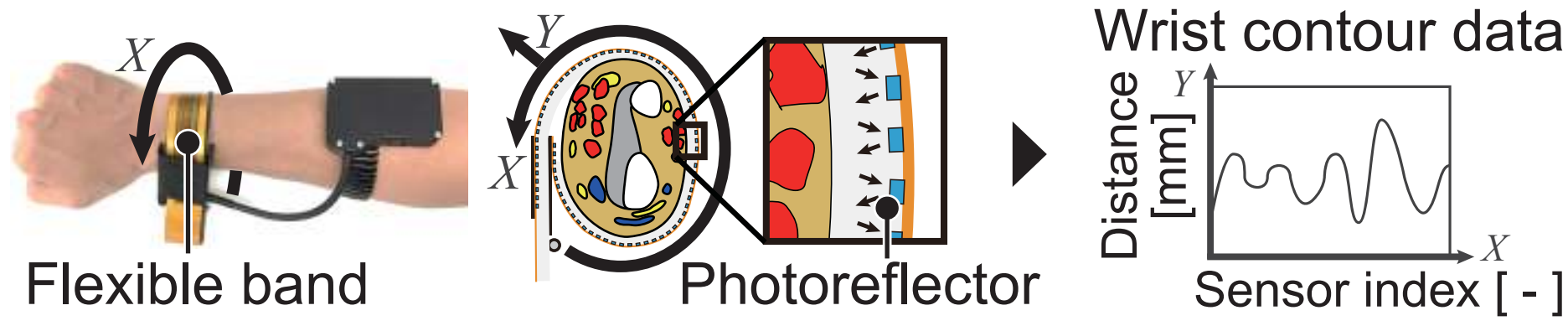# Development of a Multi-link Wrist Band for Hand Shape Recognition Based on Wrist Contour and Band Flexion
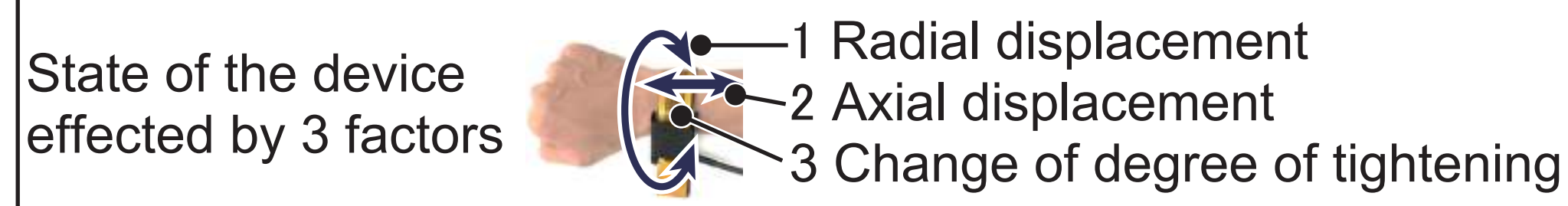
Shunsuke Okishiba, Rui Fukui, Shin'ichi Warisawa

Background

Hand shape classification using a wrist contour sensor [1] is a promising novel NUI because it is not obstructive.


Flexible band

Photoreflector

Wrist contour data

However, the attachment state effects the recognition rate severely.

State of the device effected by 3 factors
1 Radial displacement
2 Axial displacement
3 Change of degree of tightening

Approach

Measure wrist contour + attachment state
→ The recognition of the attachment state contributes to select a suitable training data.

