
OPEN LAB DAY
05.12.13, 18:00 bis 22:00
Amalienstraße 17
www.medien.ifi.lmu.de/openlab

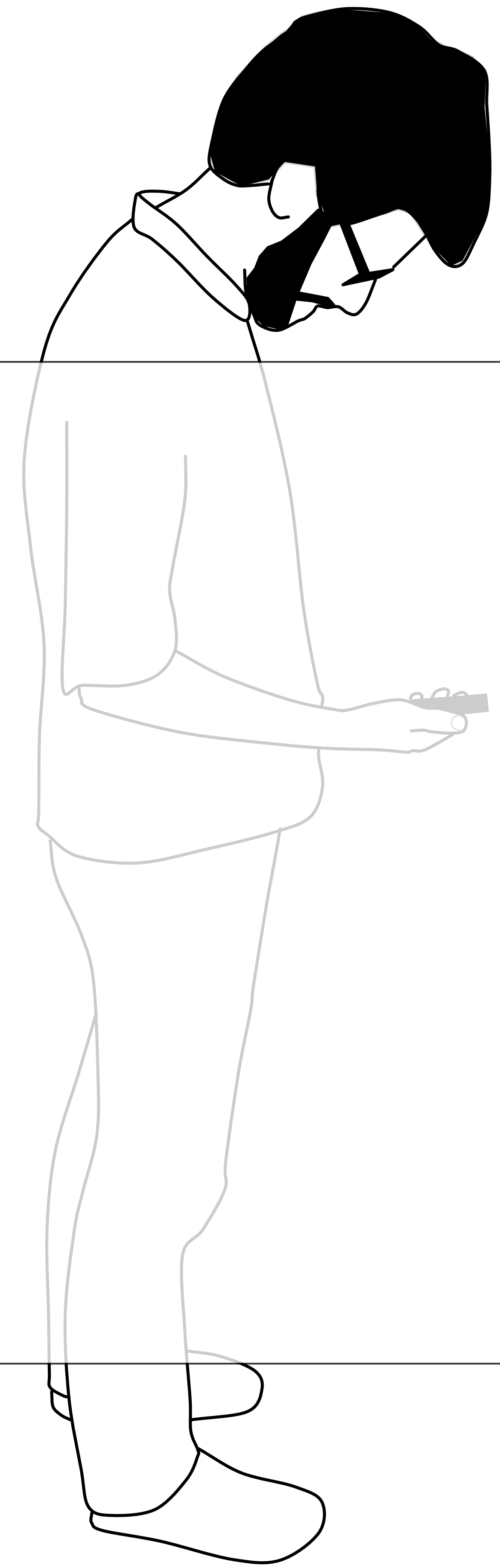
Correction: CD-gain

- control-display gain = unit free coefficient that maps the movement of the pointing device to the movement of the display pointer
  - gain = 1: display pointer moves exactly the same distance and speed as the control device
  - gain < 1: display pointer moves slower, covering less distance than the control device
  - gain > 1: display pointer moves proportionality farther and faster than the control device cursor movement.

$$CDgain = \frac{V_{pointer}}{V_{device}}$$

Literature: Géry Casiez et al., “The impact of Control-Display Gain on User Performance in Pointing Tasks”. In HCI, Vol.3 2008, pp. 215-250.

Mobile Technologies



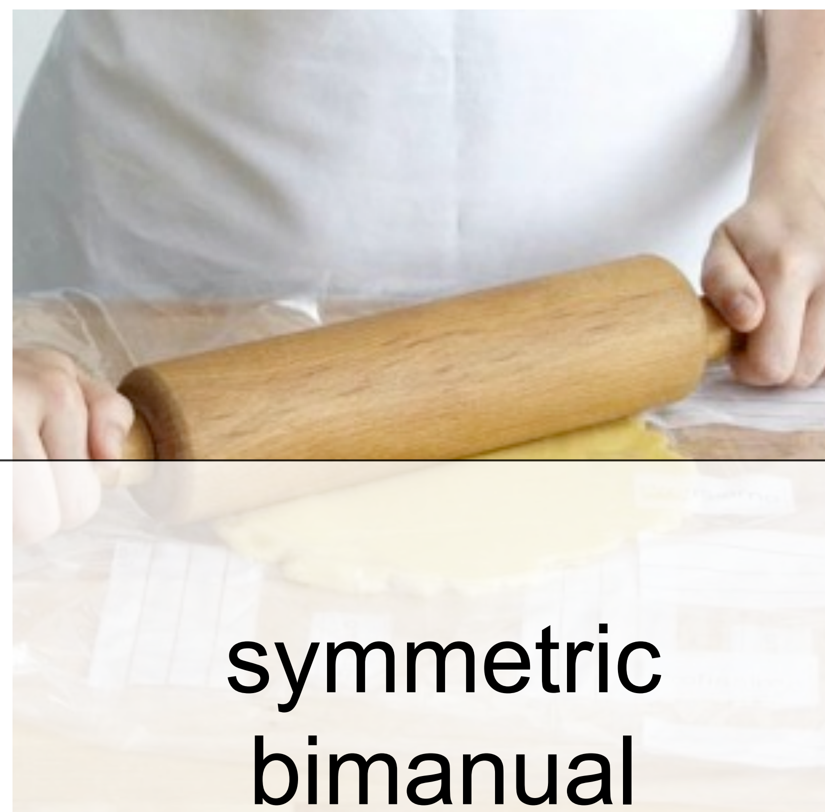
- context and task
- **challenges**
- input technologies
- challenges in interaction design
- output technologies

Theories and Models

- Device Support
  - – how HCI research started to consider the kinematic chain
  - – spatial relationship to the device affects interaction performance and perceived comfort
    - BiTouch Design Space, extension of Guiard's theory
- Gestural Input
  - – what we loose when moving from keyboard and mouse and direct touch interaction
  - – missing standards, how to describe gestures?
    - gesture documentation
    - physical approach to gestures
- Hand Occlusion
  - – how a controlled experiment can help you to come up with an approximate model of you hand occlusion
  - – how that inspires design of interaction techniques
  - – how to describe the imprecision by extending Fitt's law

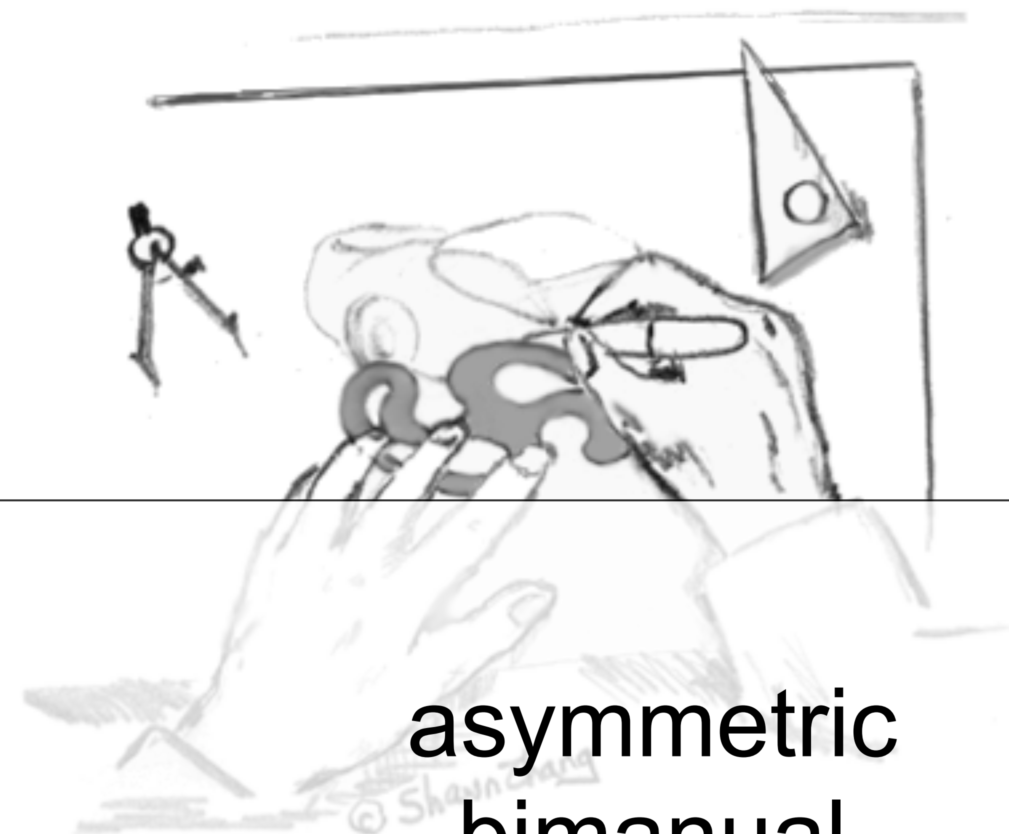
Complex Multi-limb Coordination

- Bimanual interaction
  - is not the sum of two uni-manual actions
  - remember sketchpad!
- Whole body interaction



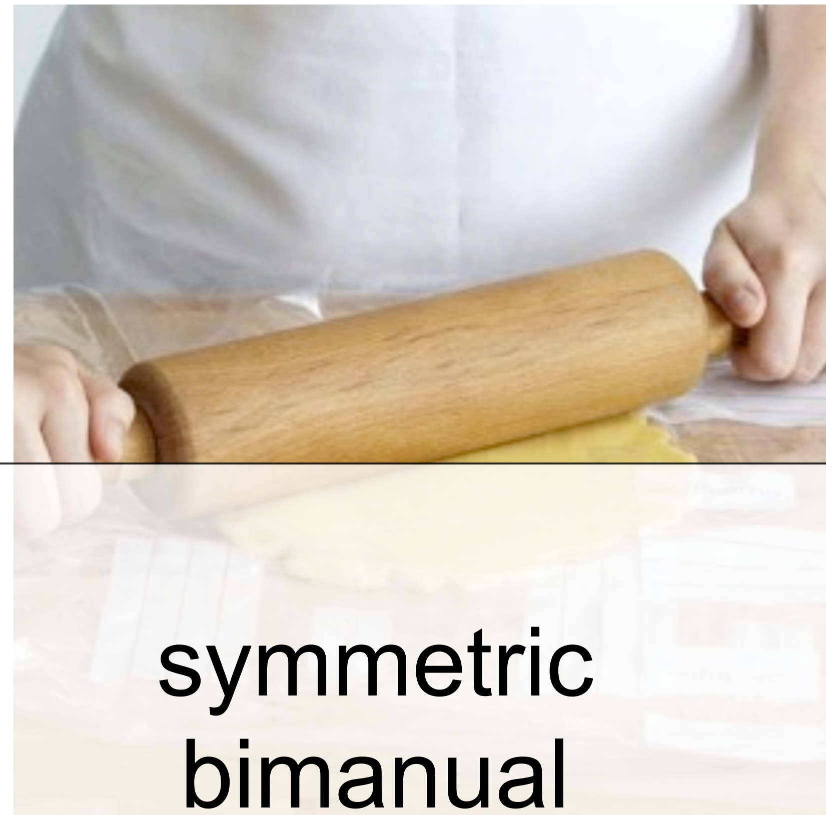
symmetric bimanual action

http://www.lecker.de/media/redaktionell/leckerde/backen_1/weihnachten_10/plaetzchenbacken/hbv_1382/muerbeteig-ausrollen_img_308x0.jpg



asymmetric bimanual action

bimanual interaction



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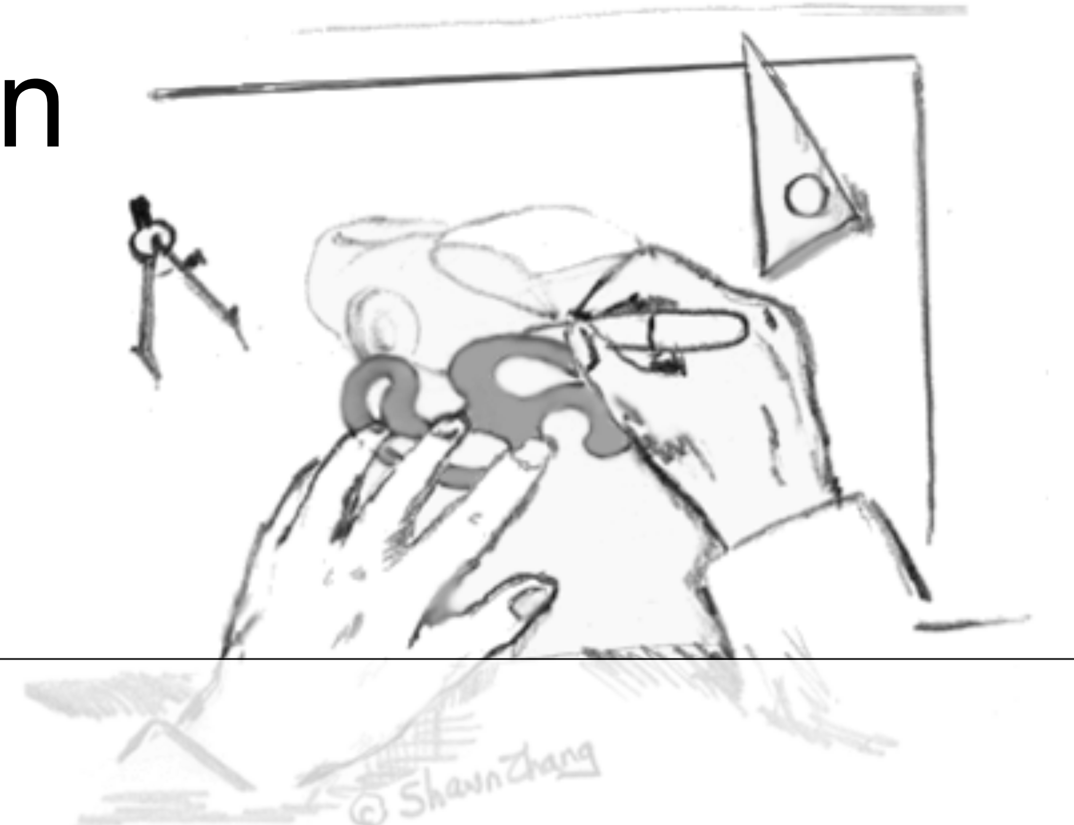
symmetric bimanual action

