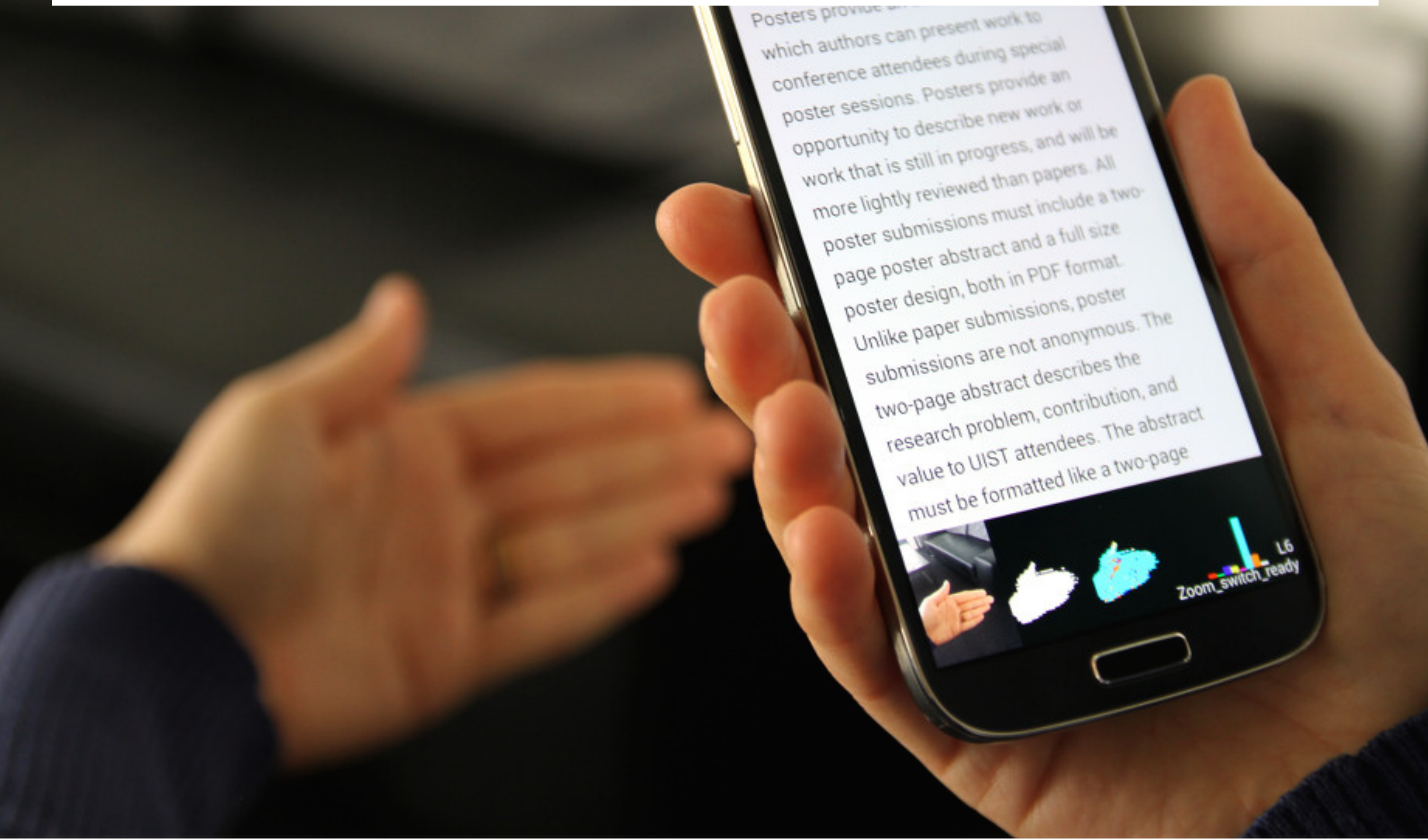
ETH zürich

Margarita Grinvald

Gesture recognition for Smartphones/Wearables



Gestures

- hands, face, body movements
- non-verbal communication
- human interaction

Gesture recognition

- interface with computers
- increase usability
- intuitive interaction

Gesture sensing

- Contact type:
  - Touch based
- Non-contact type:
  - Device gesture
  - Vision based
  - Electrical Field Sensing (EFS)

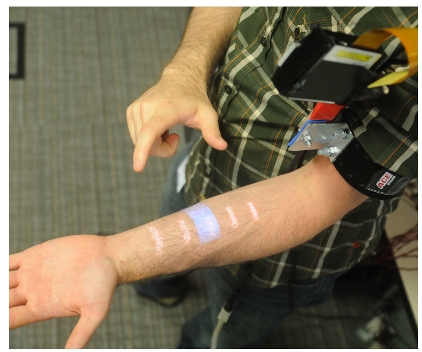
Issues on mobile devices

- miniaturisation
- lack tactile clues
- no link between physical and digital interactions
- computational power

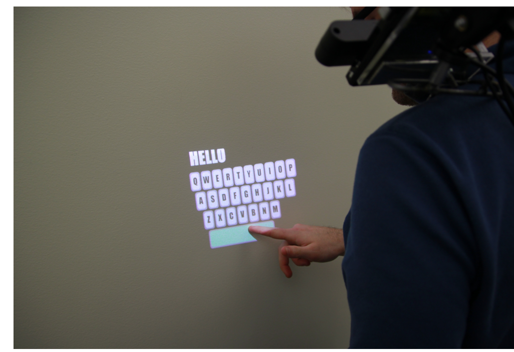
Approaches

- augment environment with digital information

Sixthsense [Mistry et al. SIGGRAPH 2009]



Skinput [Harrison et al. CHI 2010]



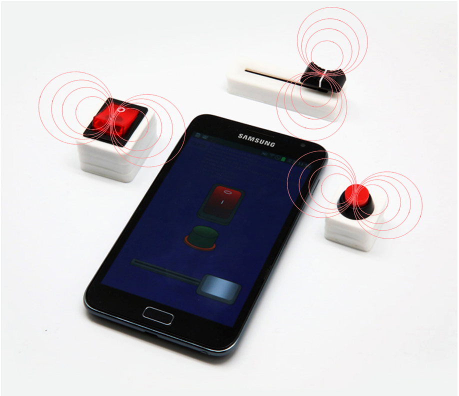
OmniTouch [Harrison et al. UIST 2011]

Approaches

- augment hardware

In-air typing interface for mobile devices with vibration feedback
[Niikura et al. SIGGRAPH 2010]

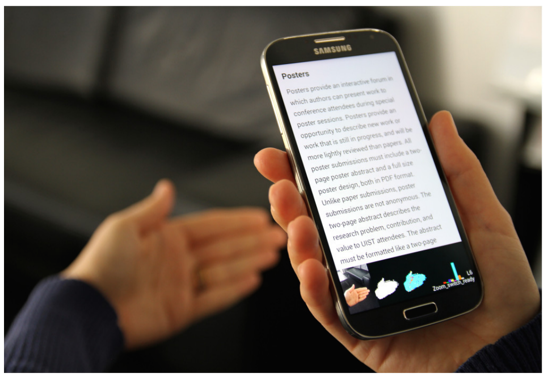
A low-cost transparent electric field sensor for 3D interaction
[Le Goc et al. CHI 2014]



MagGetz [Hwang et al. UIST 2013]

