

CyclopsRing

*Enabling Whole-Hand and Context-Aware Interactions
Through a Fisheye Ring*

Liwei Chan, Yi-Ling Chen, Chi-Hao Hsieh,
Rong-Hao Liang, Bing-Yu Chen

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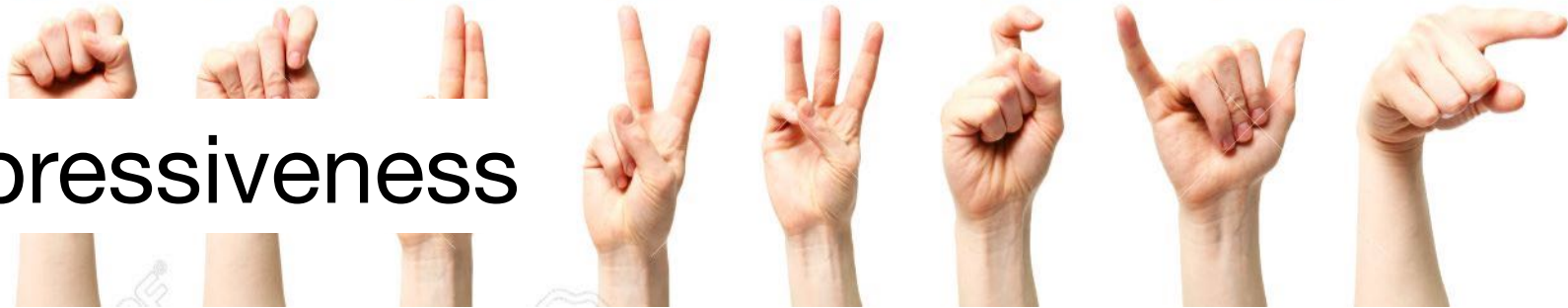


