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Notice: This poster is assiciated with a Hand-on Demo

FantaScan
- an Electric Alternative for Optacon

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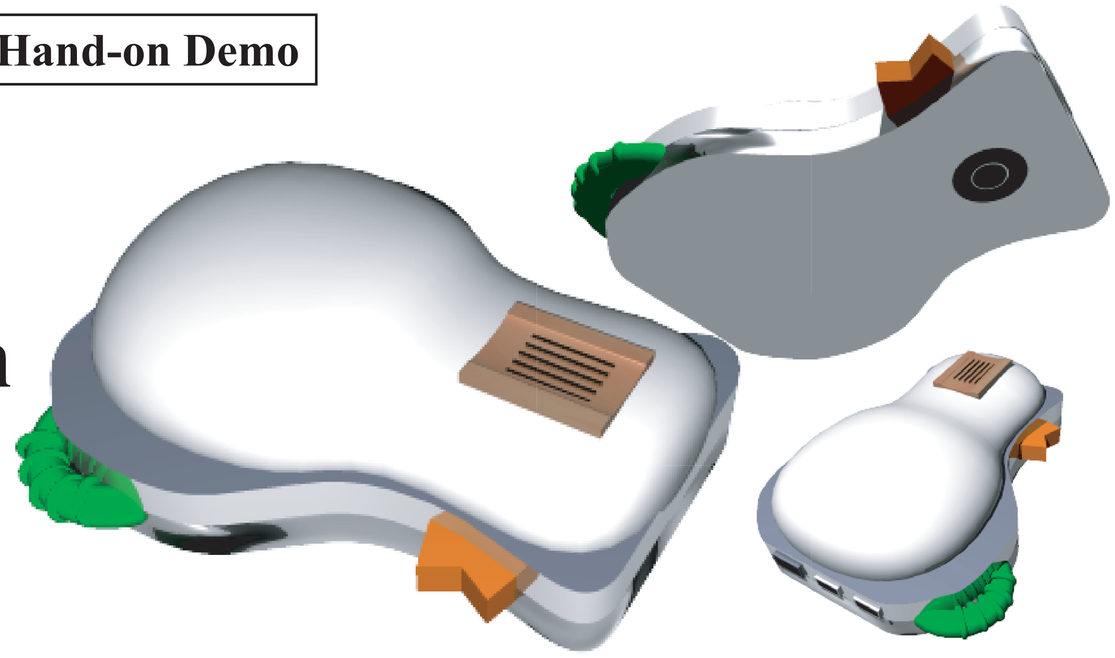

Backgroud

We have previously proposed a visual-tactile conversion system called SmartTouch[2], which is a thin plate composed of a 4 by 4 matrix of optical sensors on one side and the same number of electrodes as electro-tactile display on the other. The purpose of the system was to function as a new layer of skin that can convert visual information to tactile sensation, so it was essential for the plate to be made as thin as possible.

We developed a commercial version of the system, named FantaScan. We design it to be an alternative for the renowned Optacon[1], which was the first visual to tactile converter since the 1960s. Our main purpose is to refine the system with modern electronics so that the system becomes smaller and cheaper. Electrical stimulation was readopted with a new electric stimulation algorithm and an optimized electrode placement.

System Design

FantaScan is composed of two main components: an electro-tactile display and a camera.

The electro-tactile display is designed to cover from the top joint of the index finger to the tip. The electrode diameter is 1.0[mm], which is the minimum diameter to assure a wide enough contact area for electrical stimulation. There are 16 and 4 electrodes in the longitudinal and transversal directions, with an interval of 1.25[mm] and 2.5[mm], respectively (Fig.2(c)) As the user is assumed to move the device, transversal sparseness is complemented by the motion, which is the same strategy taken in the Optacon.

The camera is designed to cover magnification factors from one to 16. For all magnification scales, the displayed subimage size must be the same or larger than the display. For instance, when the magnification factor is 16, the 1/16 partial image must have at least 16 pixels (number of electrodes) longitudinally. To achieve this change of magnification with software, the camera must have at least 256 (=16x16) pixels longitudinally.

The other main consideation is the frame rate. Ideally, the camera should refresh at more than 200[Hz] to achieve 5[ms] temporal resolution, which is the resolution of human tactile sensation, but in practice 50[Hz] is enough. We used a CMOS imager with 352x288 pixels and 50[fps] (OV6130, Omni Vision)

In the Optacon, the user holds the camera with one hand and the tactile sensation is displayed to the other hand. On the contrary, FantaScan mounts the display on the camera and the user can handle the device with one hand.

The FantaScan has an optional USB2.0 interface. Using the interface, it can be used to explore the environment surrounding a PC desktop.