Multi-link wrist band

Angle of each link = band flexion data contains information of attachment state
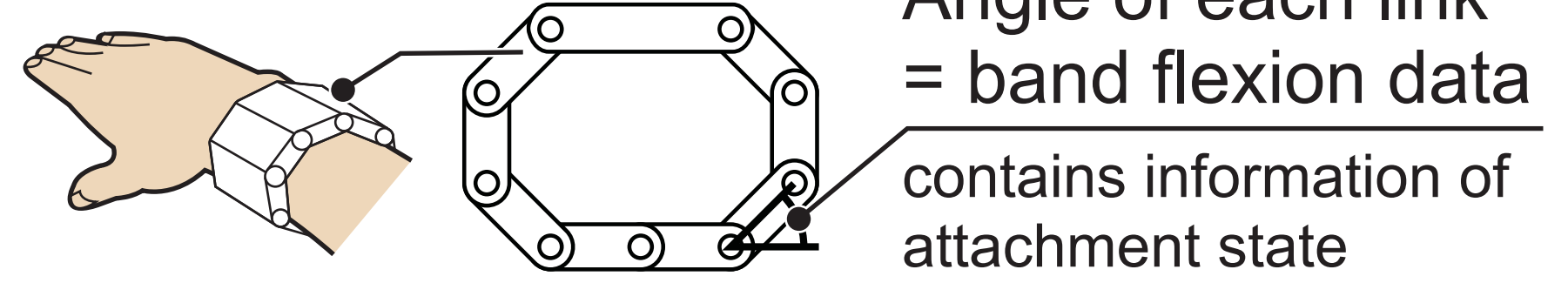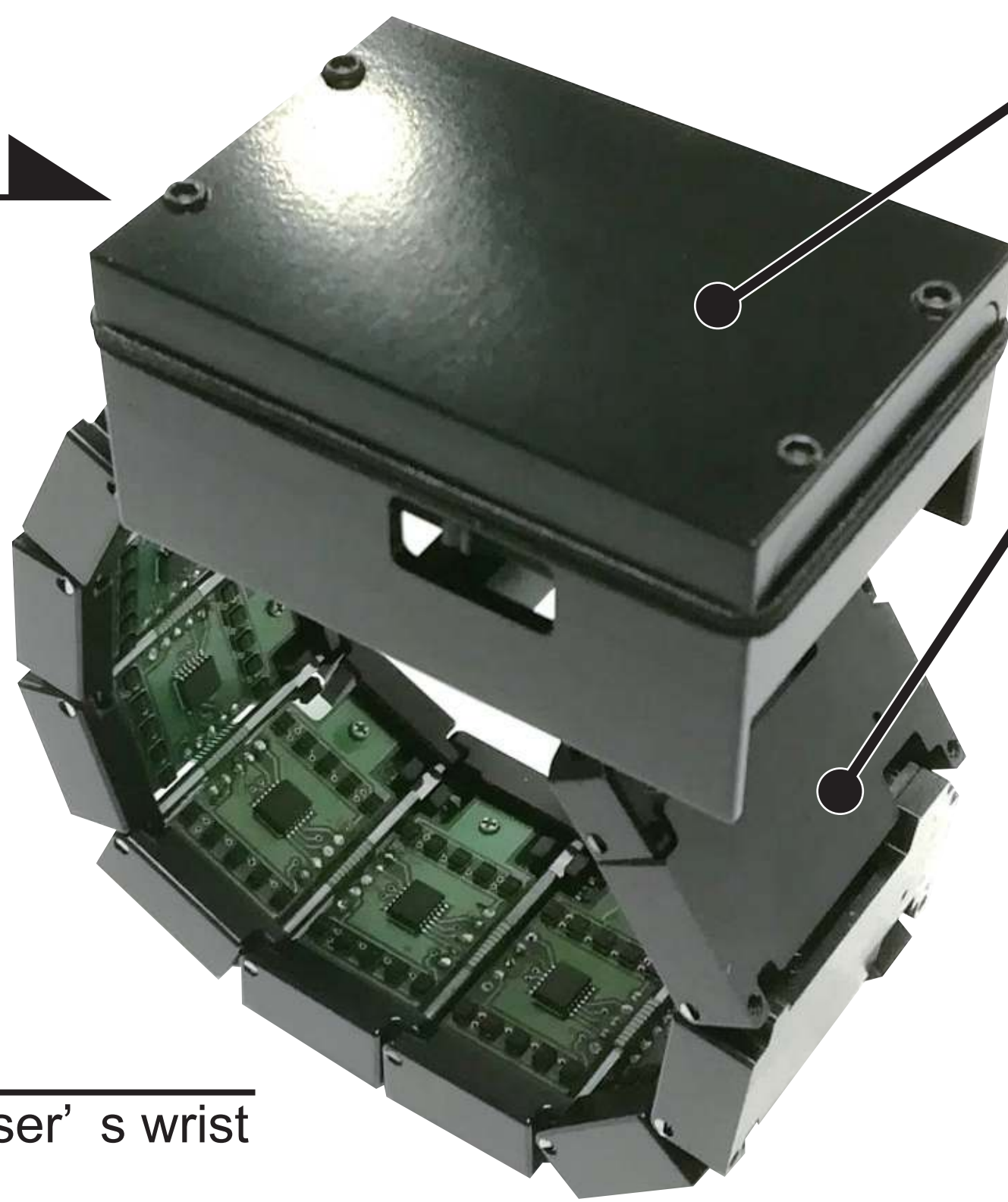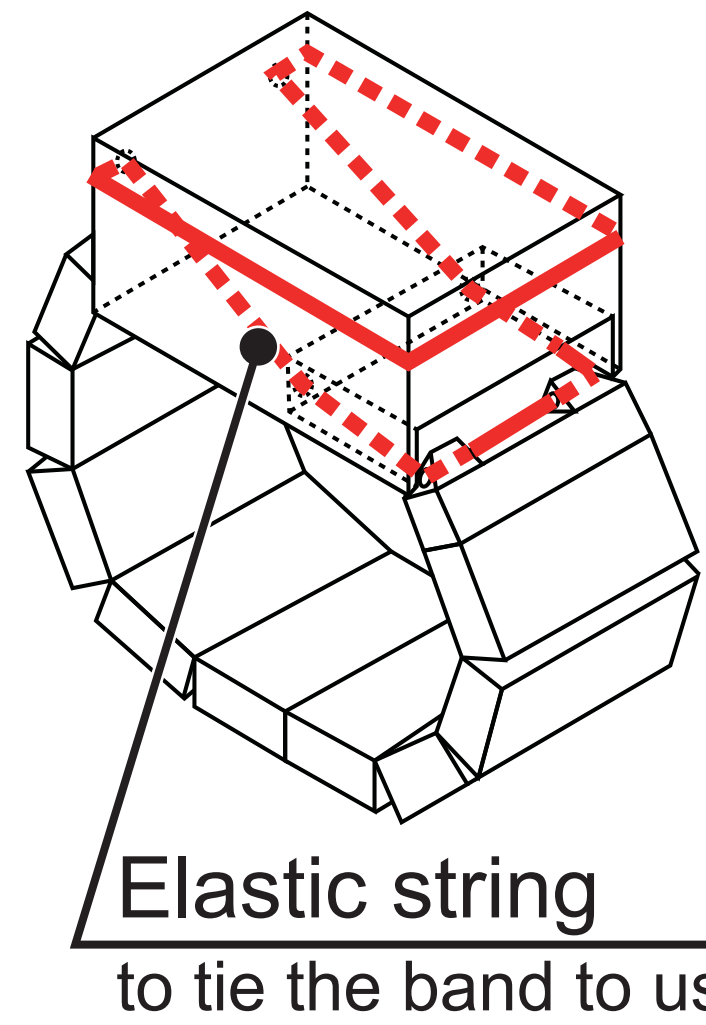
Goal

