

# Quantitative Evaluation of an Illusion of Fingertip Motion

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## Abstract

### [Purpose]

Intuitive and small input interface

### [Proposal]

We propose the force input interface that **uses an illusory feeling** we found.

#### Pointing Stick



#### Touch pad



Illusory motion

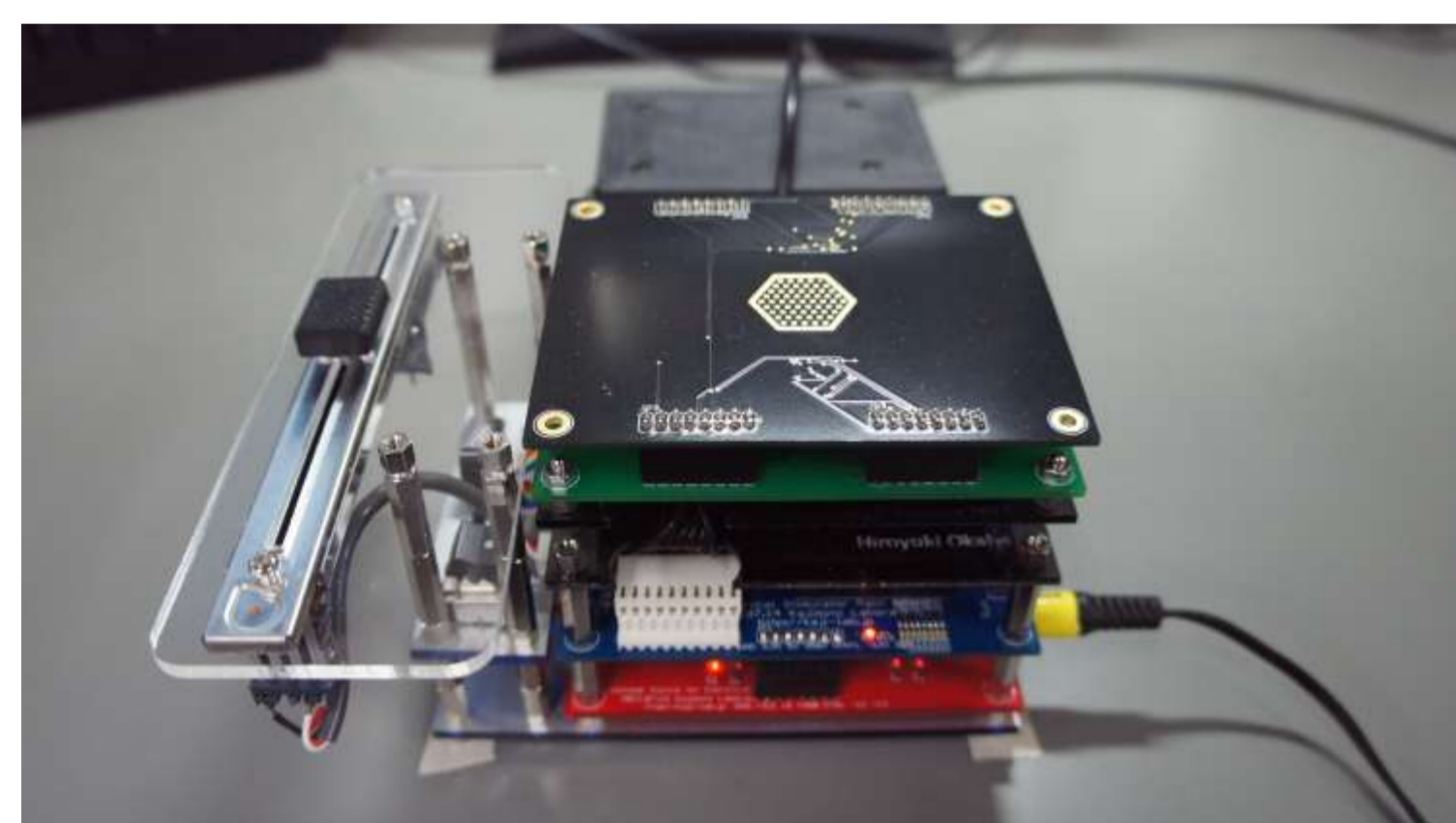


## Illusion

A subjective feeling of finger motion while the finger does **not actually move**