Approaches

- efficient algorithms



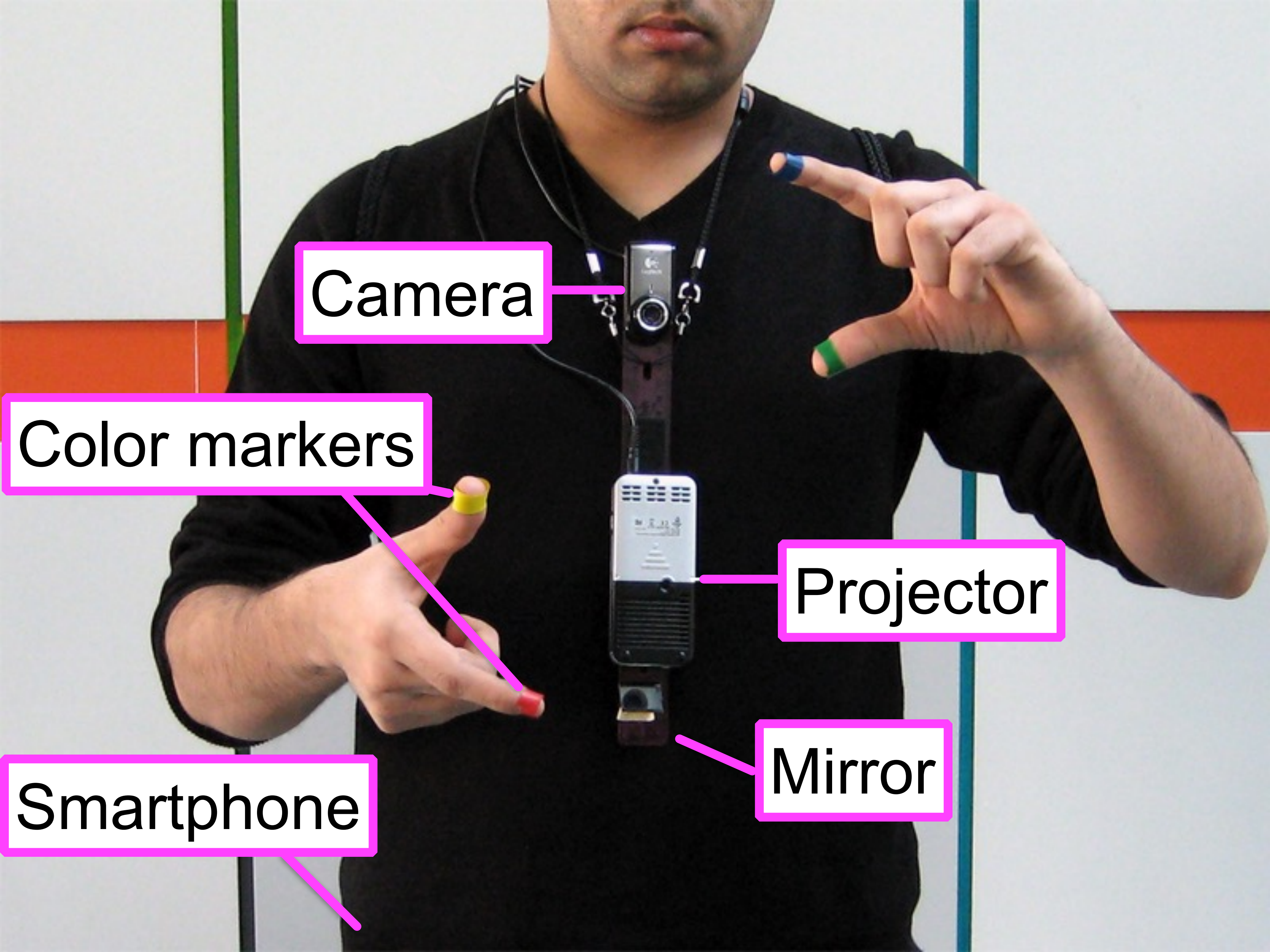
In-air gestures around unmodified mobile devices
[Song et al. UIST 2014]

- combine devices

Duet: Exploring Joint interactions on a smart phone and a smart watch
[Chen et al. CHI 2014]

Sixthsense [Mistry et al. SIGGRAPH 2009]

- augment environment with visual information
- interact through natural hand gestures
- wearable to be truly mobile



Camera
Color markers
Projector
Mirror
Smartphone

Support for arbitrary surfaces

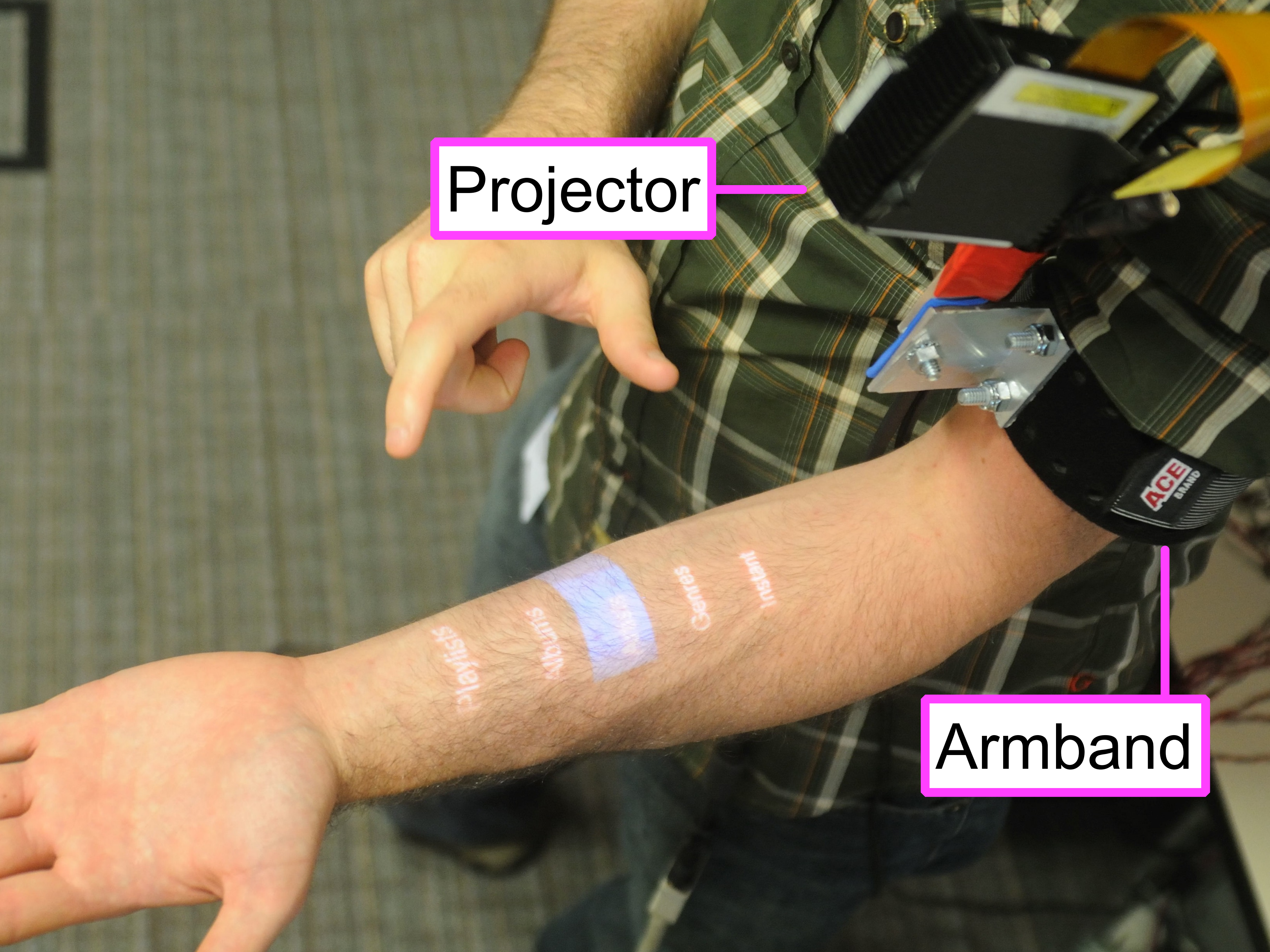
Support for multitouch

Limitations

- inability track surfaces
- differentiate hover and click
- accuracy limitations

