Multi-Touch Surfaces

Simon Voelker

Multi-touch Surfaces

Multi-touch Surfaces

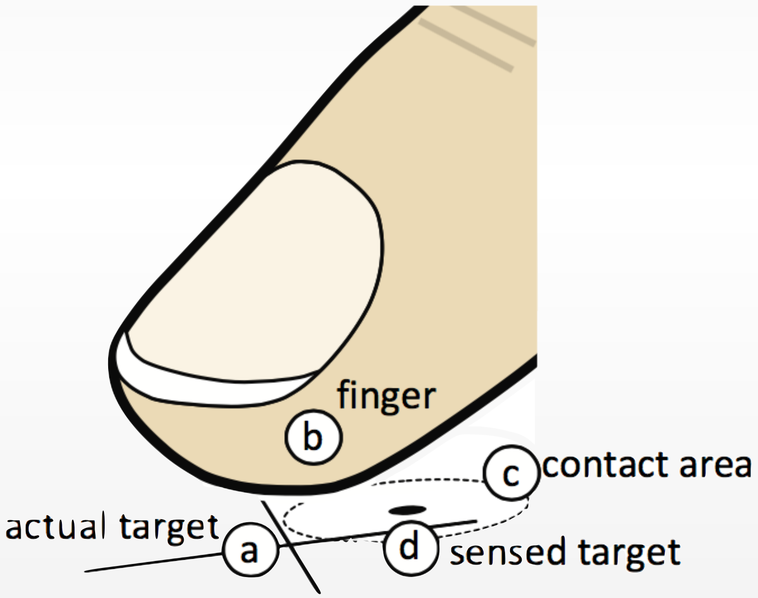
- Technologies
- Workplaces
- Gaze + Touch

Why Multi-touch Surfaces?

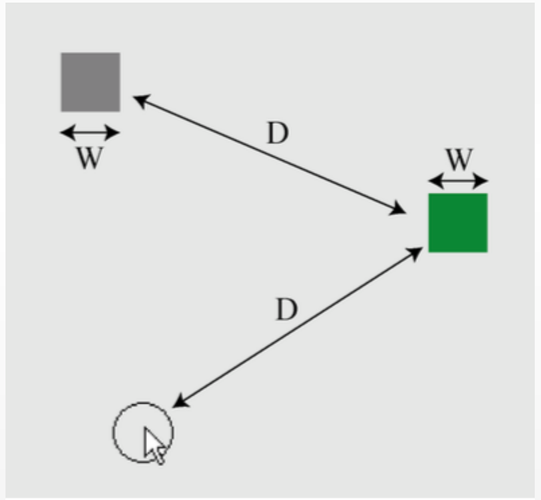
- Single-touch is already very intuitive
  - Touch at locus of attention (direct touch)
  - No additional device is necessary
- Richer and more natural interactions
  - Multiple fingers of one hand and two-handed interaction
- Further step towards Ubiquitous Computing
  - Enables multi-user interaction
  - Tabletops already convenient working environment

Problems with Touch Input

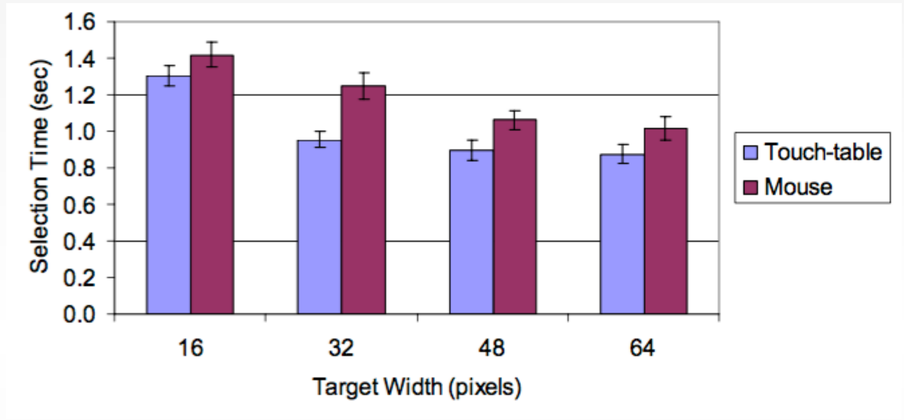
- Fat finger problem

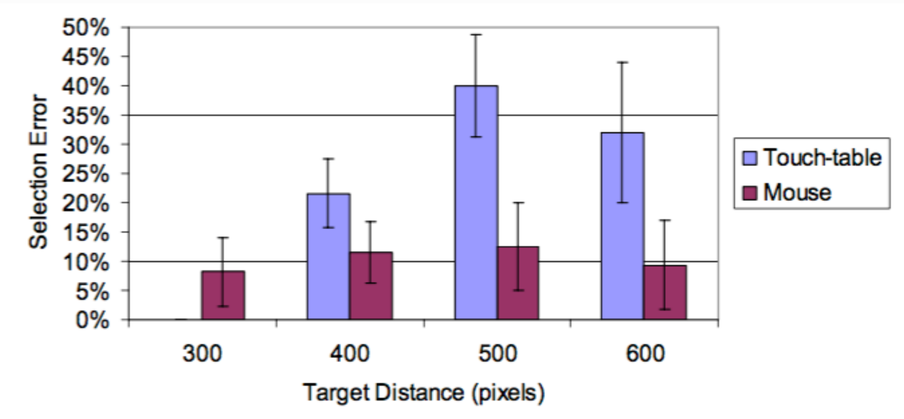


[Holz and Baudisch CHI ’11]



- Fast but in inaccurate

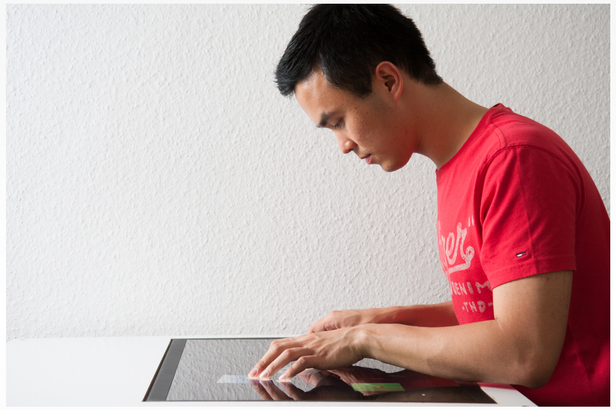




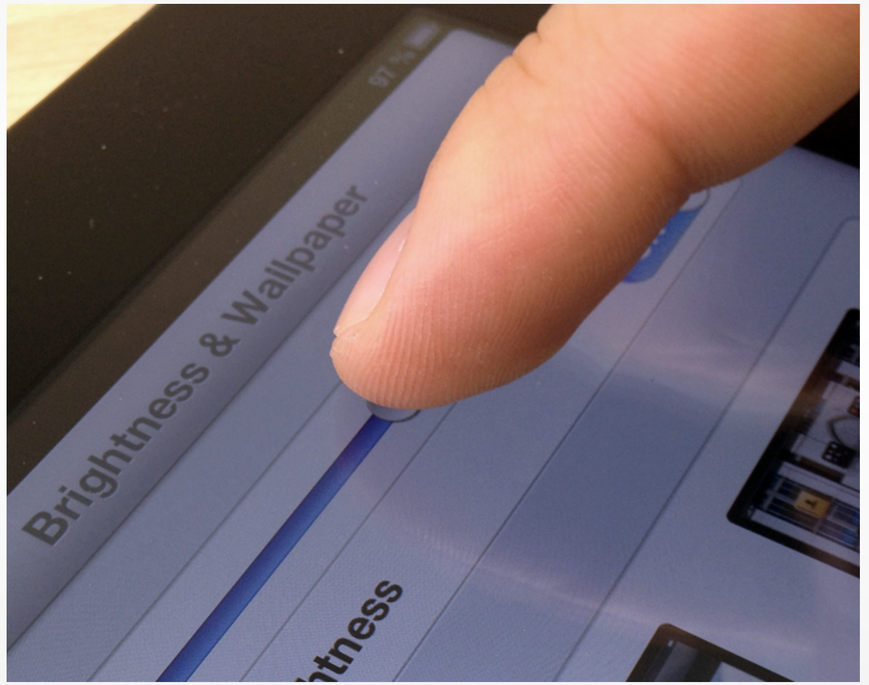
[Forlines et al. CHI ’07]

Problems with Touch Input

- Ergonomic Issues



- Lack of haptic feedback



Next Week!