185 degree



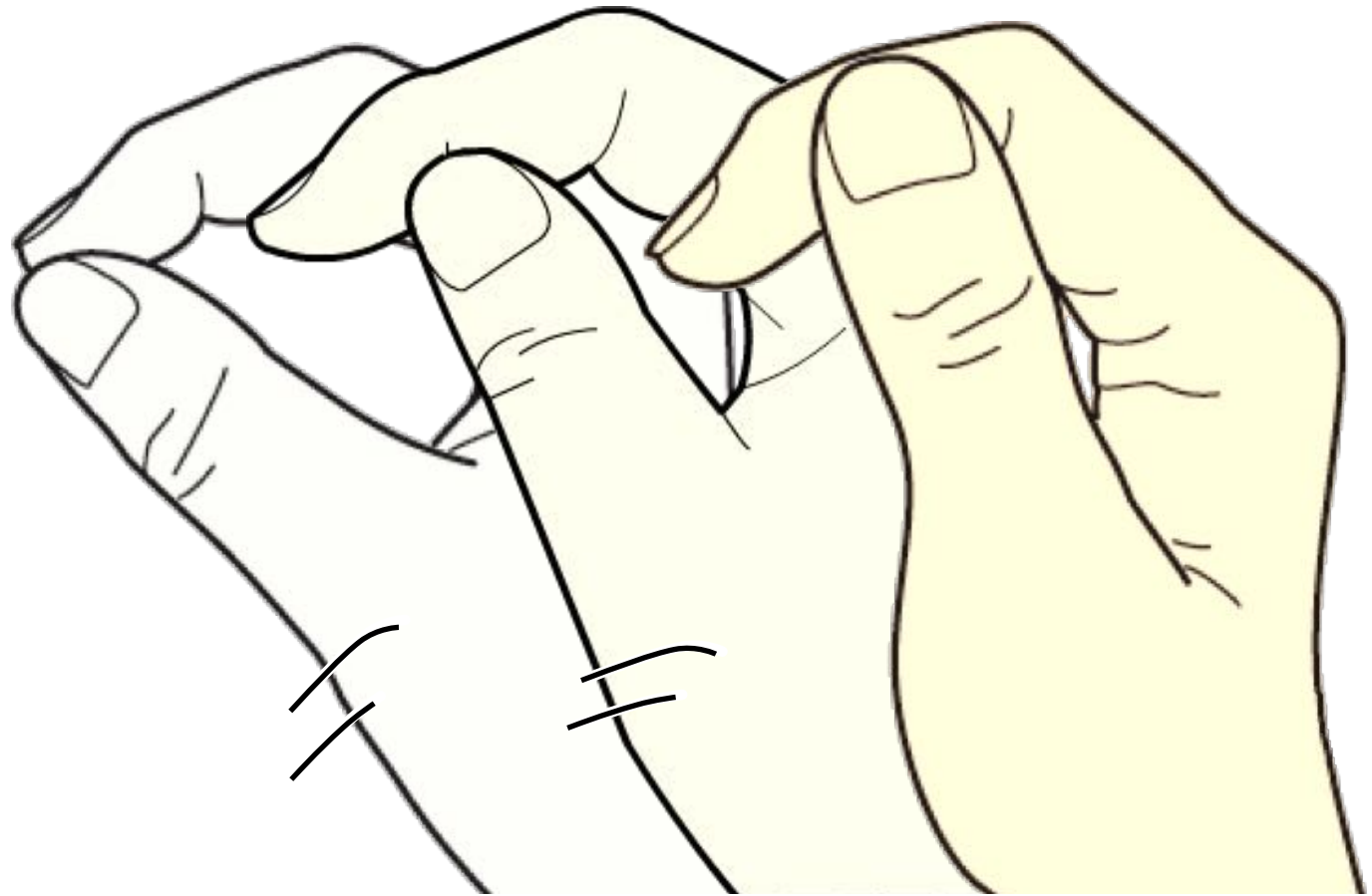


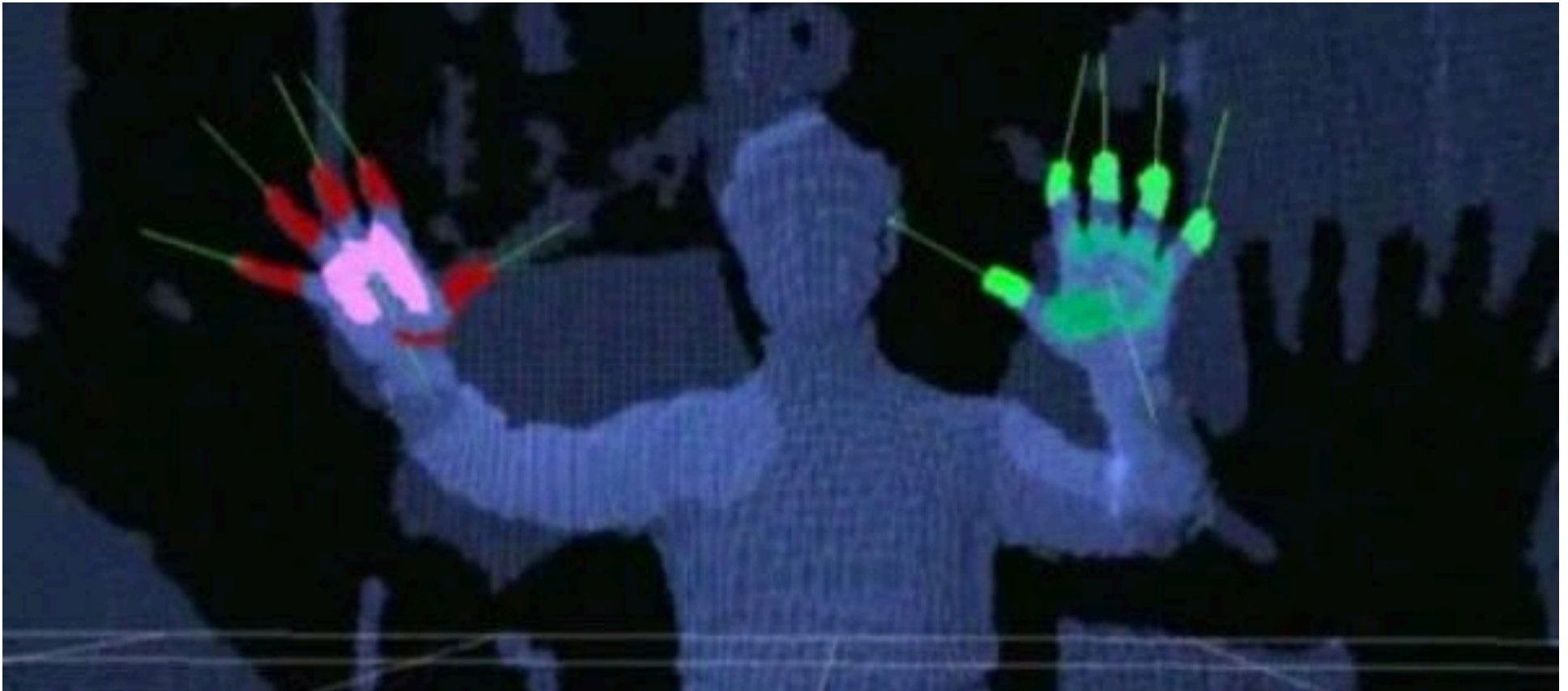
Motivation



Expressiveness

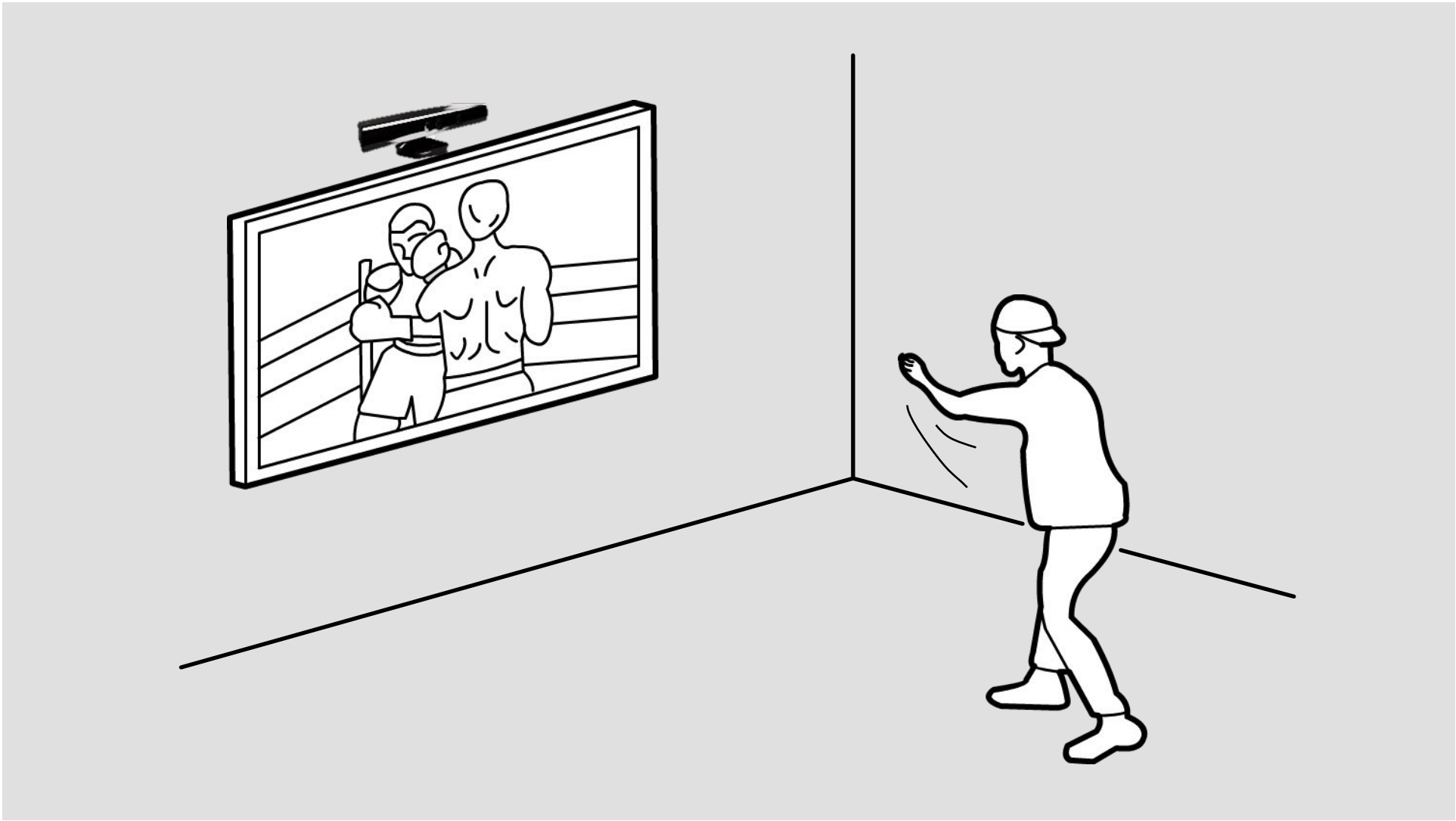
Continuity

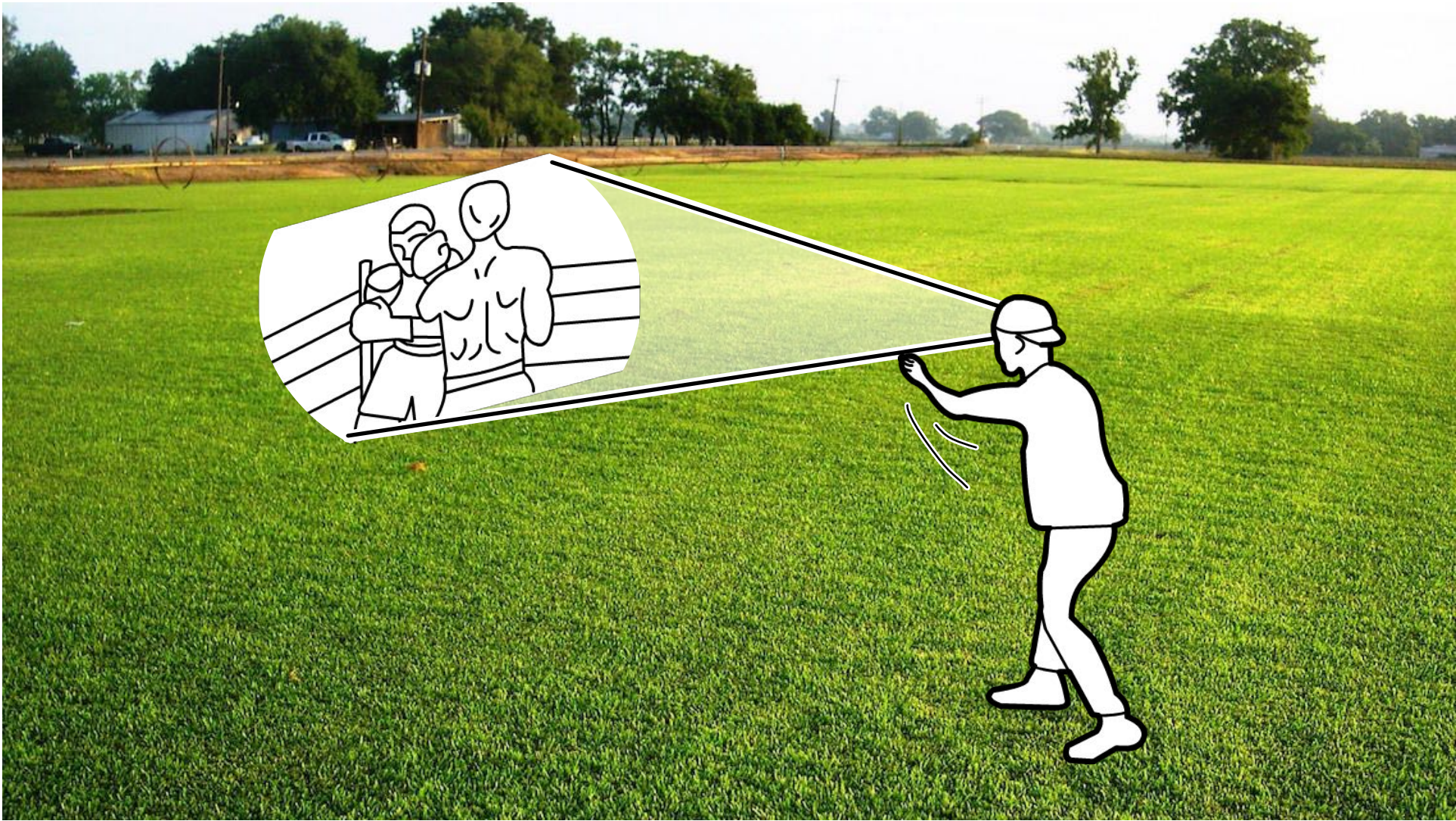




Camera

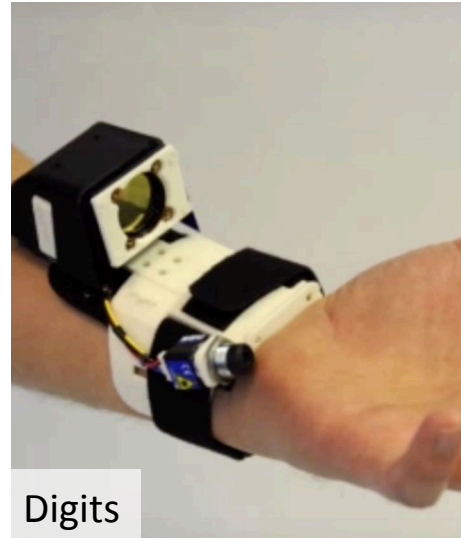
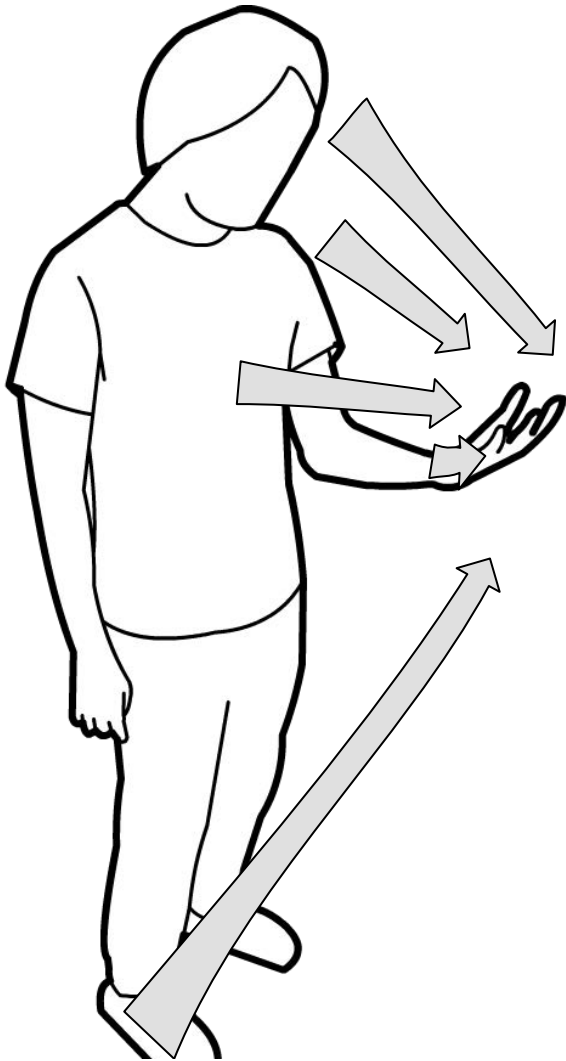