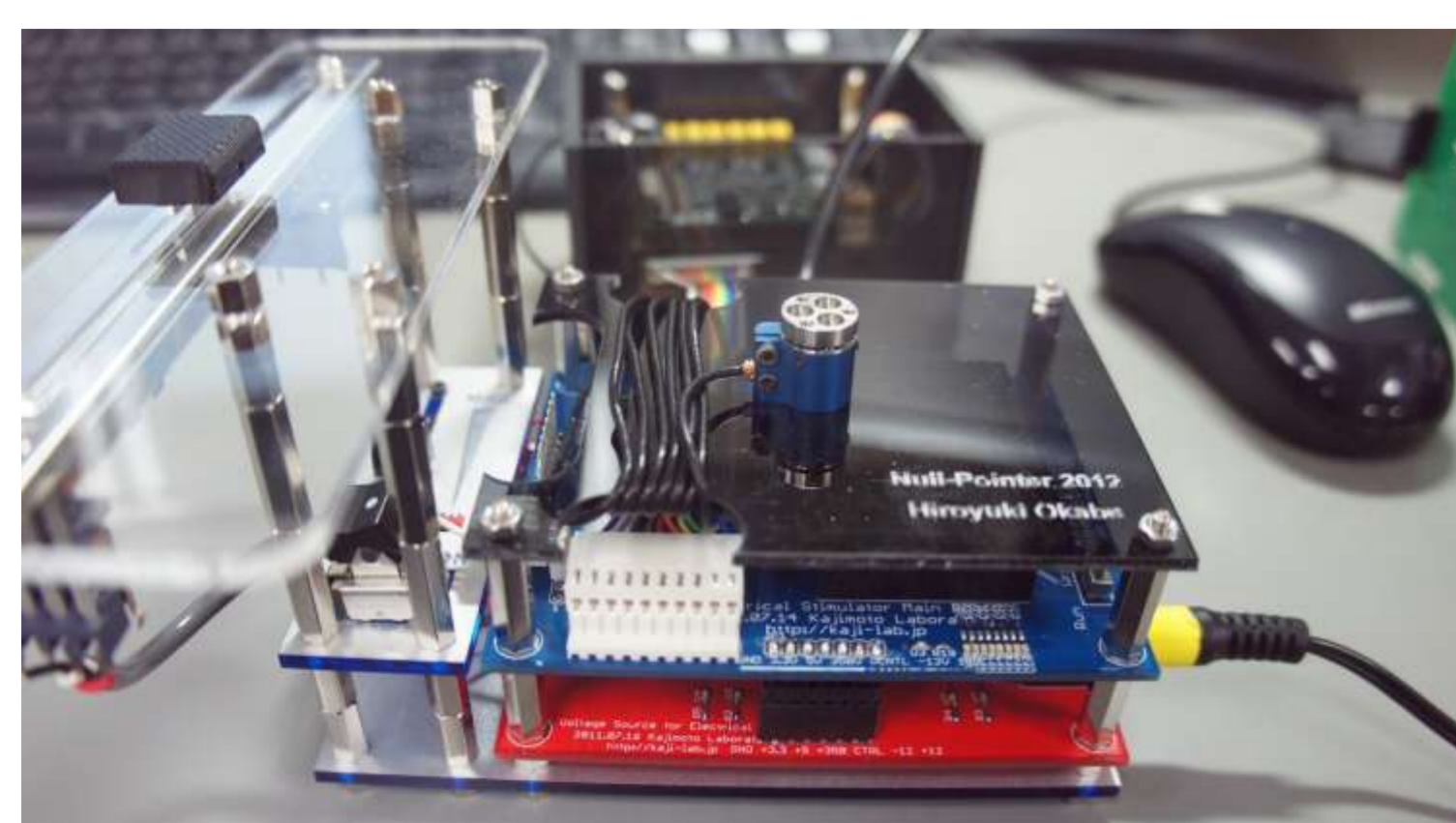
### Hardware

- Electrocutaneous display [8]
  - Present cutaneous sensation on a finger
  - 61 electrodes arranged hexagonally
  - The distance between each electrodes is 2.0mm
  - The electrode diameter is 1.0mm



