# SmartTouch: A new skin layer to touch the non-touchable

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## 1 Introduction

Our group has been working on the field of haptic AR system [Nojima et al. 2002; Ando et al. 2002], and SmartTouch is a natural extension of these developments. The SmartTouch is composed of a thin electro-tactile display and a sensor mounted on the skin. The sensed information is converted to tactile sensation through electrical stimulation. Thus, the wearer not only can make physical contact with the object, but also "touch" surface information of any modality, even those that are ordinarily non-touchable. The prototype of SmartTouch is composed of two layers. The top layer has a 4 by 4 array of stimulating electrodes on the front side of a thin plate, while the bottom layer has optical sensors on the reverse side of the plate. Visual images captured by the sensor are translated into tactile information, and displayed through electrical stimulation. We endeavored to realize the perception of luminance information as the unevenness of the object surface, by imitating the sensory nerve activity with electrical pulses. For example, the black and white stripes are perceived as bumps of the same interval.

## 2 Electro-Tactile Display

We have been developing a tactile display to present realistic skin sensation for Virtual Reality. The idea is to selectively stimulate each kind of receptor in the skin. By combining these stimuli, we can reconstruct complex tactile sensations. We call them "tactile primary colors," analogous to the three primary colors for vision.
Our approach uses electrical stimulation through the skin, or electro-tactile display. Electrical current from surface electrodes generates an electric field inside the skin, which induces nerve activity. We have shown that selective stimulation is possible through electro-tactile display [Kajimoto et al. 1999]. The basic idea is to utilize the different placement of sensory nerves, and to control the electric field by changing the current source distribution of the skin surface. We have succeeded in producing vibratory and pressure sensations.

## Future Work

Our goal is for the SmartTouch to serve as a new "functional layer of the skin". Although this year's demonstration mainly focuses on visual-to-tactile translation, the use of SmartTouch is not limited to Braille for the visually impaired. By changing the sensor, other modalities of sensation can be translated to touch as well. We are now considering combining a tactile sensor matrix with an electro-tactile display, to perform tactile-to-tactile conversion. If the tactile sensor is more sensitive than human perception, we can enhance the natural tactile experience.
Although it is not commonly known, human tactile sensitivity dramatically decreases with age. Hence, many of us need tactile aid, just like hearing aid when we get old. Our ultimate goal is to make the system negligibly thin, so that it can be worn as an unconscious but essential daily interface, just like eyeglasses.

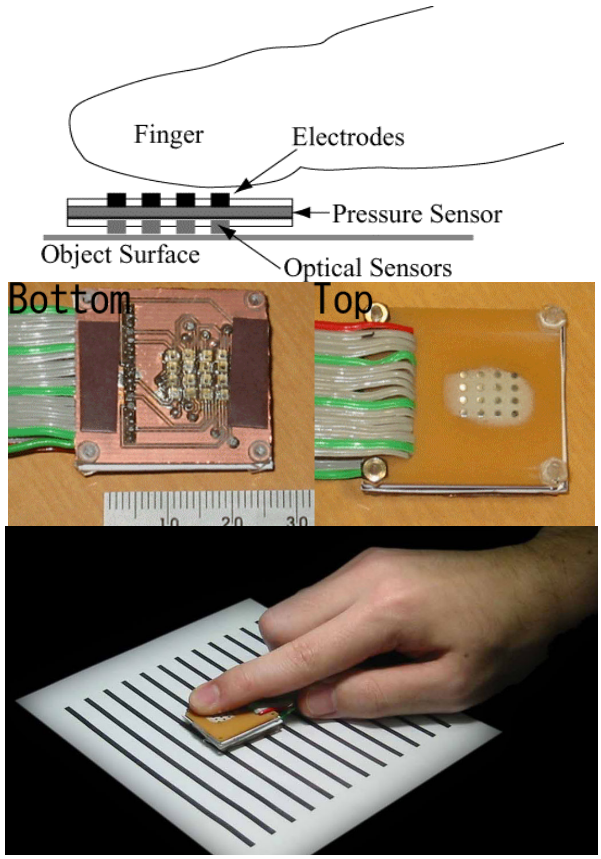


**Figure 1: Prototype SmartTouch [Kajimoto et al. 2003]. Electrodes and optical sensors are arranged 2.5[mm] by 2.0[mm] interval, 4 by 4 matrix. Visual image is captured by the sensors and displayed through electrical stimulation.**

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