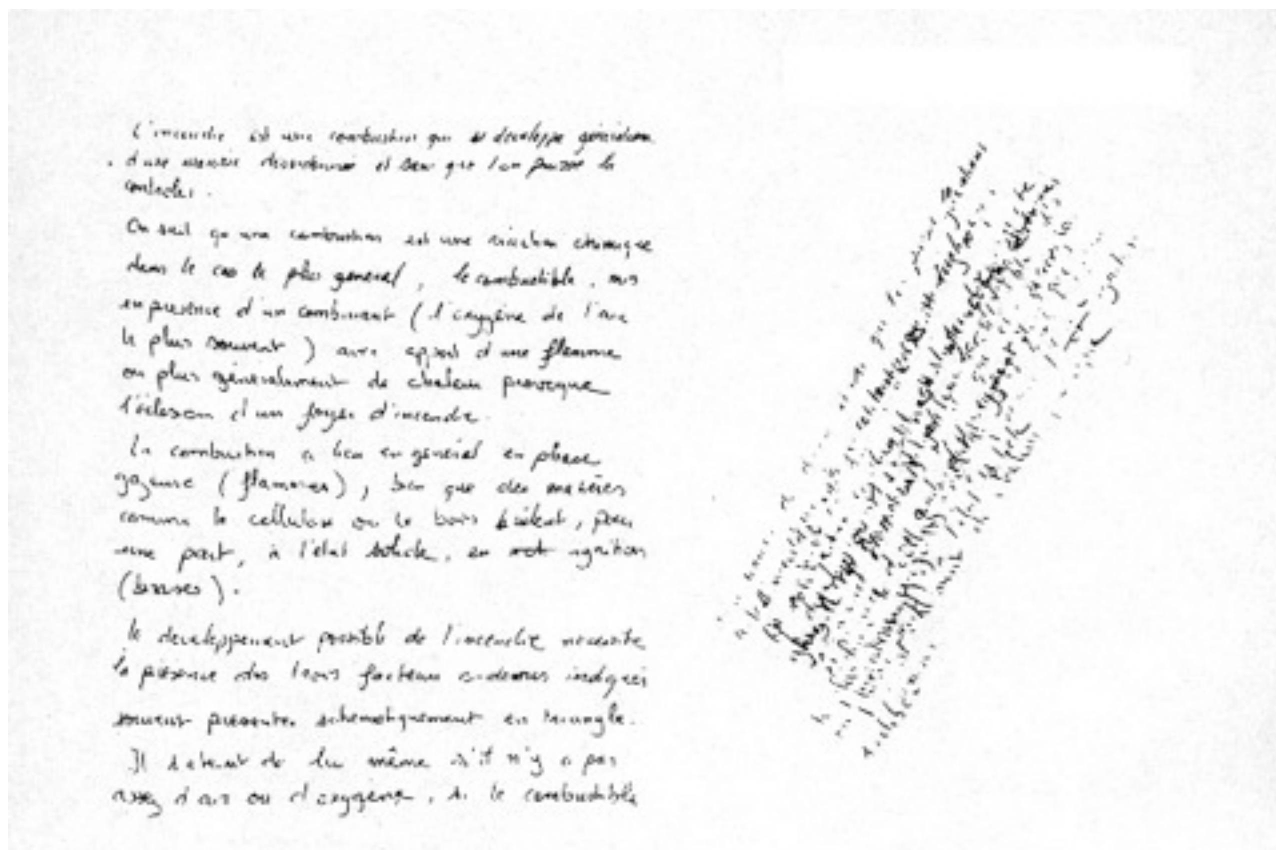


asymmetric bimanual action

- symmetric bimanual action: the two hands have the same role
- asymmetric bimanual action: the two hands have different roles

Guiard’s Kinematic Chain

“Under standard conditions, the spontaneous writing speed of adults is **reduced** by some **20%** when instructions **prevent the non-preferred hand** from manipulating the page”



Literature: Yves Guirad (1987). Asymmetric Division of Labor in Human Skilled Bimanual Action: The Kinematic Chain as a Model

Mobile

context and task

challenges

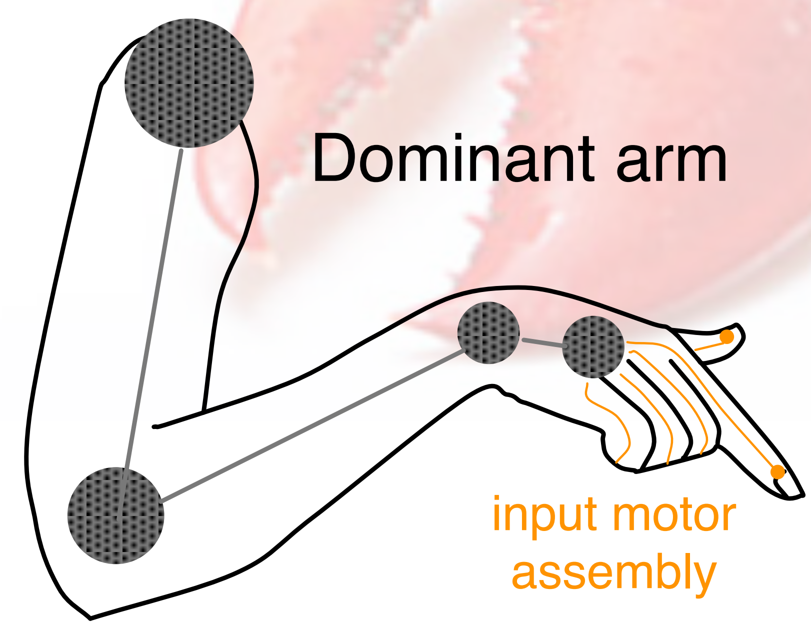
input technologies

challenges in interaction design

output technologies

http://www.lobshots.com/wp-content/uploads/2011/08/lobster_560x375.jpg

- Guiard's principles
  - *Right-to-left spatial* reference
    - The non-dominant hand sets the frame of reference for the dominant hand
  - Left-right contrast in the spatial-temporal scale of motion
    - Non-dominant hand operates at a coarse temporal and spatial scale
  - *Left hand precedence* in action
- Kinematic chain
  - each limb a motor if it contributes to the overall input motion.
- Kinematic chain theory
  - although separated, the two hands behave like being linked within the kinematic chain.



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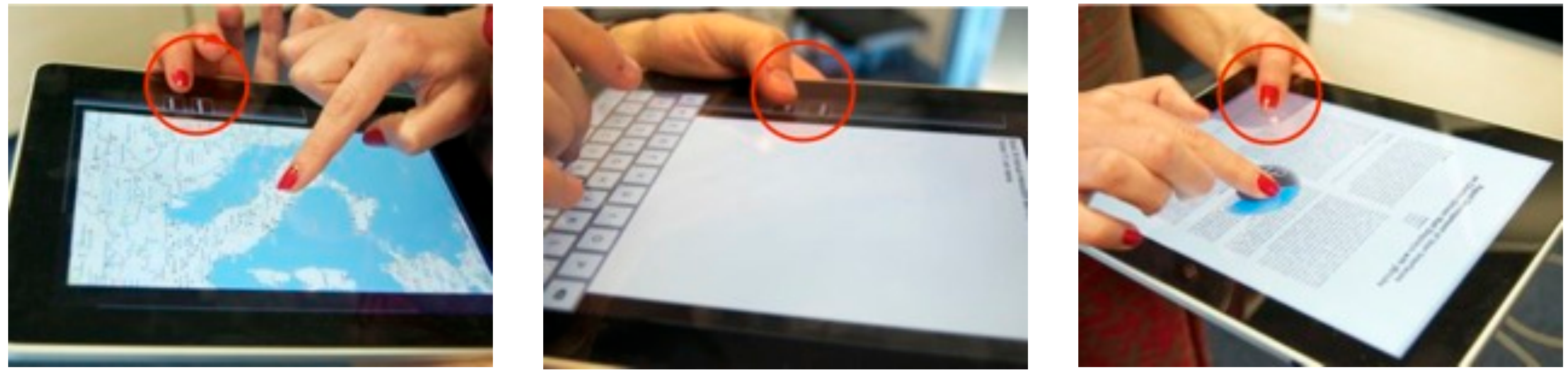
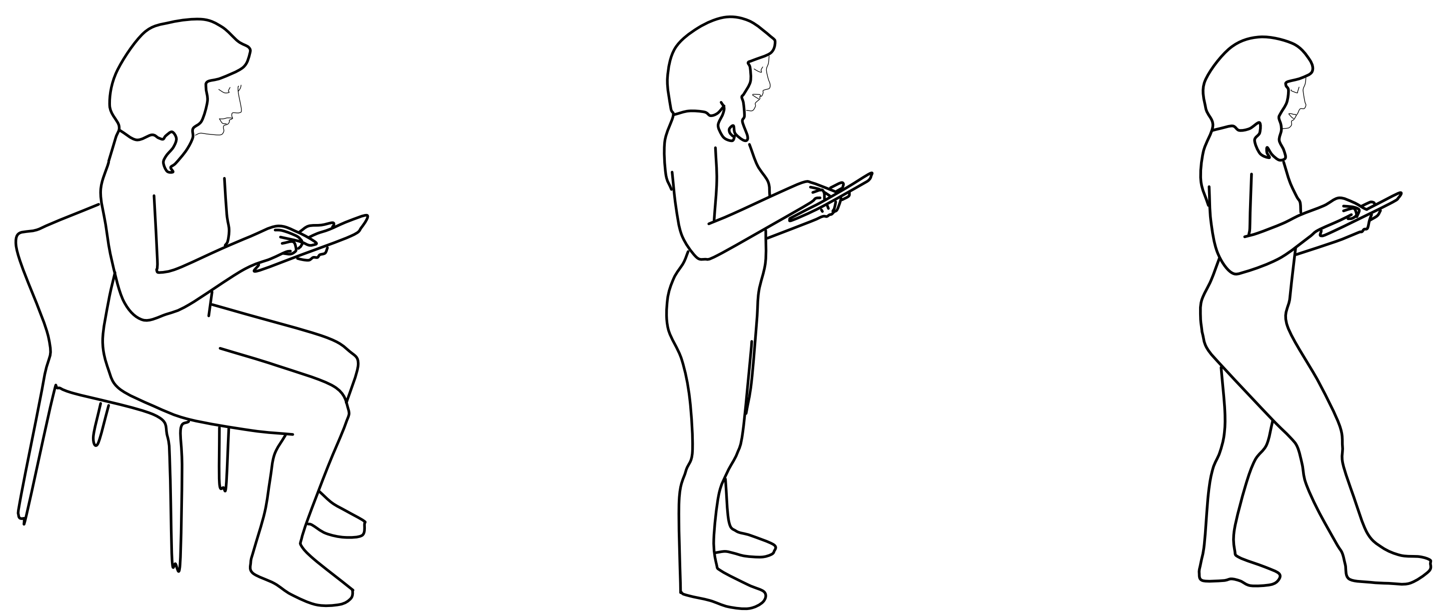


How do people naturally hold tablets?



Literature: Wagner, J. et al. (2012). *BiTouch and BiPad: Designing Bimanual Interaction for Hand-held Tablets.* CHI'12

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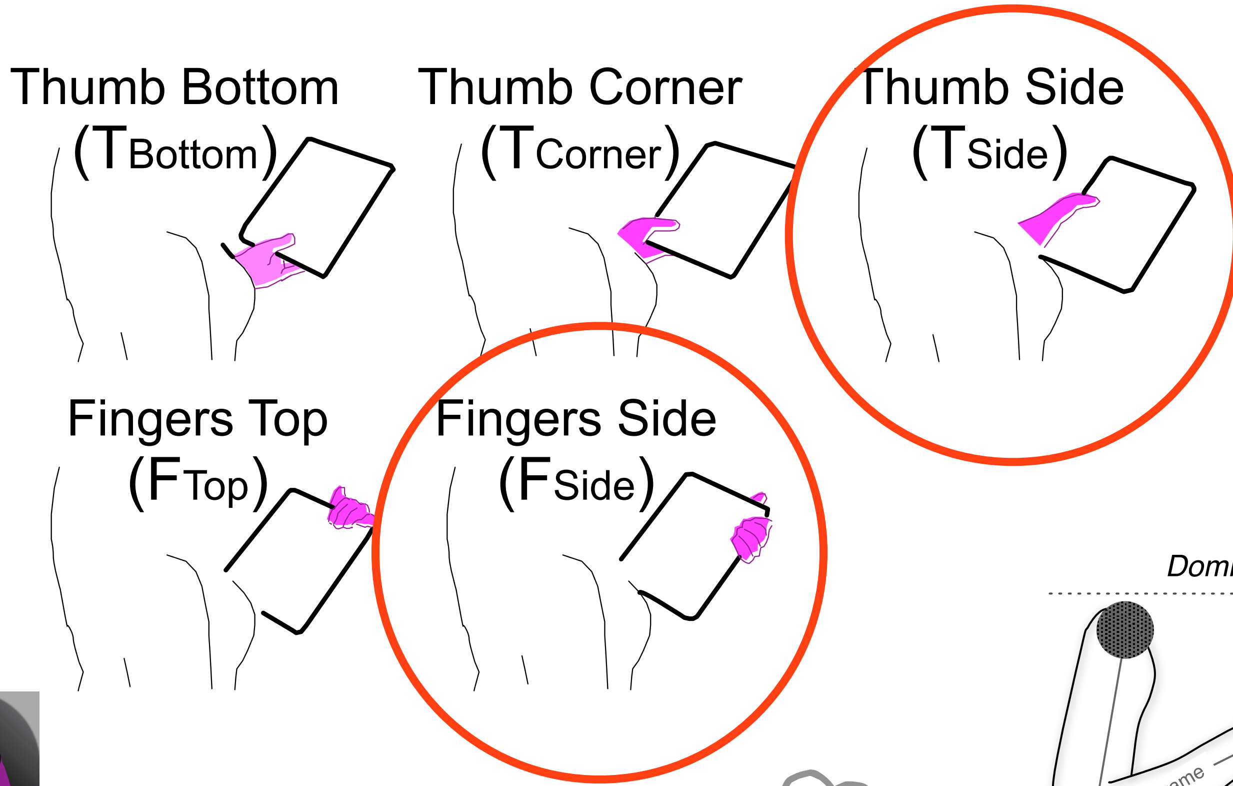
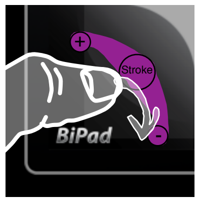
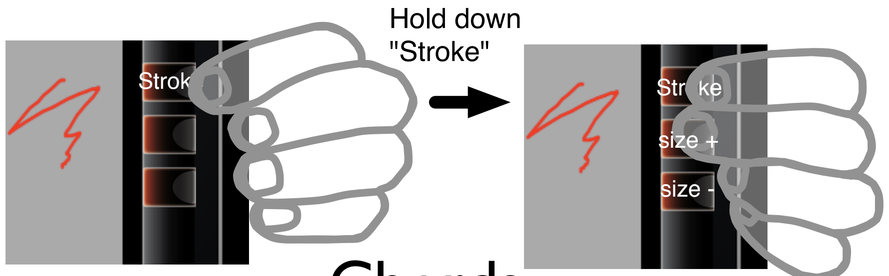
The Role of Support