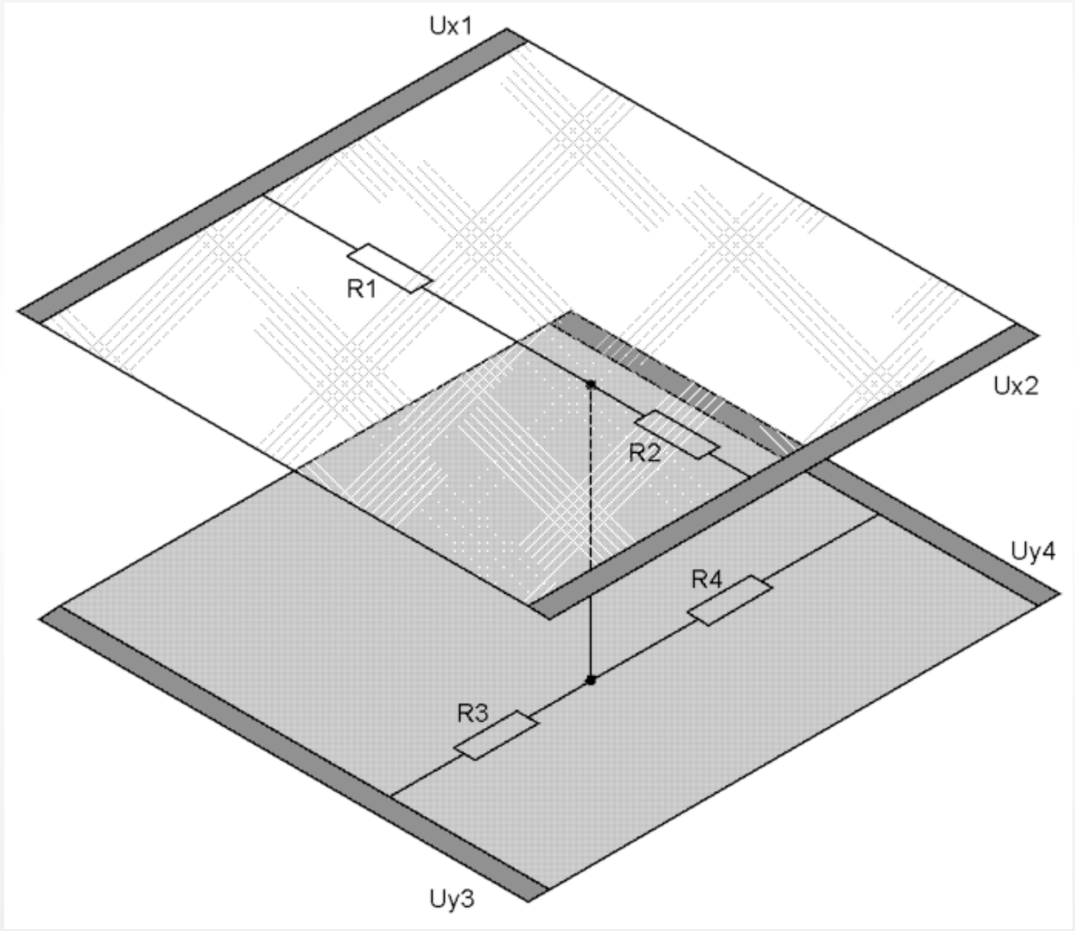
Technologies

- Resistive
- Vision-based
  - Frustrated Total Internal Reflection (FTIR)
  - Diffuse Illumination (DI)
  - Pixel Sense
- Capacitive

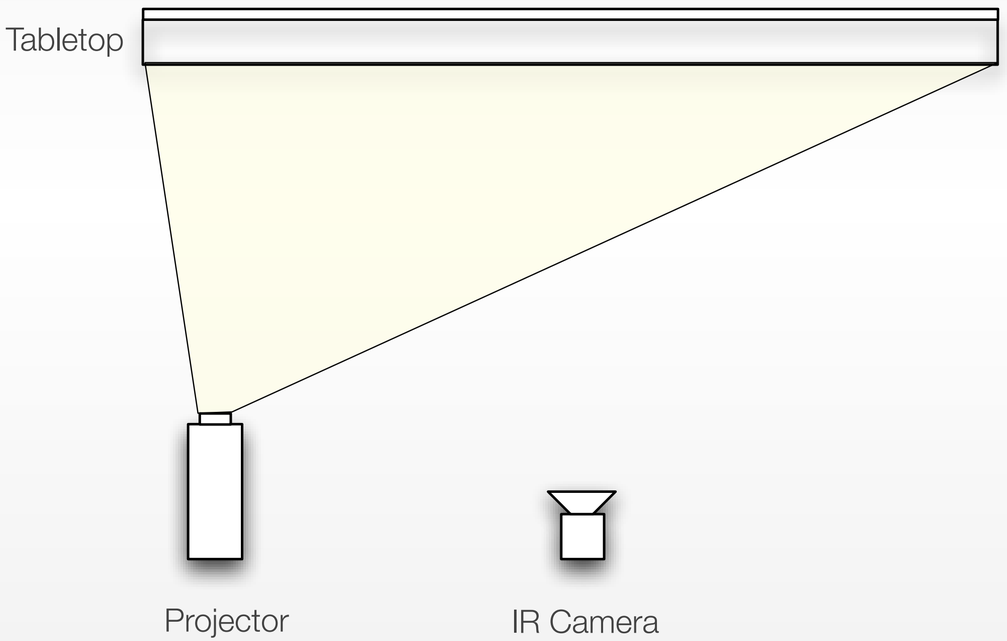
Resistive Touch Screens

- Flexible hard-coated outer membrane
- Conductive coating
- Insulating spacer dots
- Conductive coating
- Glass substrate

Resistive Touch Screens



Vision-based Touch Screens



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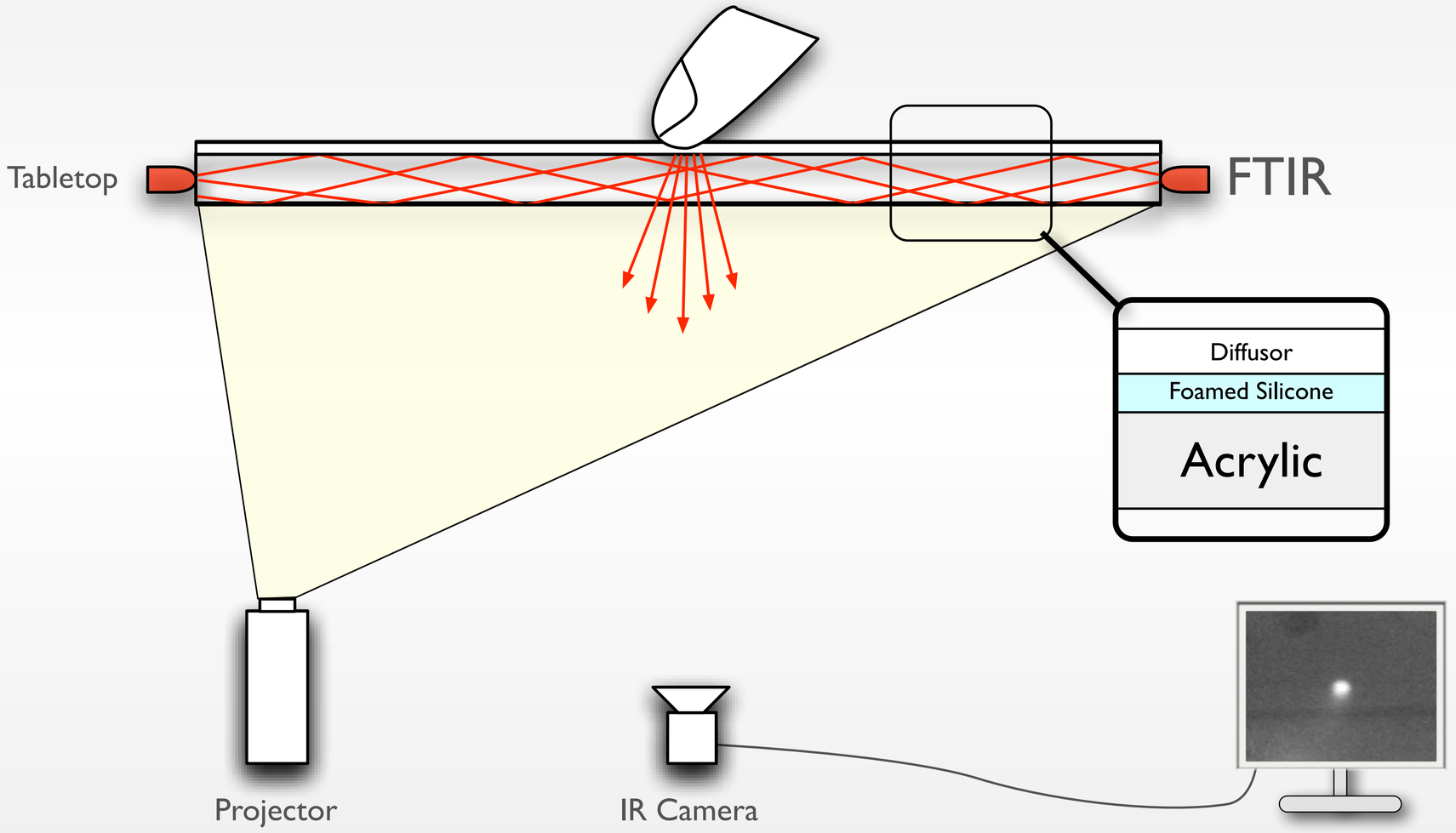
Frustrated Total Internal Reflection (FTIR)