Skinput [Harrison et al. CHI 2010]

- skin as input canvas
- wearable bio-acoustic sensor
- localisation of finger tap


Projector
Armband
Playlists
Albums
Genres
Instant

Mechanical phenomena

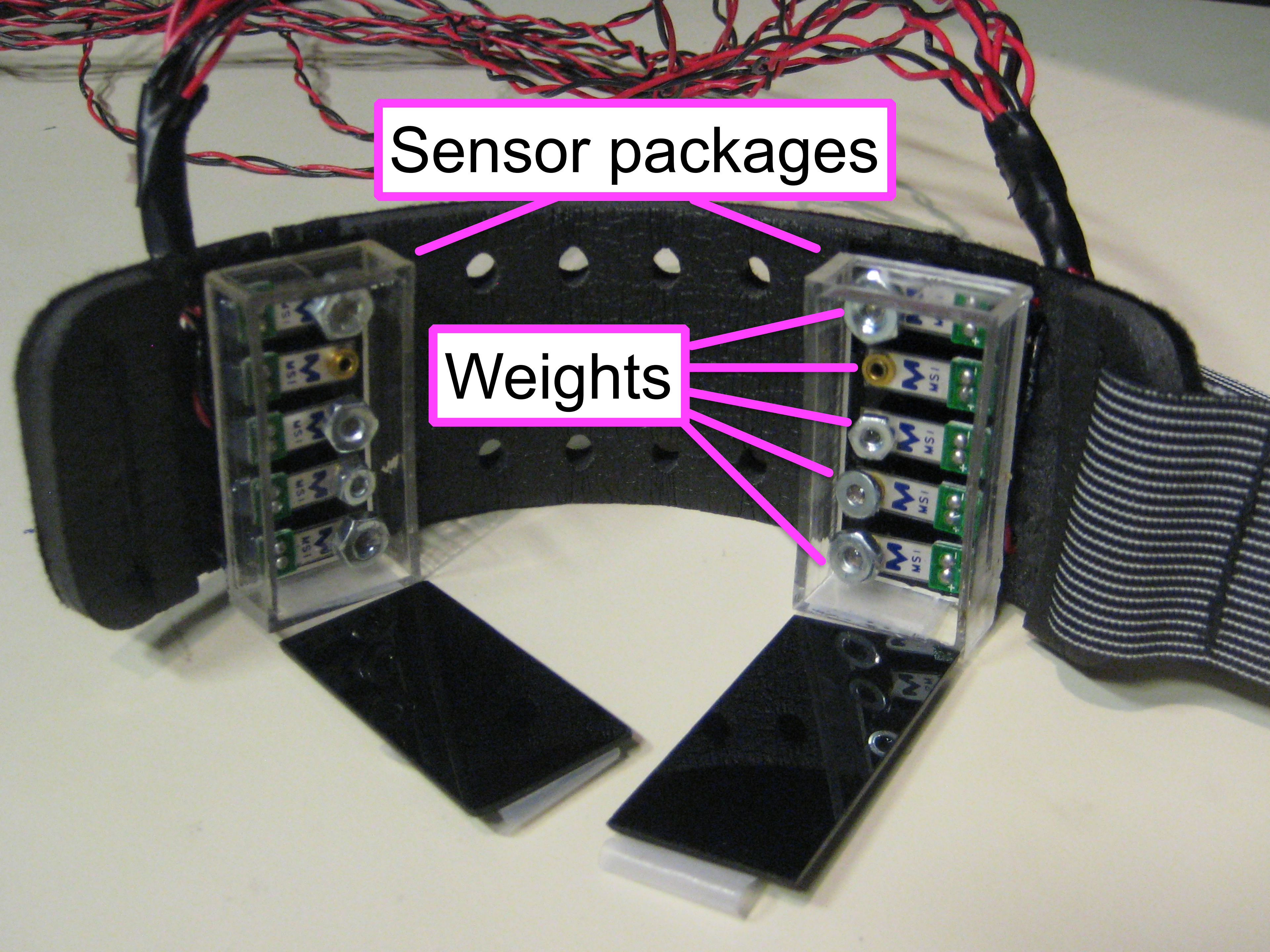
- finger tap on skin generates acoustic energy
  - some energy becomes sound waves
  - some energy transmitted through the arm

Transverse waves

Longitudinal waves

Sensing

- array of tuned vibrations sensors
- sensitive only to motion perpendicular to skin
- two sensing arrays to disambiguate different armband positions.


Sensor packages
Weights

Tap localisation

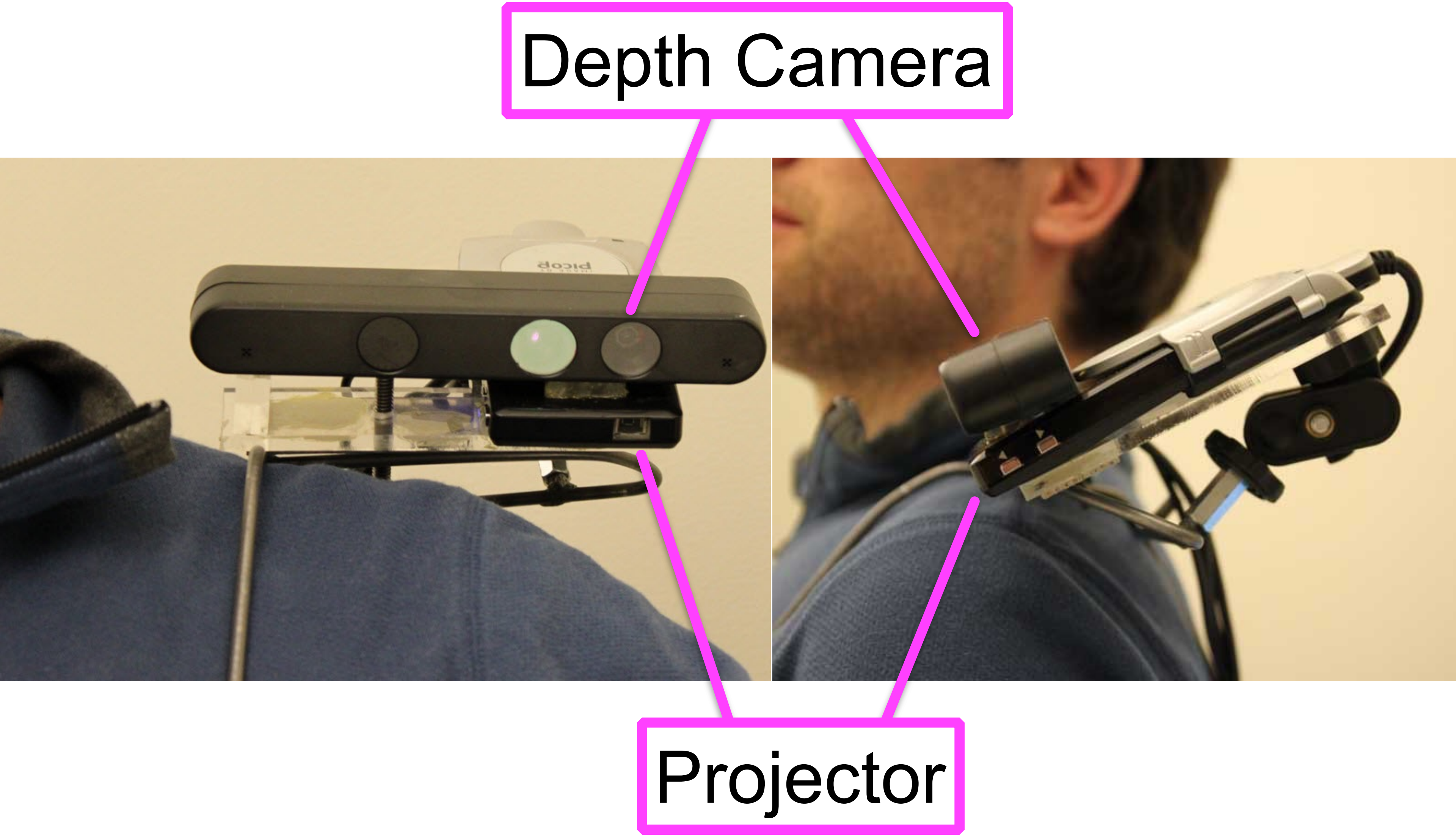
- sensor data segmented into taps
- ML classification of location
- initial training stage