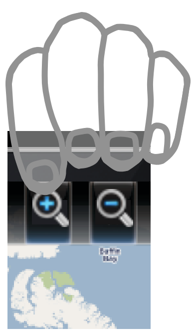


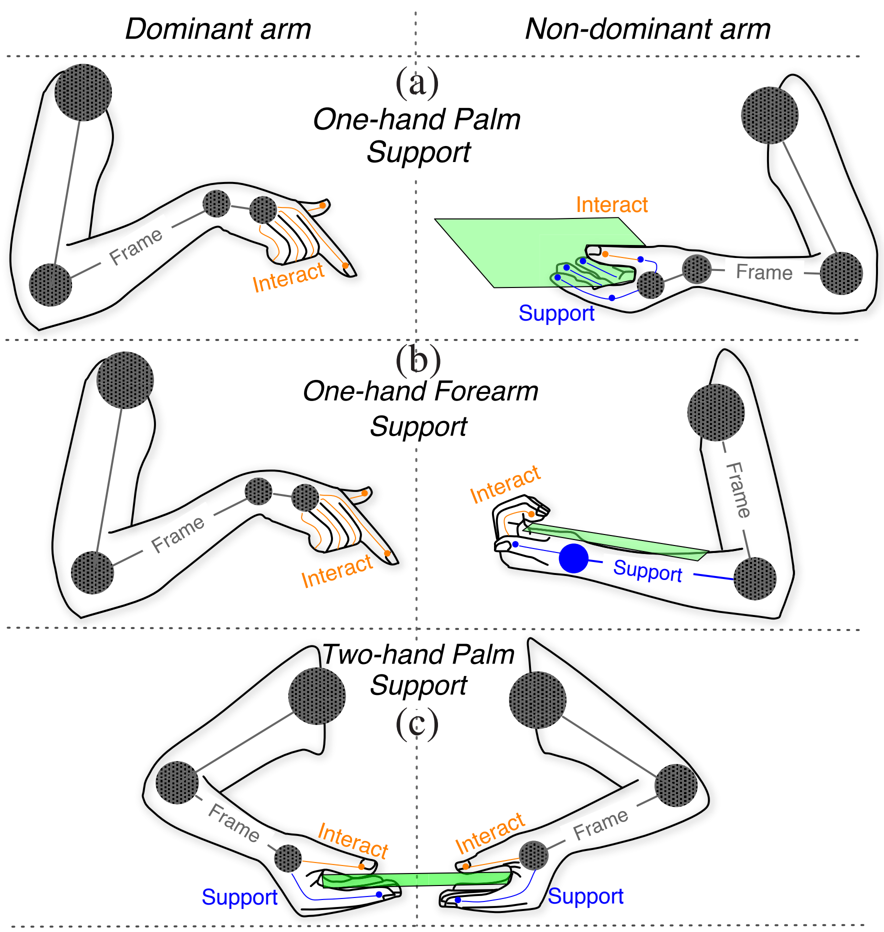


Gestures



Chords


Taps



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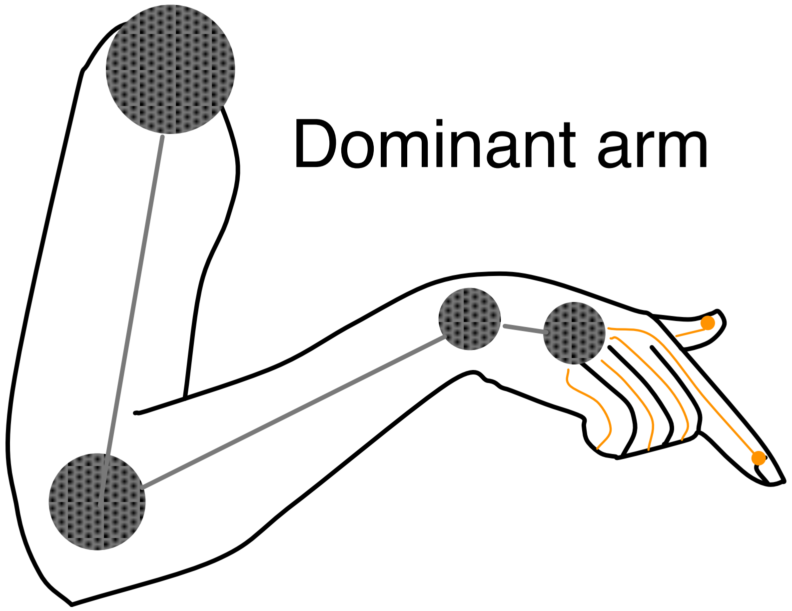
frame interaction



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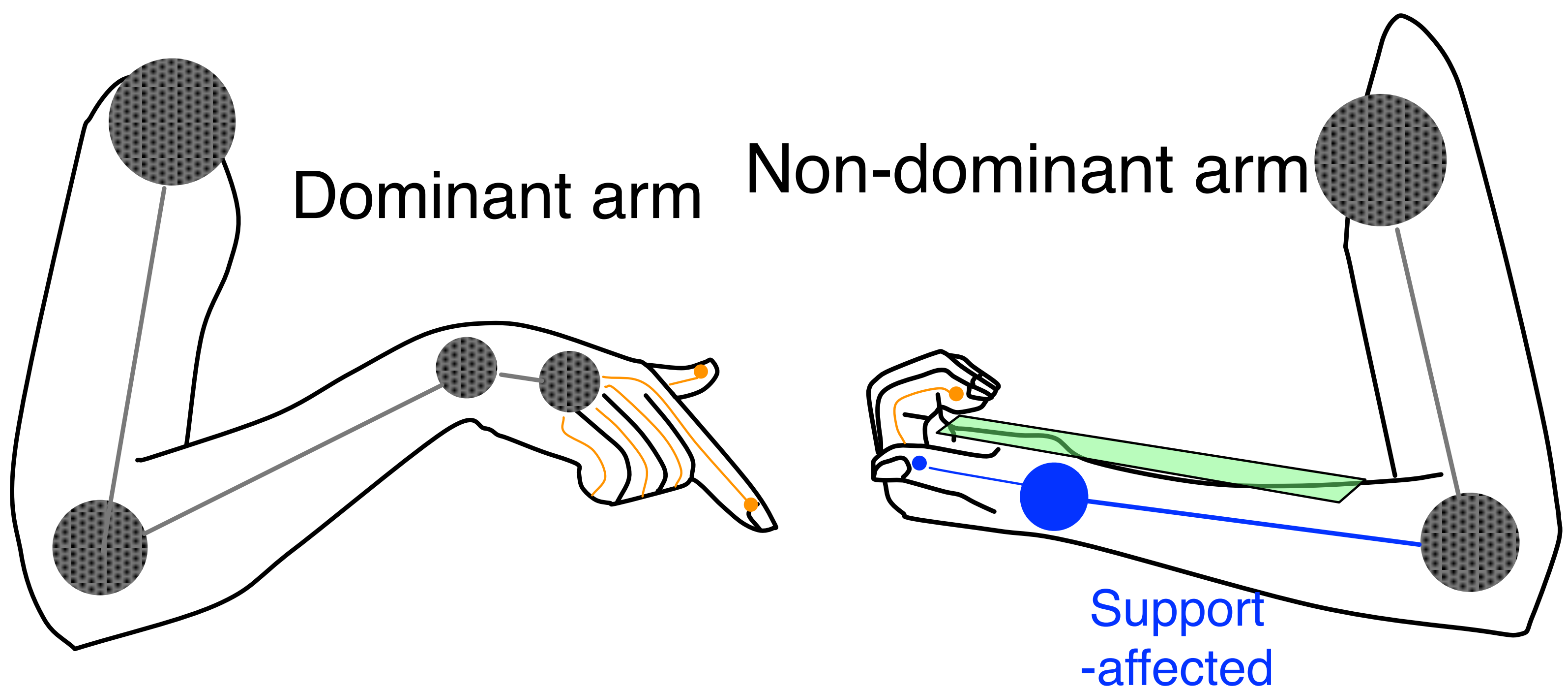
frame interaction
support



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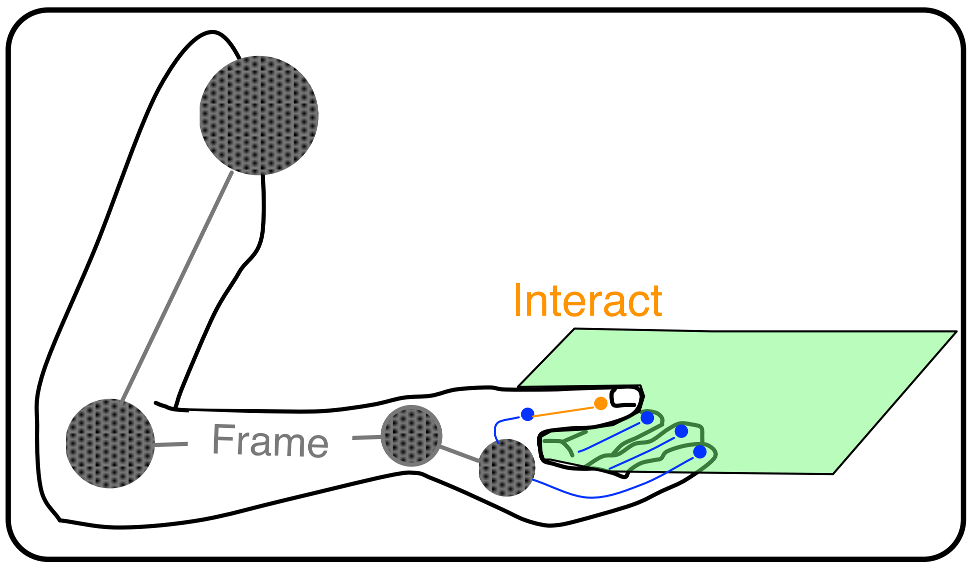
Frame, Support, Interaction

Framing	
Location:	proximal link in the kinematic chain
Distribution:	1 – n body parts
Support	
Location:	none or middle link in the kinematic chain
Distribution:	0 – n body parts
Independence:	0% – 100% body support
Interaction	
Location:	distal link in the kinematic chain
Distribution:	1 – n body parts
Degrees of freedom:	0% – 100% body movement
Technique:	touch, deformation,...

Literature: Wagner, J. et al. (2012). *BiTouch and BiPad: Designing Bimanual Interaction for Hand-held Tablets.* CHI'12