Development of a multi-link wrist band measuring wrist contour and band flexion

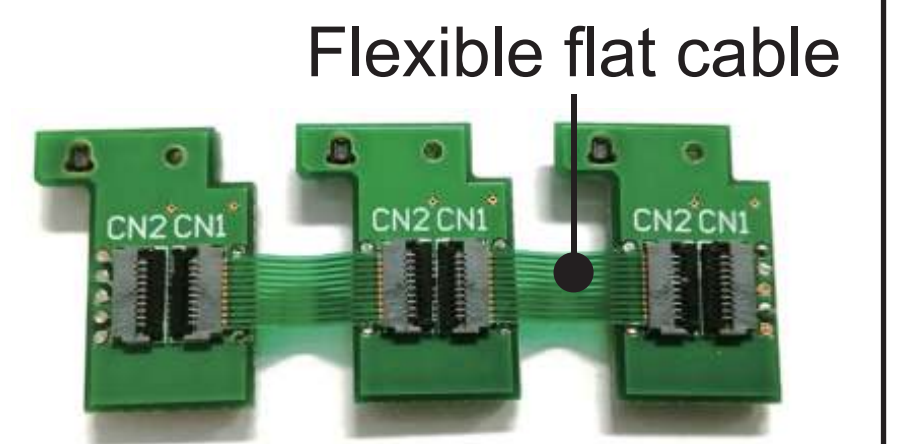## Multi-link Wrist Band

Weight : 100 g
Material : Duralumin

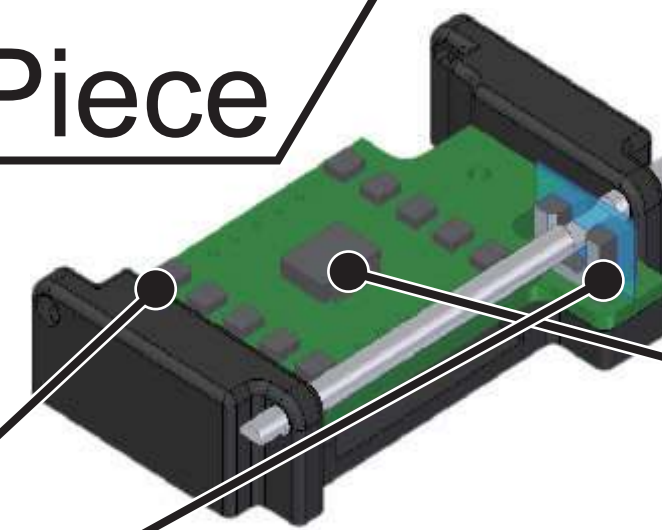Elastic string to tie the band to user's wrist

Control part

Battery

Microcontroller
Bluetooth module

Measurement part

Link index : 1 2 3 4 5 6 7 8 9

184

Piece

Shift register switching sensors in time series
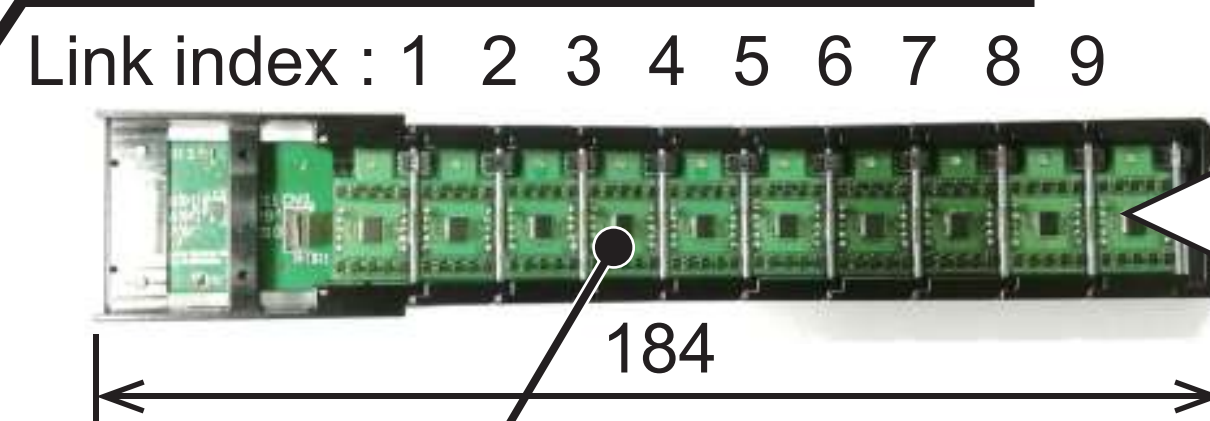
Daisy chain connection

Flexible flat cable

The length of the wrist band is variable discretely thanks to removable pieces.