Related Work





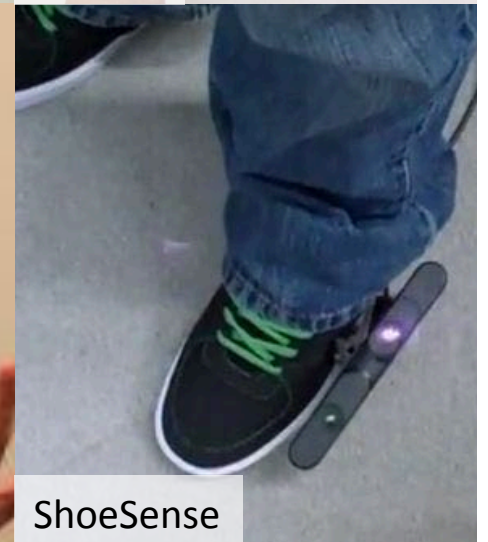
Digits



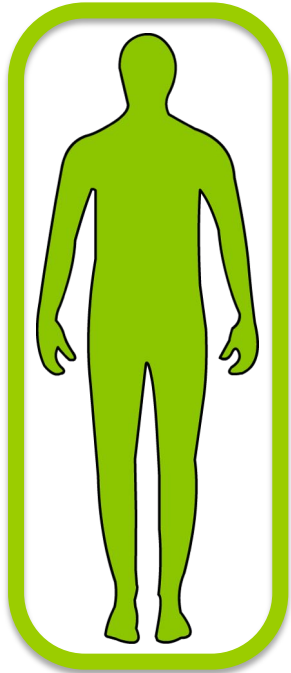
Cyclops



OmniTouch



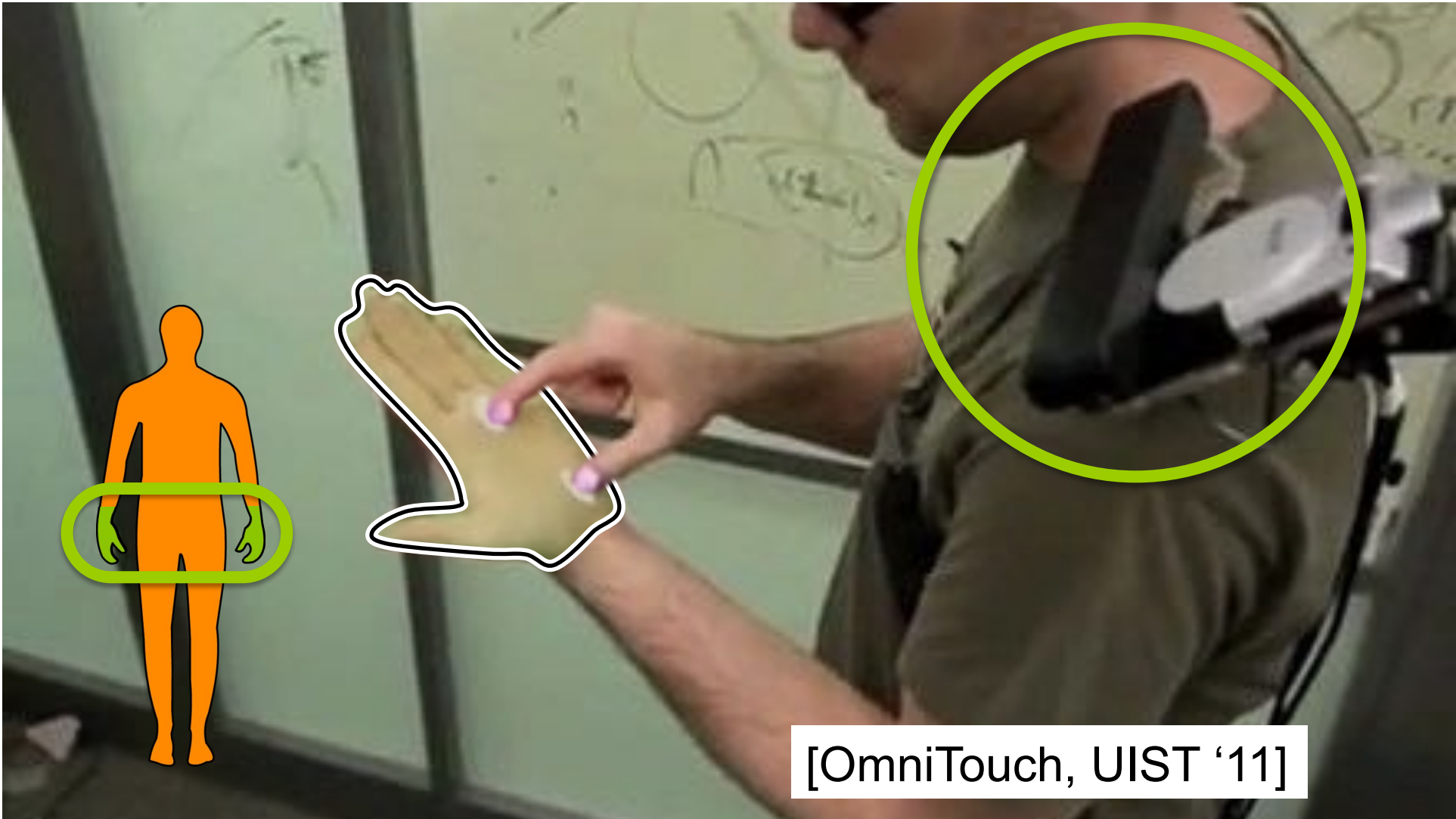
ShoeSense



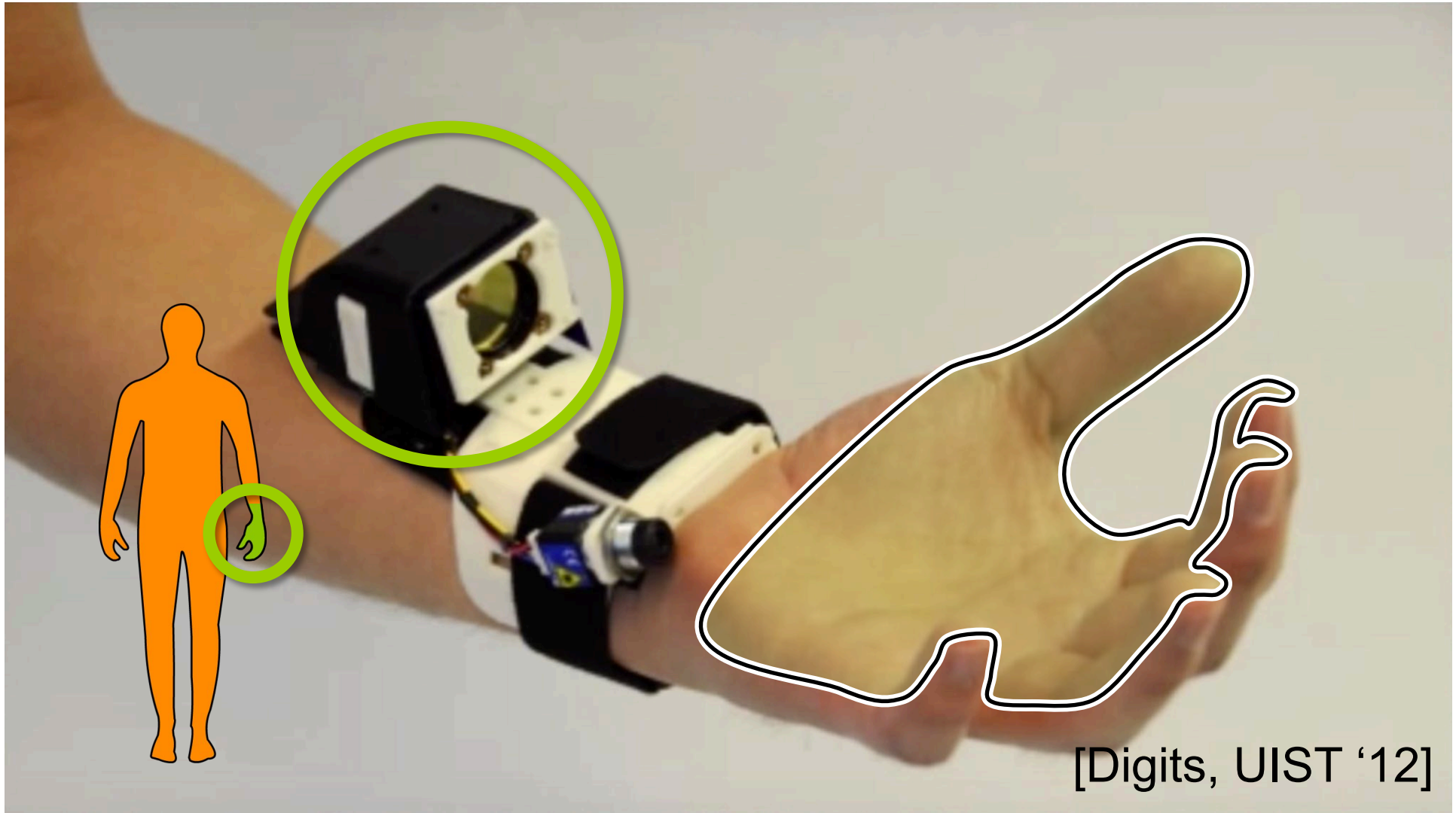
[Cyclops, CHI'15]



[ShoeSense, CHI'12]



[OmniTouch, UIST '11]



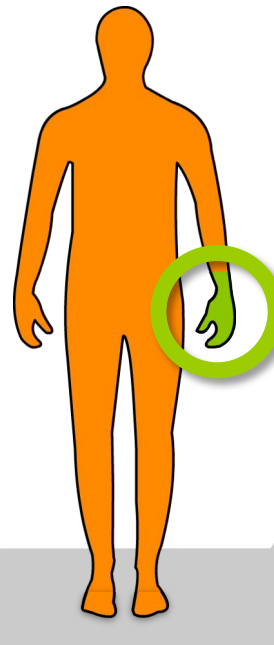
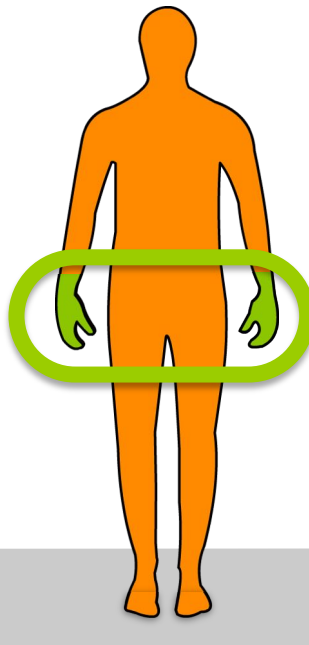
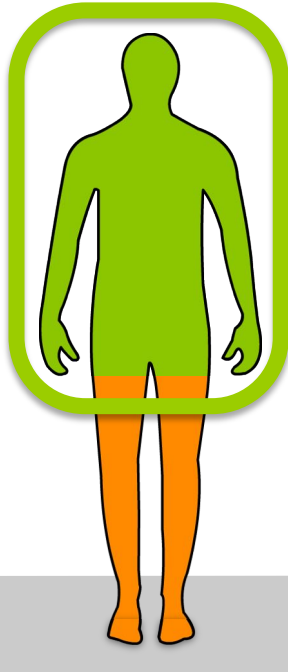
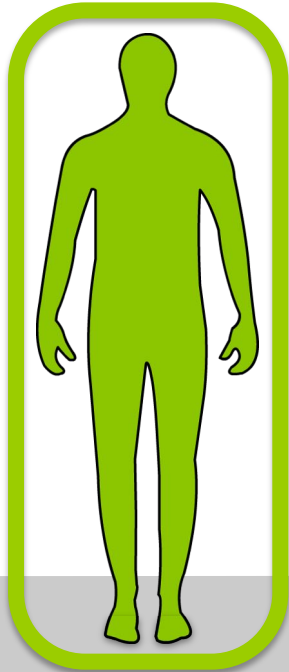
[Digits, UIST '12]