Create further hypotheses

Inverse correlation: performance & comfort



Comfort

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Performance

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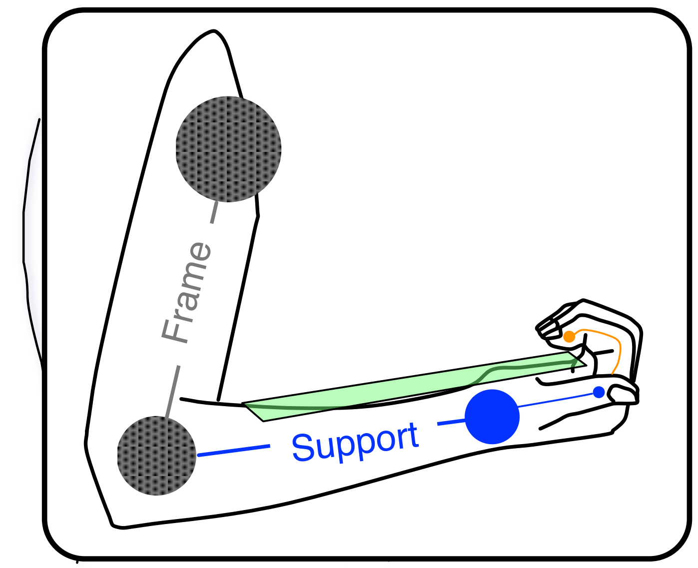
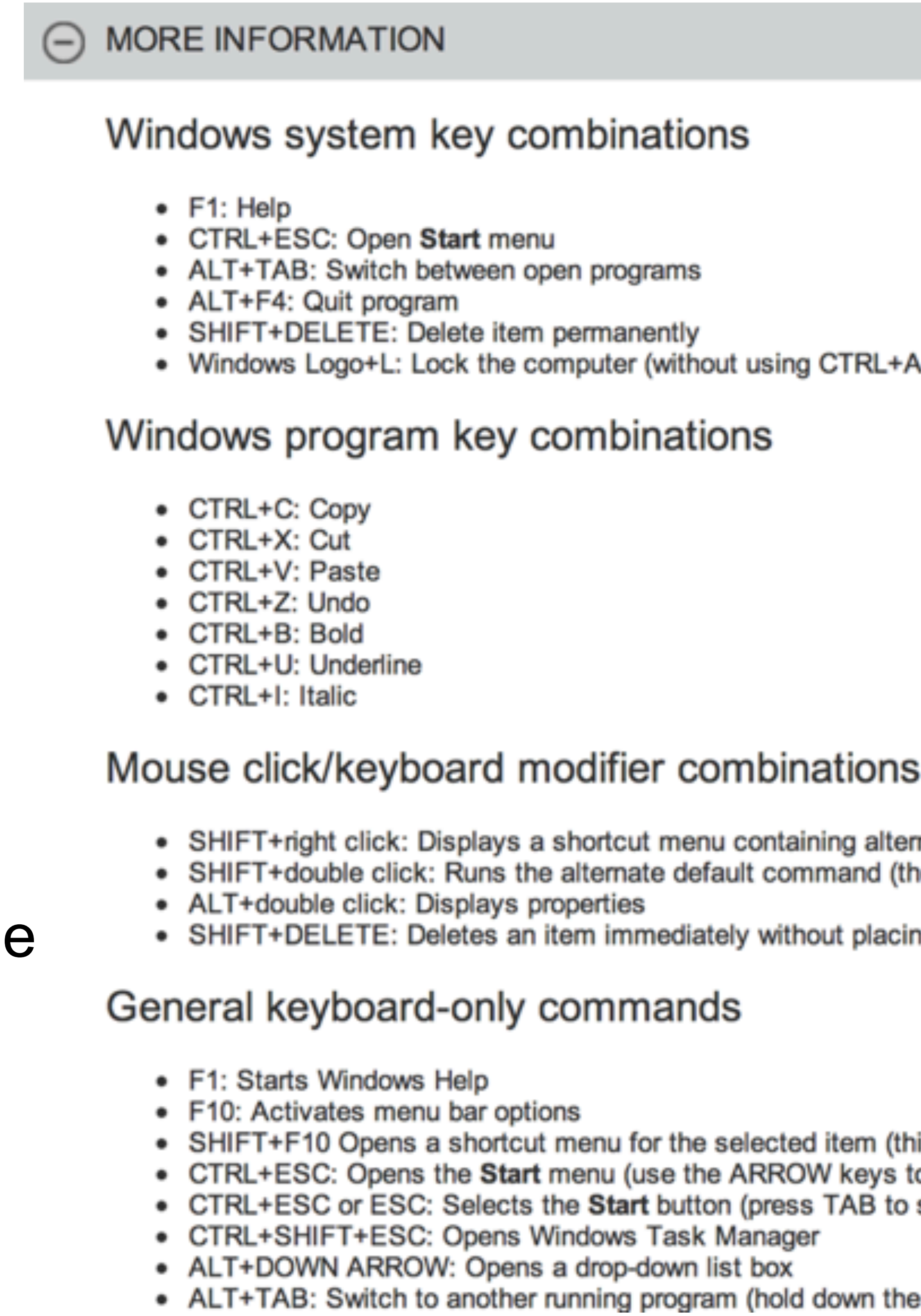


Support	Distribution	Support
high	Degree of Freedom	low

Gestural Input vs. Keyboard+Mouse

- loosing the hover state
- gesture design
  - 'natural' gestures
    - dependent on culture
  - multi-finger chords (what does that remind you of?)
- memorability
  - short-term vs. long-term retention
- gesture discoverability
- missing standards
- difficult to write, keep track and maintain gesture recognition code
  - detect/resolve conflicts between gestures
- and how to communicate and document a gesture?


MORE INFORMATION

Windows system key combinations

- F1: Help
- CTRL+ESC: Open **Start** menu
- ALT+TAB: Switch between open programs
- ALT+F4: Quit program
- SHIFT+DELETE: Delete item permanently
- Windows Logo+L: Lock the computer (without using CTRL+A

Windows program key combinations

- CTRL+C: Copy
- CTRL+X: Cut
- CTRL+V: Paste
- CTRL+Z: Undo
- CTRL+B: Bold
- CTRL+U: Underline
- CTRL+I: Italic

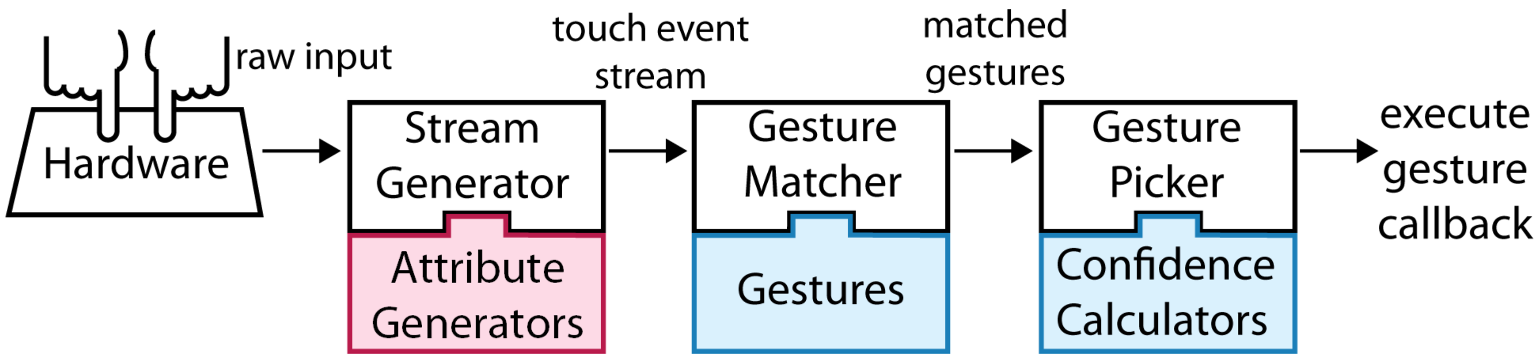
Mouse click/keyboard modifier combinations

- SHIFT+right click: Displays a shortcut menu containing alter
- SHIFT+double click: Runs the alternate default command (th
- ALT+double click: Displays properties
- SHIFT+DELETE: Deletes an item immediately without placin

General keyboard-only commands

- F1: Starts Windows Help
- F10: Activates menu bar options
- SHIFT+F10 Opens a shortcut menu for the selected item (thi
- CTRL+ESC: Opens the **Start** menu (use the ARROW keys to
- CTRL+ESC or ESC: Selects the **Start** button (press TAB to s
- CTRL+SHIFT+ESC: Opens Windows Task Manager
- ALT+DOWN ARROW: Opens a drop-down list box
- ALT+TAB: Switch to another running program (hold down the

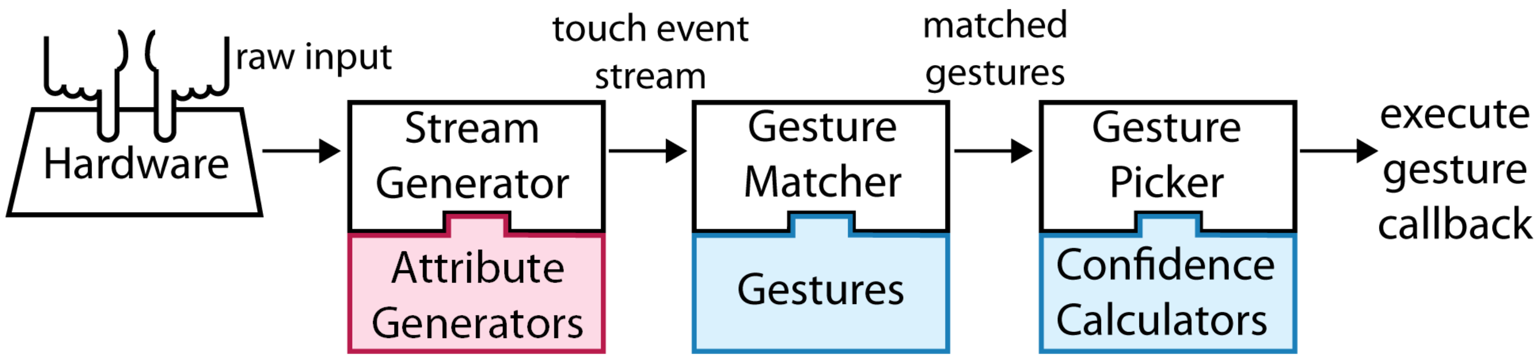
Proton++



- touch event:
  - touch action (down, move, up)
  - touch ID (1st, 2nd, etc.)
  - series of touch attribute values
    - direction = NW, hit-target = circle

Literature: Kin,K. et al. "Proton++: A Customizable Declarative Multitouch Framework", UIST 2012

Proton++



- stream generator
  - converts each touch event into a touch symbol of the form

$$E_{T_{ID}}^{A_1:A_2:A_3\ldots}$$

where E ∈ {D,M,U}, attribute values A_1:A_2:A_3, A_1 corresponds to first attribute etc.

$$M_1^{s:W}$$

move-with-first-touch-on-star-object-in-west-direction

Literature: Kin,K. et al. "Proton++: A Customizable Declarative Multitouch Framework", UIST 2012

Proton++ Gesture

- describe a gesture as regular expression over these touch event symbols

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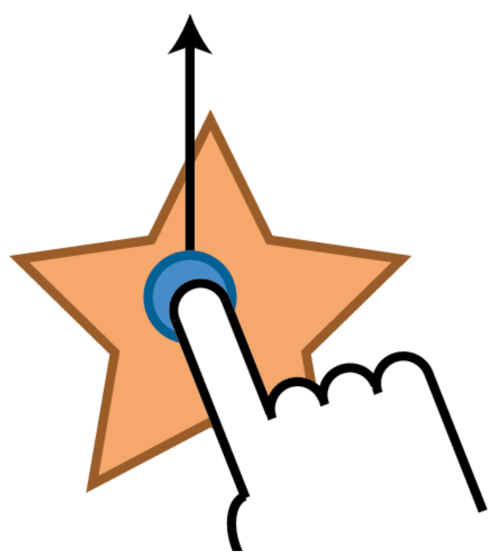

consider attributes: hit-target shape, direction

$$D_1^{s:N} M_1^{s:N} * U_1^{s:N}$$

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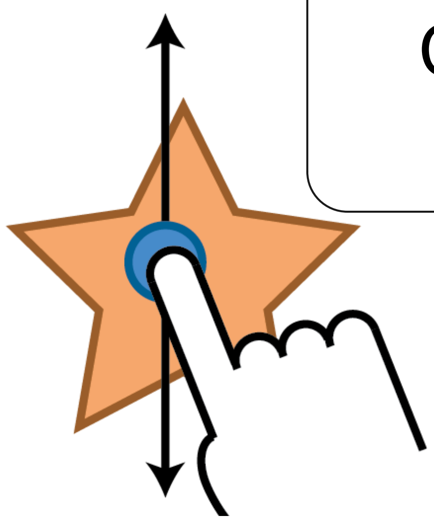
1 Minute Micro Task:
Create the regular expression for this gesture



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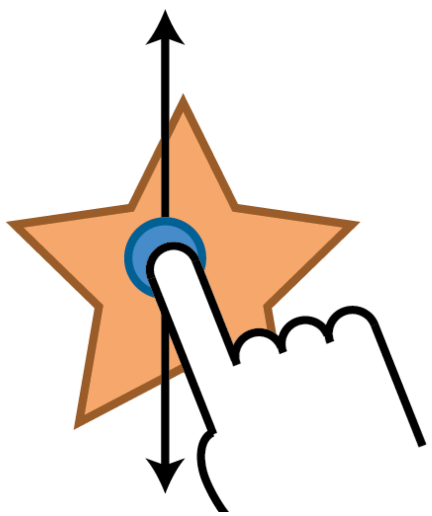


consider attributes: hit-target shape, direction

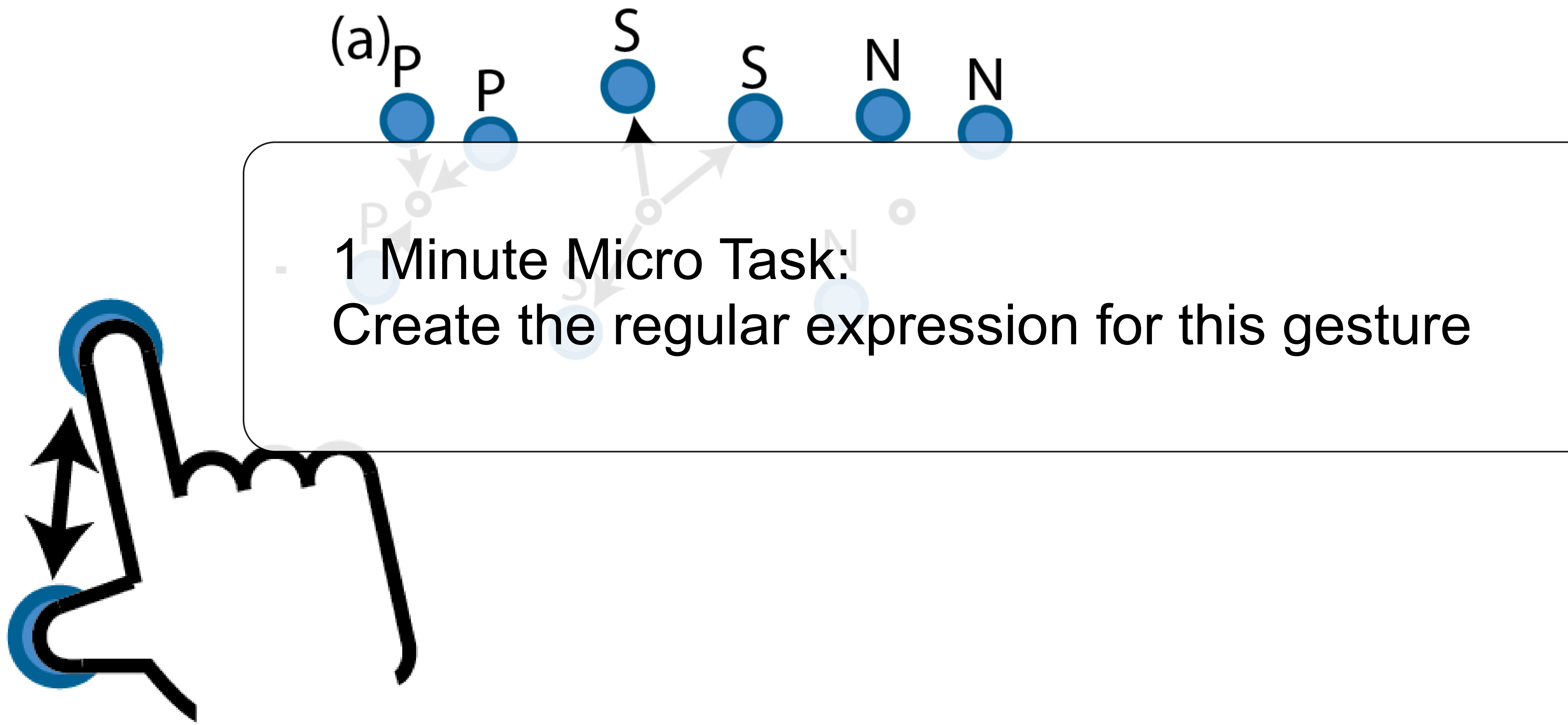
$$D_1^{s:N|S} M_1^{s:N|S} {*} U_1^{s:N|S}$$

$$(D_1^{s:N}|D_1^{s:S})(M_1^{s:N}|M_1^{s:S})*(U_1^{s:N}|U_1^{s:S})$$

Literature: Kin,K. et al. ”Proton++: A Customizable Declarative Multitouch Framework”, UIST 2012