Limitations

- lack of support of other surfaces than skin
- no multitouch support
- no touch drag movement

OmniTouch [Harrison et al. UIST 2011]

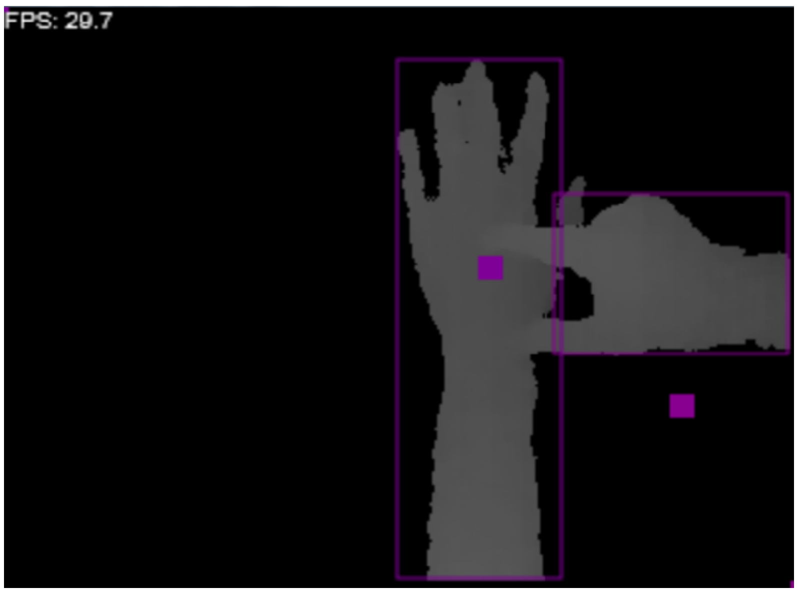
- appropriate on demand ad hoc surfaces
- depth sensing and projection wearable
- depth driven template matching


Depth Camera
Projector

Finger tracking

- multitouch finger tracking on arbitrary surfaces
- no calibration or training
- resolve position and distinguish hover from click

Finger segmentation

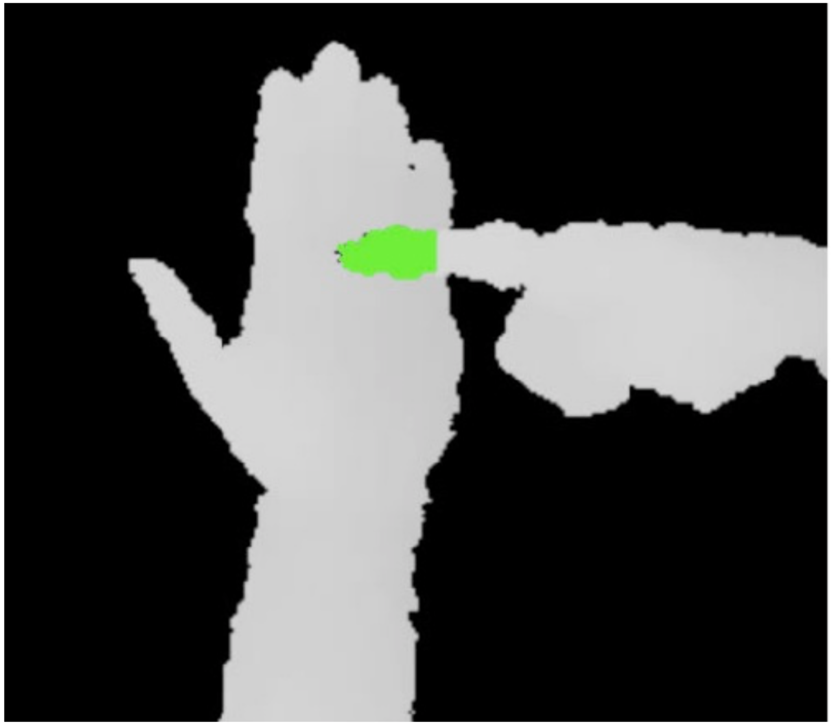


Depth map

Finger segmentation

Candidates

Click detection

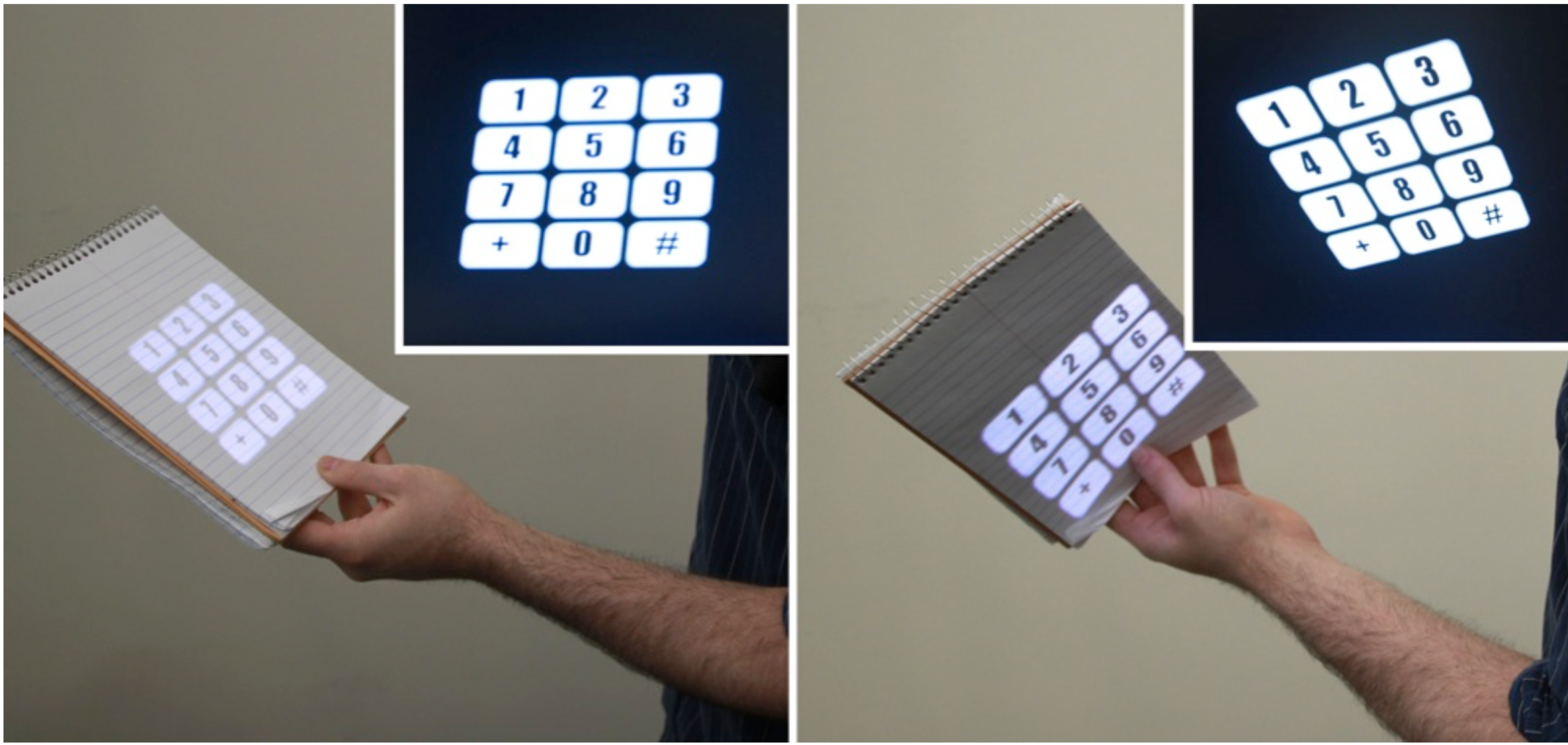


Finger hovering

On demand interfaces

- expand application space with graphical feedback
- track surface on which rendered
- update interface as surface moves

