

Tactile Sensation with High Density Pin Matrix

Hands-on Demo Available

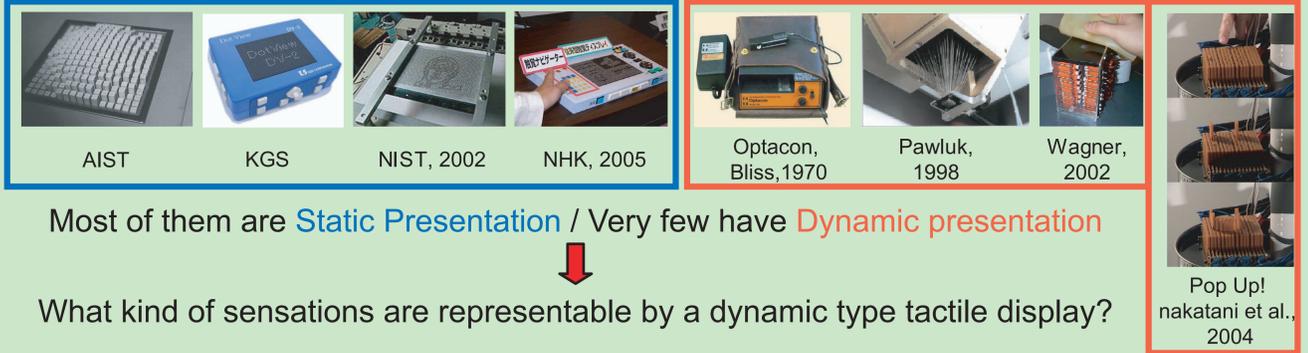
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Motivation and Background

There is a variety of existing been a lot of pin-matrix type tactile displays



Most of them are **Static Presentation** / Very few have **Dynamic presentation**

What kind of sensations are representable by a dynamic type tactile display?

How small of a pin interval is sufficient for conveying tactile information?

Investigate the tactile sensation produced with an (Ultra) HIGH resolution & FAST response pin matrix tactile display

Our solution

We developed a pin matrix with a dense pin arrangement, which is driven mechanically by moving in over the presented texture.

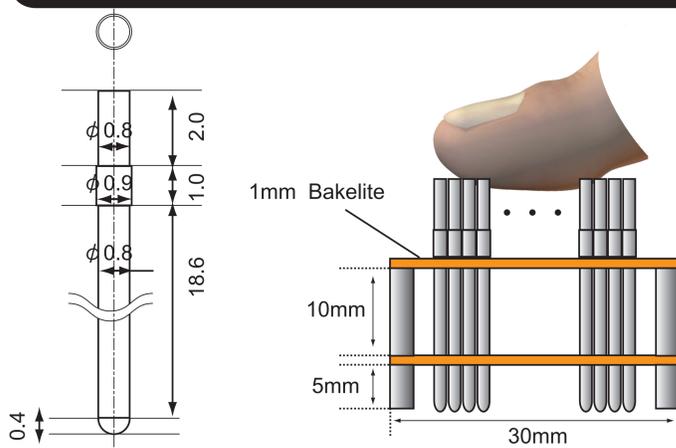
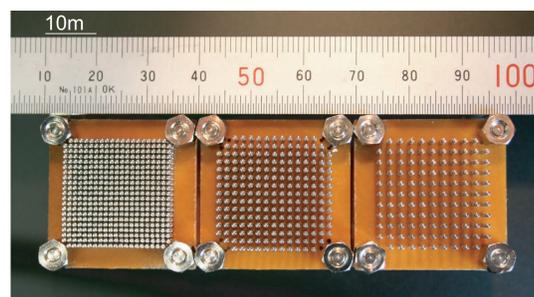


Fig. 1 Dimensions of the pin-rod

Fig. 2 Profile of the Pin Matrix



PM 1 P. I. = 1.0 mm
PM 2 P. I. = 1.5 mm
PM 3 P. I. = 2.0 mm
(P. I. : Pin Interval)

Fig. 3 Three types of the Pin Matrix using in the experiment

- Pin motion is strictly vertical
- Pins sample the height information from the texture and present tactile information without any delay
- an ideal measuring & displaying system

Experiment 1

Can human recognize the shape with using a pin matrix?