Custom Attributes

- for example a pinch attribute:
  - relative movements of multiple touches
  - touches are assigned a ‘P’ when on average the touches move towards the centroid, an ‘S’ when the touches move away from the centroid and an ‘N’when they stay stationary



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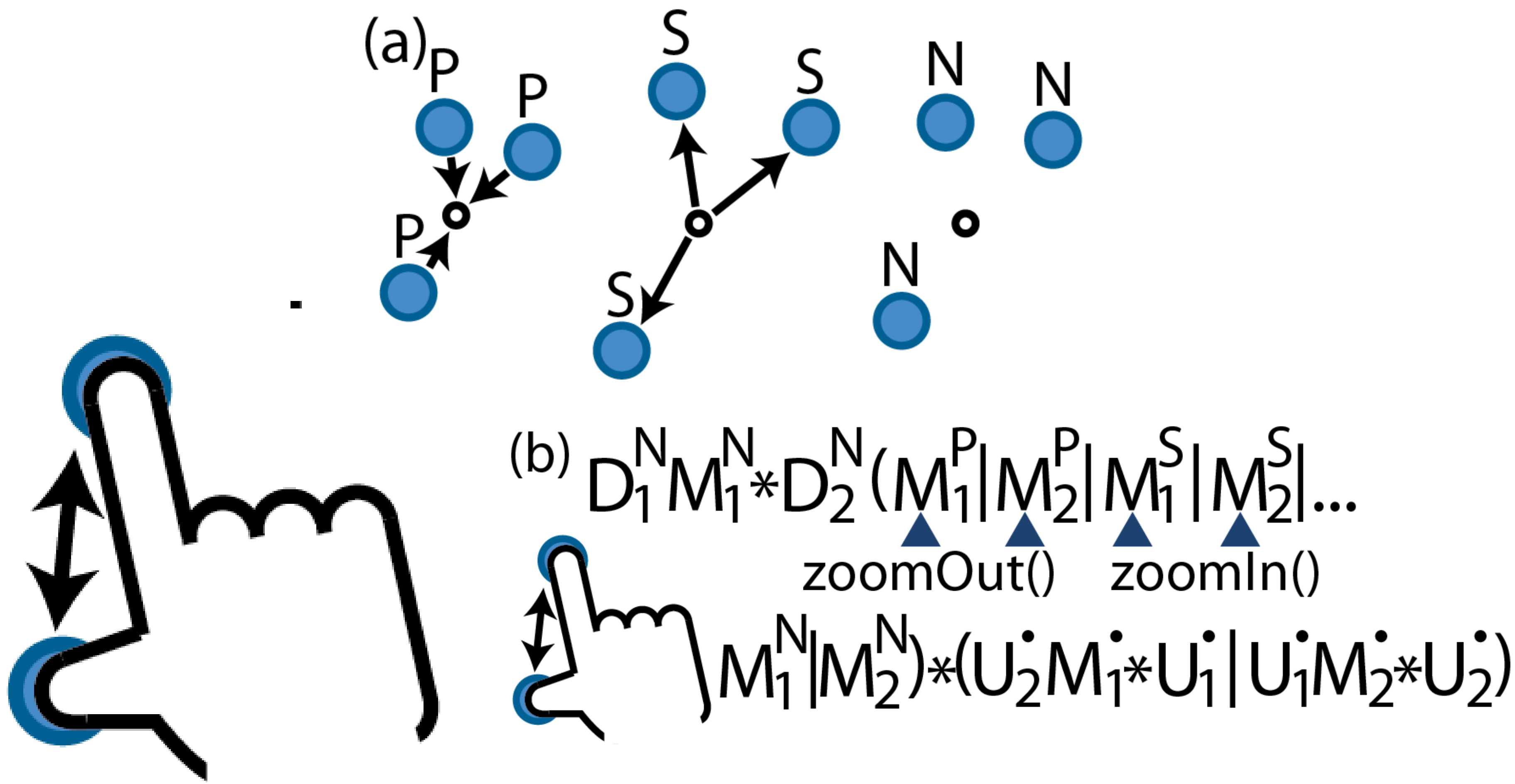


Literature: Kin,K. et al. ”Proton++: A Customizable Declarative Multitouch Framework”, UIST 2012

Further Attributes

- Direction Attribute
- Touch Area Attribute
- Finger Orientation Attribute
- Screen Location Attribute

→ Let’s practice that in the exercise

Literature: Kin,K. et al. ”Proton++: A Customizable Declarative Multitouch Framework”, UIST 2012

But: how can we represent this?

Shape-based interaction

- Interaction in the real world uses not just contact points
- We use whole hands, arms, tools
- Cannot be adequately expressed using just contact points
- How can we deal with this?

- Remember the lava lamp in Jeff Han‘s TED talk? (http://www.youtube.com/watch?v=QKh1Rv0PIOQ)
- Seriously: How can we do useful stuff with this?

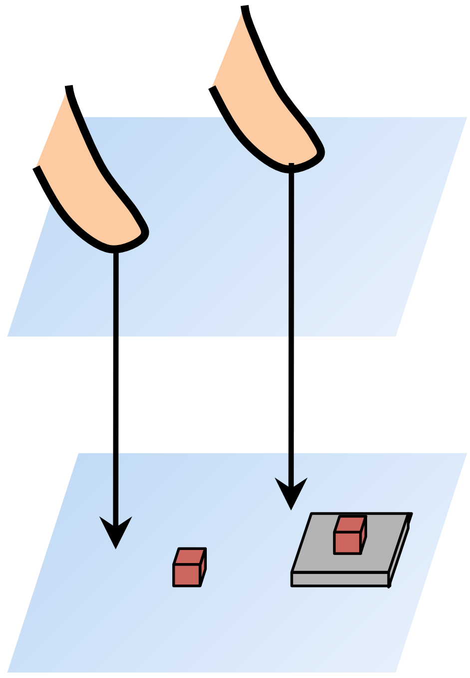
Idea: Interaction using a physics simulation

- Take a ready-made physics engine for games
- Represent every interface object as a 3d physical object
- Assign proper weight and friction
- Entire interface behaves like real physics

- How do we deal with shape input?
- Idea: proxy objects

- Material on the following slides by Otmar Hilliges

Approach: Proxy Objects



- [Otmar Hilliges, UIST2008 best paper]

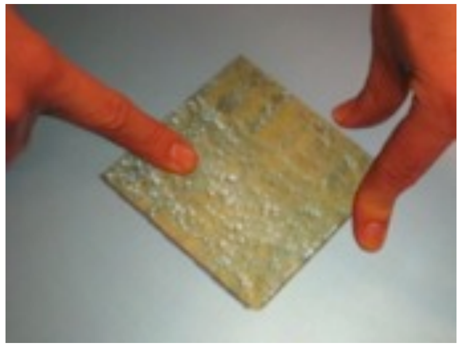
- Special objects introduced into the simulation per contact point
- Incarnation of fingertips in the virtual world
- Collide with other objects and push them aside.