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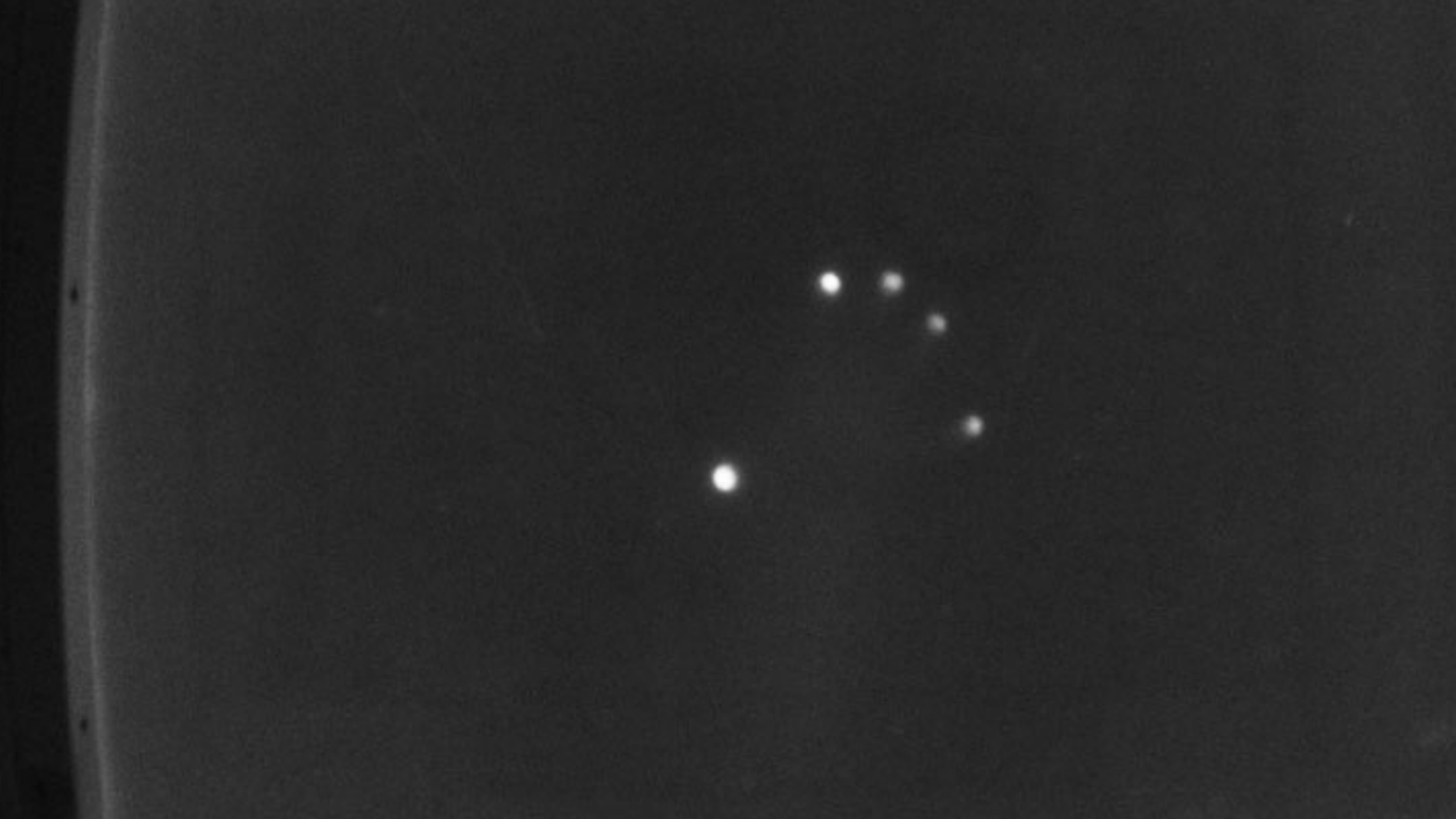
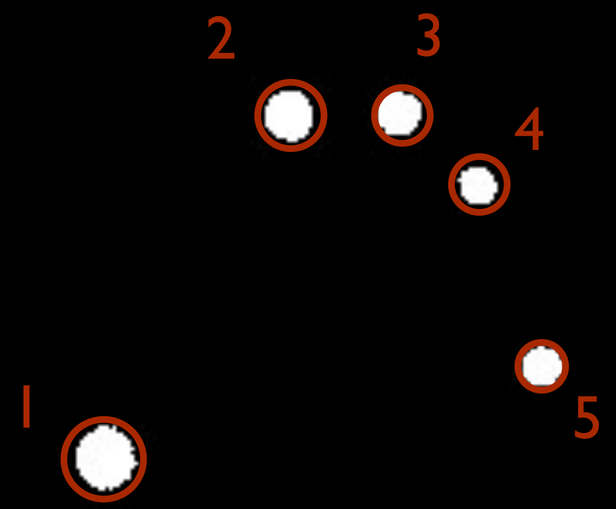