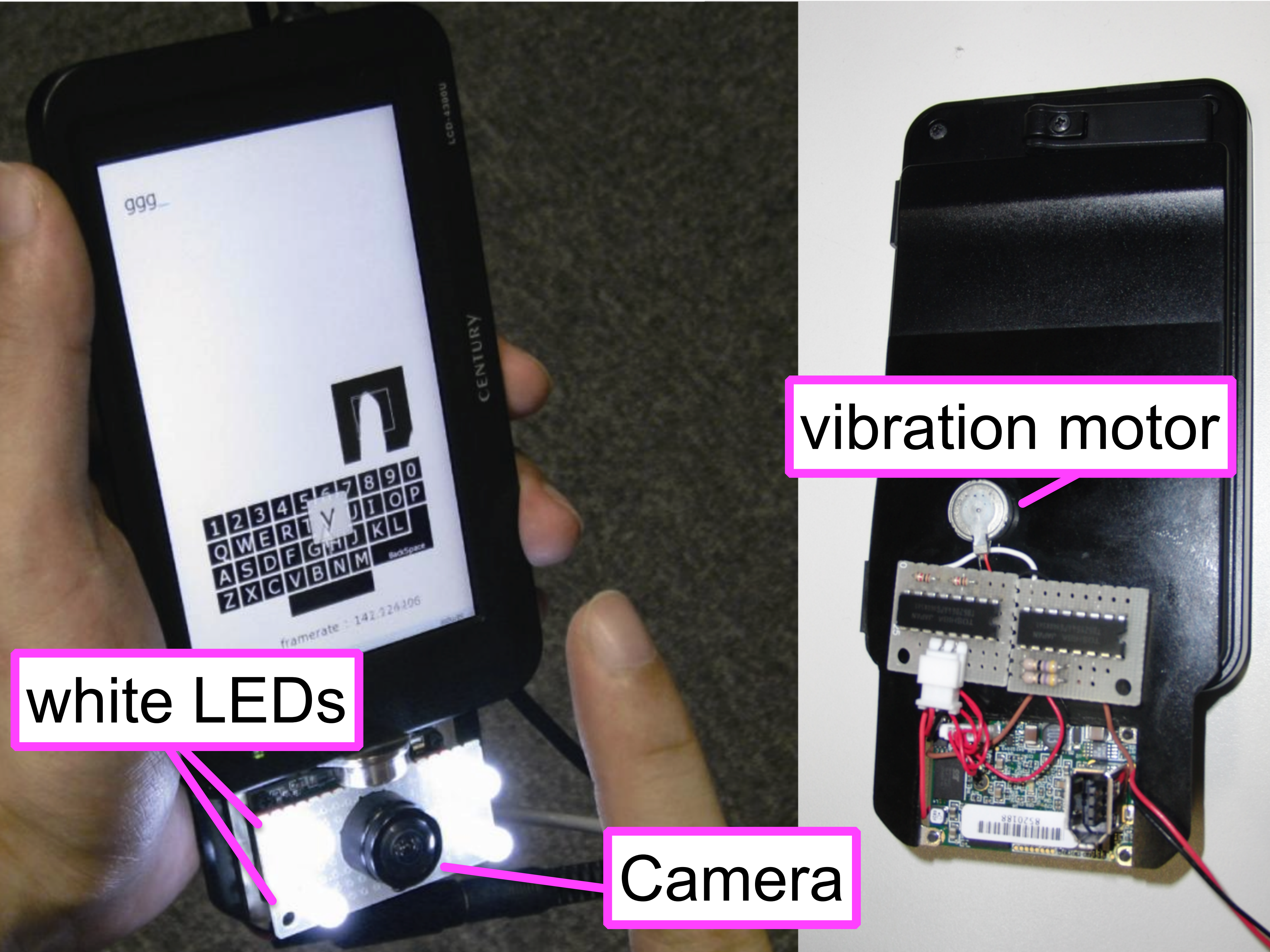
Interface ‘glued’ to surface



In-air typing interface for mobile devices with vibration feedback

[Niikura et al. SIGGRAPH 2010]

- vision based 3D input interface
- detect keystroke action in the air
- provide vibration feedback


vibration motor
white LEDs
Camera

Tracking

- high frame rate camera
- wide angle lens needs distortion correction
- skin colour extraction to detect fingertip
- estimate fingertip translation, rotation and scale

Keystroke feedback

- difference of the dominant frequency of the fingertips scale to detect keystroke
- tactile feedback is important
- vibration feedback is conveyed after a keystroke