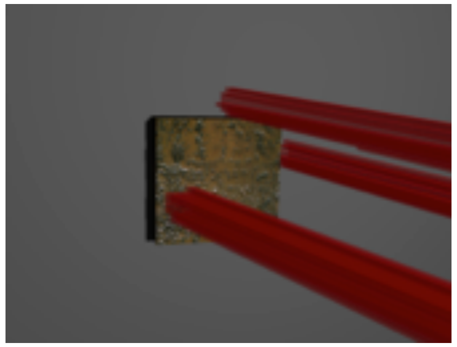
Leveraging Collision Forces

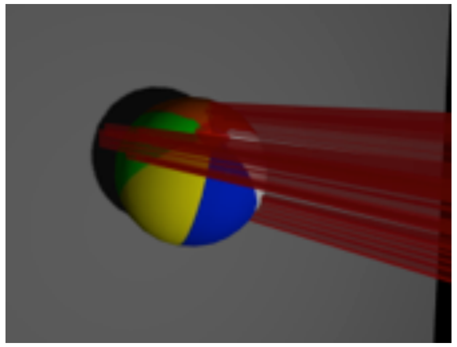
Leveraging Friction Forces

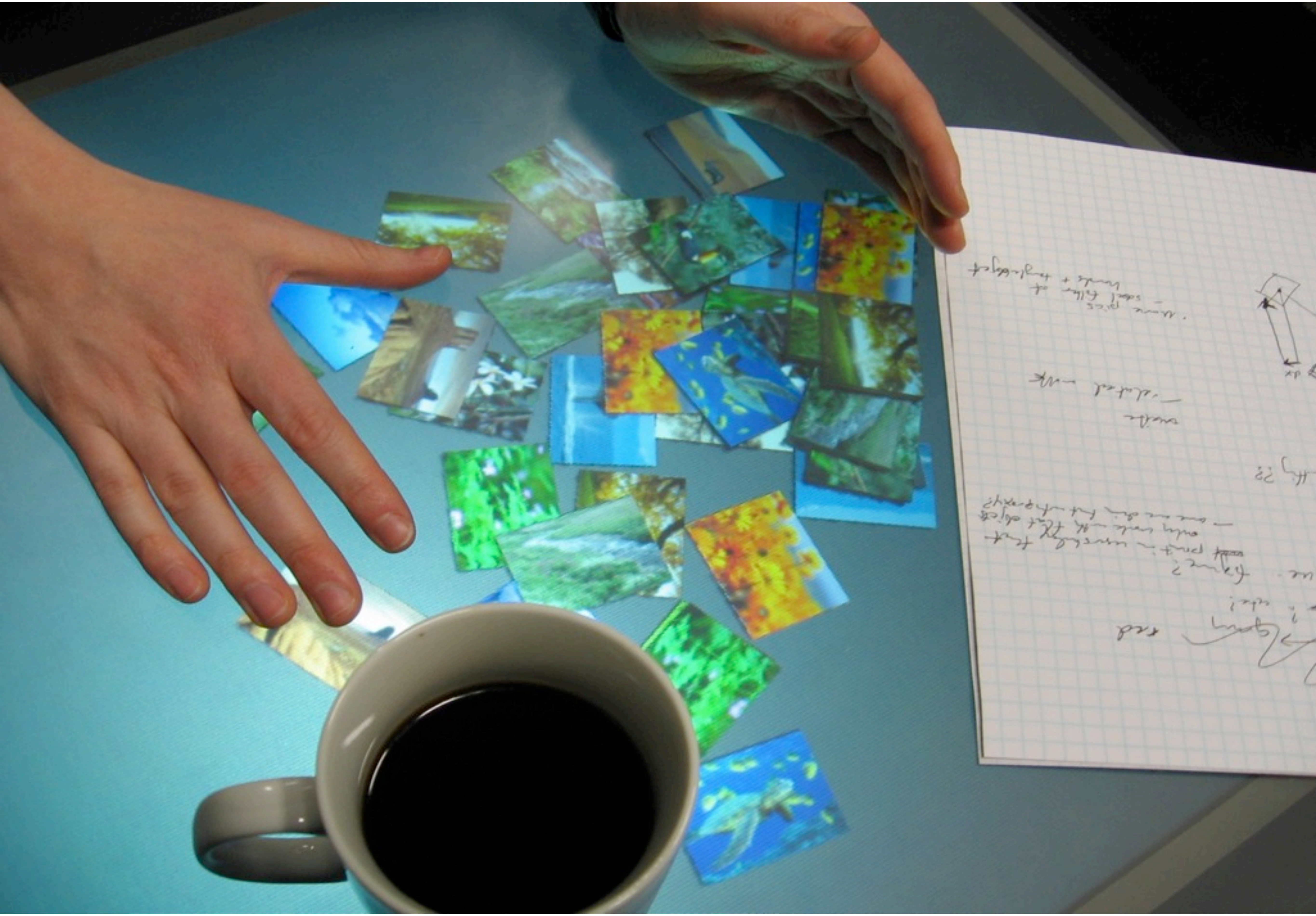
Particle Proxies

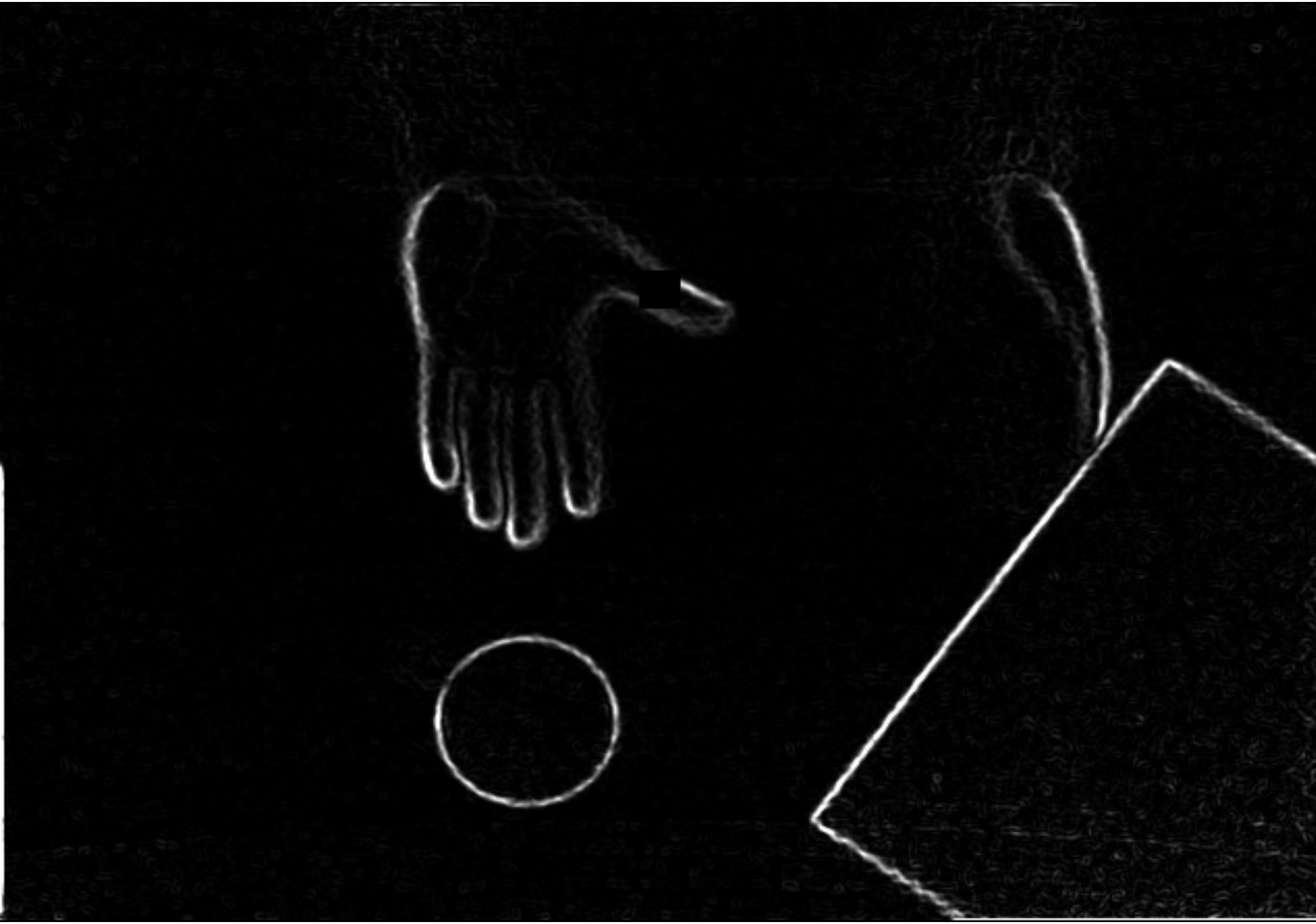
- Idea: model contact shape with many proxy objects (particles)
- Collisions obey shape of the contact (e.g., flat or side of the hand)
- Distribution of forces is modeled more accurately (e.g., conforms to 3D shape)