Stimulation Algorithm

In electrical stimulation, anodic current is used to achieve higher resolution than cathodic current[2]. The basic stimulation method is shown in Fig 3(Left). The stimulation point is set as an anodic current source, and all surrounding electrodes are grounded. This switching is achieved by an electrical switch called a half-bridge circuit, which is often used in motor drivers. Only one electrode serves as a stimulation point at a time, and time based scanning is used to present surface information, similar to television.

However, as the electrode density is quite high in this system, when we use single electrode as anode, the electrical current only goes through the shallow region of the skin, and the nerves do not get stimulated. We used neighboring electrodes simultaneously to enlarge the anodic electrode. Upper and middle electrodes work as an anode for 0.2[ms], and lower and middle electrodes work as an anode in the consecutive 0.2[ms] (Fig.3(Right)). We call this scheme "High-speed local switching". We confirmed that the sensation became stable, while the spatial resolution of the sensation was not deteriorated.

Spatial and temporal edge enhancement are key to clear sensation. In addition to ordinary stimulation at the location where image intensity is below the threshold, we stimulated using the Laplacian of the image (spatial edge) and the absolute difference with a previously captured image (temporal edge).

References

[1] Stein, "The Optacon: Past, Present, and Future," http://www.nfb.org/bm/bm98/bm980506.htm.
[2] Kajimoto et. al., "SmartTouch: Augmentation of skin sensation with electrocutaneous display," Haptic Symposium 2003, pp.40-46, Mar 2003.

Acknowledgement

This is a collaborative work with EyePlusPlus Inc.

Table 1 Specification and comparison with Optacon

	Optacon[1]	FantaScan
Stimulation	Mechanical	Electrical
Pin interval	1.27x2.54[mm]	1.25x2.5[mm]
Pin number	100(20x5)	64(16x4)
Camera frame rate		50[fps]
Magnification	1 to 8	1 to 16
Circuit size		70x90x25[mm]
PC interface		USB2.0