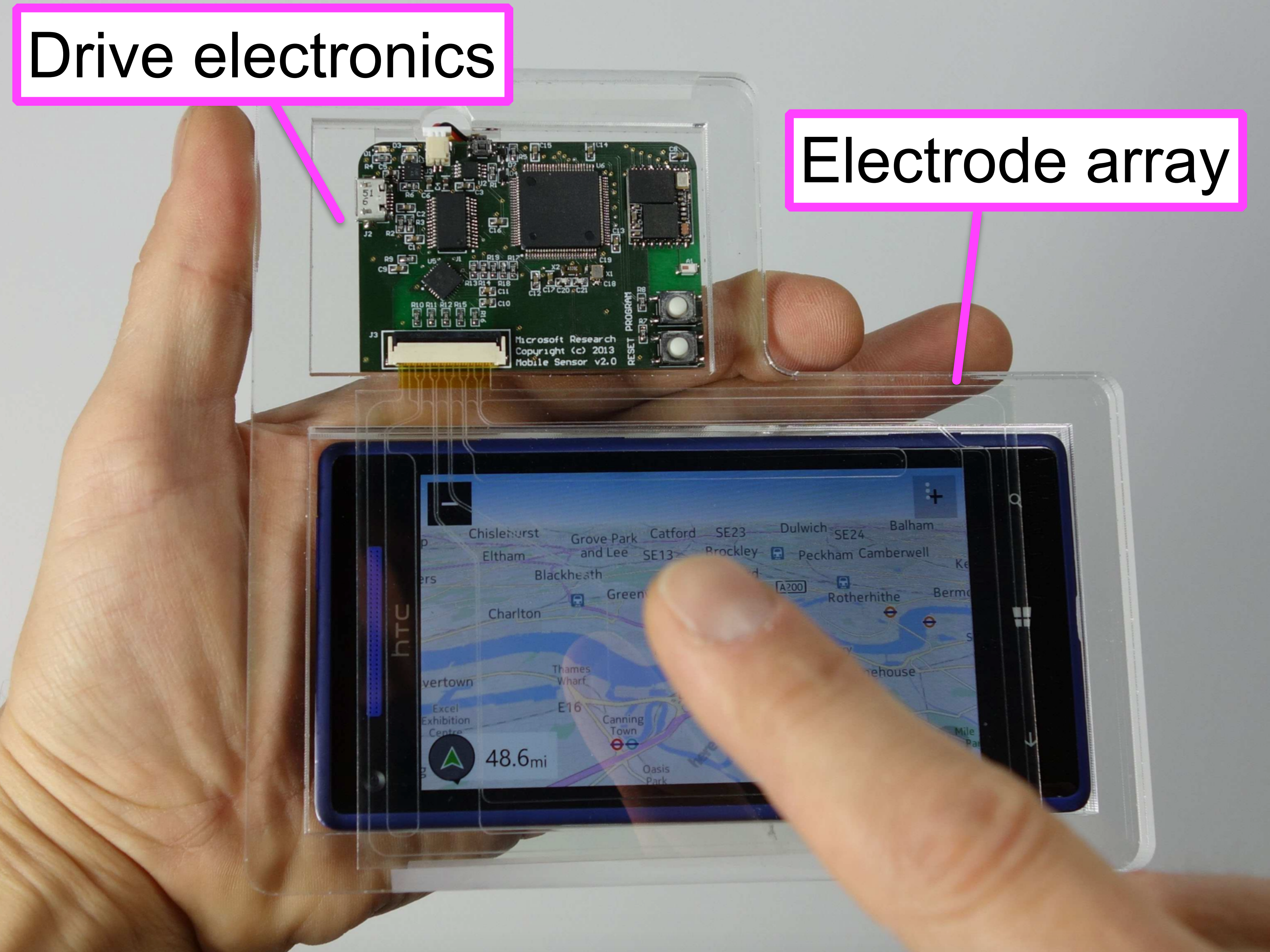
Vision limitations

- camera is rich and flexible but with limitations
- minimal distance between sensor and scene
- sensitivity to lighting changes
- computational overheads
- high power requirements

A low-cost transparent electric field sensor for 3D interaction

[Le Goc et al. CHI 2014]

- smartphone augmented with EFS
- resilient to illumination changes
- mapping measurements to 3D finger positions.



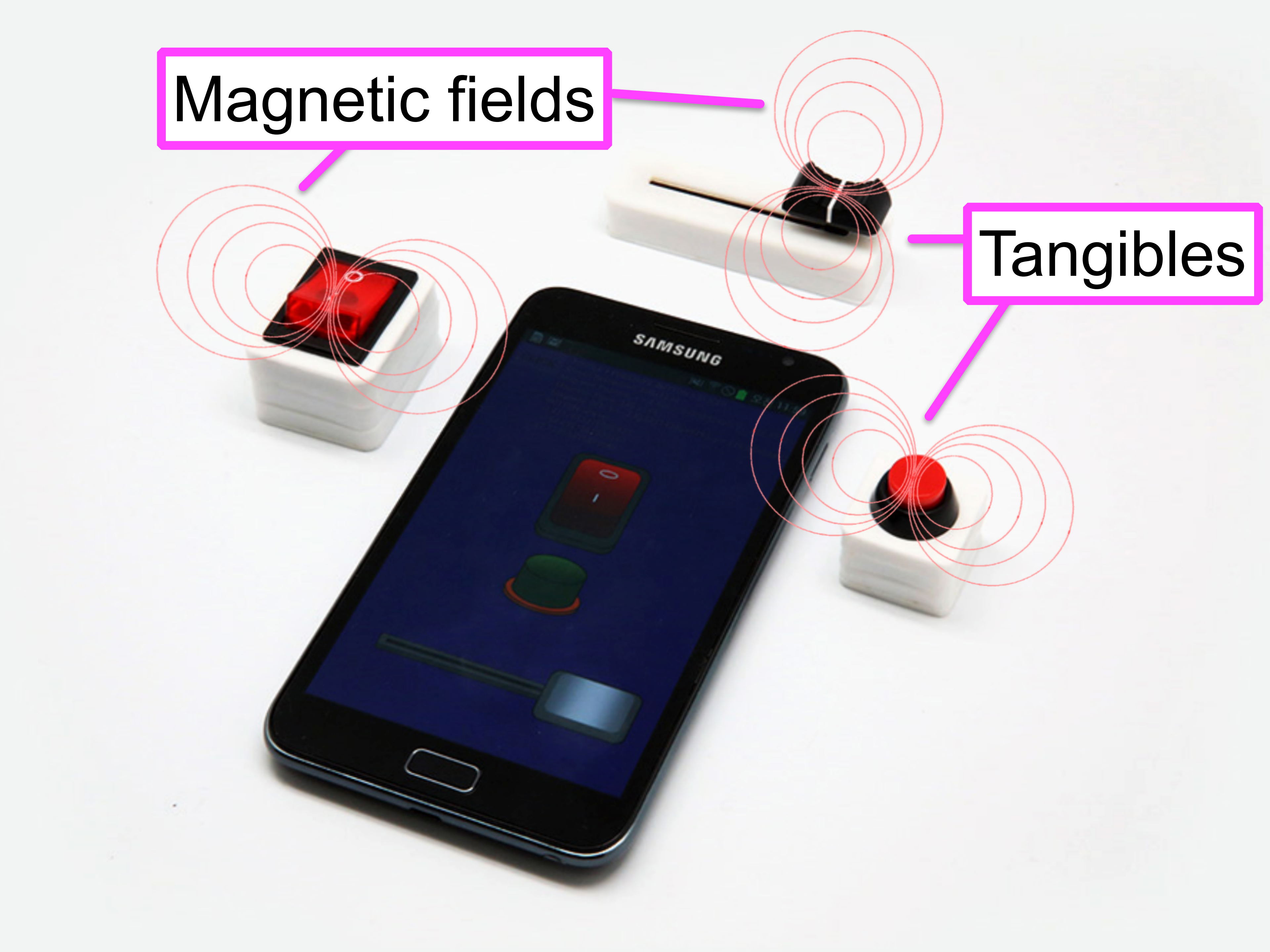
Drive electronics
Electrode array
Microsoft Research
Copyright (c) 2013
Mobile Sensor v2.0
RESET
PROGRAM
htc
Chislehurst
Eltham
Grove Park
and Lee
Catford
SE23
SE13
Brockley
Dulwich
SE24
Peckham
Camberwell
Balham
Blackheath
Rotherhithe
Charlton
Thames
Wharf
E16
Canning
Town
Excel
Exhibition
Centre
Oasis
Park
48.6mi

Recognition

- microchip built-in 3D positioning has low accuracy
- Random Decision Forests for regression on raw signal data
- speed and accuracy

MagGetz [Hwang et al. UIST 2013]

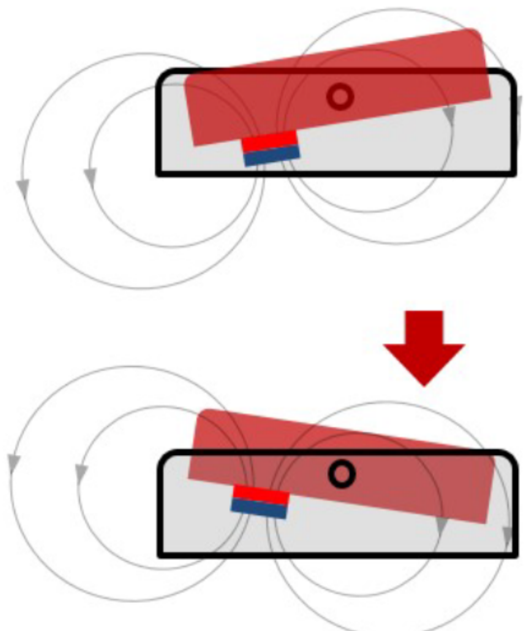
- tangible control widgets for richer tactile clues
- wider interaction area
- low cost and user configurable unpowered magnets


Magnetic fields
Tangibles
SAMSUNG

Tangibles

- traditional physical input controls with magnets
- magnetic traces change on widget state change
- track physical movement of control widgets

Tangibles magnetism



Toggle switch

Limitations

- object damage by magnets
- magnetometer limitations

In-air gestures around unmodified mobile devices

[Song et al. UIST 2014]