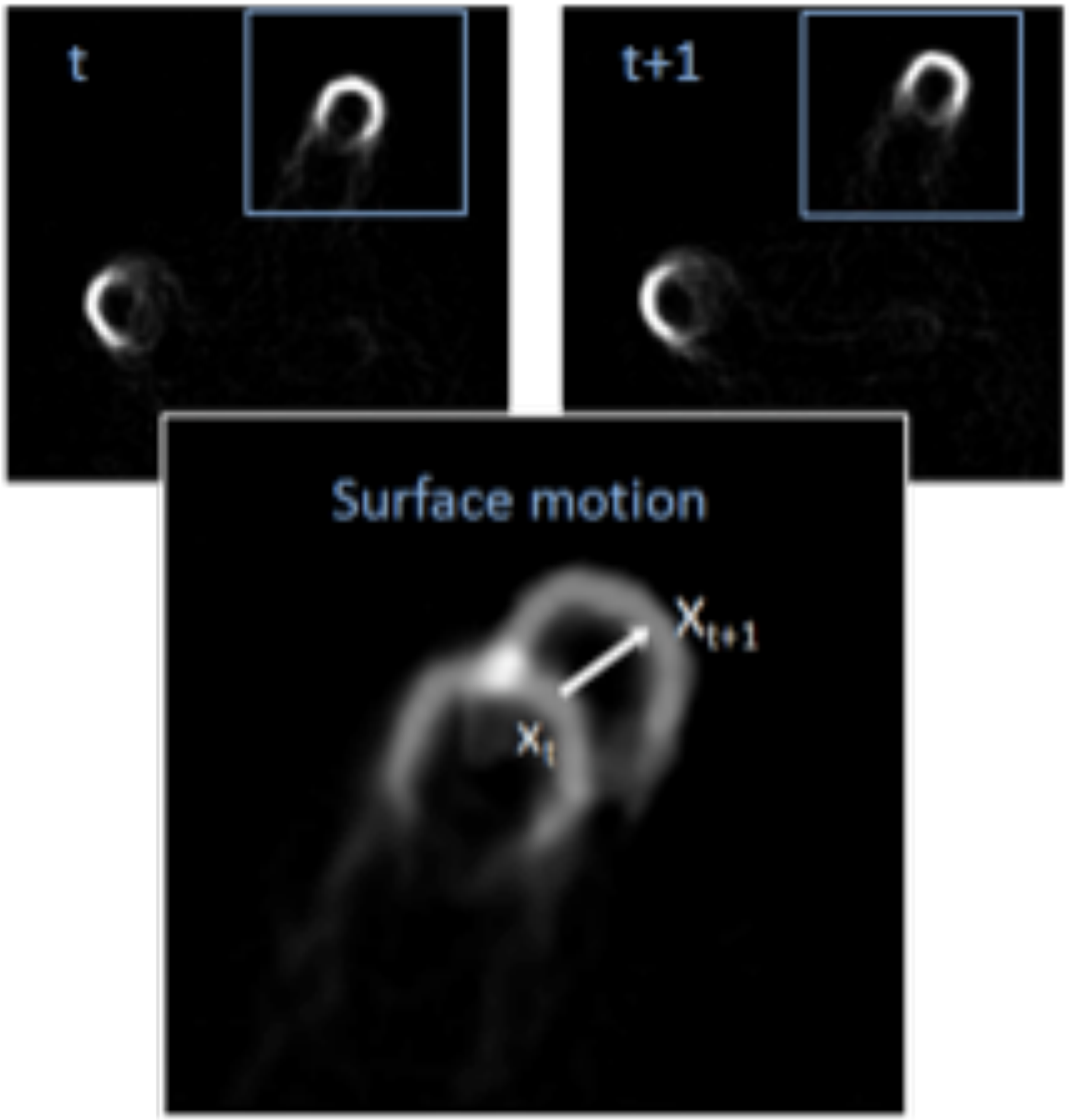


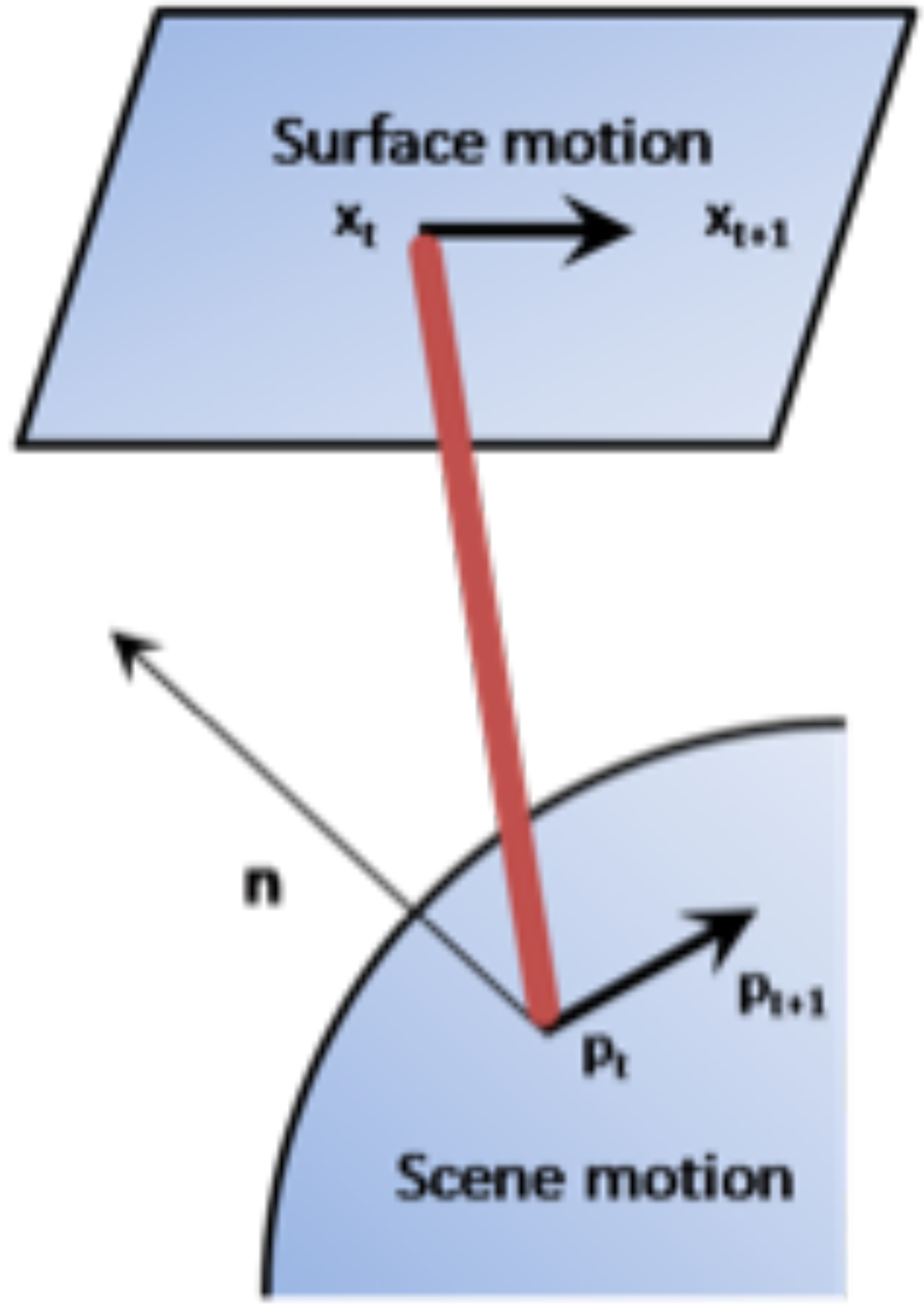


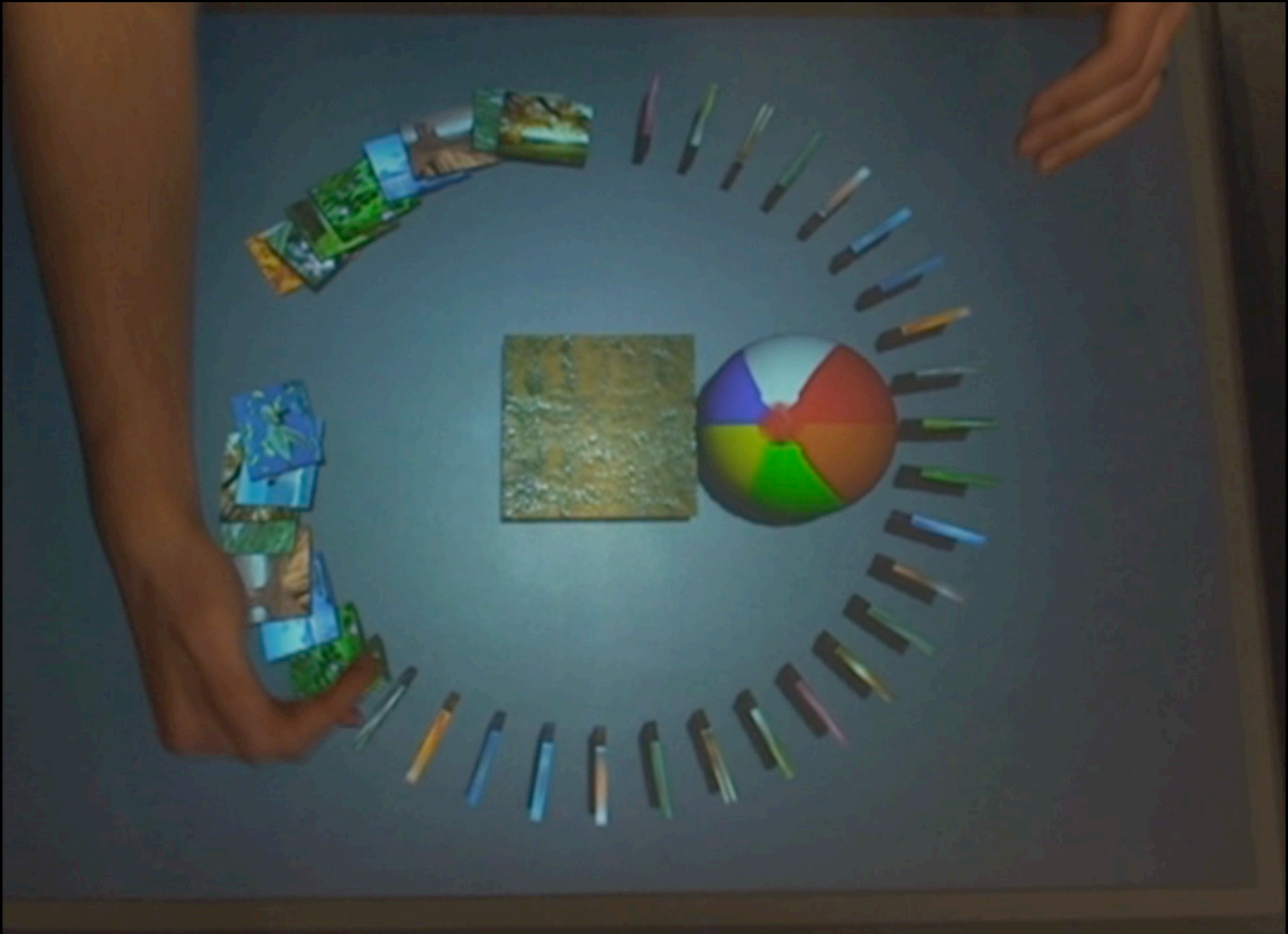




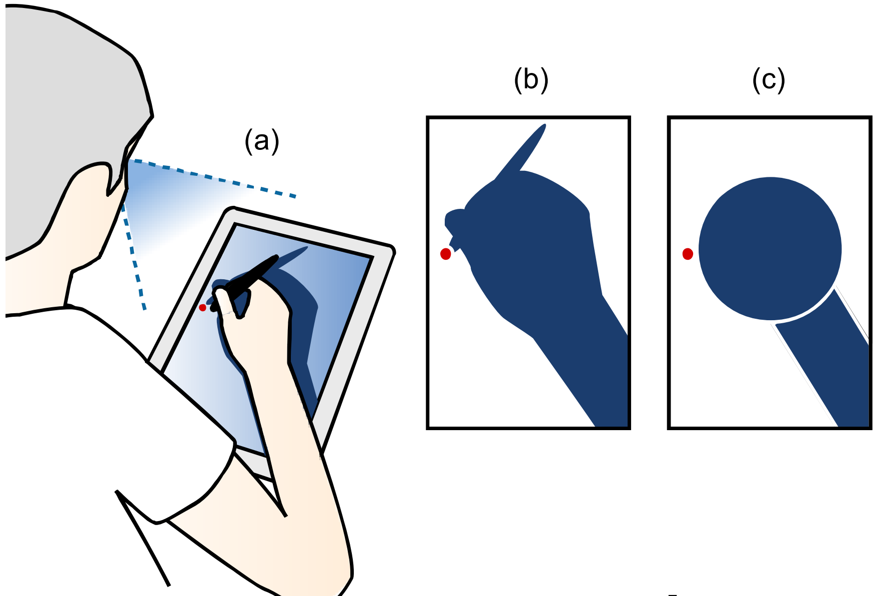
From Tracking to Flow







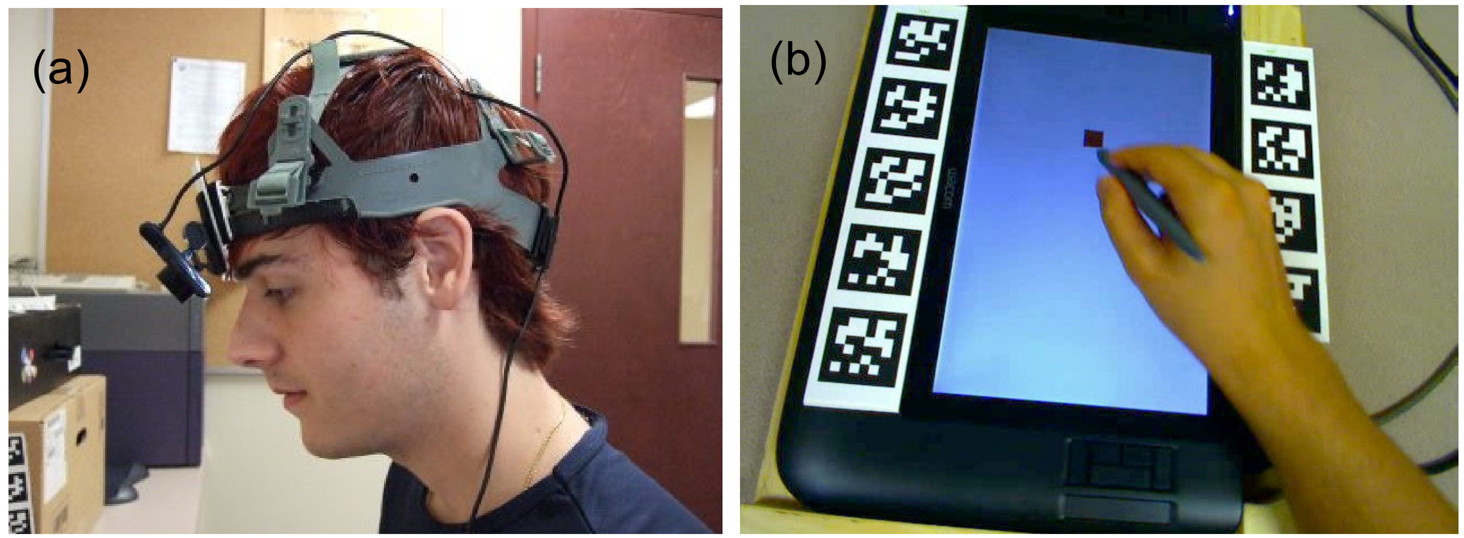
Occlusion



- problem: system generated messages may be positioned under the user's hand.
- one approach: experimental study using a novel combination of video capture, augmented reality marker tracking, and image processing techniques to capture *occlusion silhouettes*.
- result: five parameter geometric model which matches the silhouette with larger precision than the simple bounding box approach
- useful for *occlusion aware interfaces*

Literature: Vogel, D. et al. (2009). *Hand Occlusion with Tablet-sized Direct Pen Input,* CHI'09

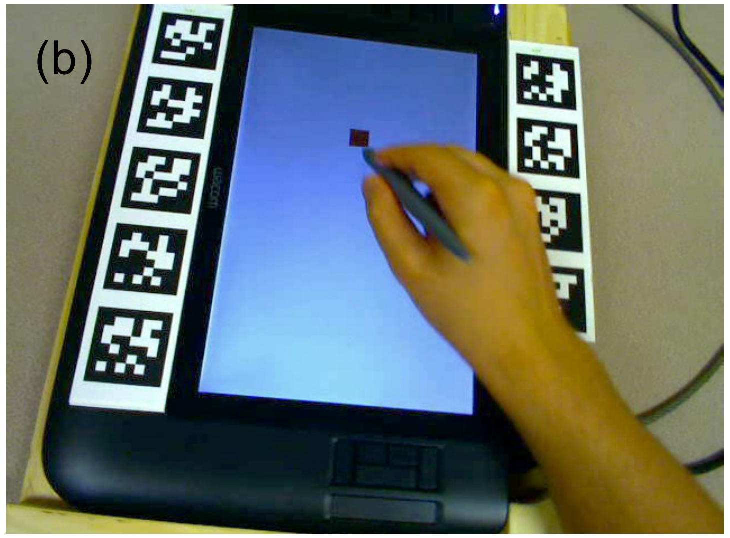
Vogel’s Controlled Experiment



- goal: measure size and shape of occluded area of a tablet-sized display.
- home target: on the far right side
- measurement target: positioned somewhere on an invisible grid (7 x 11 = 77 different locations)

Literature: Vogel, D. et al. (2009). *Hand Occlusion with Tablet-sized Direct Pen Input,* CHI’09

Image Processing



- Frame extraction: video frames taken between successful down and up pen event.
  - synchronize video and data log similar to a movie clapperboard: blend in a large red square containing a unique number.
- Rectification: track fiducial and determine screen corners
- Isolation: blur filter (noise reduction) + extract blue color channel + applied threshold to create an inverted binary image.

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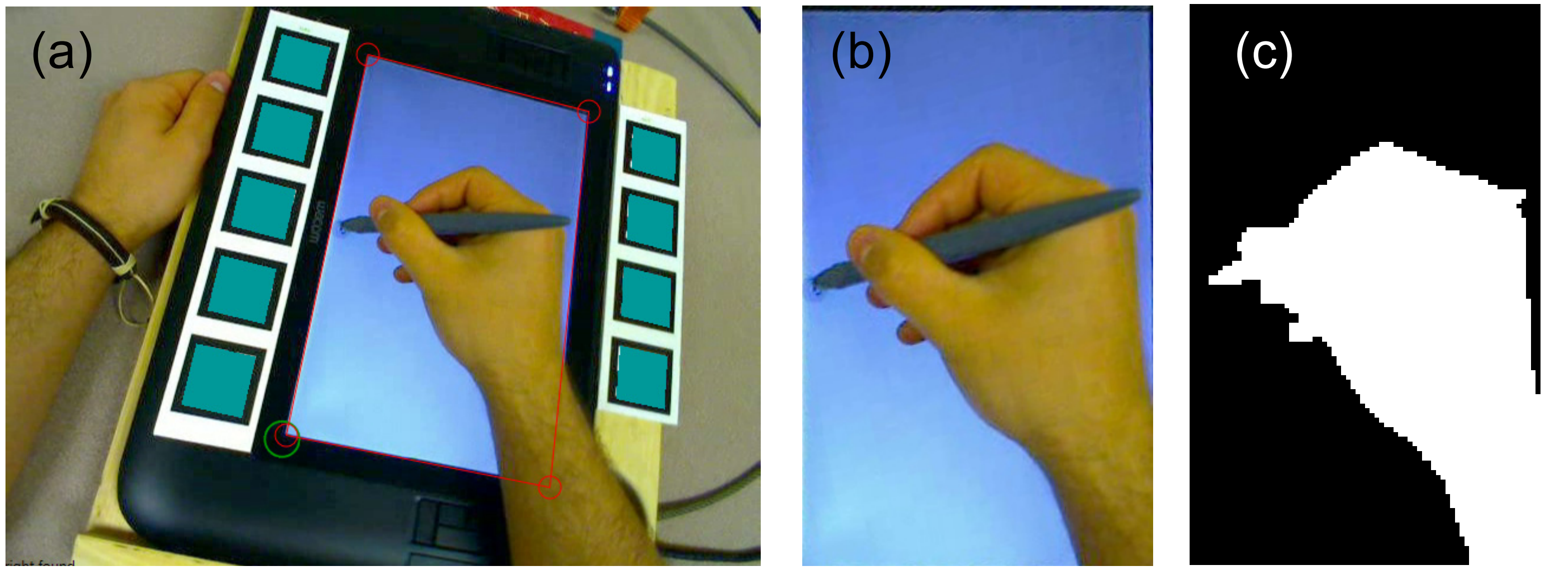

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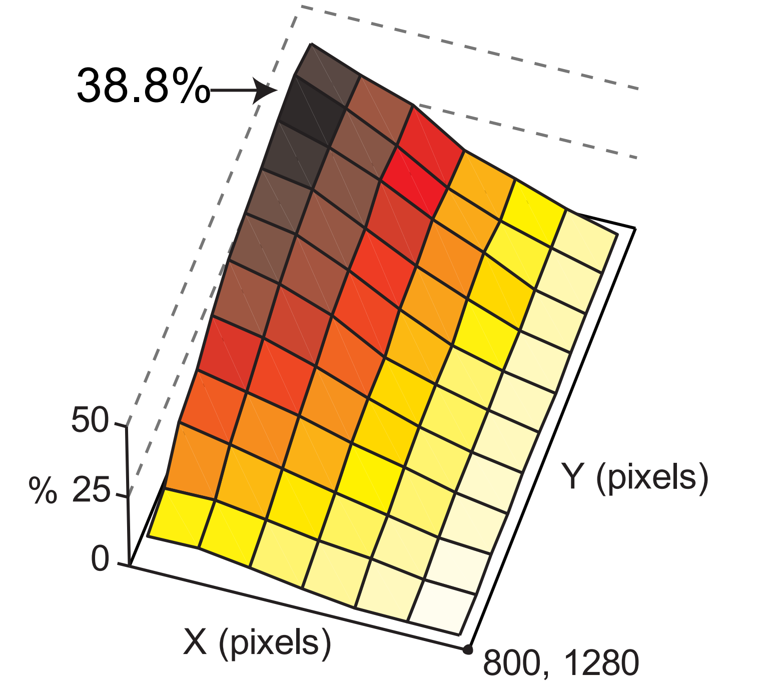
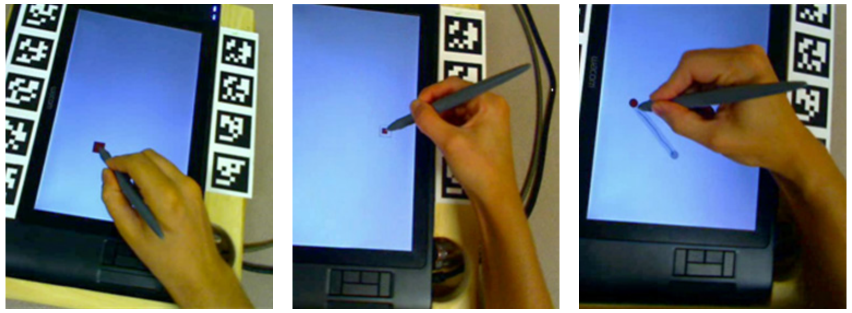
Results

