Development of tactile display to investigate the perception threshold for high frequency vibration

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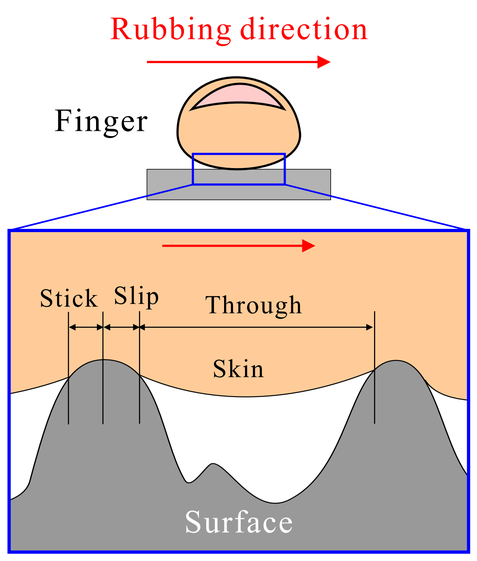
Motivation

When we rub solid surface with our finger, vibrations are generated on the finger skin. The vibrations are perceived as tactile sensation. Several devices producing the tactile sensation have been developed. Peak of human vibration sensitivity is around 250 Hz [1]. Therefore, many haptic devices have focused on lower frequency vibration. As a result, higher frequency vibration perception, more than 1 kHz, hasn't been focused. In this research, we considered higher frequency vibration for reproducing the tactile sensation, because such frequency vibration may contribute reality of the displayed sensation.

[1] G. A. Gescheider, S. J. Bolanowski, and K. R. Hadrick "The frequency selectivity of information-processing channels in the tactile sensory system", Somatosensory & Motor Research, Vol. 18, No. 3, pp.191-201, 2001.

Tactile sensation



Stick : Stationary state

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Slip : Collision state

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Through : Non-contact state

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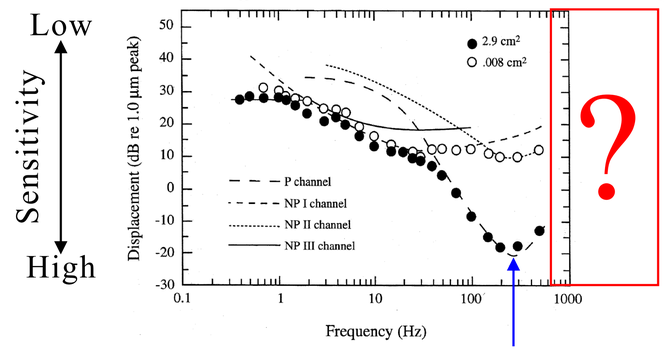
Vibrations are generated on the finger skin.

The vibration are perceived as tactile sensation.

Perception threshold

Gescheider et al investigated the vibration perseption threshould.



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Peak of human vibration sensitivity is about 250 Hz.

Many haptic devices have focused on lower frequency vibration.

Higher frequency vibration perception hasn't been investigated.

Tactile display to investigate higher friquency vibration perception

Design guidelines
- Investigating higher frequency vibration perseption threshould.
- Observing whether finger surface follows the vibration of the actuator.

- Leaf springs & Strain gauges

  Measuring touching force

- Microscope

  Observing the state of a finger skin

- Vibrating part

  A sinusoidal voltage is applied to the piezo-stack actuators

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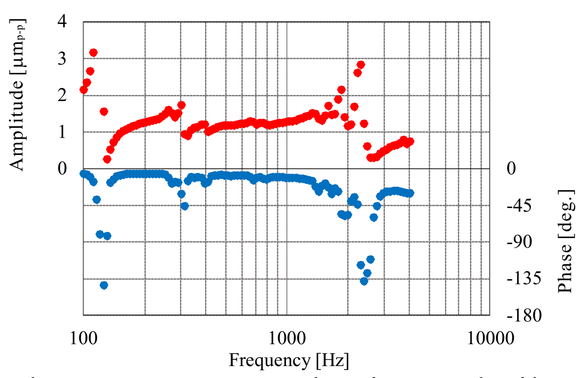
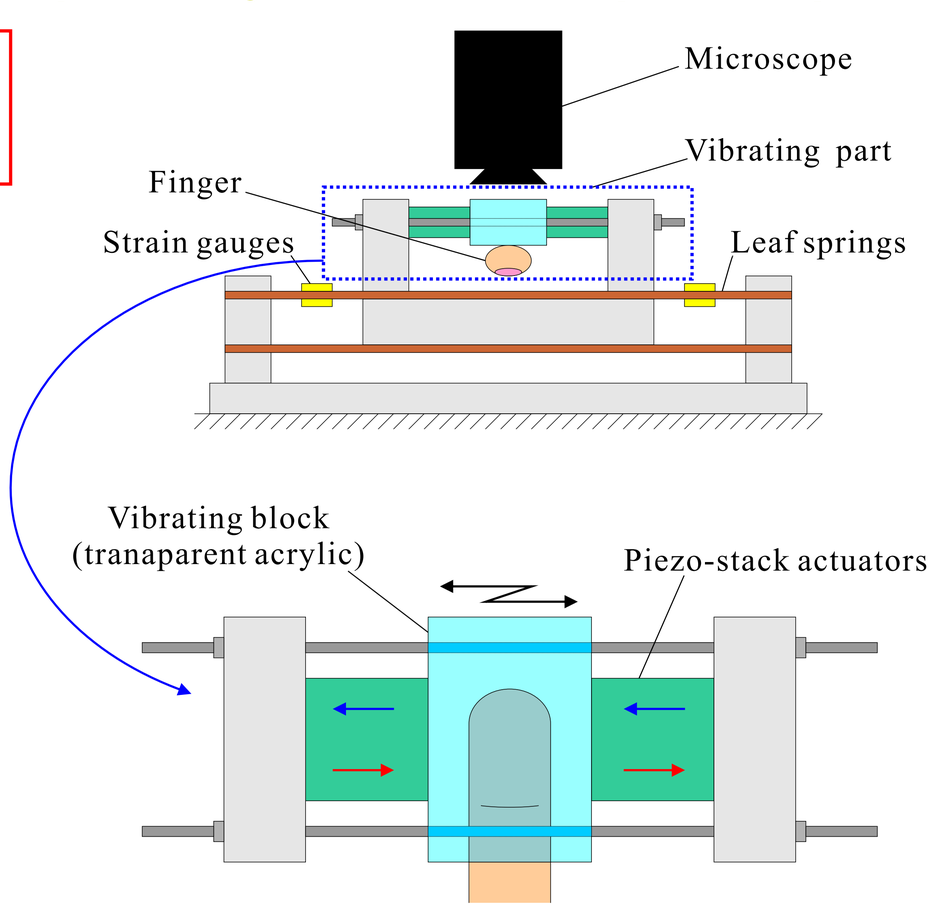
  The vibrating block is ocillated in horizontal direction