Photoreflector measuring wrist contour

Hand side array
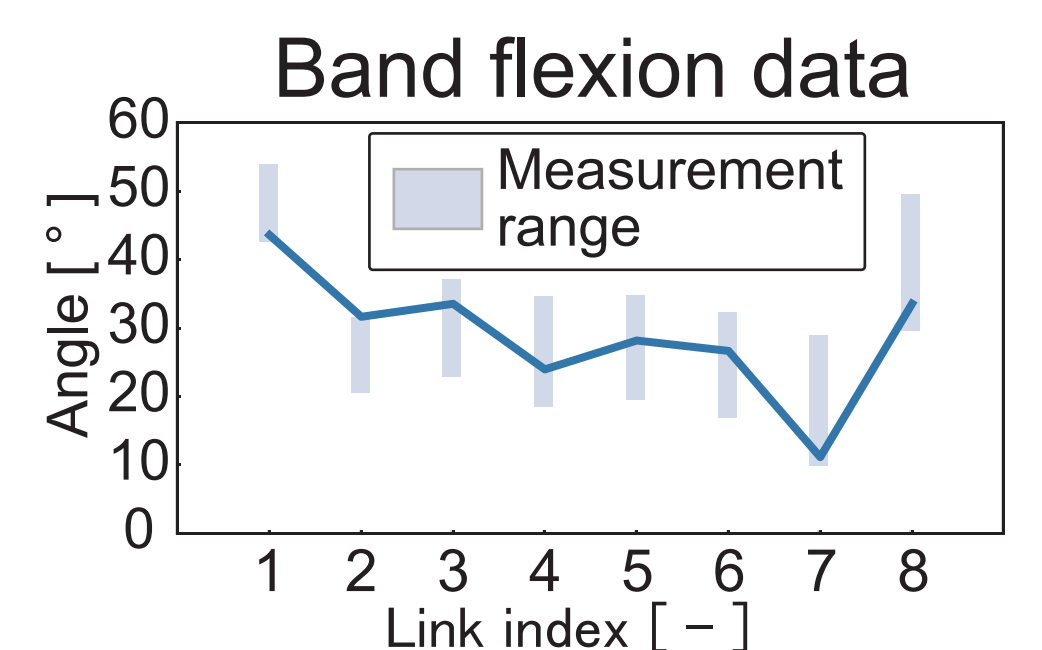Elbow side array

Wrist contour data
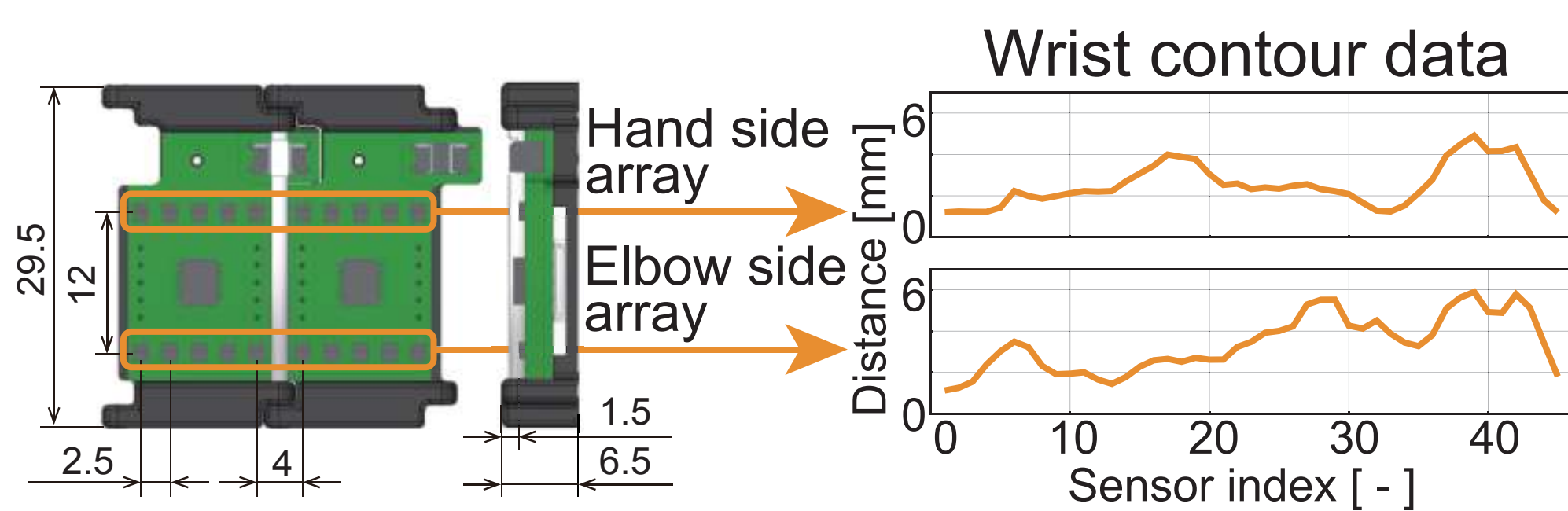
Two photoreflector arrays measure the distance between the wrist surface and the multi-link wrist band.