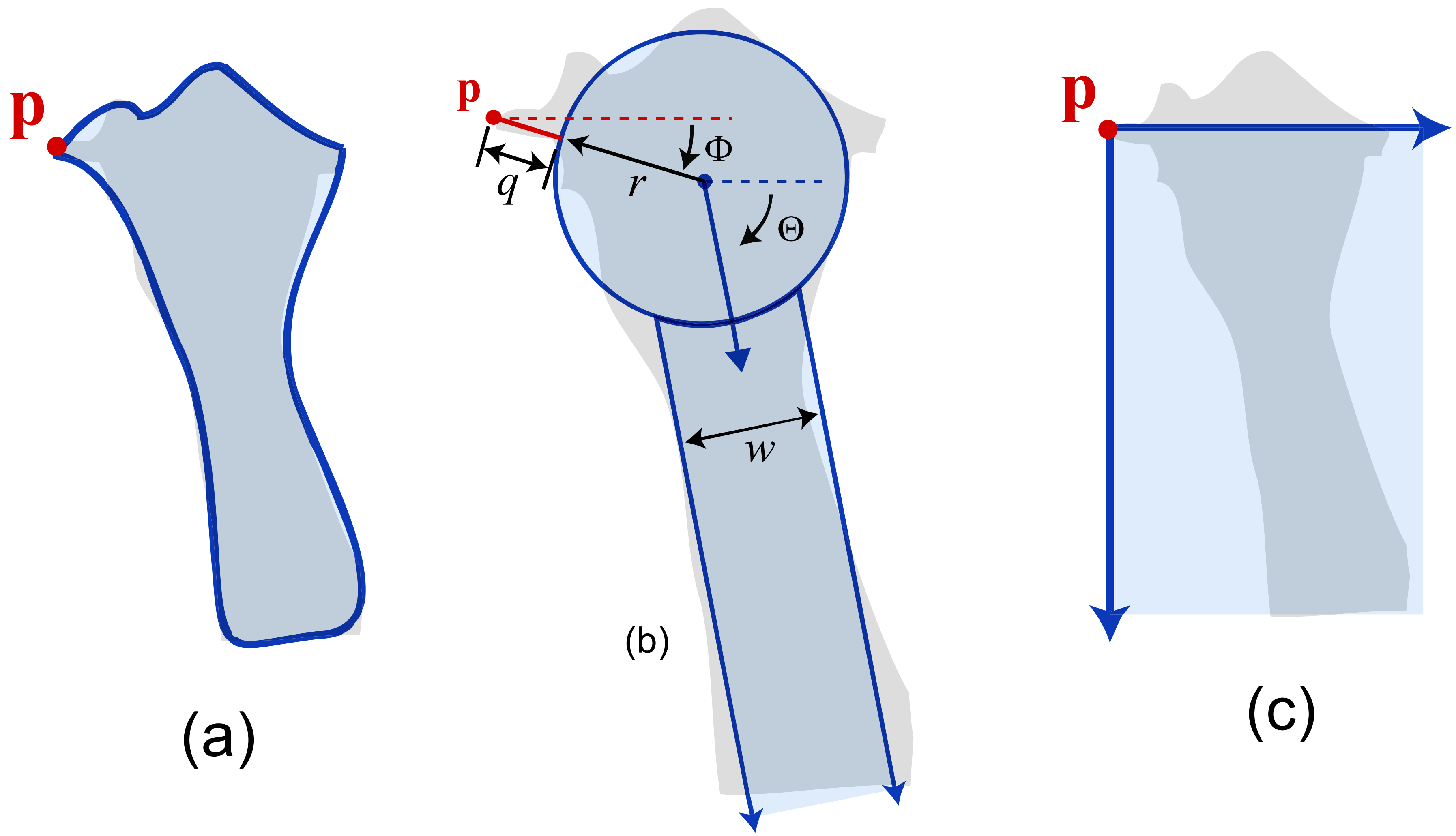
- largest occlusion when tapping the top left corner (occlusion rate: 38.8%)
- identified 3 grips
- large within-subject consistency in occlusion shape.
- “can we find a simple geometric model that could describe the general shape and position of the occlusion silhouettes?”





Literature: Vogel, D. et al. (2009). *Hand Occlusion with Tablet-sized Direct Pen Input,* CHI’09

Scalable Circle and Pivoting Rectangle Model



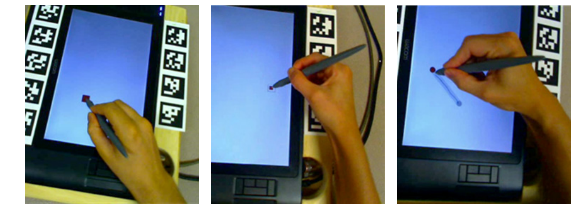
(a) Bézier spline

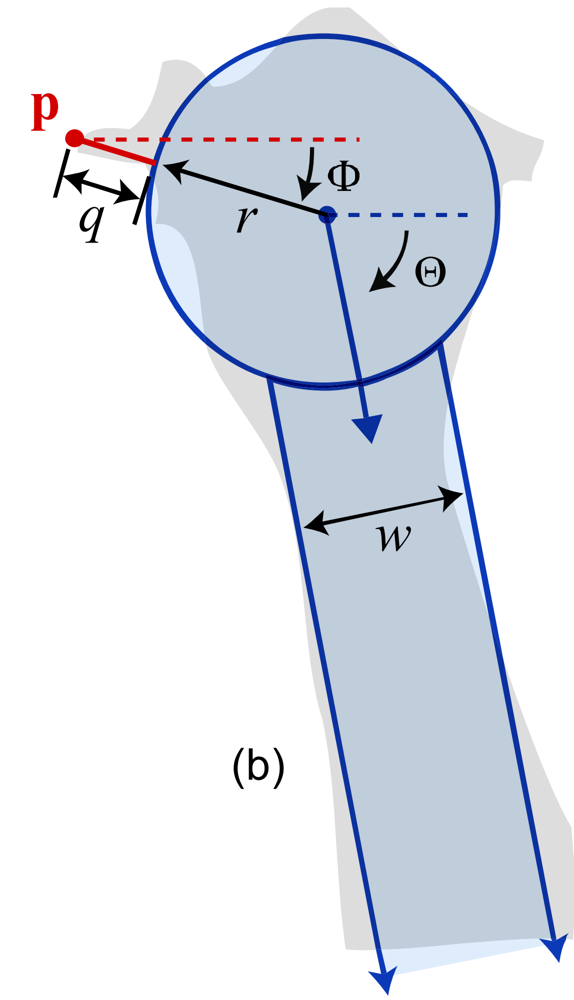
(c) bounding rectangle model

Literature: Vogel, D. et al. (2009). *Hand Occlusion with Tablet-sized Direct Pen Input,* CHI'09

Scalable Circle and Pivoting Rectangle Model

- 5 parameters:
  - q offset from pen position to circle edge
  - r radius of the circle
  - ϕ rotation angle of circle around p
  - Θ rotation angle of rectangle around the center of the circle
  - w width of rectangular representation of forearm.





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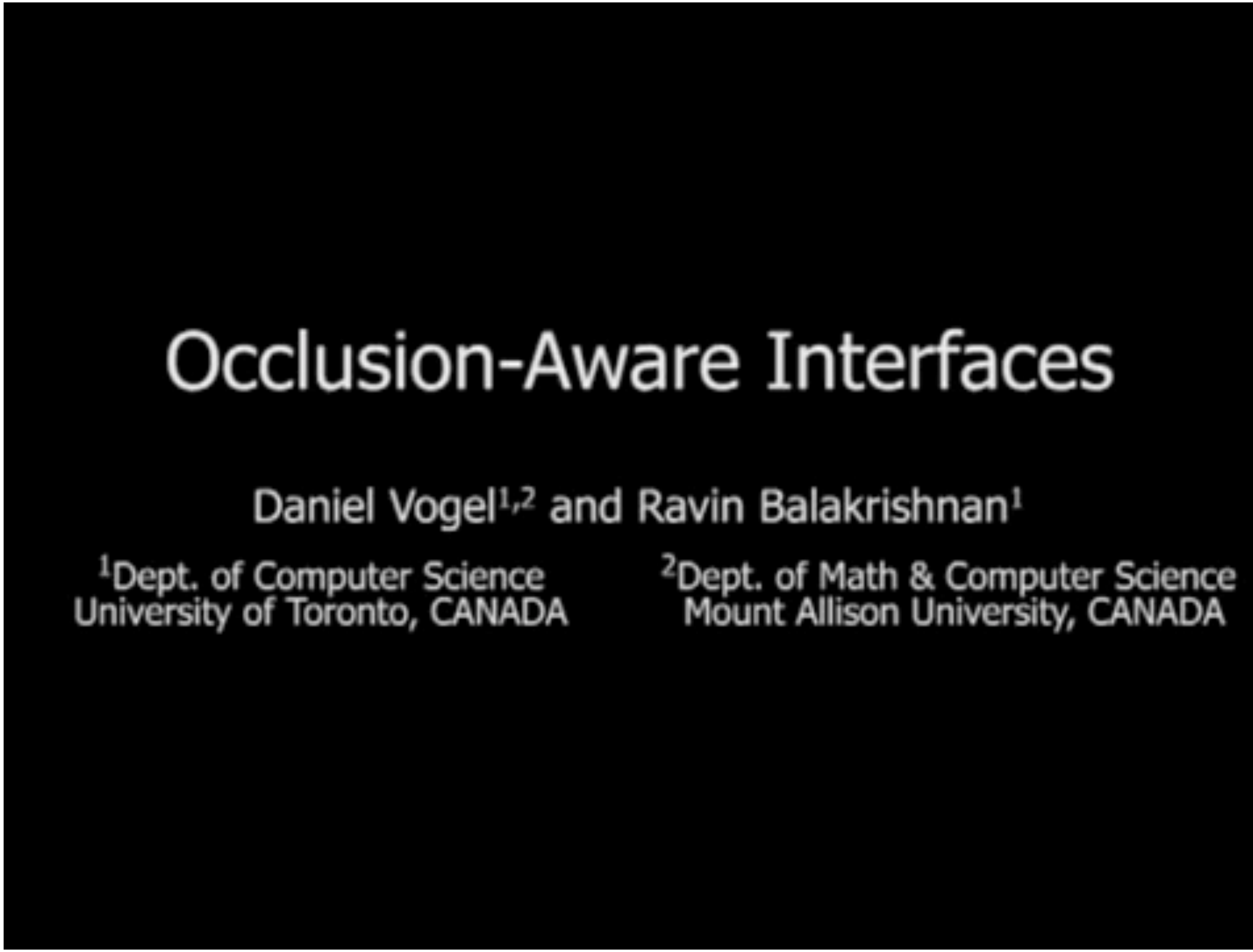
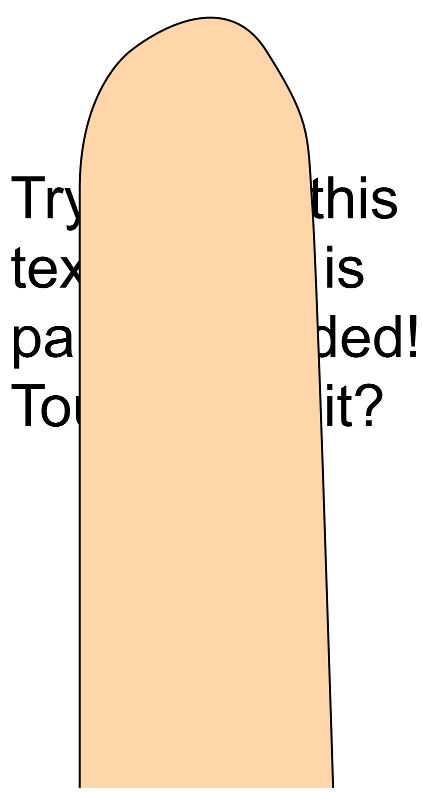
Occlusion-aware techniques

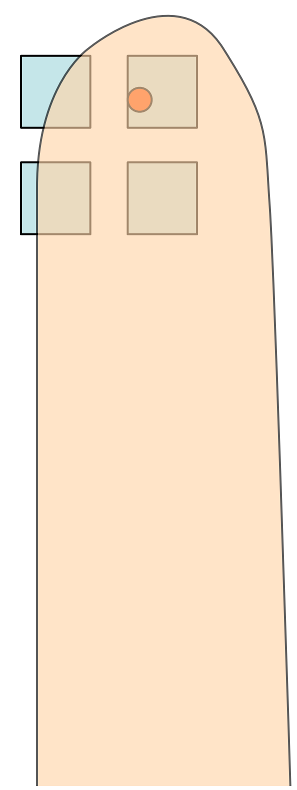


http://www.youtube.com/watch?v=4sOmlhEJ2ac

Occlusions and the Fat Finger Problem

- Fingers and hands can occlude screen objects
  - minimize by adapting the screen layout!
- Fingers may hit several small objects
  - just use large objects ;-)
- Exact hit point is occluded, precision limited!





Fat Fingers and FFitts law

- For small targets and fat fingers, there is a limit to pointing precision!
  - Fitt‘s law fails to predict performance in this situation
- Modify Fitt‘s law formula to account for precision
  - think of it like of Newtonian and relativistic physics:
    - at small speeds, both are the same
    - towards the speed of light, they differ

$$T = a + b \log_2\left(\frac{A}{W} + 1\right) = a + b \log_2\left(\frac{A}{\sqrt{2\pi e}\sigma} + 1\right)$$

$$T = a + b \log_2\left(\frac{A}{\sqrt{2\pi e(\sigma^2 - \sigma_a^2)}} + 1\right)$$

Precision

Xiaojun Bi, Yang Li, Shumin Zhai: FFitts Law: Modeling Finger Touch with Fitts’ Law, ACM CHI 2013, http://yangl.org/pdf/ffits.pdf

Take-away message

- Three on-going research challenges with touch and pen input
  - device support
  - gestural input
  - occlusion & fat fingers
- Approaches:
  - analyzing interaction using the kinematic chain
  - apply, extend and test existing theories from other fields (psychology, mathematics, linguistics, physics)
- In particular: the body’s spatial relationship affects interaction performance and perceived comfort (was that the case in desktop env.?)


OPEN LAB DAY
05.12.13, 18:00 bis 22:00
Amalienstraße 17
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