Cyclops

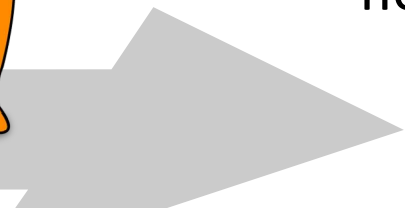
ShoeSense

OnmiTouch

Digits

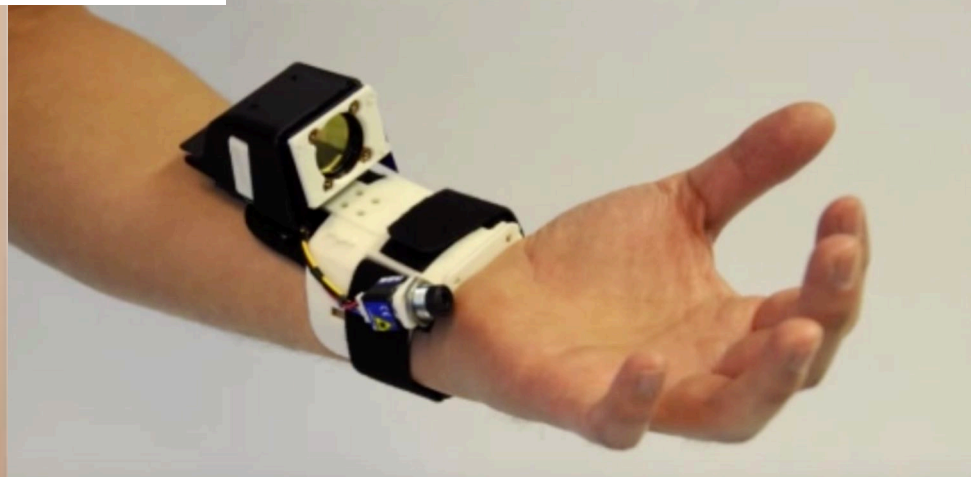


— most
dedicated /
flexible





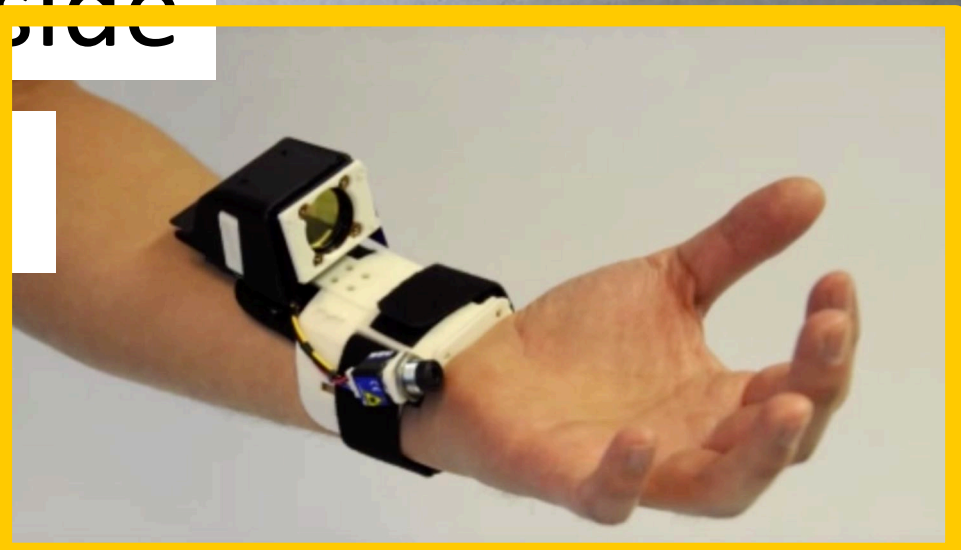
Observing from outside

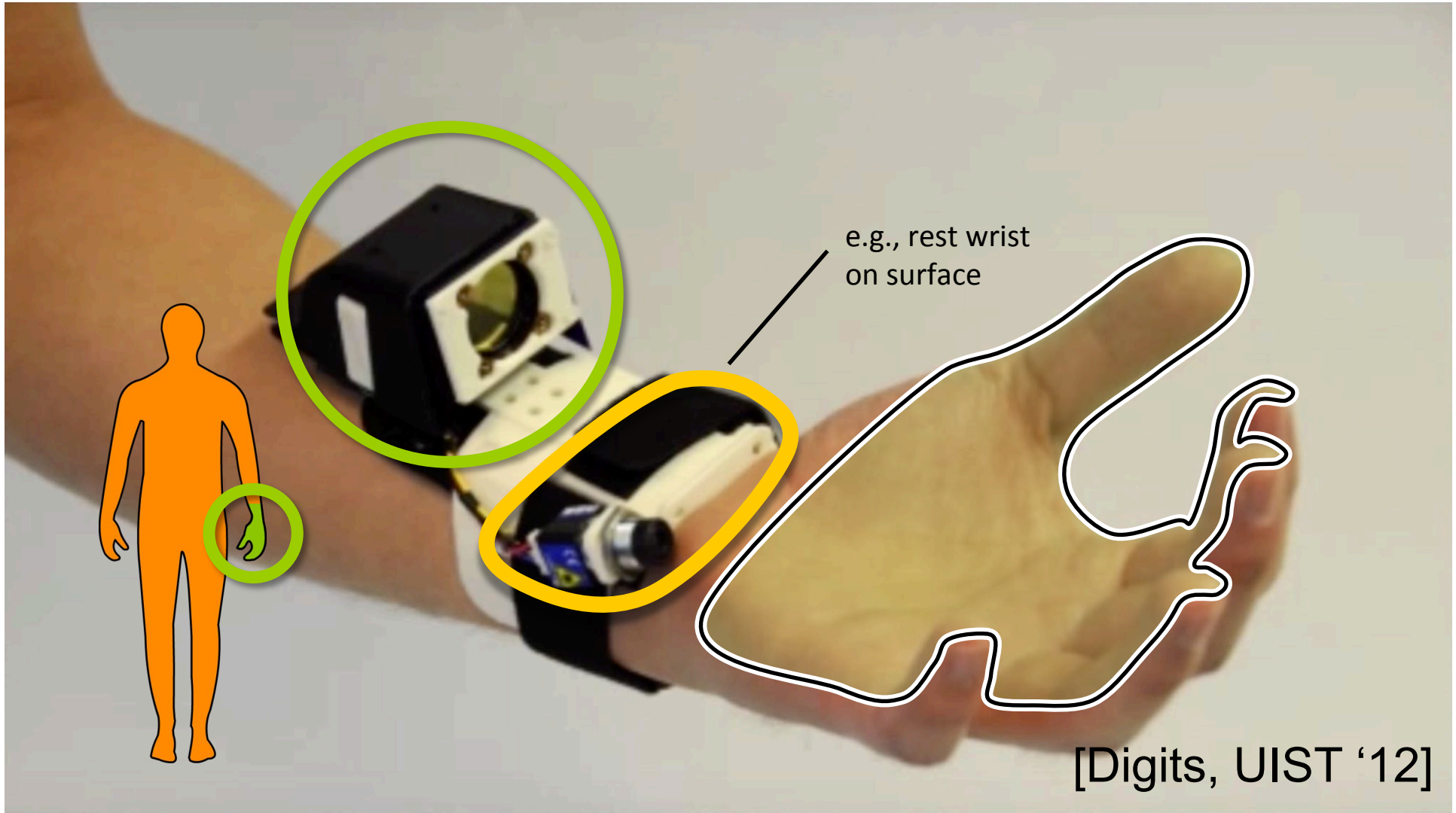


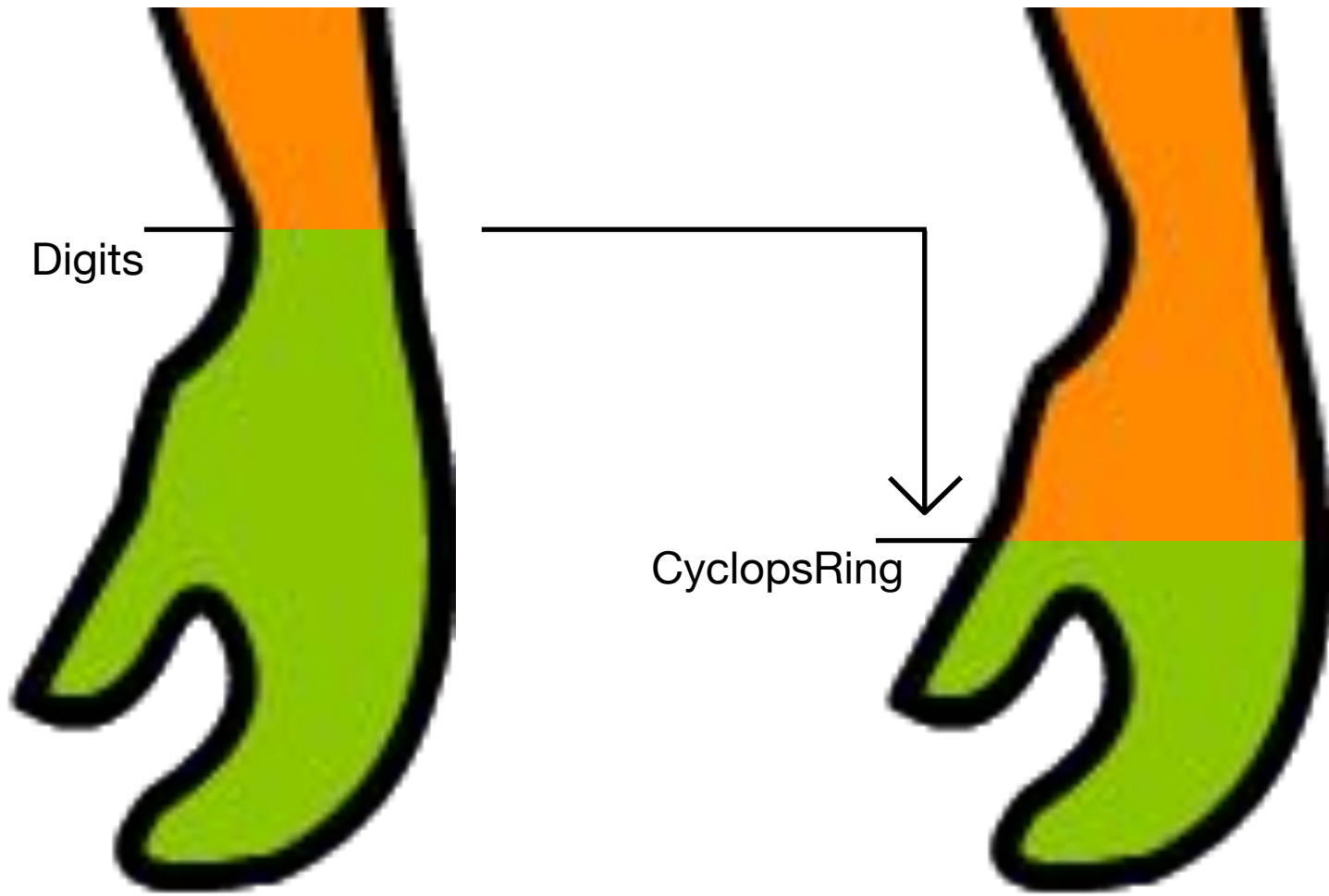


Observing from outside

→ Cause occlusions





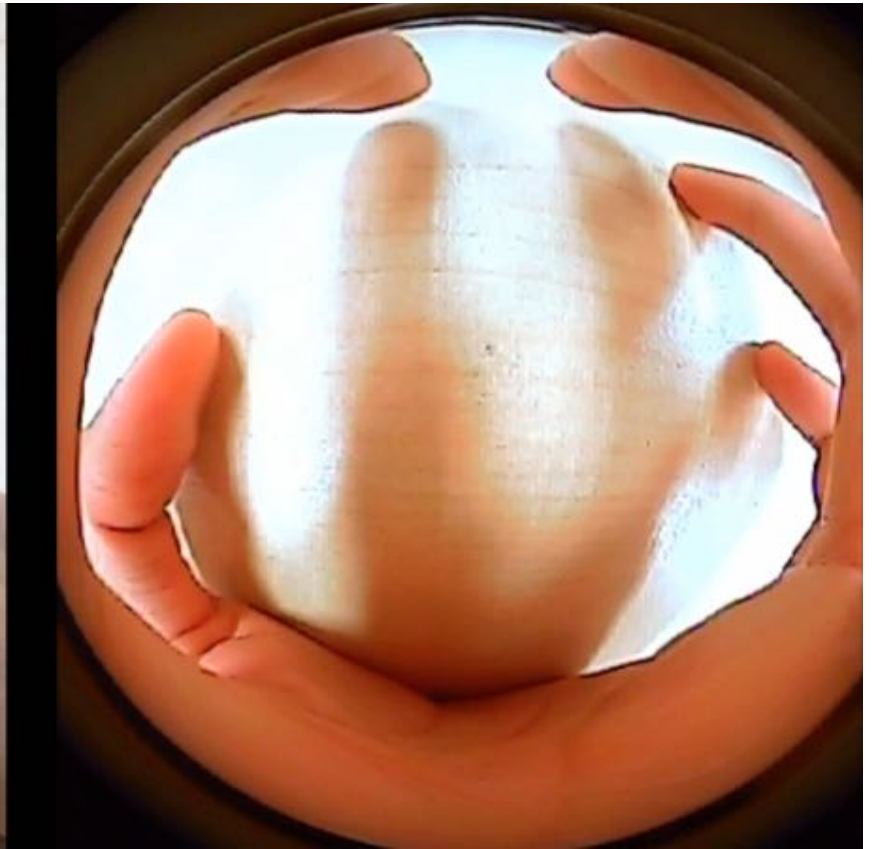


Digits

CyclopsRing



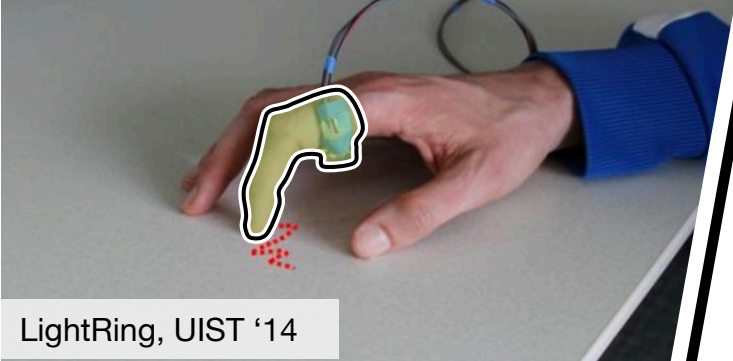
Observing from ...
where is occlusion-free



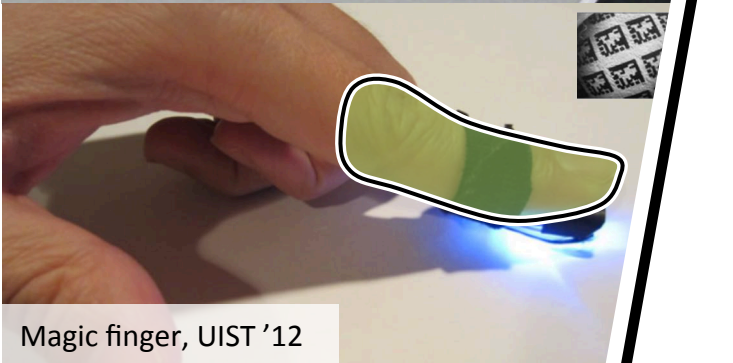
comparing with
other
ring wearables...