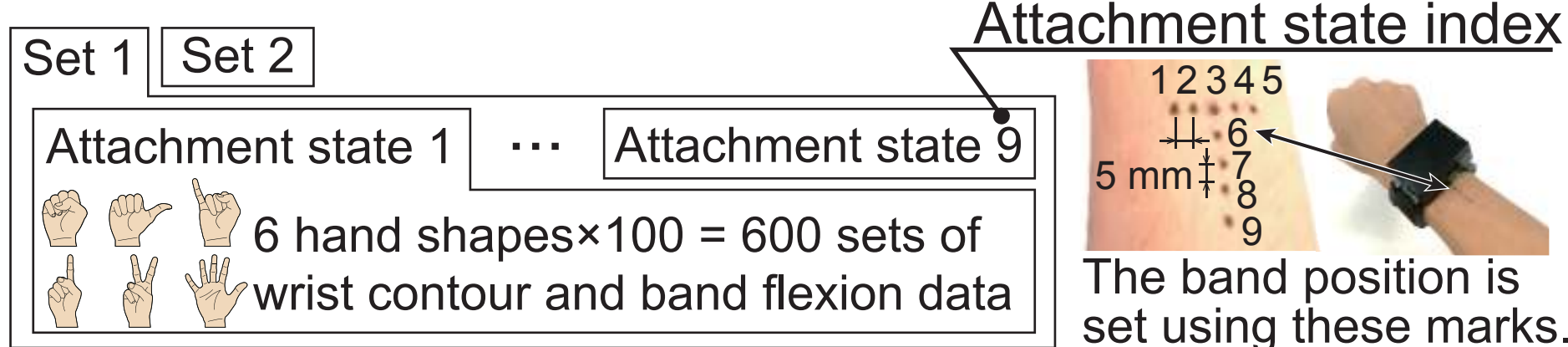### Photointerrupter measuring band flexion

Phototransistor   LED
Light path
Shaft

$\theta = 0°$ $\theta = 30°$ $\theta = 60°$
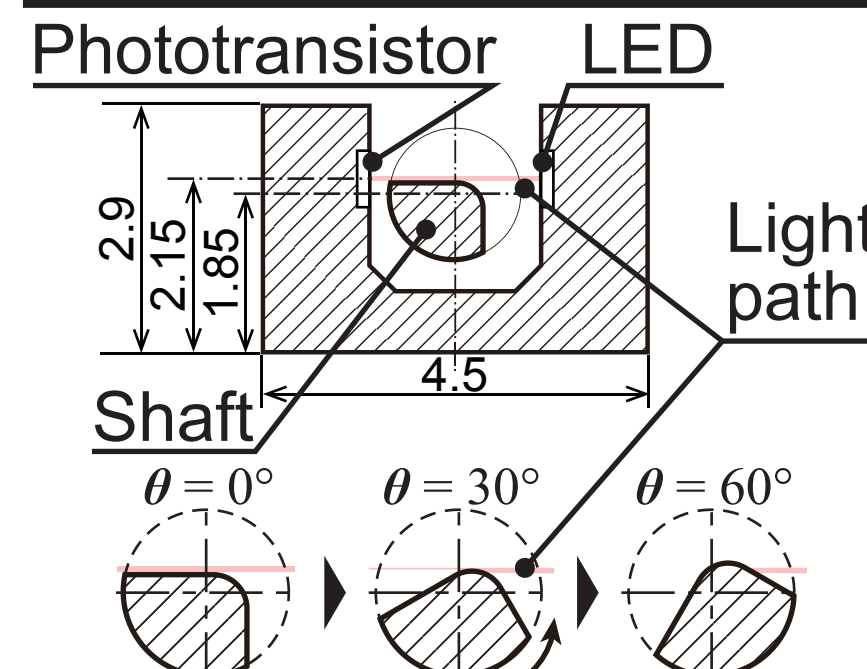
The shielding rate of the light changes due to the link angle.