Background

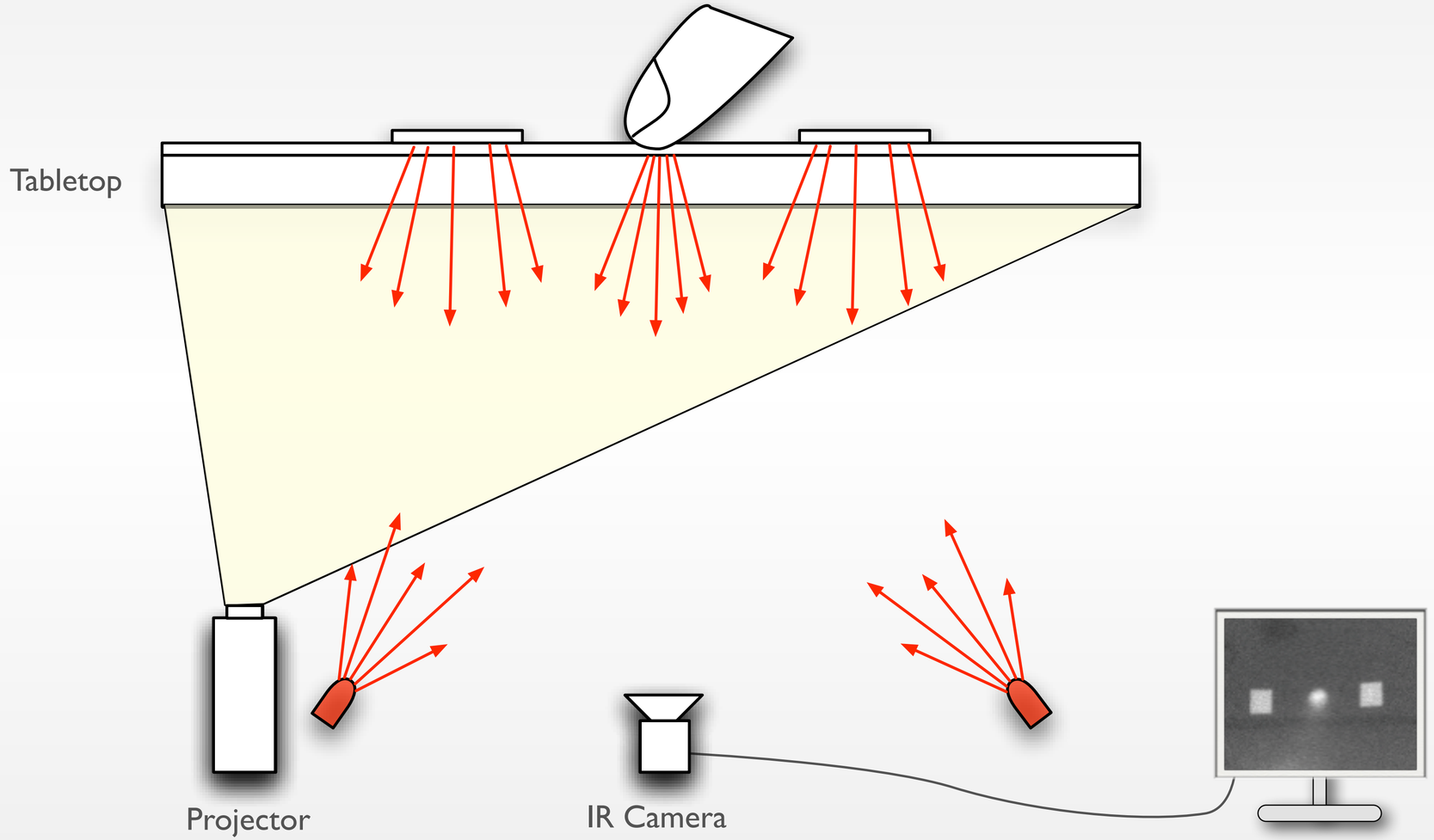
Background Subtracted

Thresholded

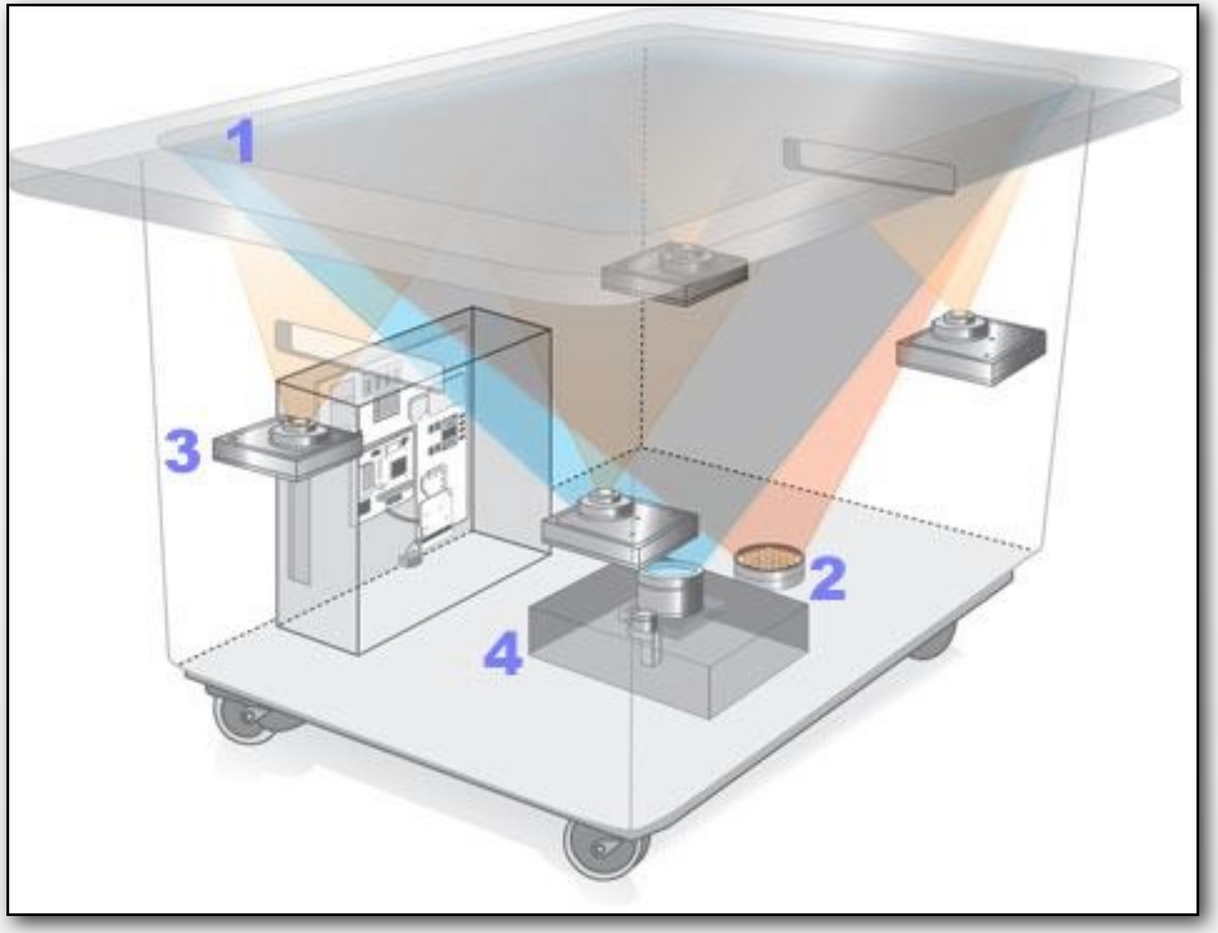
Detected Spots



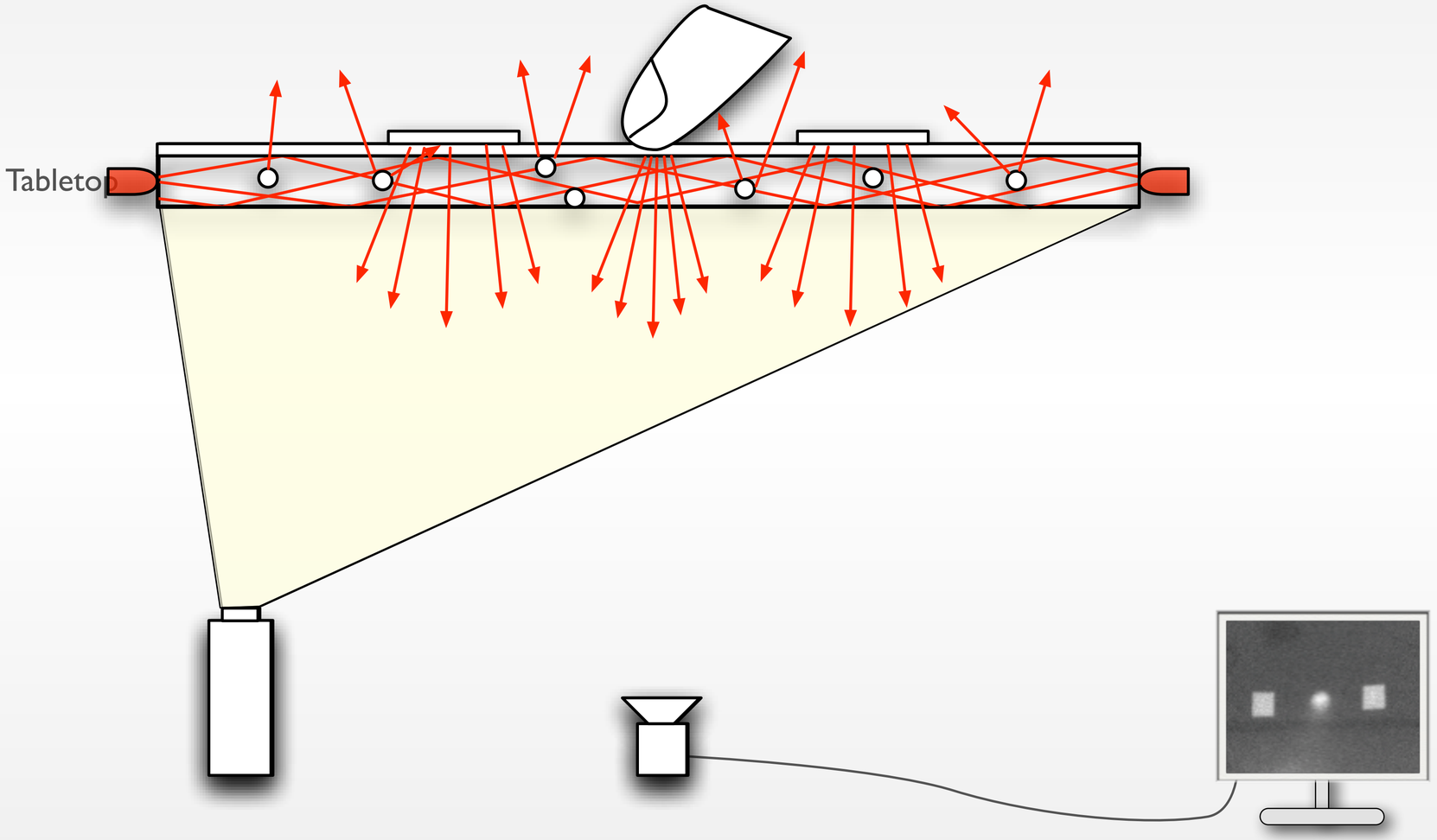
Diffuse Illumination (DI)