iRing, UIST '12

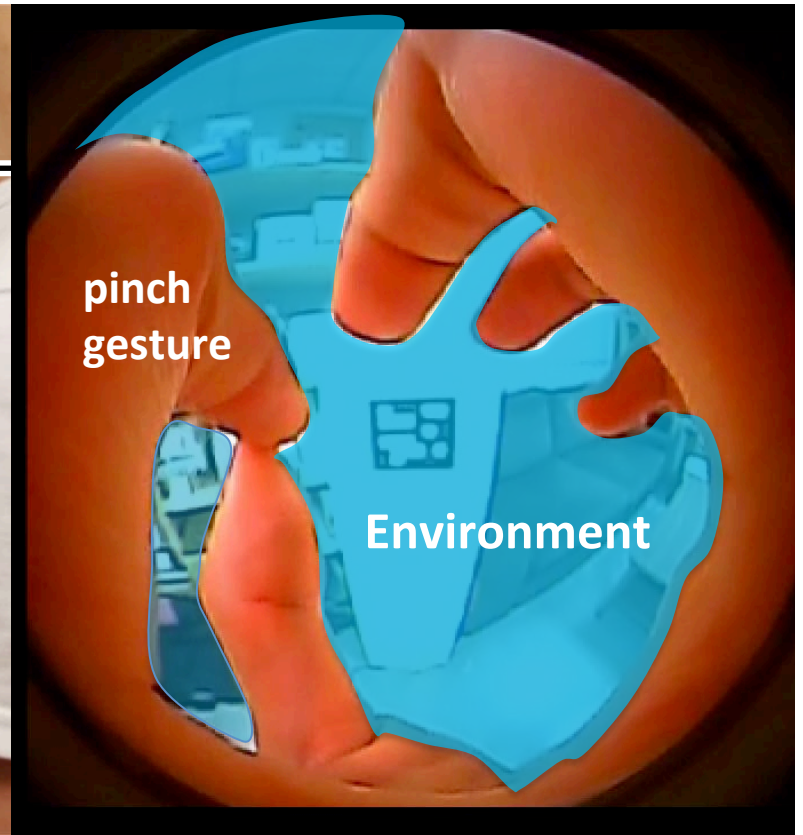


LightRing, UIST '14



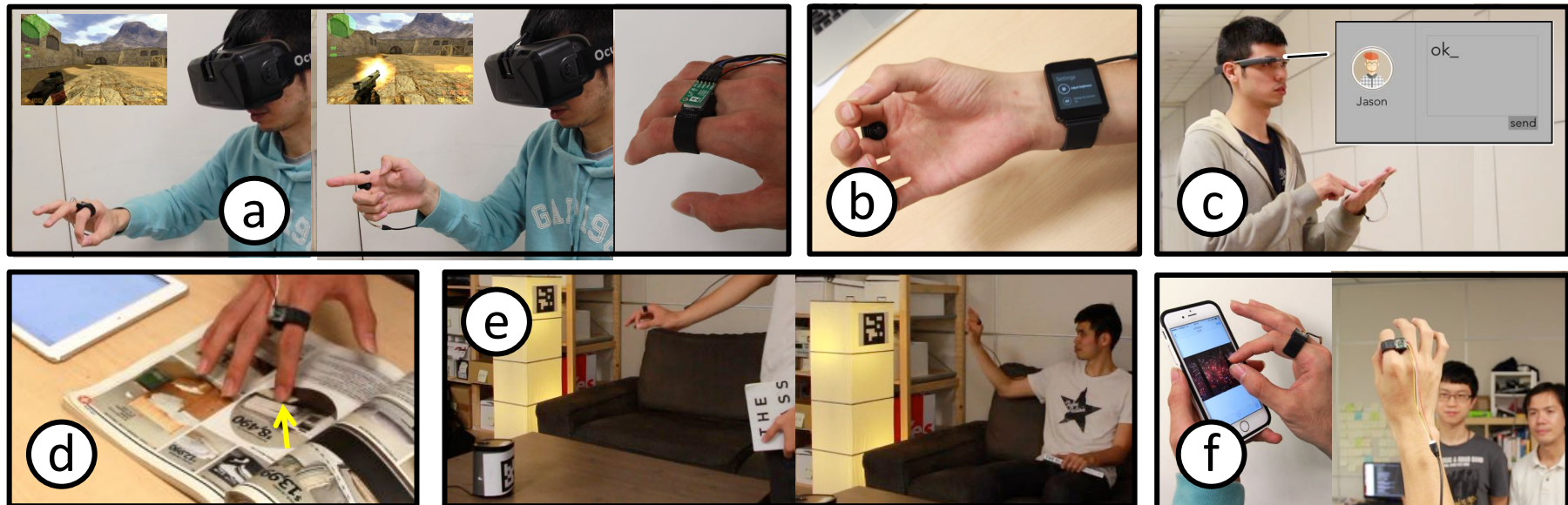
Magic finger, UIST '12





Gesture + Environment

Applications



CyclopsRing

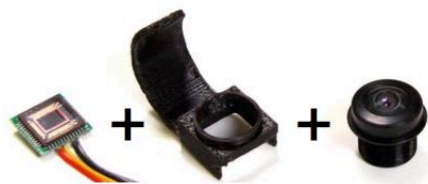
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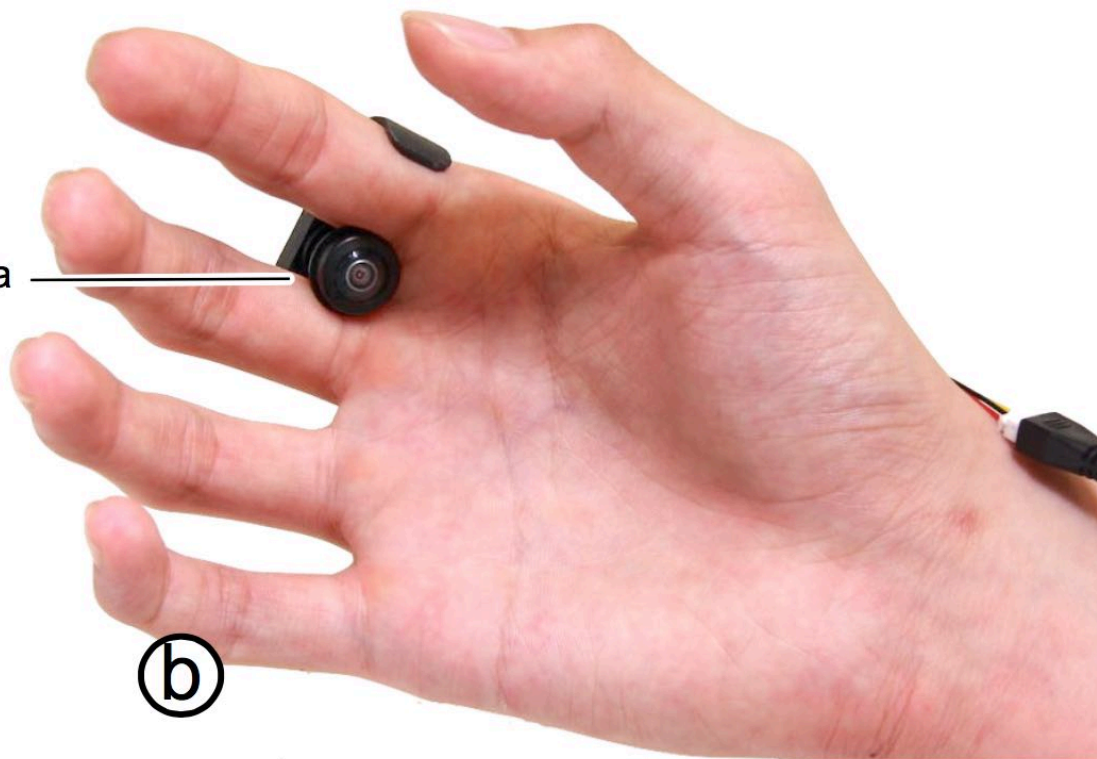


CyclopsRing



Ⓐ

Color camera
with 185°
fisheye lens

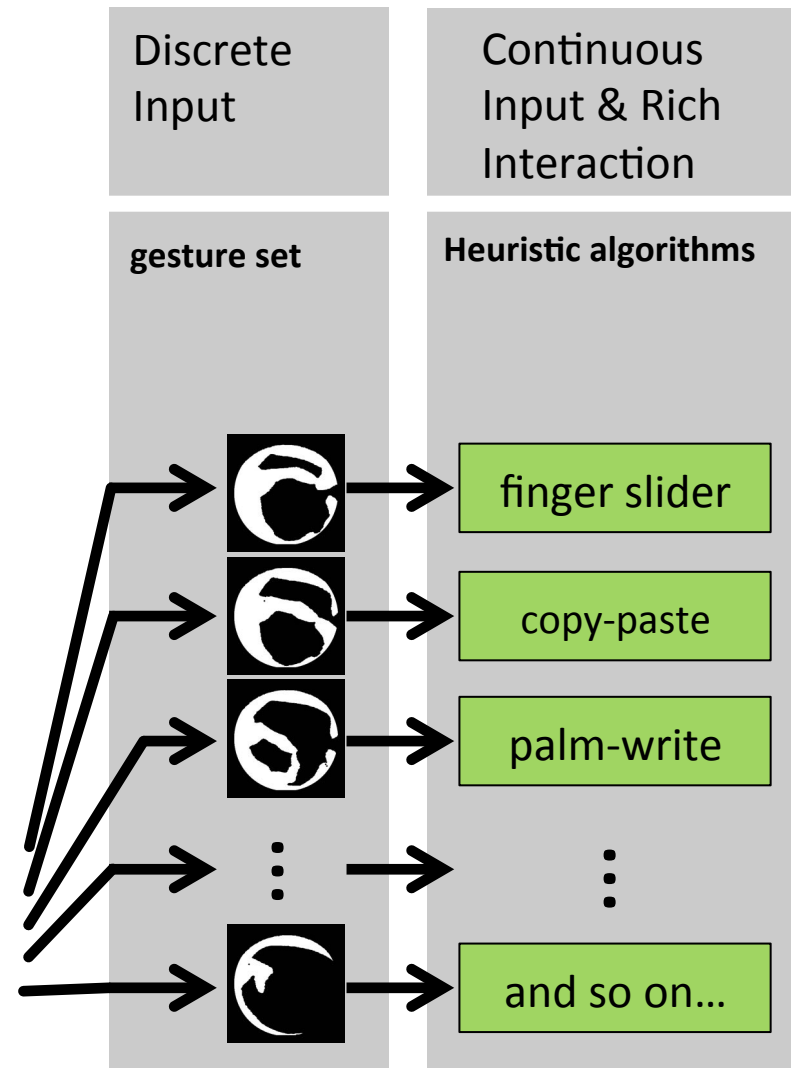
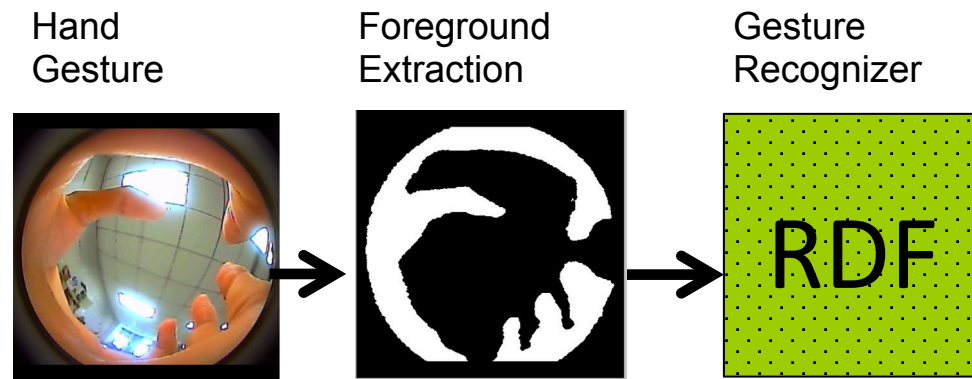


Ⓑ

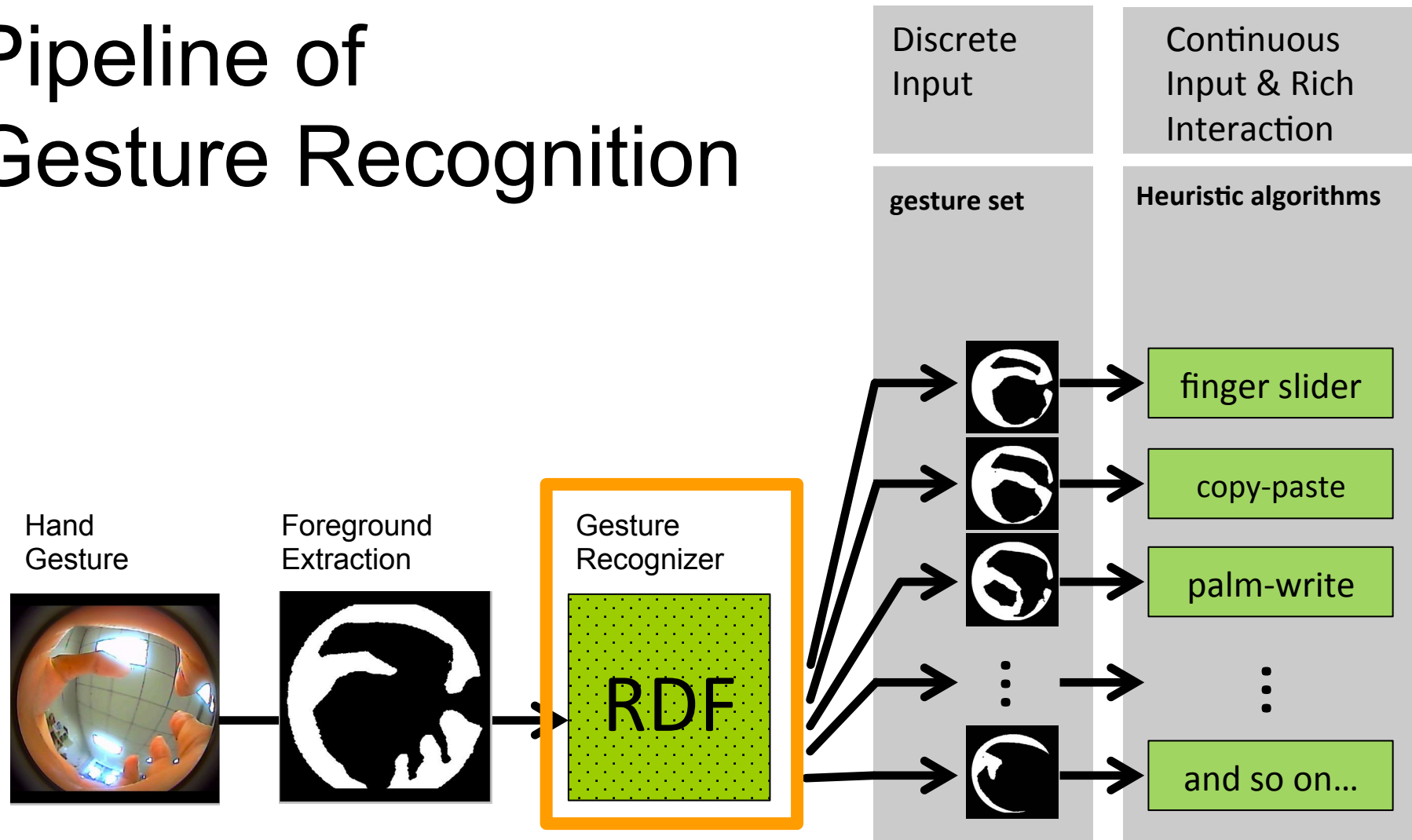
Implementation



Pipeline of Gesture Recognition



Pipeline of Gesture Recognition



Random Decision Forest (RDF)