Band flexion data

Measurement range

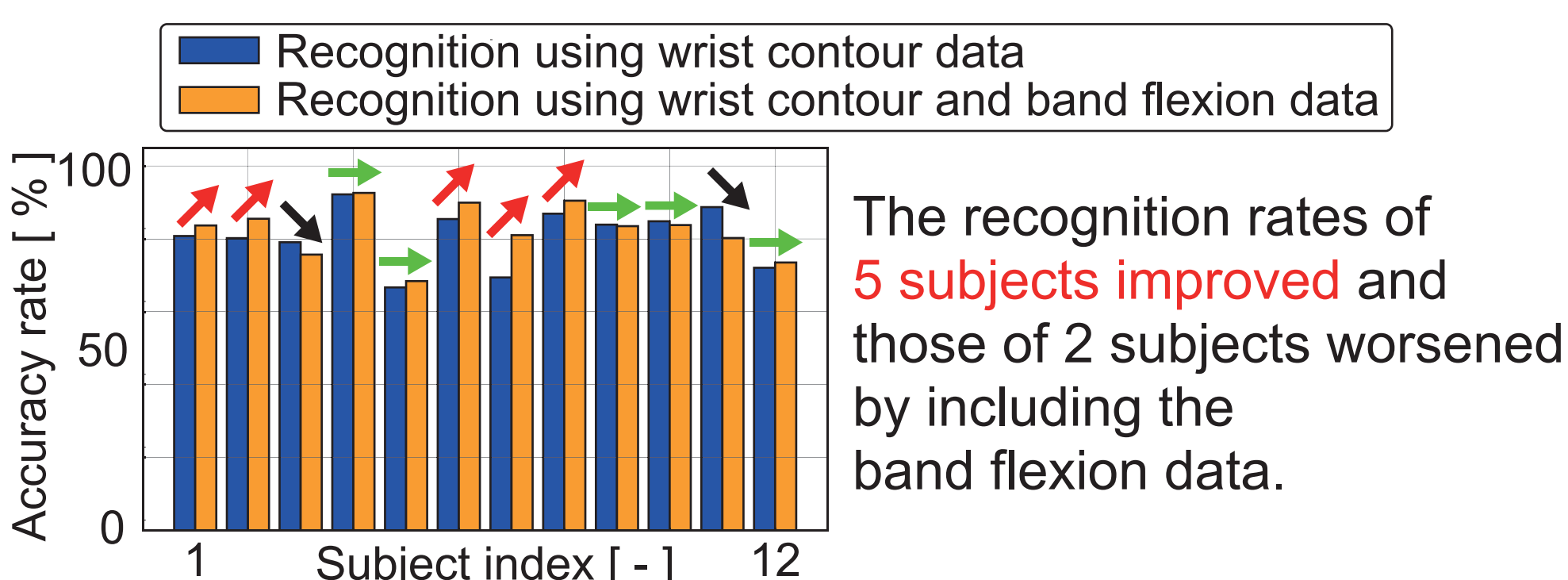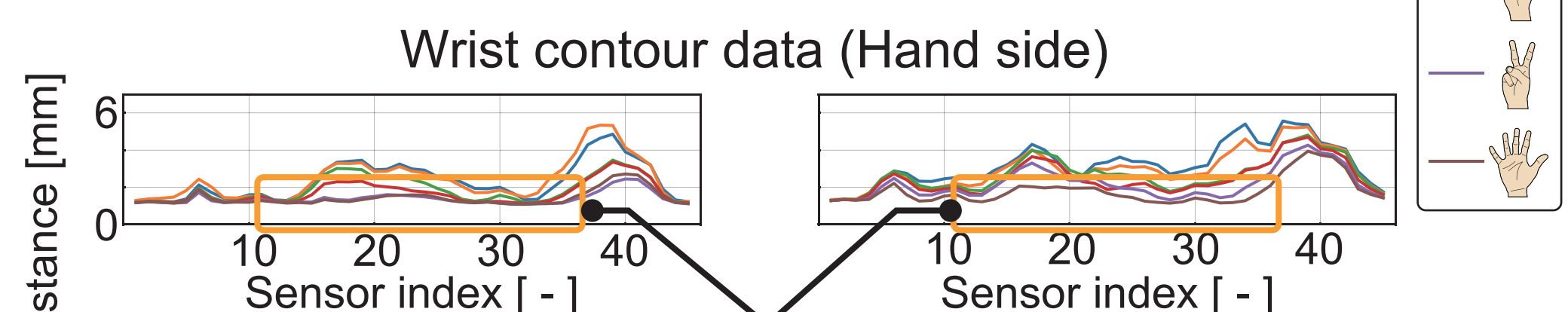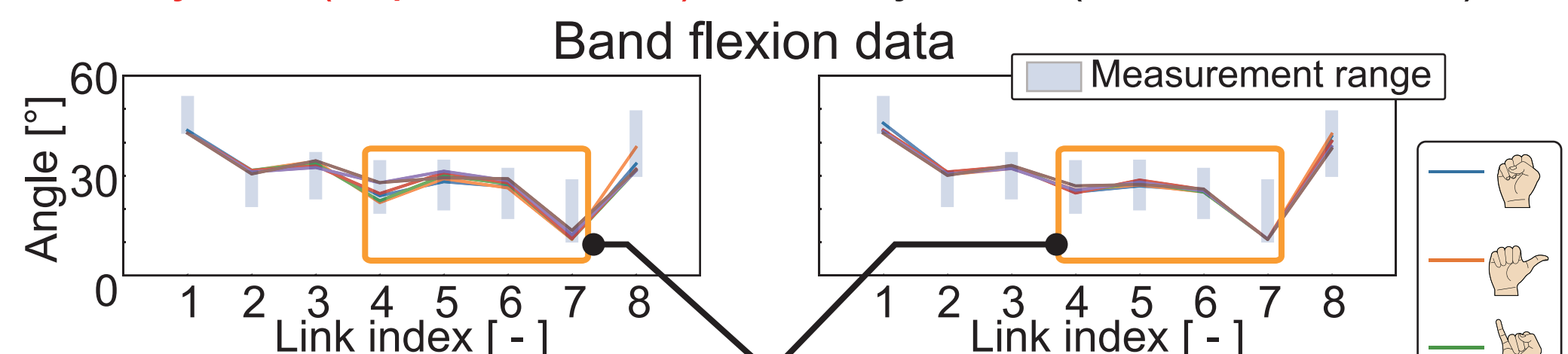Each sensor has measurement range of about 10 to 20°.

Hand shape recognition based on band flexion data

The following 18 dataset are acquired from 12 subjects.
1 set is test data and 17 sets are training data. Classifier is SVM.

Set 1 Set 2

Attachment state 1 ··· Attachment state 9

6 hand shapes×100 = 600 sets of wrist contour and band flexion data

Attachment state index
1 2 3 4 5
5 mm 6
7
8
9
The band position is set using these marks.

Recognition using wrist contour data
Recognition using wrist contour and band flexion data

The recognition rates of 5 subjects improved and those of 2 subjects worsened by including the band flexion data.

Subject 7 (Improved most)   Subject 11 (Worsened worst)

Band flexion data

Measurement range

Effect of hand shape in subject 7 is larger

Wrist contour data (Hand side)

Gap between the band and wrist in subject 11 is larger

To acquire band flexion data containing information of attachment states, it is important to contact the wrist band and wrist tightly.

[1] Rui Fukui, et al. Hand shape classification with a wrist contour sensor. analyses of feature types, resemblance between subjects, and data variation with pronation angle. The Intl. J. of Robotics Research, Vol. 33, No. 4, pp. 658-671, 2014.