- extend interaction space with gesturing
- mobile devices RGB camera
- robust ML based algorithm

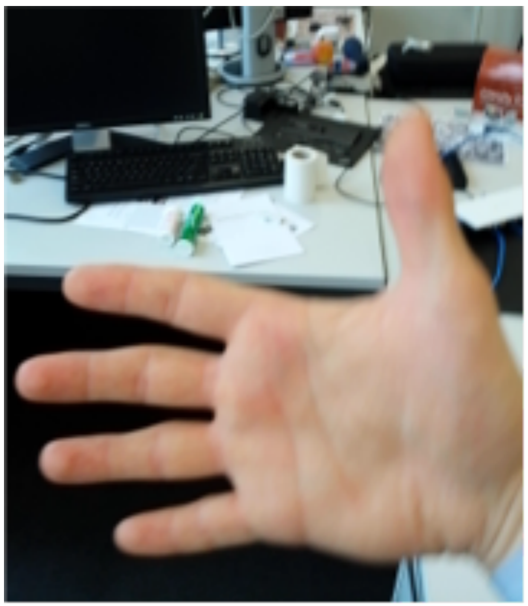
Gesture recognition

- detection of salient hand parts (fingertips)
- works without relying on highly discriminative depth data and rich computational resources
- no strong assumption about users environment
- reasonably robust to rotation and depth variation

Recognition algorithm

- real time algorithm
- pixel labelling with random forests
- techniques to reduce memory footprint of classifier

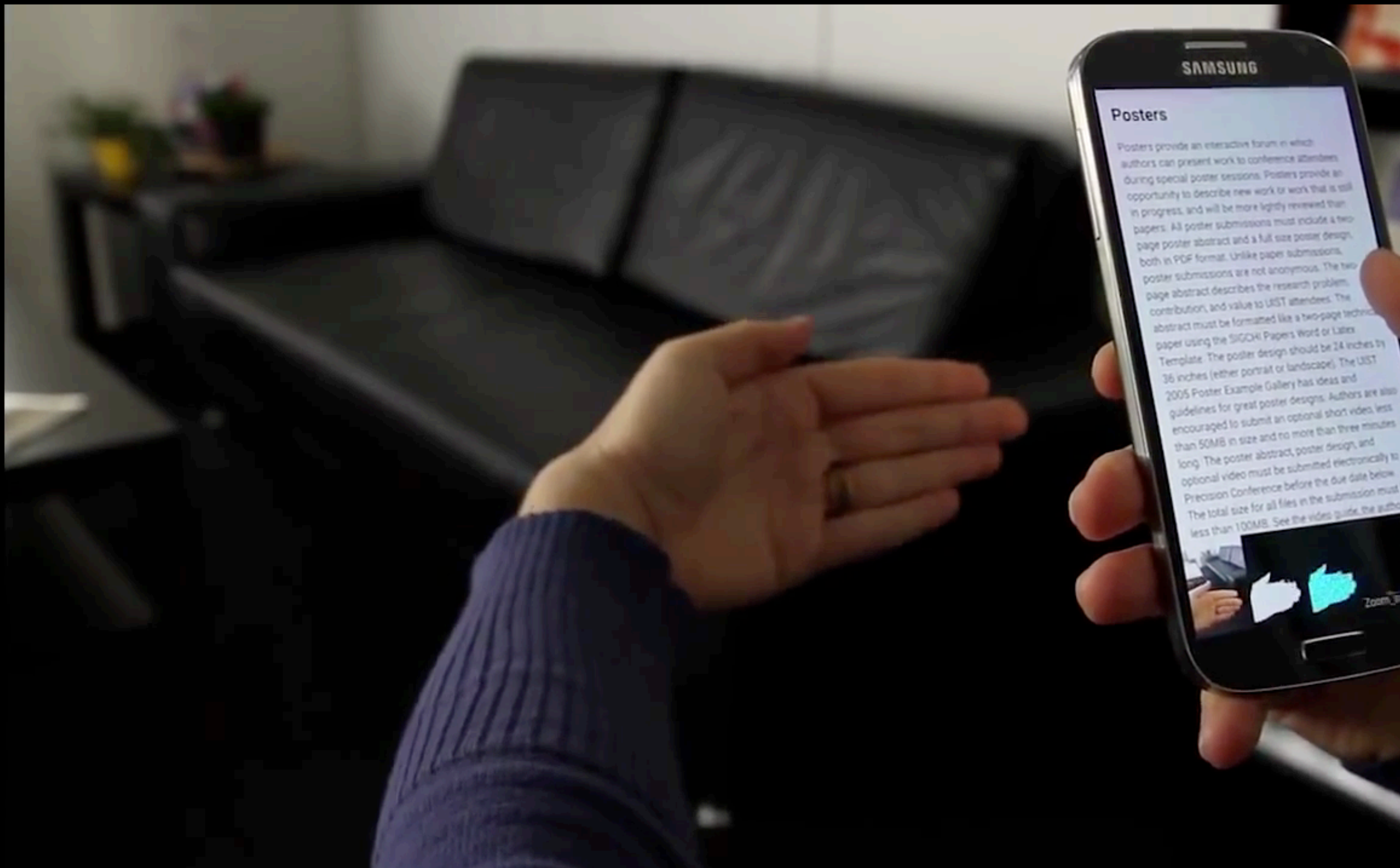
Recognition steps



RGB input

Applications

- division of labor
- works on many devices
- new apps enabled just by collecting new data


SAMSUNG
Posters

Duet: Exploring joint interactions on a smart phone and a smart watch

[Chen et al. CHI 2014]

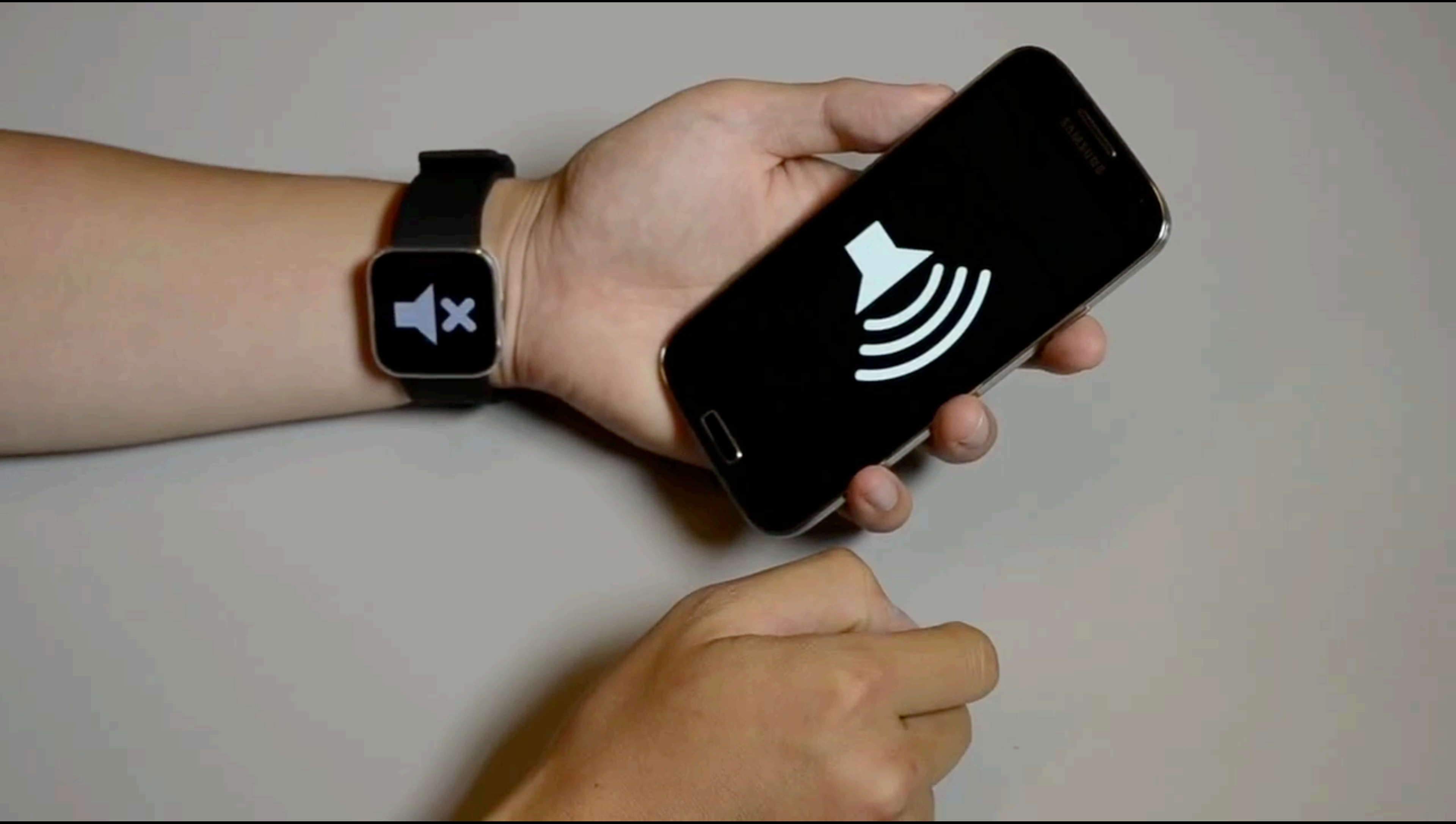
- beyond usage of single device
- allow individual input and output
- joint interactions smart phone and smart watch