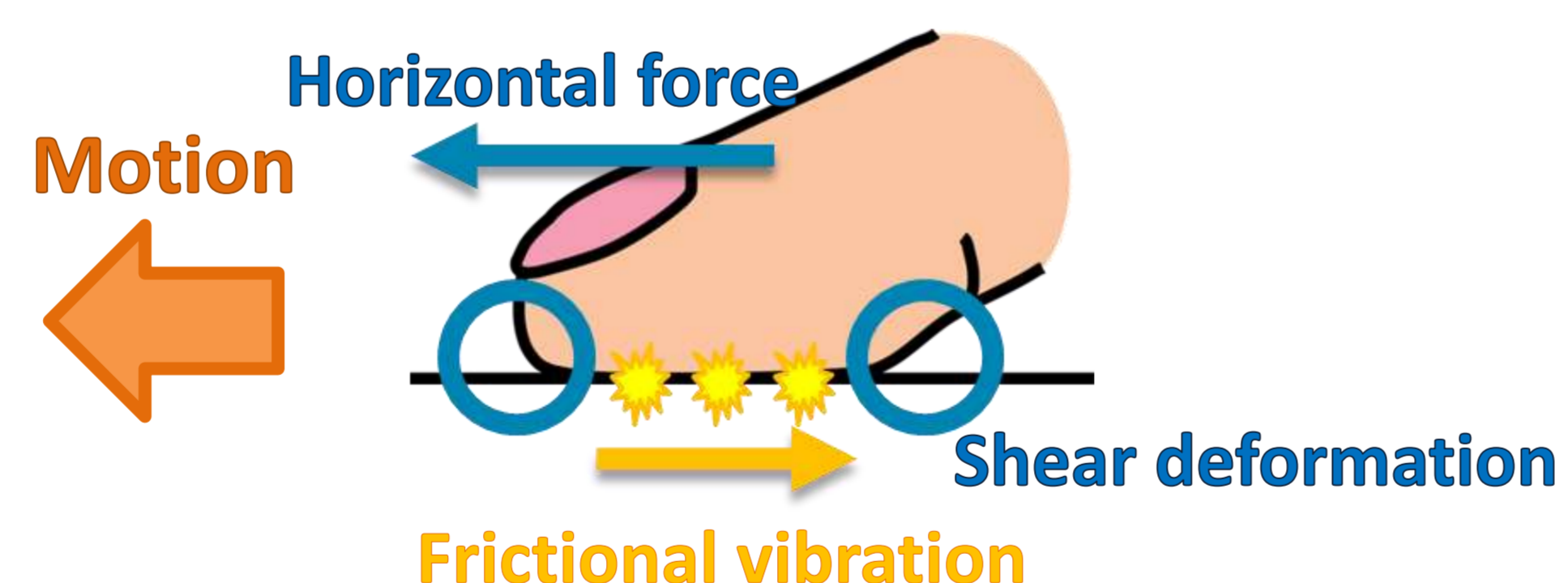
### Force sensor

- 6 axis force sensor (NITTA Corp., TFS12-10)
- Measure shear and vertical force applied to the display



