A and E are superior to any other experiments without visual information. But Exp. C and F have better results with visual information. Height sensation can enhance when changing pulse interval.

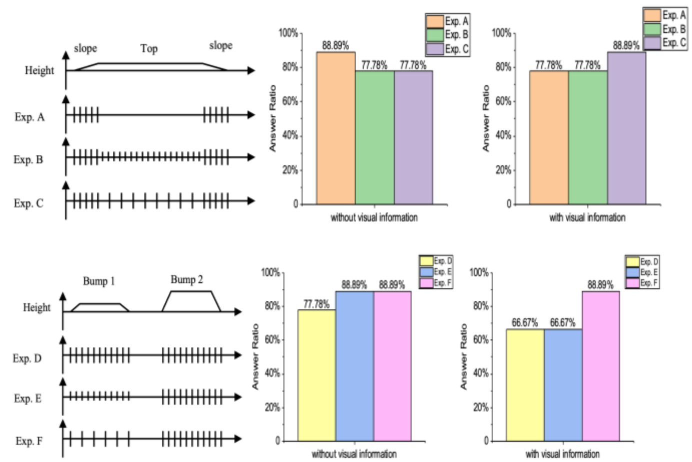

Figure 1 Conditions and Results of Sliding Diagram

V. Conclusion & discussion

We propose a stimulating system using an electrotactile display. The waveform of stimulation and the location of firing cells should be modified more to enhance shape detection when tapping and sliding mode. With the advantage of miniaturization of the electrotactile display, the electrical stimulation system can be applied to various fields requiring tactile perception of a shape and a height reproduction. We will study more how to implement multiple levels of height in the near future.

References

[1] H. Kajimoto, N. Kawakami, T. Maeda, and S. Tachi, "Electro-tactile display with tactile primary color approach," *Graduate School of Information and Technology, The University of Tokyo*, 2004.

[2] K. Sato and S. Tachi, "Design of electrotactile stimulation to represent distribution of force vectors," in *2010 IEEE Haptics Symposium*, 2010: IEEE, pp. 121-128.

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