Design space theory

- conversational duet
- foreground interaction
- background interaction

Design space

	Watch Foreground	Watch Background
Phone Foreground	Duet: • Phone as a primary input and output platform; • Watch as an input device or extended display.	Duet: • Phone as a primary input and output platform; • Watch as a sensor.
Phone Background	Current commercial designs: • Phone as an inactivated information portal • Watch as a viewport or remote control	Prior research: • Both phone and watch used for context and activity sensing



Design space

	Watch Foreground	Watch Background
Phone Foreground	Duet: • Phone as a primary input and output platform; • Watch as an input device or extended display.	Duet: • Phone as a primary input and output platform; • Watch as a sensor.
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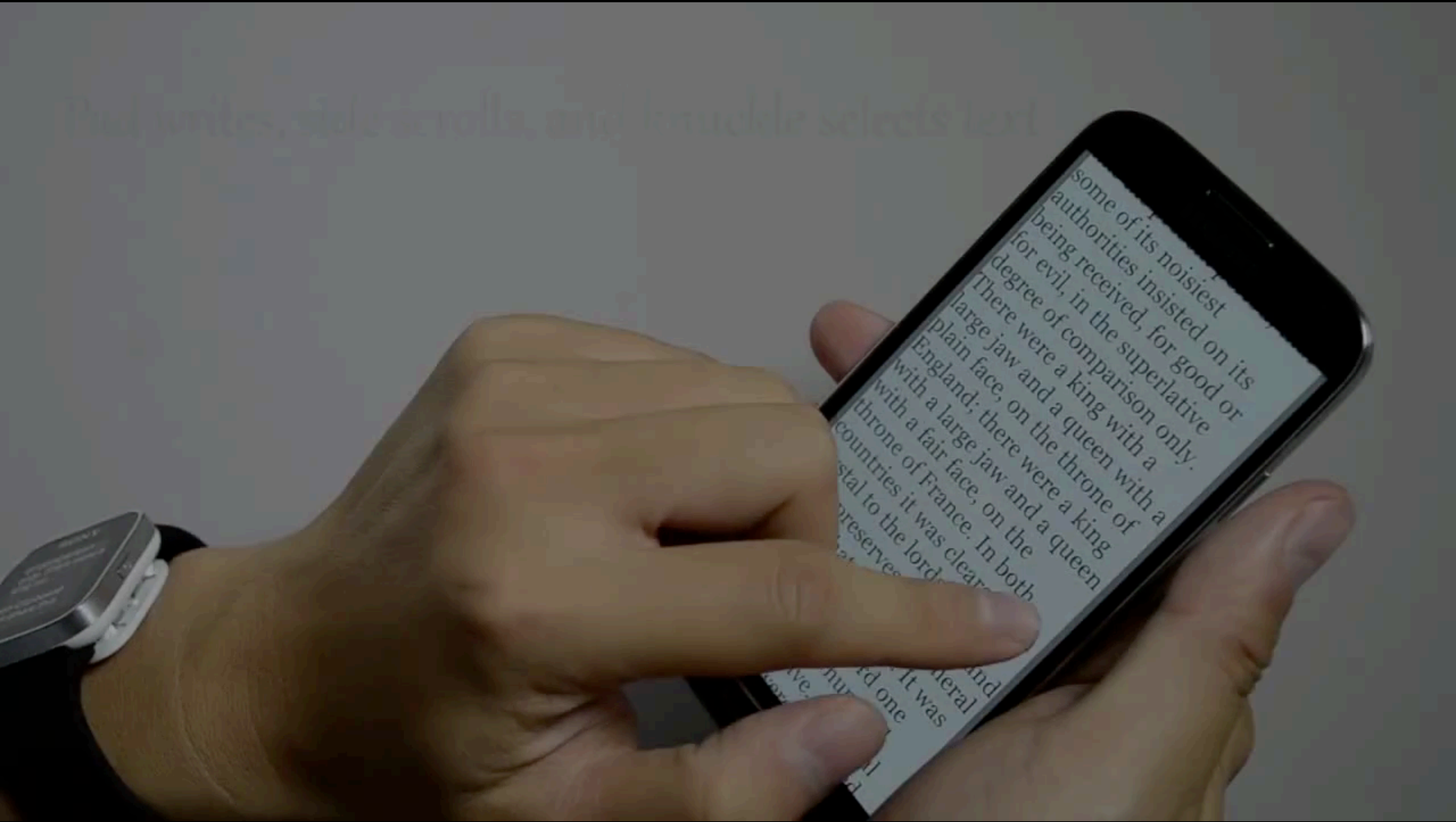
Pad writes, side scrolls, and knuckle selects text
some of its noisiest
authorities insisted on its
being received, for good or
for evil, in the superlative
degree of comparison only.
There were a king with a
large jaw and a queen with a
plain face, on the throne of
England; there were a king
with a large jaw and a queen
with a fair face, on the
throne of France. In both

Gesture recognition

- ML techniques on accelerometer data
- handedness recognition
- promising accuracy

Summary

- wearables extend interaction space to everyday surfaces
- augmented hardware in general provides an intuitive interface
- no additional hardware is preferable but there are still computational limitations
- combination of devices may be redundant

References

- SixthSense: a wearable gestural interface [Mistry et al. SIGGRAPH 2009]
- Skinput: Appropriating the Body As an Input Surface [Harrison et al. CHI 2010]
- OmniTouch: Wearable Multitouch Interaction Everywhere [Harrison et al. UIST 2011]
- In-air typing interface for mobile devices with vibration feedback [Niikura et al. SIGGRAPH 2010]
- A Low-cost Transparent EF Sensor for 3D Interaction on Mobile Devices [Le Goc et al. CHI 2014]
- MagGetz: customizable passive tangible controllers on and around [Hwang et al. UIST 2013]
- In-air gestures around unmodified mobile devices mobile devices [Song et al. UIST 2014]
- Duet: Exploring Joint Interactions on a Smart Phone and a Smart Watch [Chen et al. CHI 2014]