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Demonstration of Displaying Sense of Adhesion by Electrotactile Display

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***Abstract*— When a person pulls their finger away from an adhesive surface, they experience a sense of adhesion—an important component of tactile sensation. However, most existing methods for presenting this sensation require external environmental devices. We propose a method that combines force sensation via a finger cap fixed to a stand, and cutaneous sensation via an electrotactile display. The electrotactile display can be wearable and allows flexible control of stimulation timing and location. In this demonstration, the sense of adhesion is reproduced using electrical stimulation based on changes in tensile force and contact area observed on an actual adhesive surface.**

Keywords*— *sense of adhesion, area, electrotactile display, timing, wearable

I. Introduction

Presenting tactile sensations in virtual reality environments is believed to enhance immersion, and various methods have been proposed. One such sensation is a "sense of adhesion," defined here as the feeling of skin being pulled when a finger touches and is lifted from an adhesive surface. This sensation can be divided into a force sensation and a cutaneous sensation. To present the force sensation, resistance must be provided to prevent a finger from detaching from the surface. To present the cutaneous sensation, the characteristic hysteresis of contact area changes when the finger is pulled away from the adhesive surface are utilized. However, conventional methods often require large-scale equipment [1][2]. From the perspectives of portability and cost, a more wearable solution is desirable.

We propose a method that combines force sensation achieved by fixing a finger cap to a stand, with cutaneous sensation via an electrotactile display. Electrotactile display is easily miniaturized and suited for wearable applications. Furthermore, it can achieve relatively high spatial resolution, and represent tensile forces and gradual changes in contact area when a finger is lifted, as observed in a previous study [1]. In this demonstration, we present the sense of adhesion using this proposed method.

II. Device

The device used in this demonstration is shown in Fig. 1. It consists of a finger cap made of ABS resin, fabricated with a 3D printer (Stratasys F120), and flexible circuit board electrodes placed inside for electrical stimulation. A six-axis force sensor (Touchence, S18C1-WM155-K1-P4I) is mounted directly beneath the cap. The cap is attached to the sensor, which is fixed to the stand with double-sided tape. When the user applies a pushing or pulling force, it is detected by the sensor, and an electrical stimulation is delivered in response.

The flexible circuit board has 128 electrodes, was designed based on research by Sobue et al[3]. Since the electrodes were placed from the joint to the fingertip, stimulation can be applied to the entire fingertip via the inner surface of the cap.

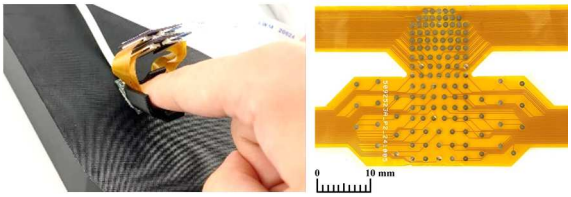

Fig.1. (Left) Device used in this demonstration, (Right) Electrode

III. Demo Experience

In this demonstration, using the device described in Section II, the sense of adhesion is presented through electrical stimulation that replicates both the onset of tensile force and the gradual change in contact area observed on an actual adhesive surface in a previous study[1]. Additionally, electrical stimulation with varying timing is presented as comparative conditions.

References

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