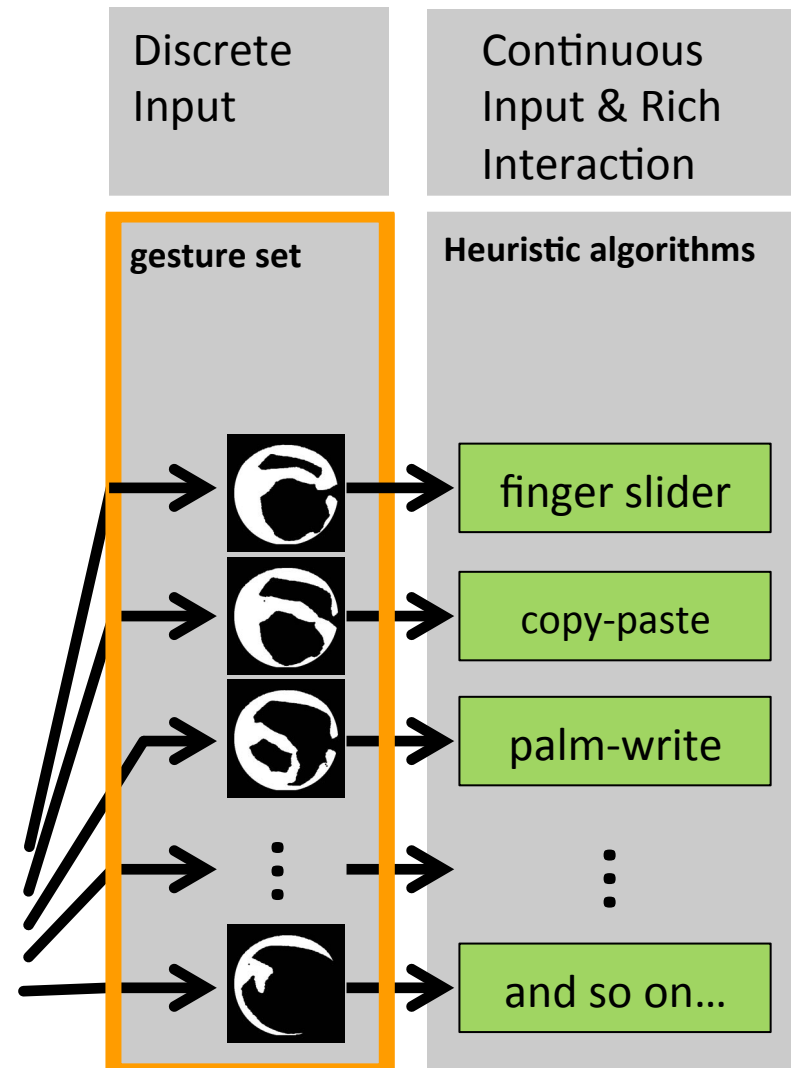
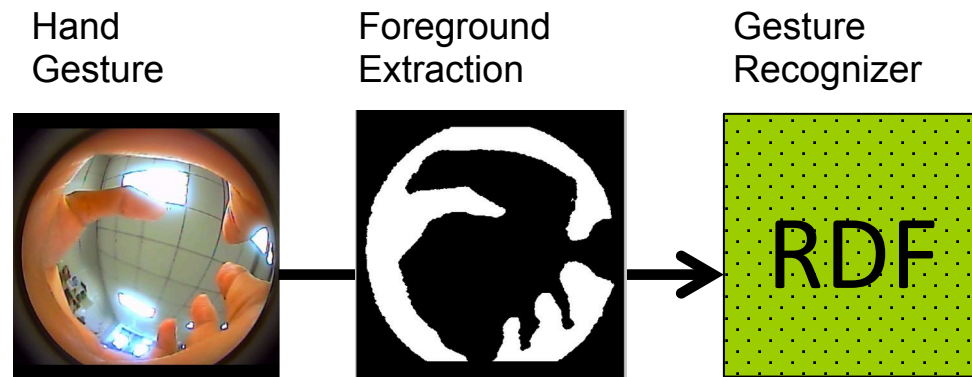
- Data-driven learning algorithm
- Notable example: Kinect
- RDF: a set of decision trees; each internal node is a weak learner

Feature response

$$f(l, x) = i(x + u) - i(x + v)$$

image coordinate

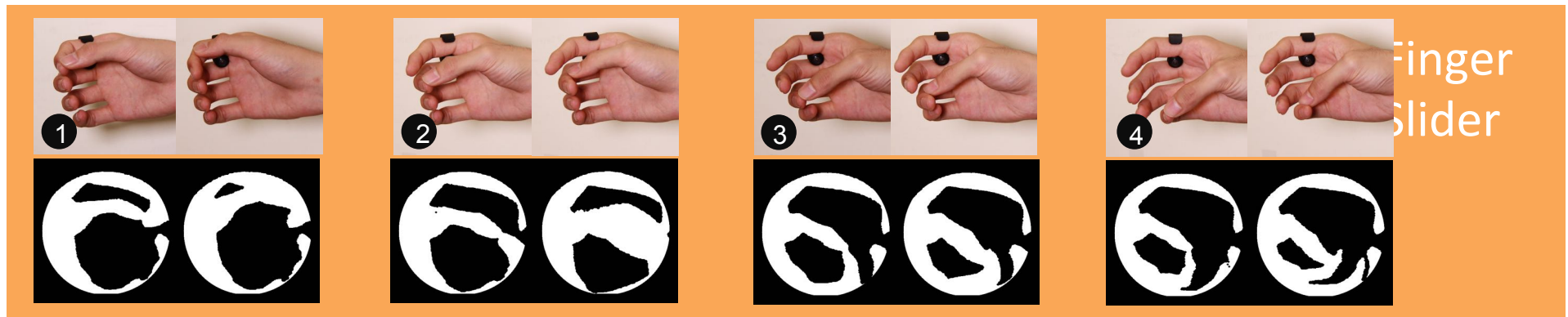
Pipeline of Gesture Recognition



7 gestures for applications

1 2 3 4

Finger Slider

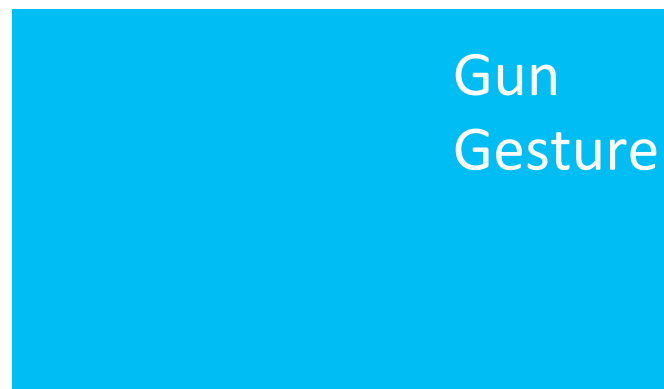


5 6 7

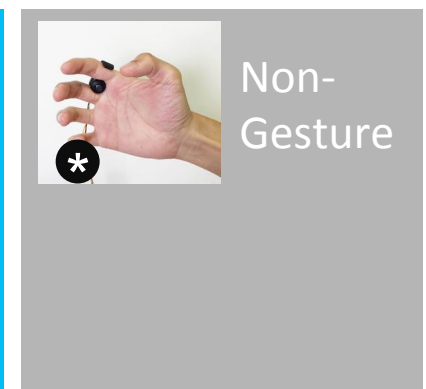
Finger



Gun Gesture



* Non-Gesture

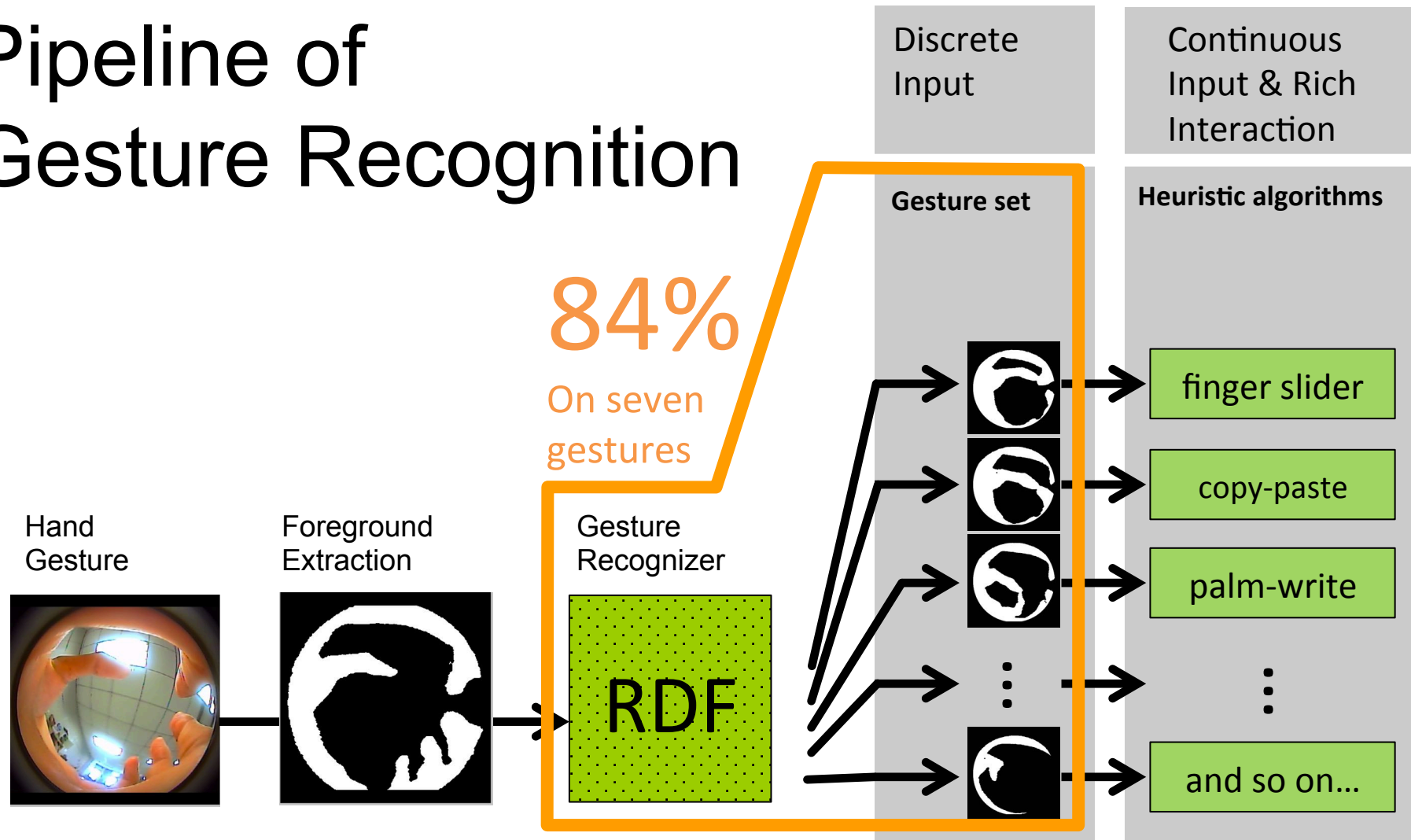


Gesture Recognition based on RDF

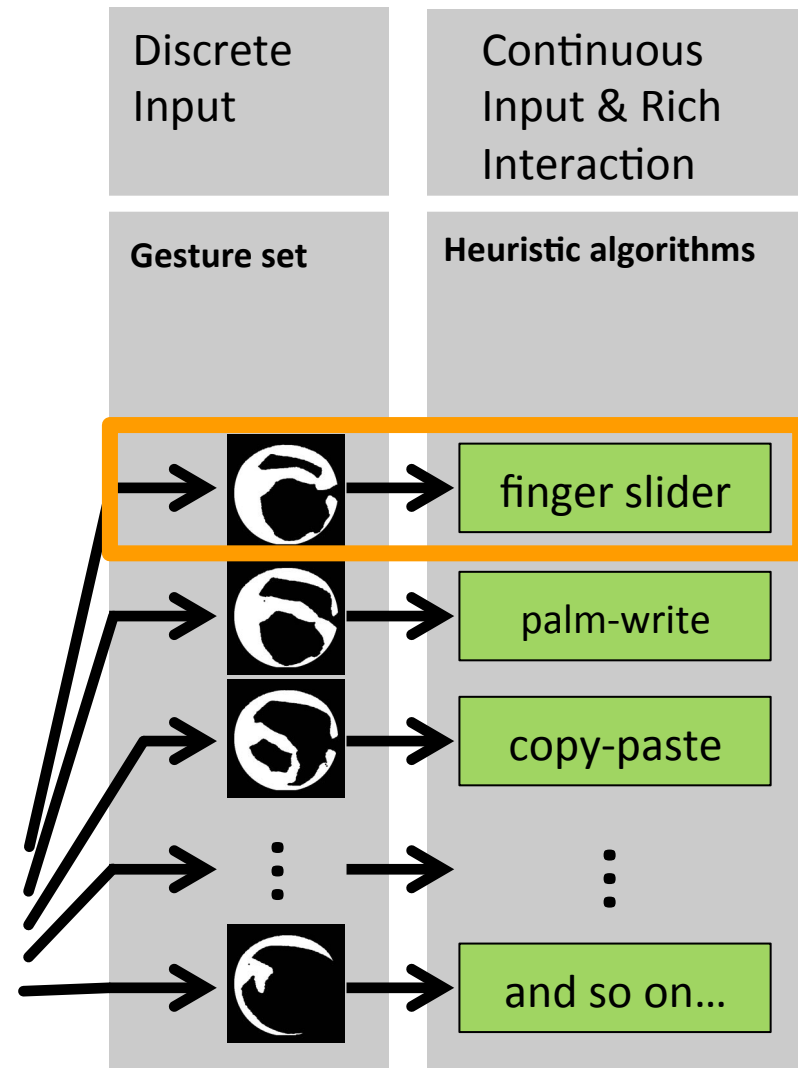
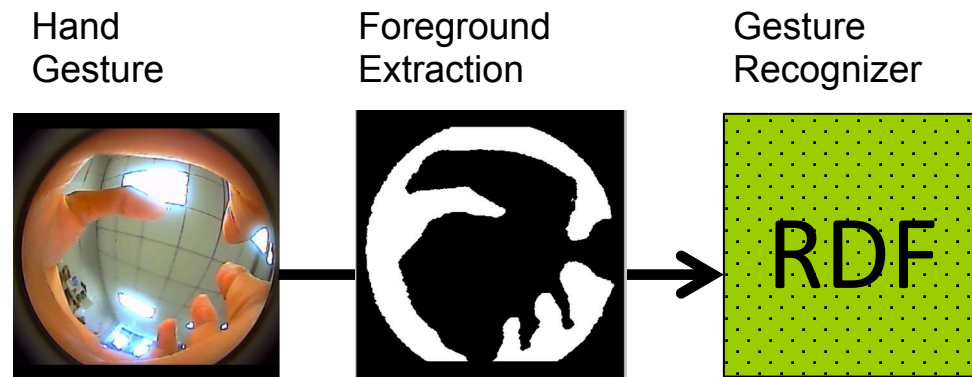