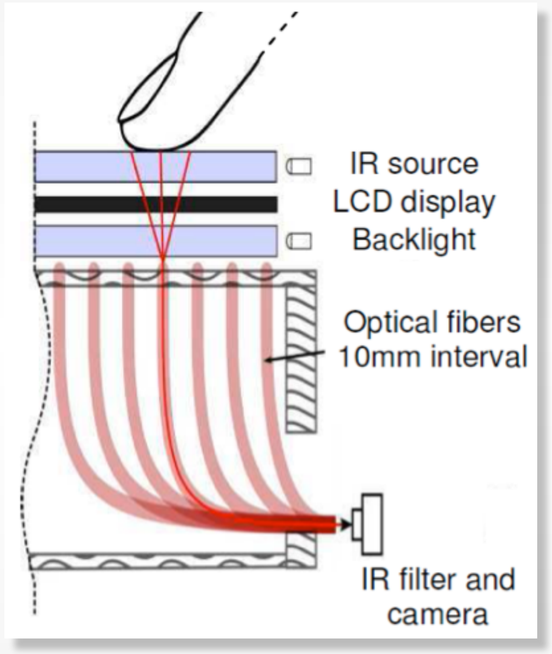
Example of DI: Microsoft Surface 1



Diffused Surface Illumination

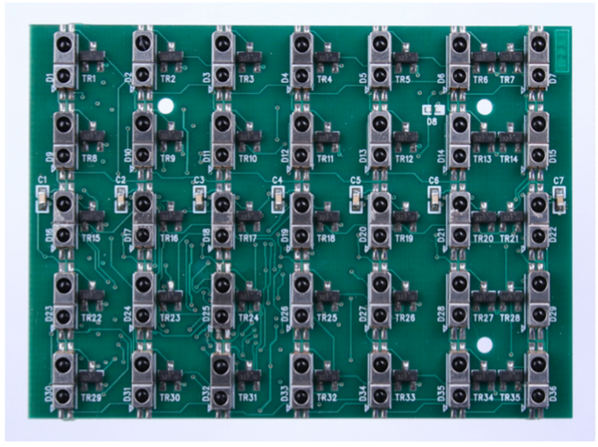


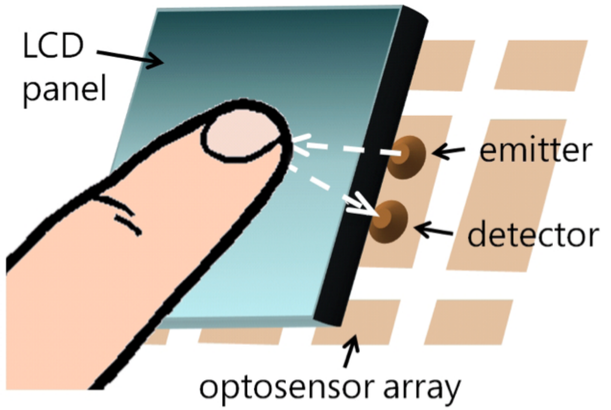
Reduced Form Factor

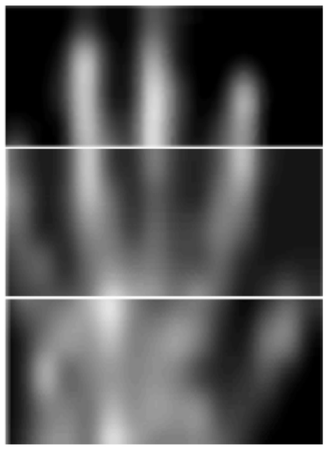


FiberBoard

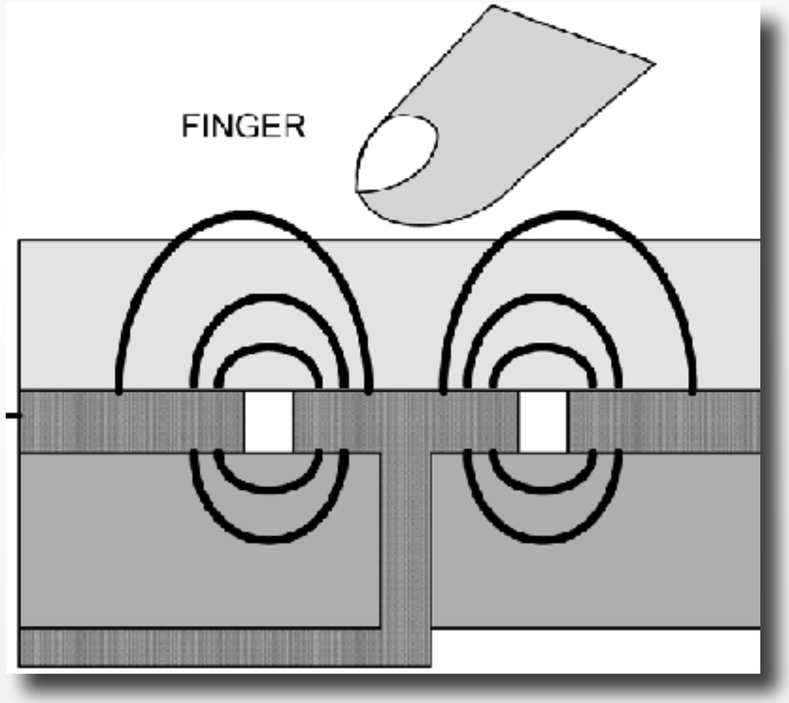
Microsoft Surface (Pixel Sense)





