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

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
- combine devices

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

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
Support for arbitrary surfaces
Support for multitouch
Limitations

- inability to 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
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
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
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
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
Posters

Posters provide an interactive forum in which authors can present work to conference attendees during special poster sessions. Posters provide an opportunity to describe new work or work that is still in progress, and will be more highly reviewed than papers. All poster submissions must include a title slide, a full-page poster abstract, and a full-size poster design, both in PDF format.

Posters are 36 x 48 inches (either portrait or landscape). The abstract must be formatted like a two-page technical paper using the SIGCHI Papers’ Word or LaTeX Template. The poster design should be 34 x 48 inches. Authors are encouraged to submit an optional poster design. The poster must be submitted electronically by the due date below. The total size for all fills in the submission must be less than 10MB. See the video guide for authors.
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

<table>
<thead>
<tr>
<th>Phone Foreground</th>
<th>Watch Foreground</th>
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Paul writes, side scrolls, and knuckle selects text.
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]
- 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]
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