Gesture types
are color
encoded

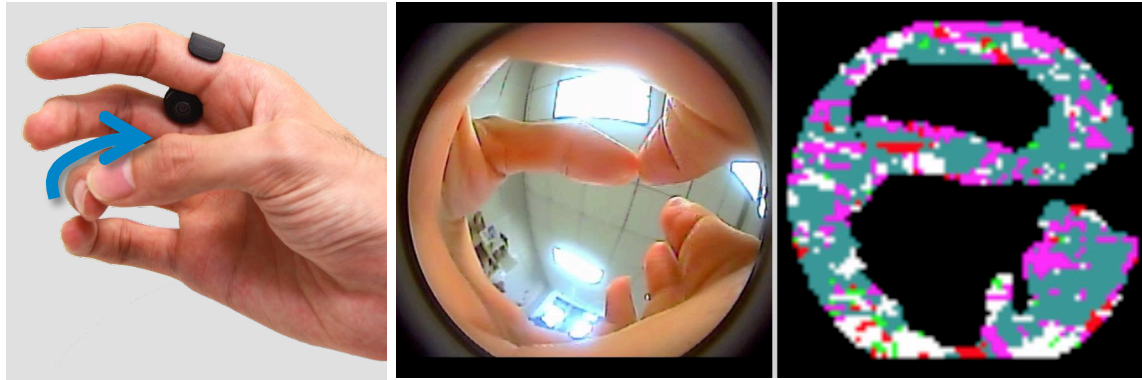
Pipeline of Gesture Recognition



Pipeline of Gesture Recognition



On-Finger Slider (Continuous Input)



0. Raw Image

1. Gesture
Recognition

On-Finger Slider (Continuous Input)



0. Raw Image

1. Gesture
Recognition

2. Find the size of
an enclosed area

Slider Value

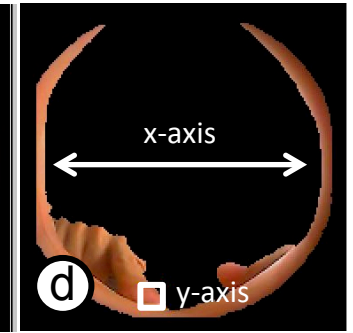
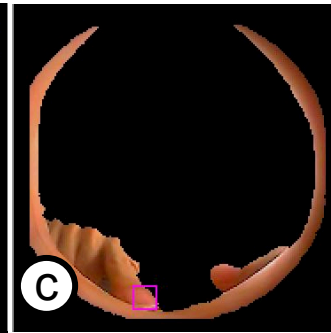
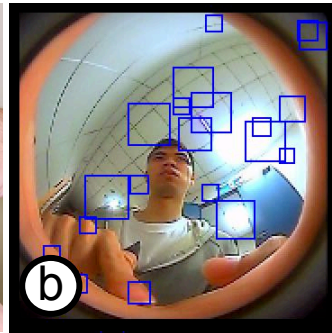
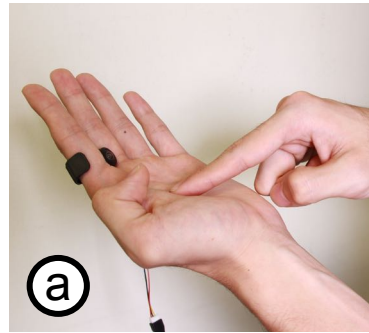
IndexFinger: 52

MiddleFinger: 80

RingFinger: 45

LittleFinger: 20

Palm Writing



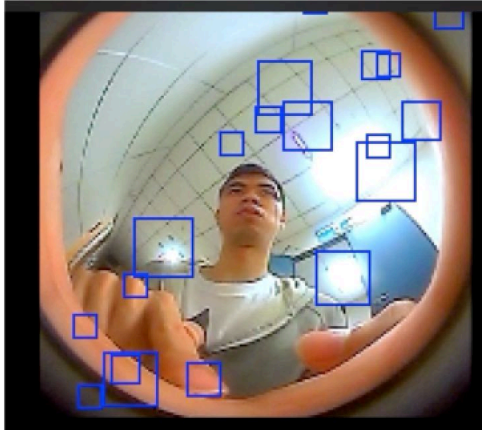
Viola-jones
fingernail
detector

Filtering
with skin
region

Stroke →
x-axis: x of the
fingernail
y-axis: size of
the fingernail



Viola-jones
fingernail detector



Viola-jones
fingernail detector



Heuristics

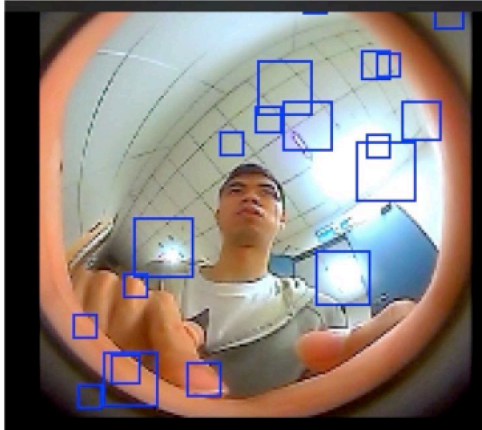
1. Only keep windows that are in contact with background region.

2. Size/temporal coherent



background





Viola-jones
fingernail detector



Heuristics

1. Only keep windows that are in contact with background region.

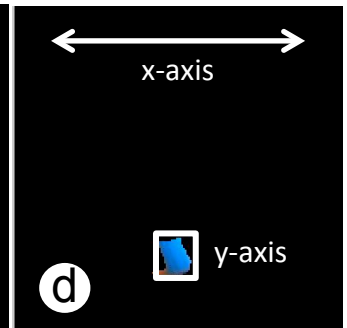
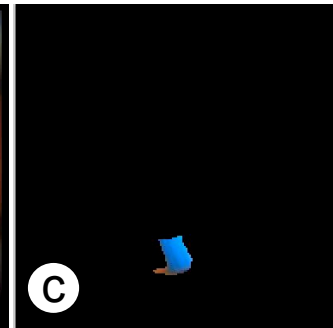
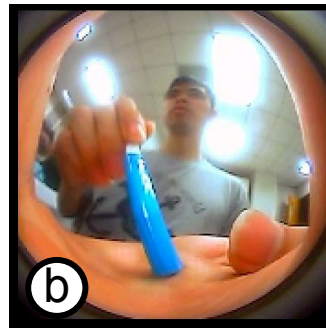
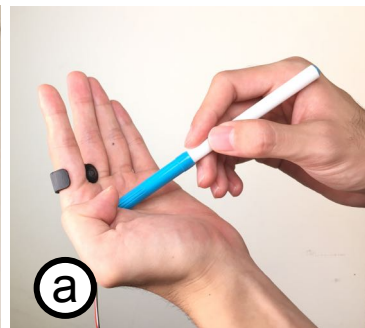
2. Size/temporal coherent



background



Pen Writing



Color
filtering

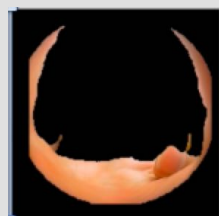
Find the part
in background
region

Stroke →
x-axis: x of
the cap
y-axis: size
of the cap

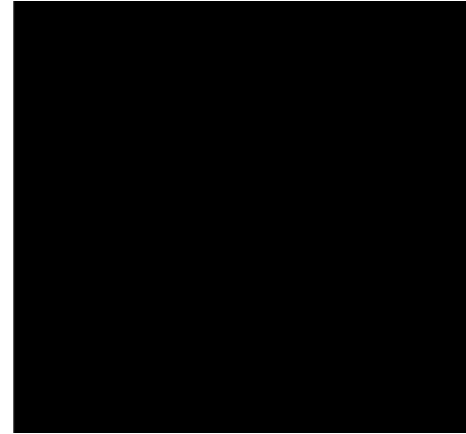


Heuristics

1. Only keep the color cap that is inside the background region.

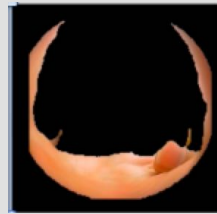


background



Heuristics

1. Only keep the color cap that is inside the background region.



background

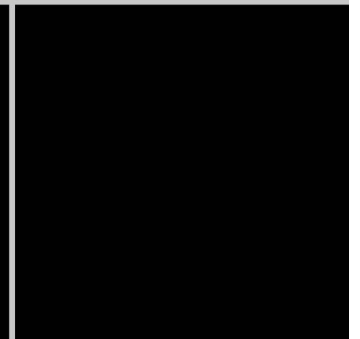
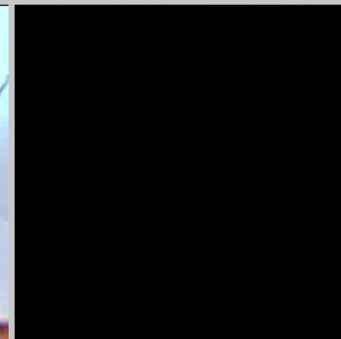
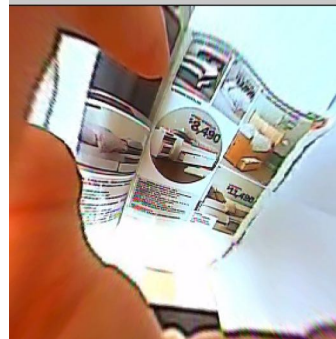
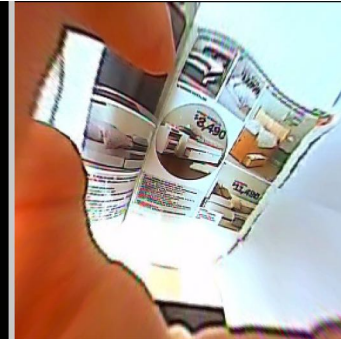
Visual Feature Tracking / Recognition