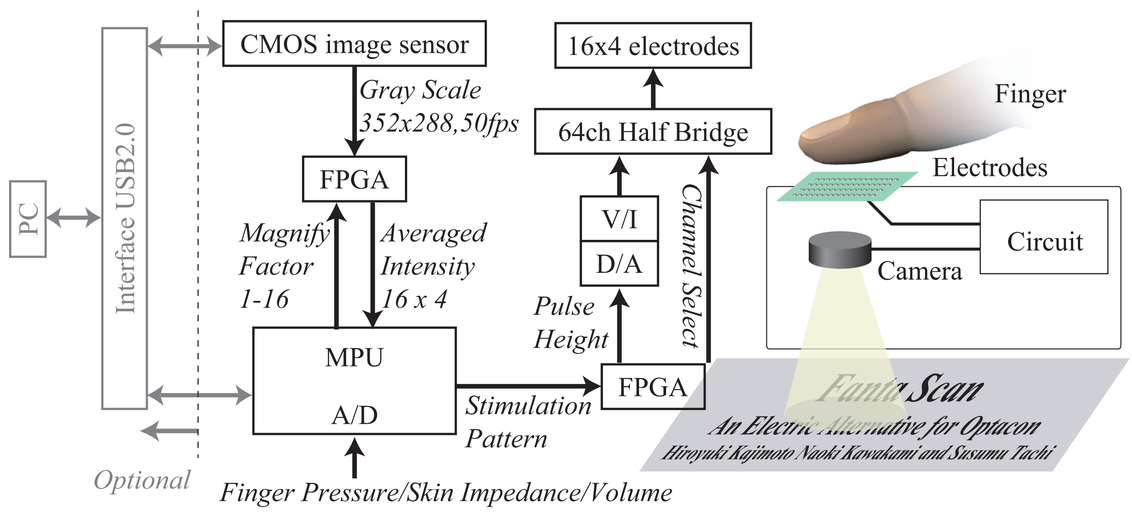

Fig.1 System Architecture

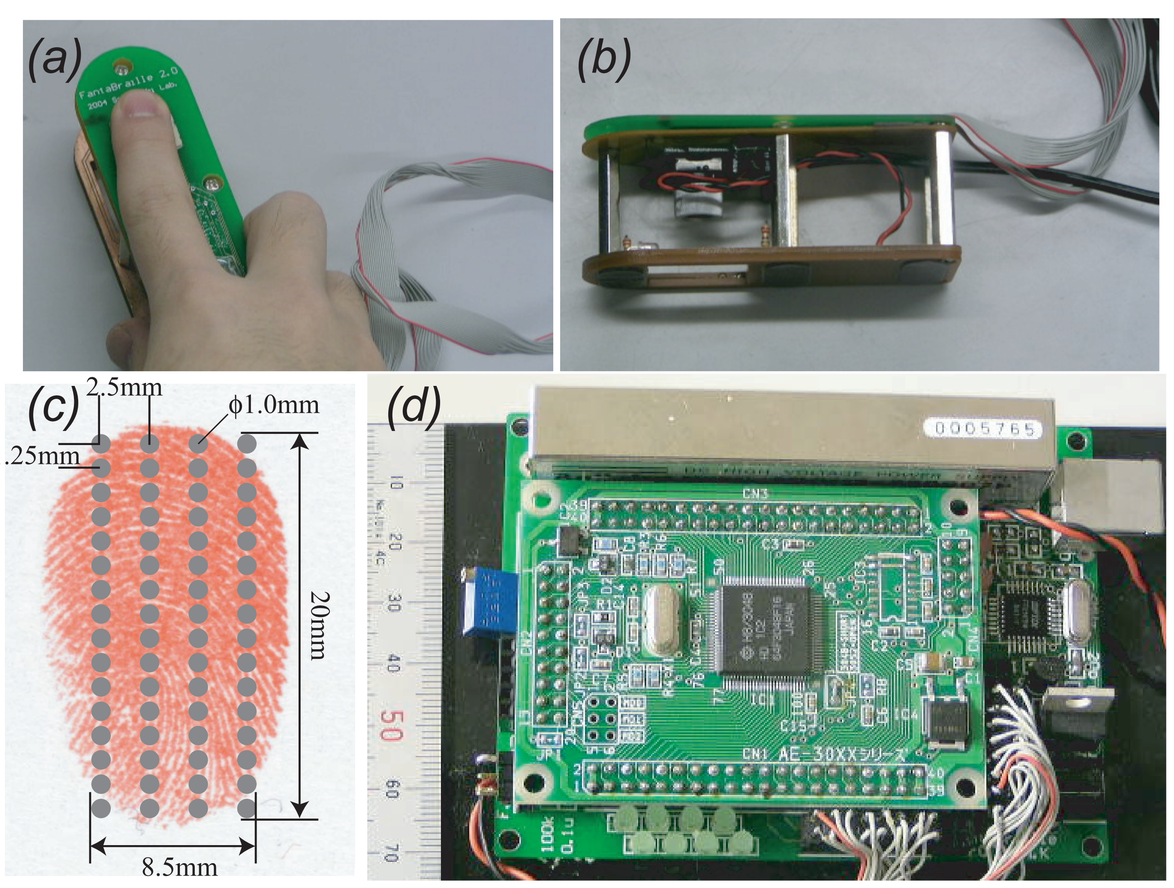

Fig.2Preliminary system. (a)Usage (b)Side view (c)64 electrodes (d)Circuit

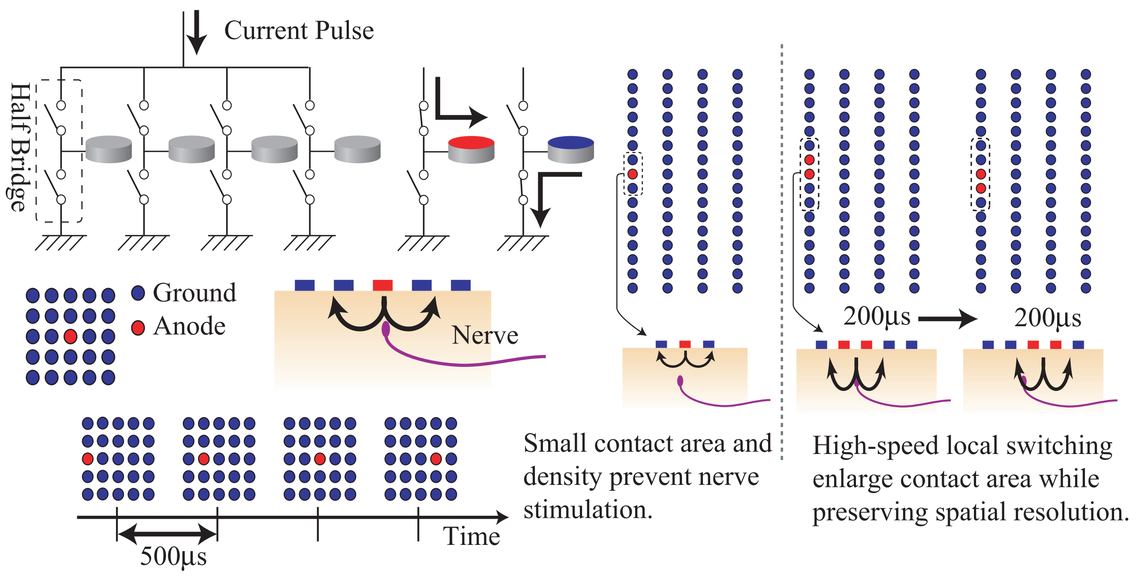

Fig.3 (Left)Half Bridge and Basic Scanning (Right)High-speed local switching