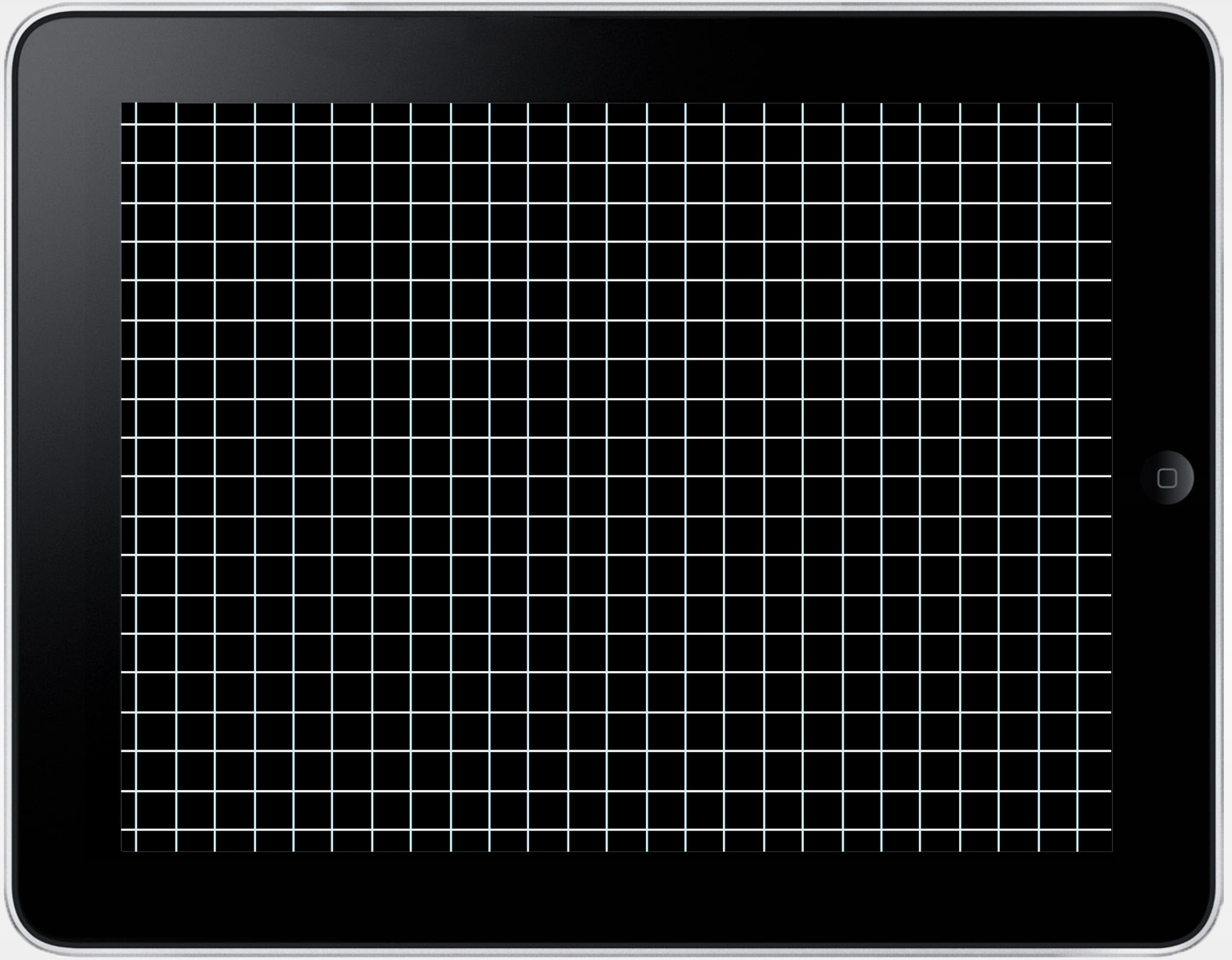


Capacitive touch



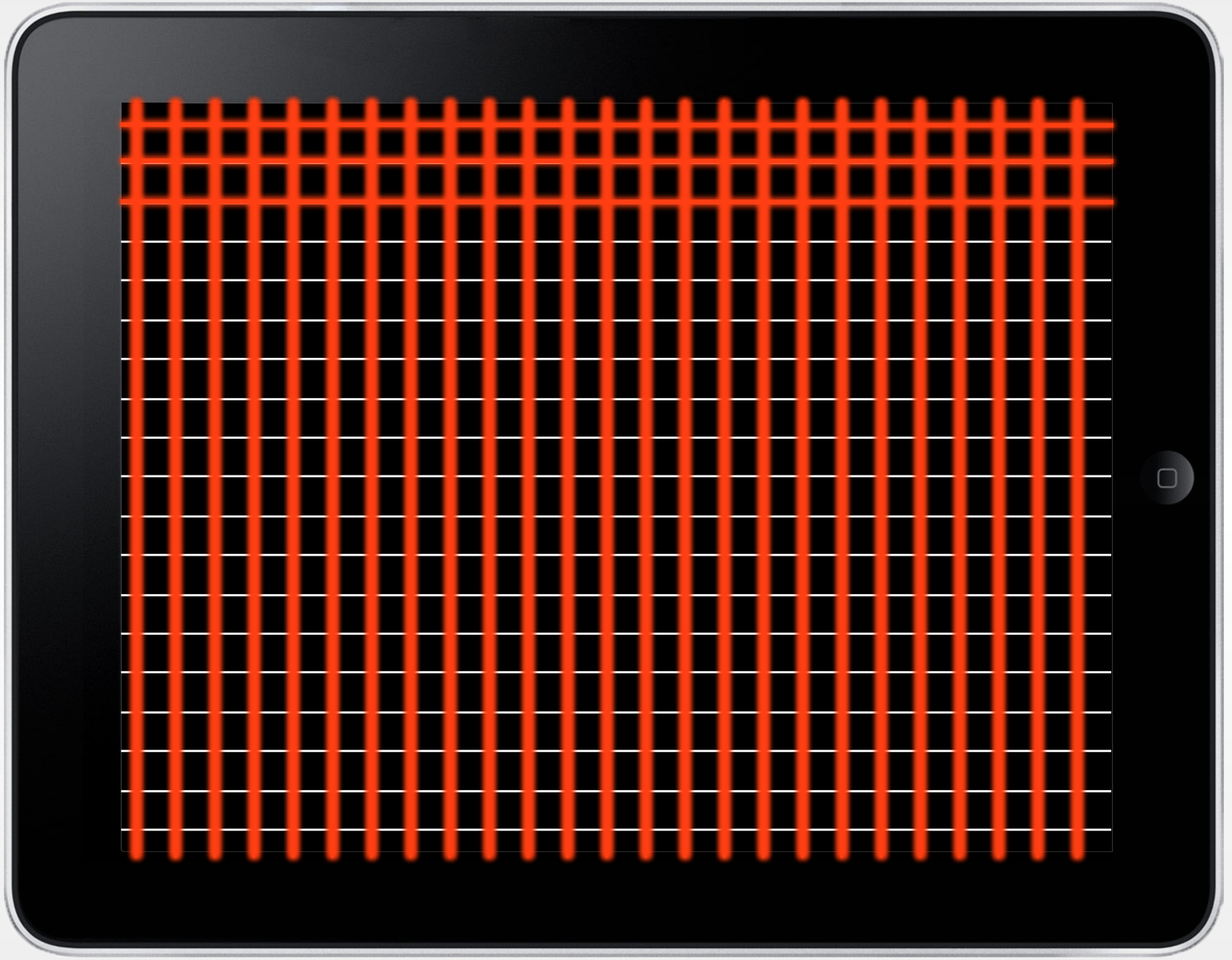
Receiving Electrodes

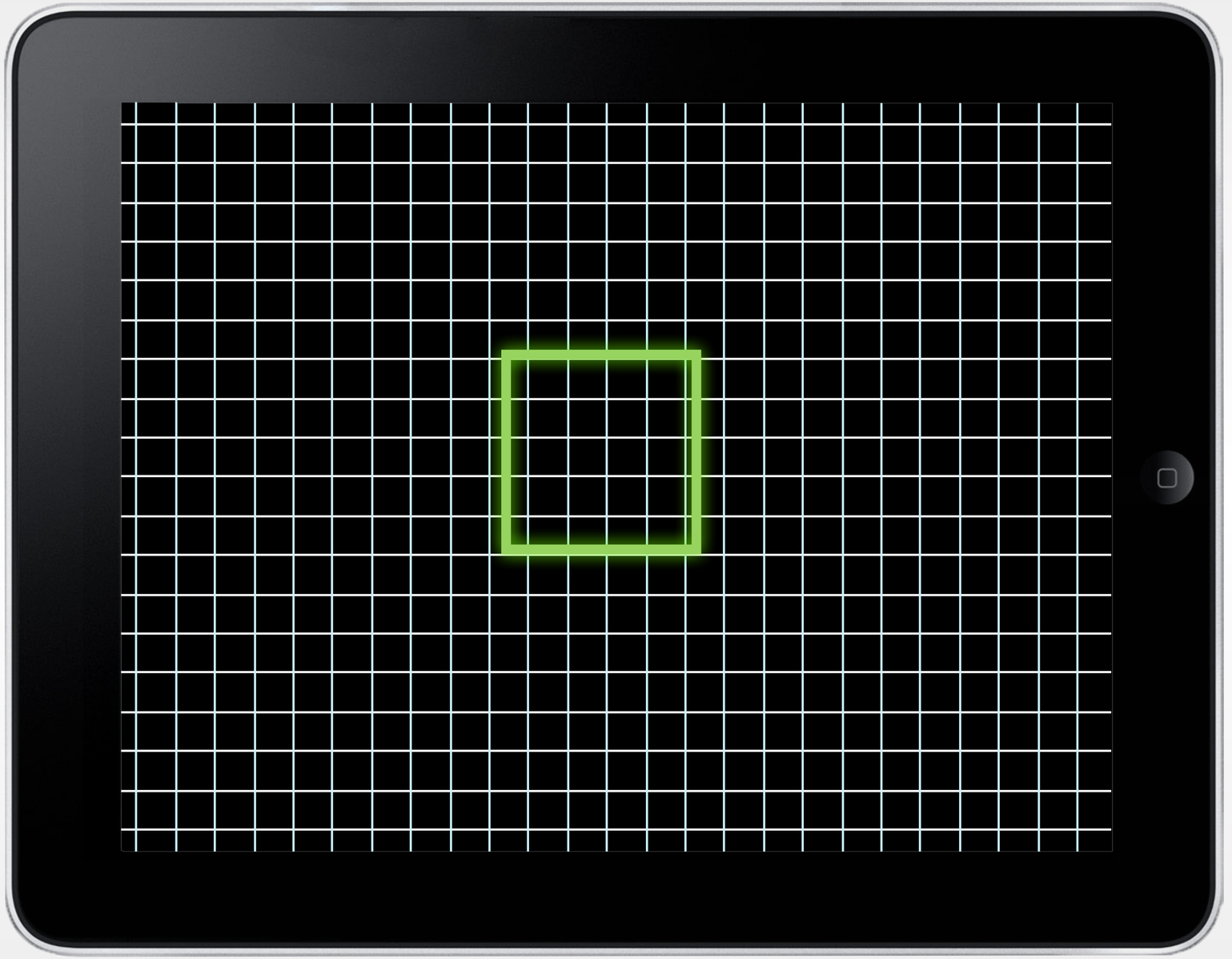
Transmitting Electrodes

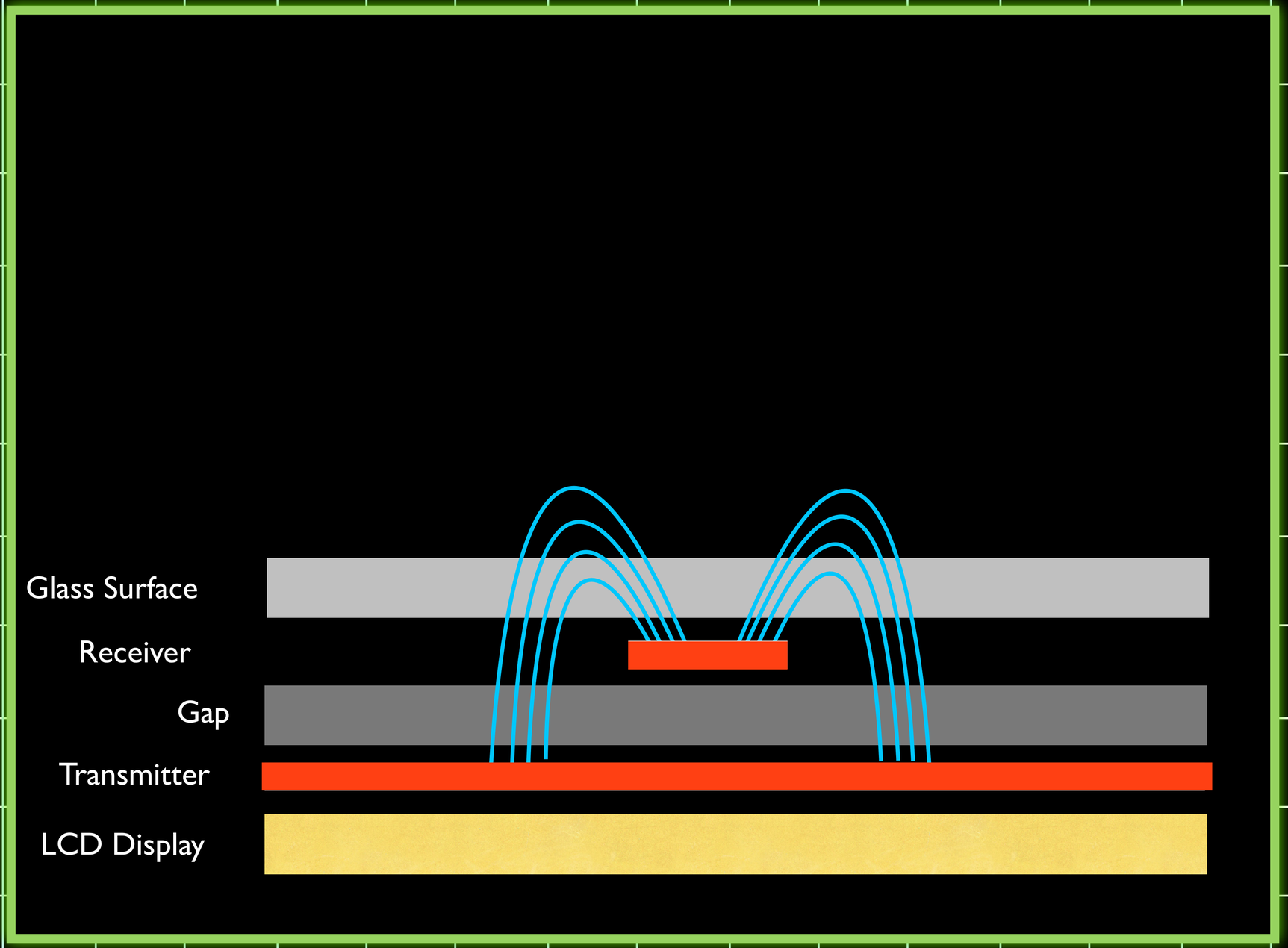


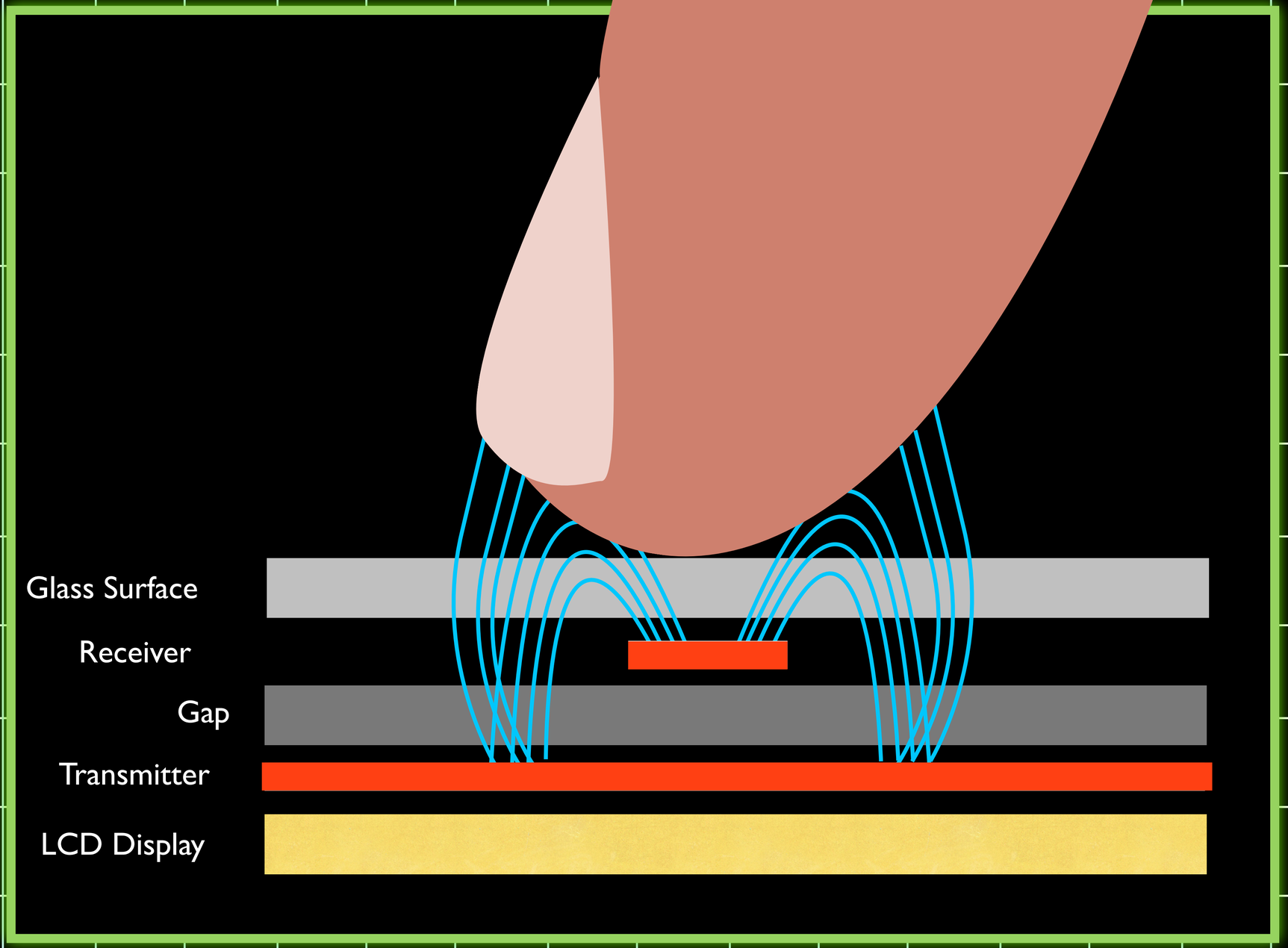
Receiving Electrodes

Transmitting Electrodes





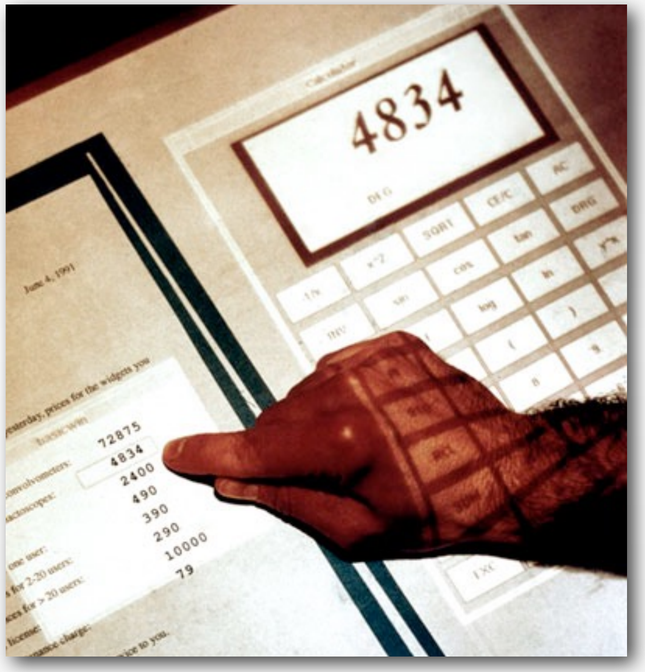

Glass Surface
Receiver
Gap
Transmitter