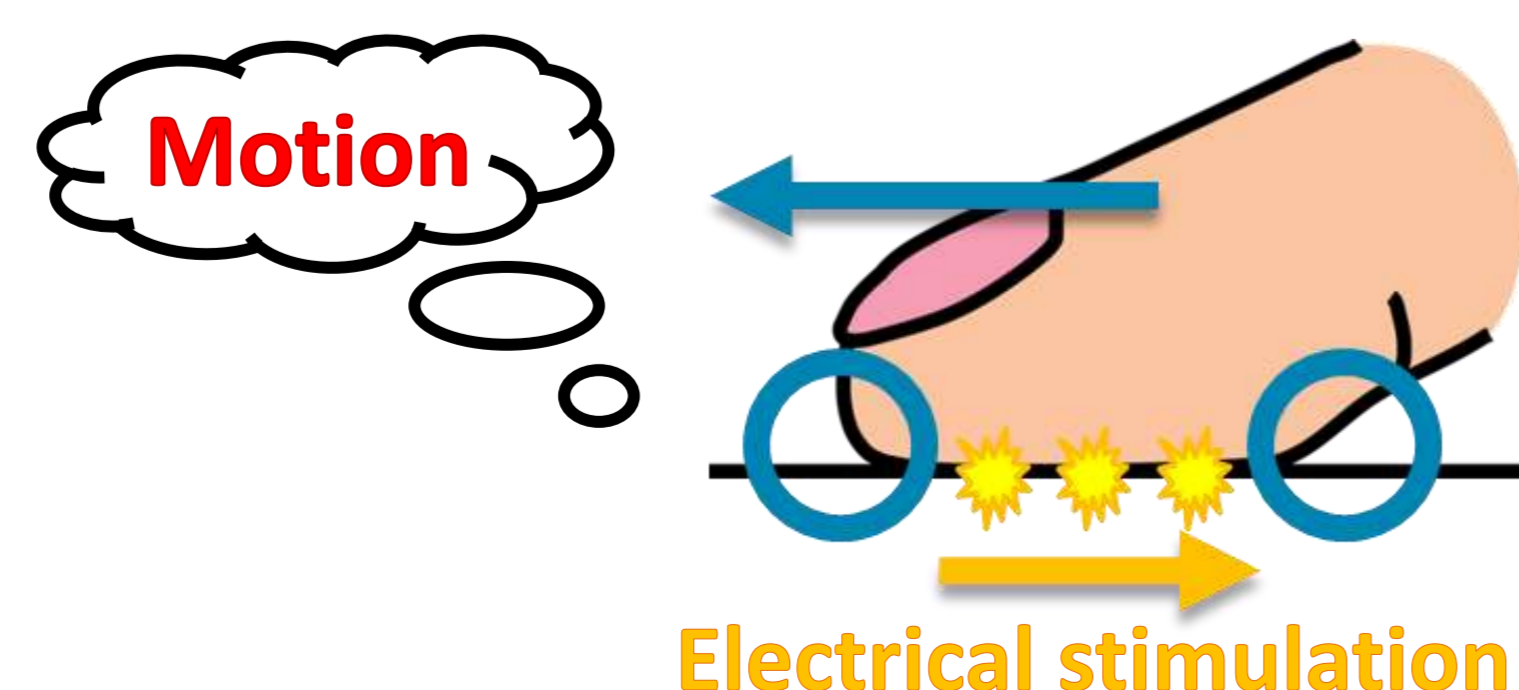
### Mechanism

- Real
  - Cutaneous sensation (Frictional vibration, Motion of a pattern)
  - Proprioceptive sensation (Joint angle, Shear deformation)



### Illusion

- Cutaneous sensation (**Motion of a pattern by Electrical stimulation**)
- Proprioceptive sensation (Joint angle, Shear deformation)



## Experiment

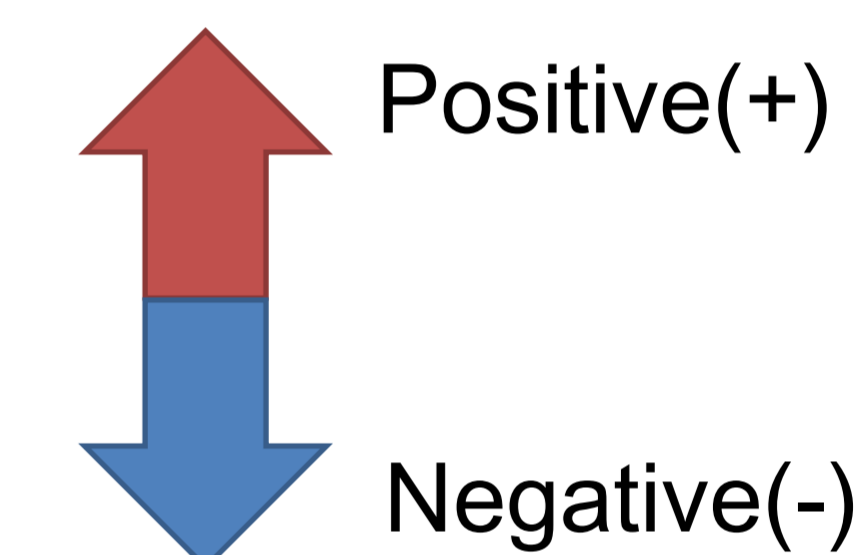
[Evaluation] Directional characteristic focusing on the illusory position of the finger perceived

### Experimental conditions

- 5 participants (2 males including experimenter and 3 females, 21-25 years)
- Electrical stimulation
  - 0.0-5.0 mA (adjusted by each participant)
  - Pulse width of 0.05 ms
  - Pulse frequency of 50 Hz
- Presented electrical stimulation
  - 2 line pattern velocities (10.0, 20.0 mm/sec)
  - 2 directions (positive(+), negative(-))
  - No electrical stimulation
  - Random (1dot, 20ms)
- Applied Shear force condition
  - 2 amplitudes (Low(0.0-1.0N), High(1.0-2.0N))
  - 2 directions (positive(+), negative(-))

