An Attempt of Displaying Softness Feeling Using Multi-Electrodes-Based Electrostatic Tactile Display

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Abstract. Touchscreen interfaces have become increasingly popular worldwide. However, few commercial touchscreens enable reactive tactile signals. We use lateral-force-based tactile feedback devices that employ electrostatic force. In this research, we attempted to display softness feeling by using multi-electrodes and a pressure sensor. When using our system, we observed that the user can feel change of the display area on the fingertip when his pressure toward the surface is changed.

Keywords: Haptic Display · Electrostatic Force · Multi-Electrodes

1 Introduction

Touchscreen interfaces have become increasingly popular worldwide. At the same time, numerous popular consumer electronics devices use a dedicated touchscreen as an interface. However, few touchscreens enable reactive tactile signals.

Several researchers have employed vibrations to display texture information. In recent years, other lateral-force-based tactile feedback devices that employ static electric fields have been developed (Bau, et al. [1]). However, this display device cannot express softness feelings on the screen. Several researches revealed that the change of contact area on a fingertip induces softness feelings to the user. Thus, we consider the feasibility of the method with the electrostatic force display.

In this paper, we proposed displaying softness feeling with our display and attempted to use the system.

2 Method of Displaying Softness and Prototype

Fujita, et al. and Bicchi, et al investigated whether the finger feels soft by changing the contact area of the fingertip [2, 3]. When a user is pressed on a tactile

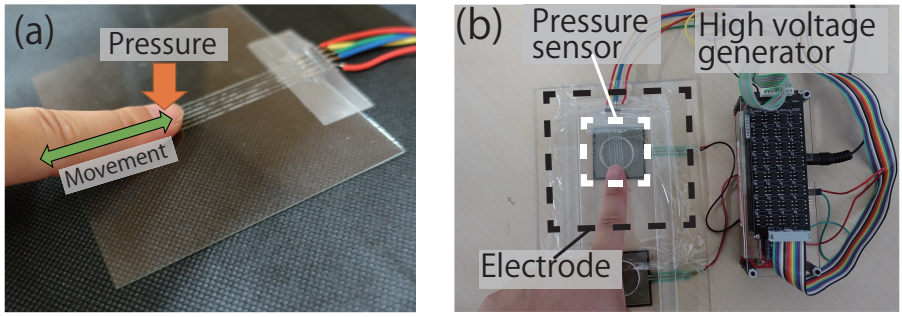

Fig. 1. (a) The user rubbed back and forth on the multi-electrodes, which is generated by dividing one ITO electrode into five lines. (b) Overview of the system. It consists of electrodes, pressure sensor, and high-voltage generator.

display, he/she feels softness in case the contact area is widened, otherwise he/she feels hardness in case the contact area does not change. We assumed that softness expression can be displayed by changing the presentation area to be widened with the electrostatic force display. Therefore, we created multi-electrodes to change the presentation area, and developed an area-controllable electrostatic force display (Fig. 1).

Our device is composed of a personal computer, a control circuit for high voltage, a pressure sensor, multi-electrodes and an insulator. The control circuit device includes a microcontroller, called mbed, which can control maximum 600 V of output voltage, its waveform and maximum 16 channels of multiple switching outputs by changing the program. The programmed waves are outputted to the electrode surface for displaying electrostatic tactile feedback. An insulator is placed on the electrode. Multi-electrodes are created by dividing one ITO electrode into five lines. The pressure sensor is installed under the multi-electrodes to measure the user's pressing force.

We conducted a preliminary experiment to evaluate whether softness feeling can be displayed to the user by our proposed method. Through the experiment, we asked participants whether the change of the tactile sensation is felt, and whether the softness sensation is felt on the tactile display. We collected the following answer from several participants, "I felt the change of the tactile sensation, however, I hardly felt the softness ever". Thus, we considered that our proposed method can make user feel some kind of changes of the display area on the fingertip skin surface, however, it cannot make the user perceive the softness sensation. We plan to perform other displaying methods by using different layout of multi-electrodes to generate softness sensation.

3 Conclusion

In this paper, we attempted to display softness feeling using electrostatic force display. We focused on the fact that changing the contact area on the fingertip induce softness feeling to the user. The changing presentation area is implemented by using multi-electrodes. We developed a prototype system and held a preliminary experiment. The results showed that the users can feel change of the display area but it is difficult for them to perceive the tactile sensation as softness feeling with the proposed method. We plan to perform other displaying methods by using different layout of multi-electrodes.

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