LCD Display


Glass Surface
Receiver
Gap
Transmitter
LCD Display

In-class Exercise: Predicting Future

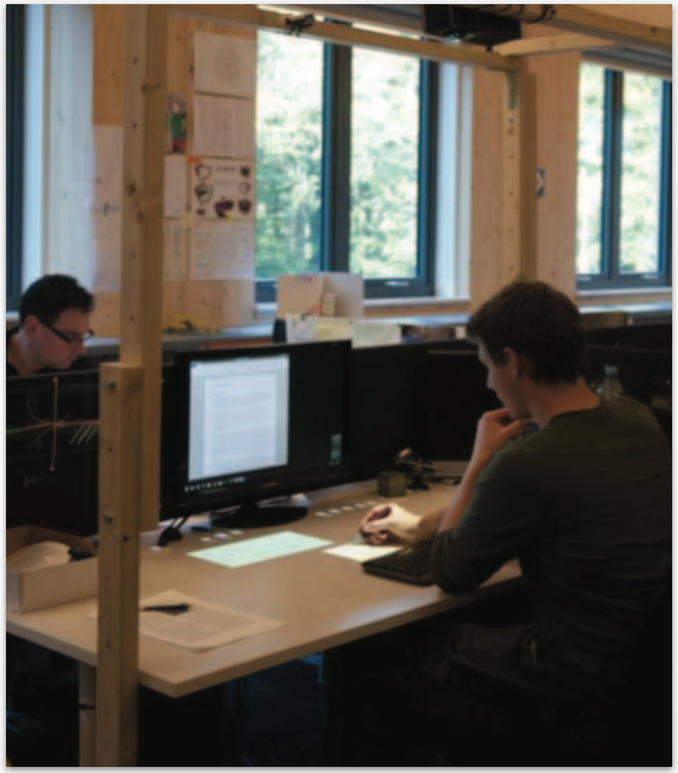
Will multi-touch interaction replace the desktop metaphor?

Multi-touch Workspaces



The DigitalDesk (CHI ’91)

Living with a Tabletop (TABLETOP ’07)



Experiences (CHI ‘12)

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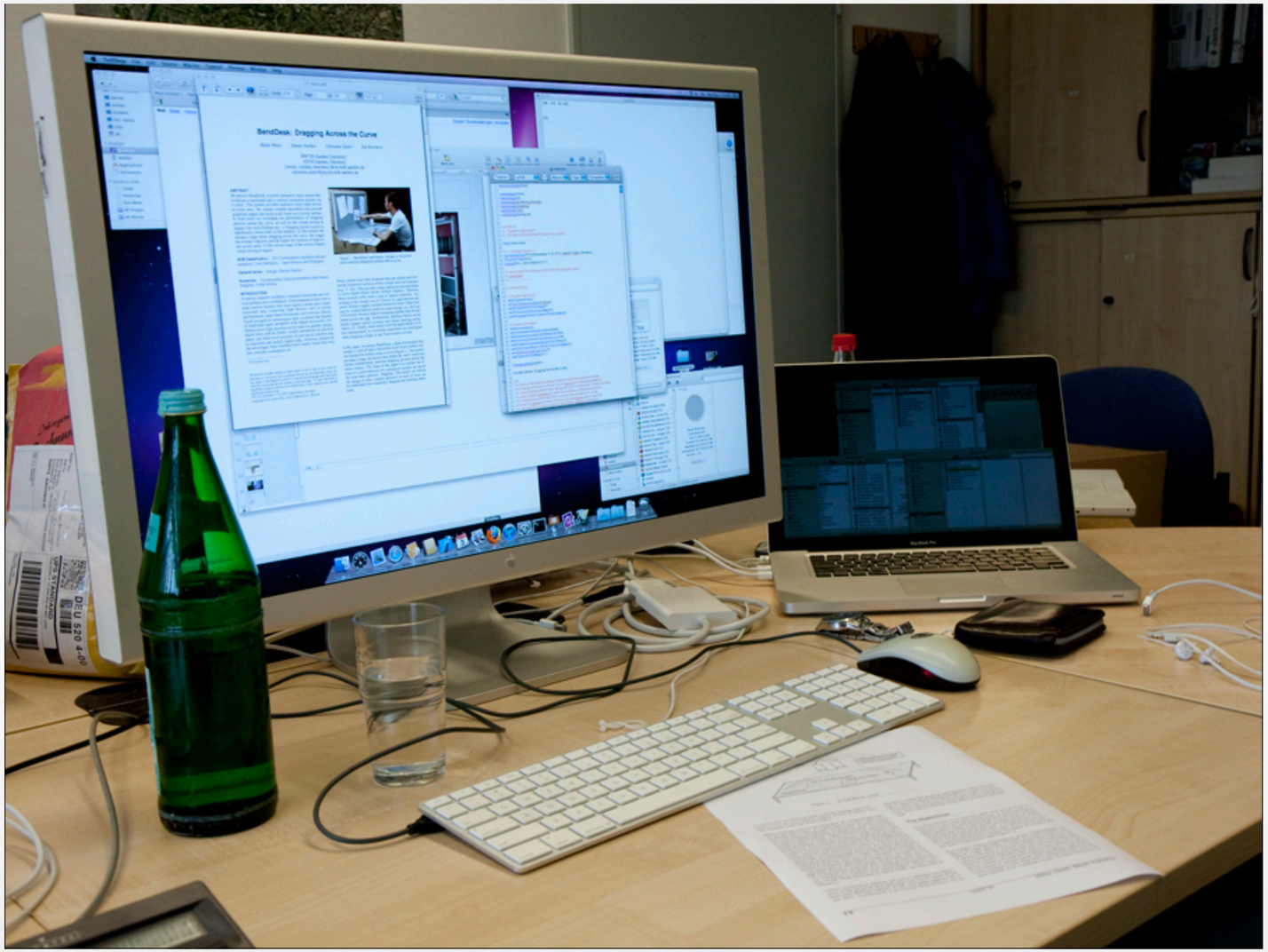