- Frequency characteristics of the display



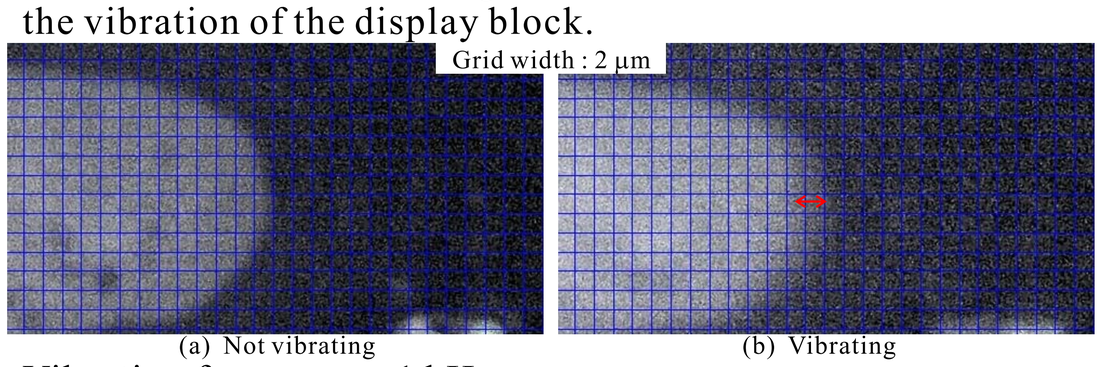
The display can generate horizontal vibration more than 1 kHz.



Top of view

Observing finger skin

It was confirmed by the microscope that the vibration of the finger skin followed the vibration of the display block.

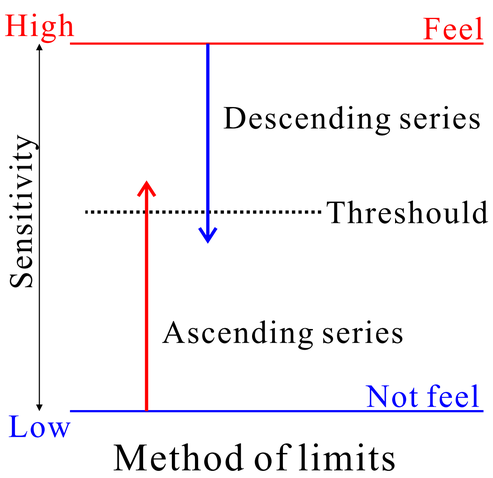


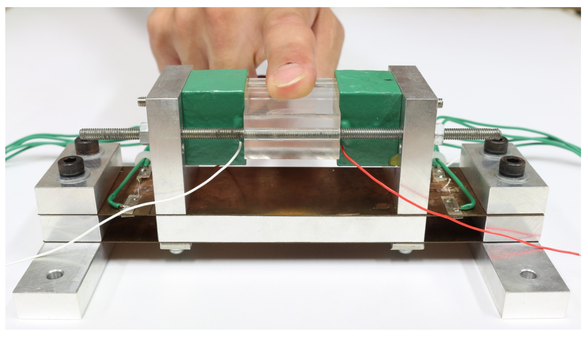
(a) Not vibrating (b) Vibrating

Vibration frequency : 1 kHz

Mersurement result of vibrating block amplitude by Laser Doppler vibrometer : 4 $\mu m_{p\text{-}p}$

Future plan





Method of limits

The investigation of vibration perception discrimination by method of limits by the display will be carried out.

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