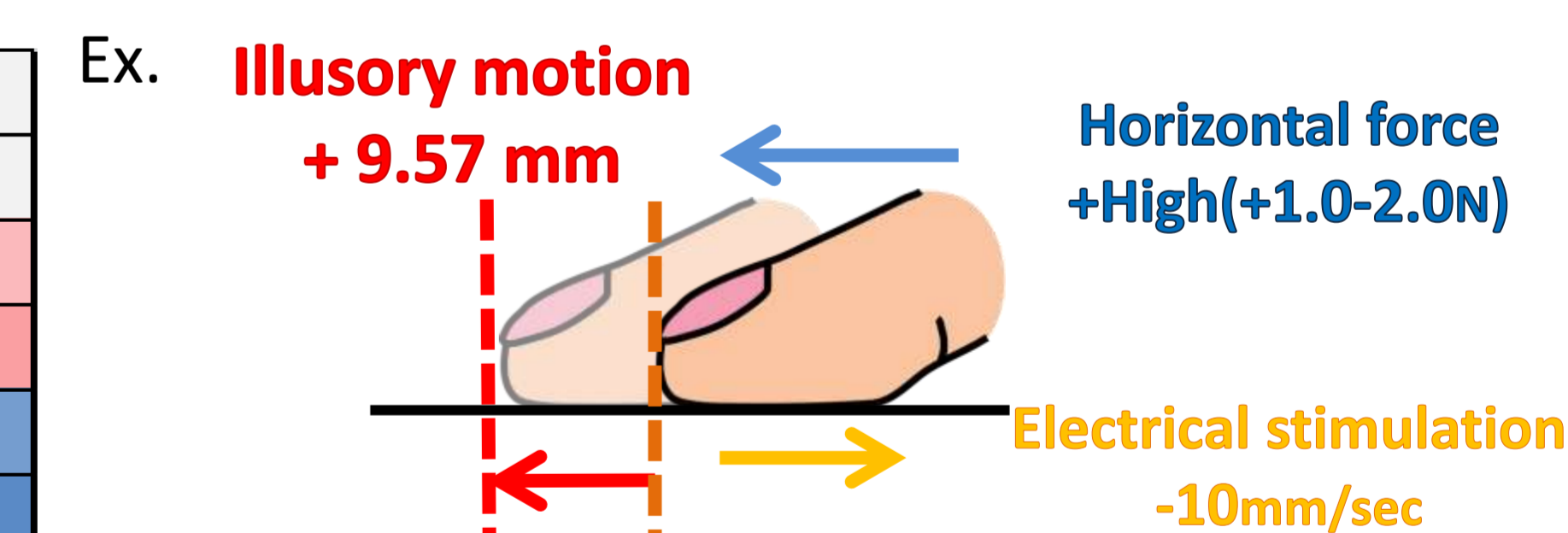
### Experimental procedure

- Participants keep shear force
- Experimenter began presenting electrical stimulations to right index finger
- When participants perceived a finger motion, they were asked to slide a potentiometer with their left index finger
- The position of slider was recorded 10s



## Results and Conclusions

| Total moving distance [mm]       |       | Velocity of the electrical stimulation [mm/sec] |        |       |       |       |        |
|----------------------------------|-------|---|--------|-------|-------|-------|--------|
|                                  |       | No  | Random | -20   | -10   | +10   | +20    |
| Direction and amplitude of shear | +High | 1.81  | 2.26   | 8.31  | 9.57  | 1.31  | 3.87   |
|                                  | +Low  | -0.24   | 0.79   | 8.04  | 6.54  | 2.53  | 5.71   |
|                                  | -Low  | -1.67   | -2.11  | -4.31 | -5.39 | -8.47 | -8.74  |
|                                  | -High | -2.08   | -2.97  | -6.24 | -7.38 | -8.63 | -10.36 |



- The direction of the illusory movement always coincides with **the direction of the applied shear force**
  - The correlation agrees with previous observations that proprioceptive sensation predominates over cutaneous sensation in the feeling of self-motion [4],[5],[6]
- Conditions under which electrical stimulation is presented in **the direction opposite to the force** of the finger has the most strong illusion

## References

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