1. Lens un-distortion
2. Feature tracking (SURF)
3. Motion estimation



Cyber Clipboard

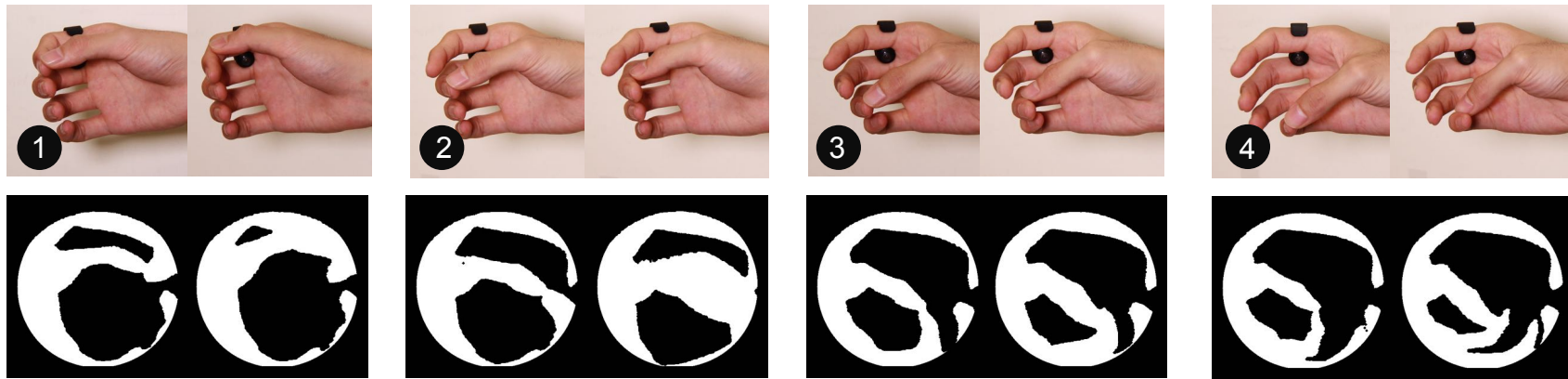


Gestural Interaction Gaming

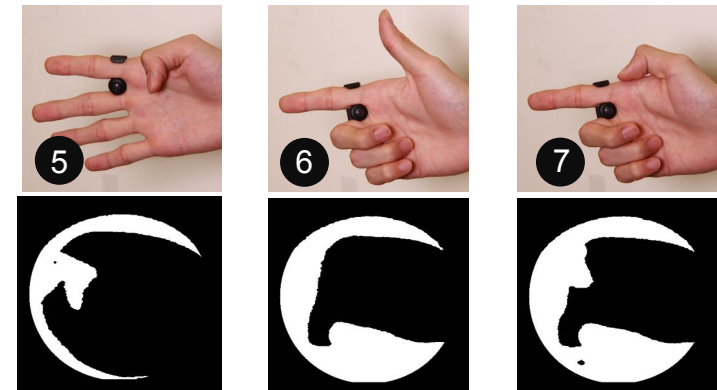


Experiment

Experiment



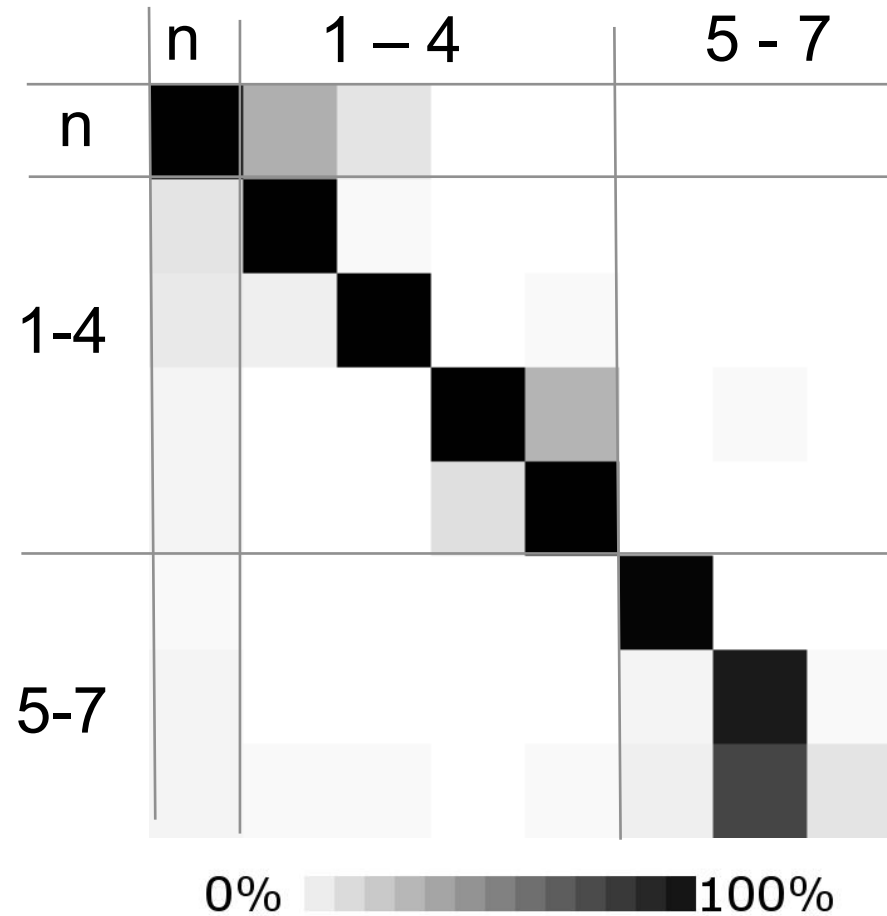
- **15 Participants**; the lengths of their hands are recorded. ($M = 17.79$ cm, $Std = 1.21$ cm)
- Non-gesture hand motions were recorded by asking to casually stretch or curl their fingers.



Experiment

Leave-one-person-out cross-validation results

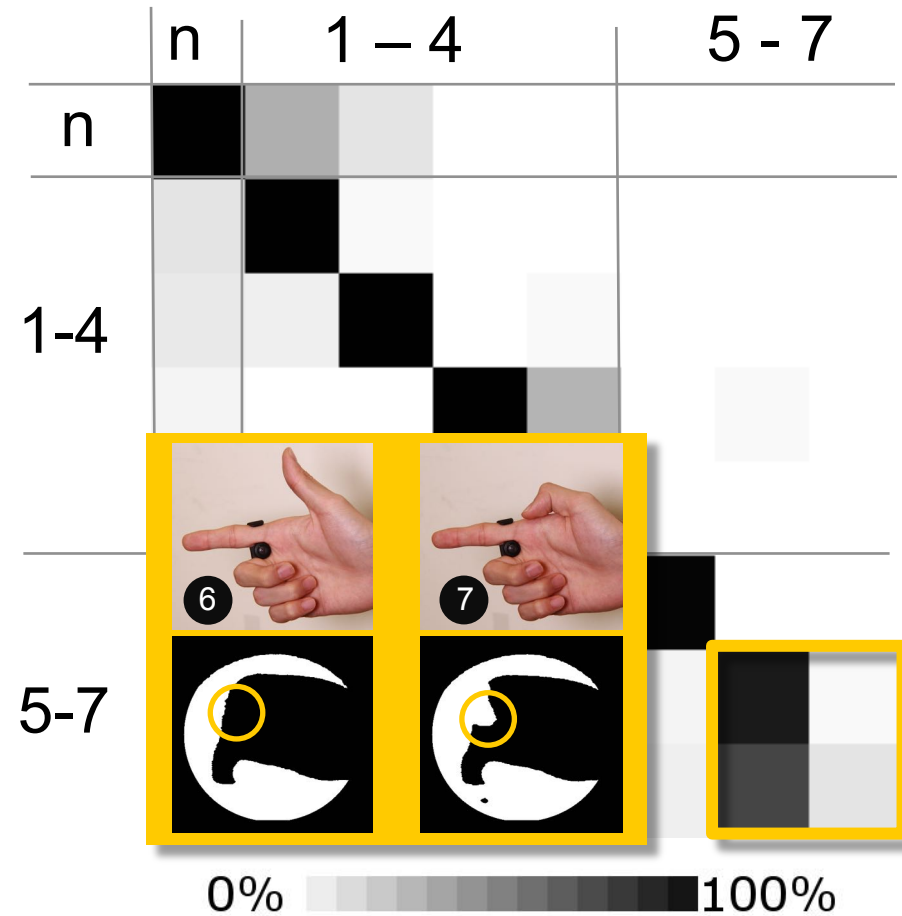
- Average gesture recognition rate:
84.75%



Experiment

Leave-one-person-out cross-validation results

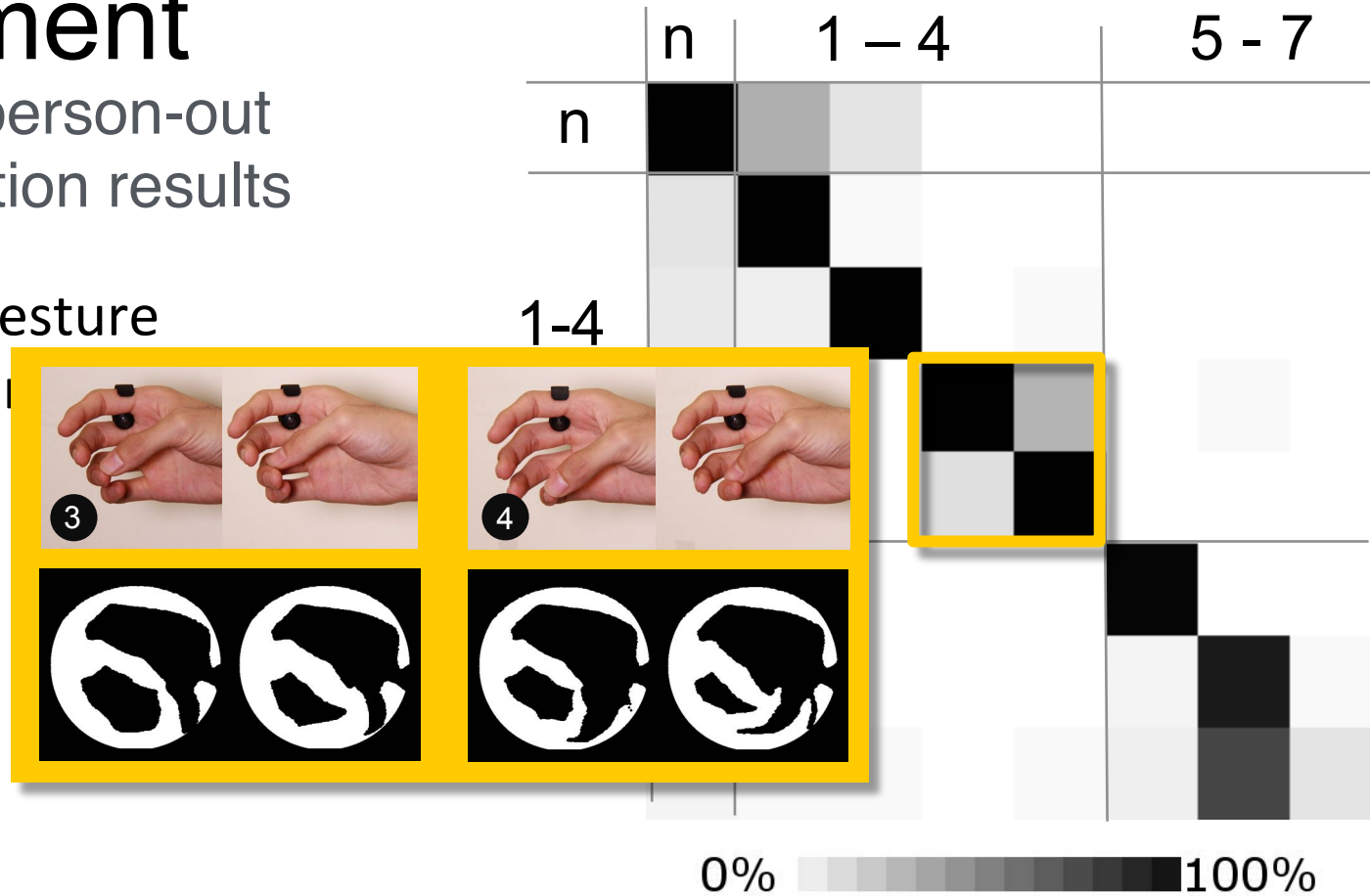
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Experiment

Leave-one-person-out cross-validation results

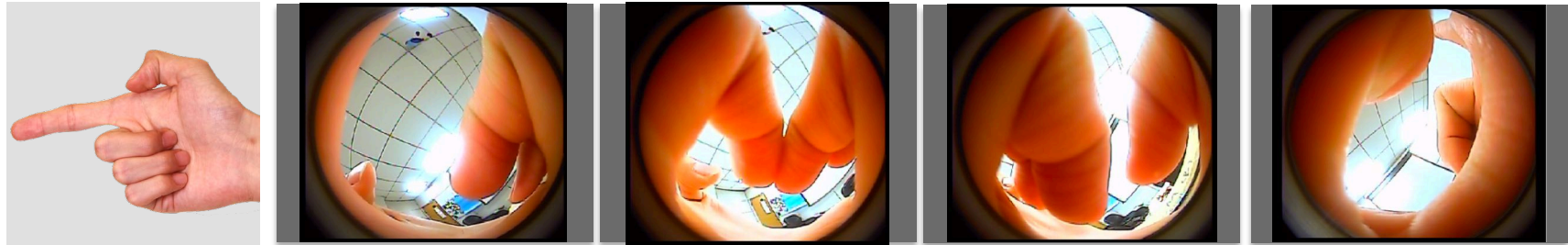
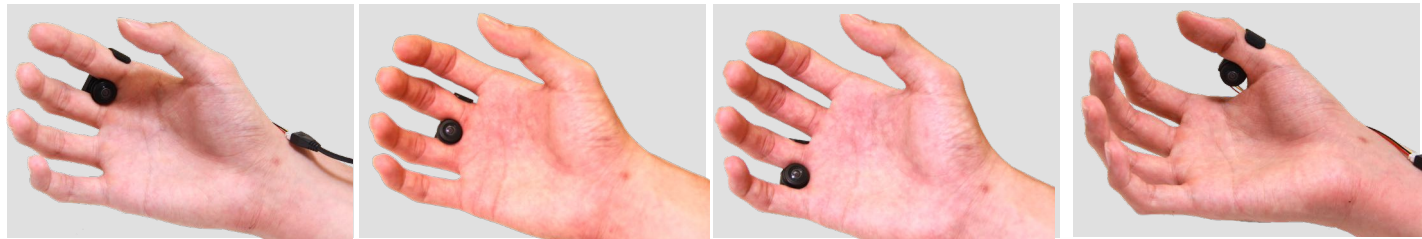
- Average gesture recognition
84.75%



Multi-lens CyclopsRing



Viewpoint from different webbings



Conclusion

- A ring-wearable for whole-hand and context-aware interaction
- Discrete Input with a gesture recognizer
- Continuous/Rich Input with heuristics
- Envision this device with wide-angle short-range depth sensing in the future