- Stimuli in psychophysical experiment

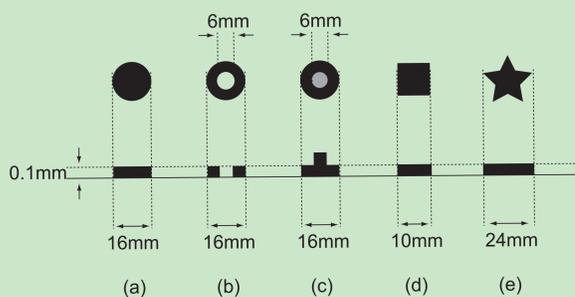


Fig. 4 Shapes using through the experiment

- Thin seals (0.11mm) shaped as (a)-(e) are pasted on to a smooth acrylic board.
- The subjects scanned assigned pin matrix (PM 1, 2, 3) over a prescribed texture.

Result

The smaller pin-interval is, the higher the recognition rates subjects had

	Blank	(a)	(b)	(c)	(d)	(e)
Bare Finger	100%	100%	100%	100%	100%	100%
PM1 (1.0mm)	100%	83%	33%	67%	100%	83%
PM2 (1.5mm)	83%	83%	17%	50%	33%	83%
PM3 (2.0mm)	100%	33%	33%	0%	17%	50%

- Most subjects observed **exaggerated edges** of the shape (spatial derivative effect?)
- Some subjects misunderstood the convex shape and concave shape.

Experiment 2

Is edge-perception enhanced by the jumping of the pin-rod?

- Developed driving system

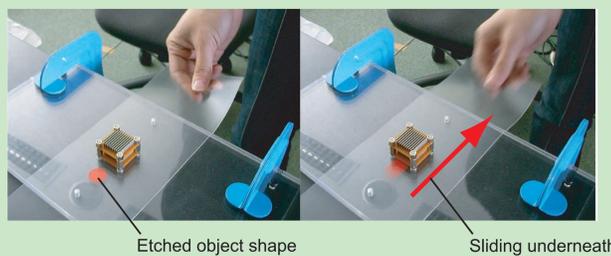
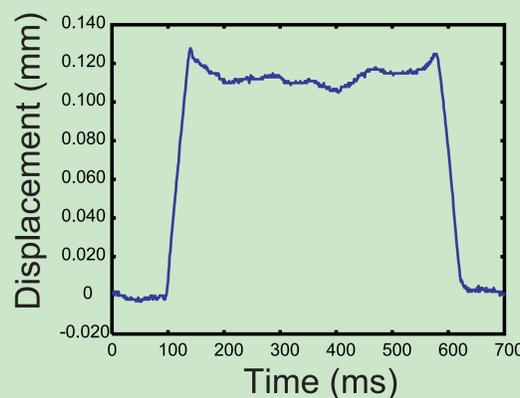


Fig. 5 Driving a pin-matrix by moving a texture

- Fix the Pin Matrix and driving each pin-rod
- Measured pin-rods movement with a laser displacement sensor

Result



- Height difference is only $\sim 10 \mu\text{m}$
- Vertical velocity may be predominant for pin matrix tactile display

Experiment 3

How important is the pin-interval?

- Comparison with pin-rods with a small tip

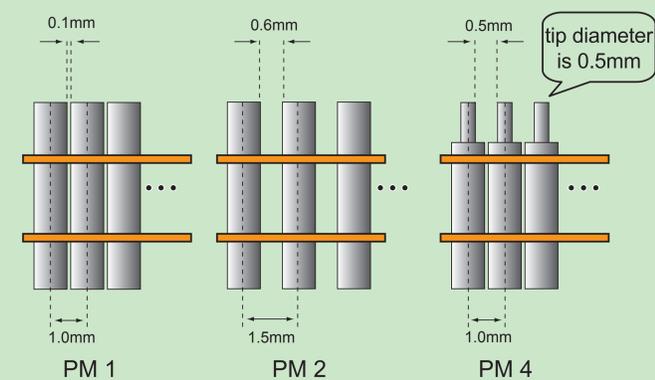


Fig. 7 Additional experiment for evaluating the space between the pin-rods

Result

- Almost all subjects misunderstood PM1 and PM4, but not PM1 and PM2.
- The spatial sampling frequency (pin interval) is more important than the spacing between contact areas.

Discussion & Future vision

Engineering Applications

- * Optimal design of a pin matrix type tactile display for interacting with computer graphics

Scientific Research

- * Investigate the relative importance of vertical displacement for tactile sensation
- * Research on Active touch vs. Passive touch