Multi-touch Workspaces



Vertical vs. Horizontal Surfaces

- Vertical
  - \+ Good for reading task
  - \+ Good for overviews
  - – Gorilla arm effect
- Horizontal
  - \+ Annotation task
  - \+ Placing everyday object
  - – Neck pain

Combining Horizontal and Vertical

Tilted Tabletop (Müller-Tomfelde, ’08)

ViCat (Chen, Tabletop ‘06)

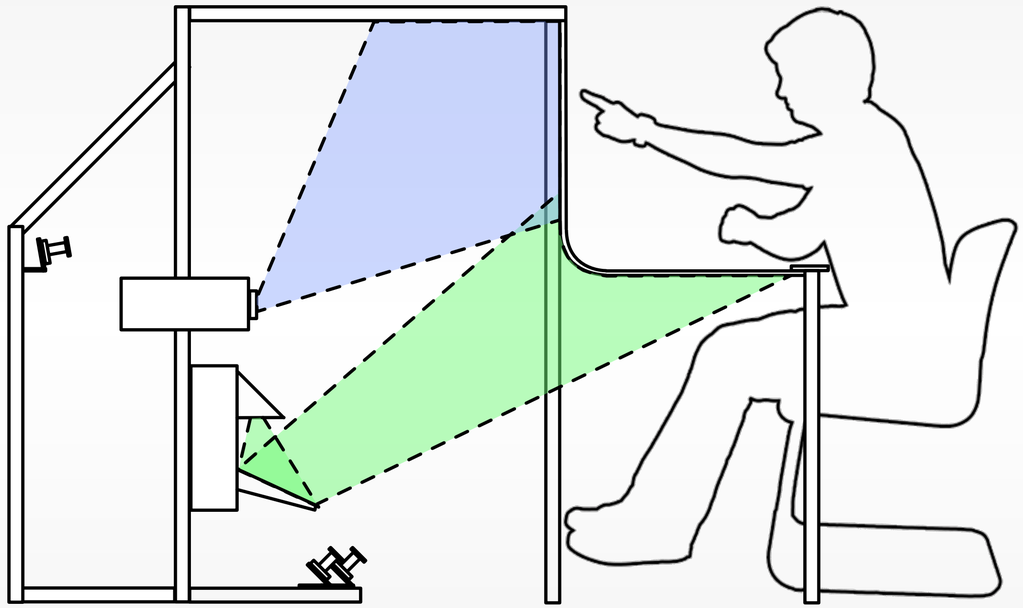
Curved Surfaces

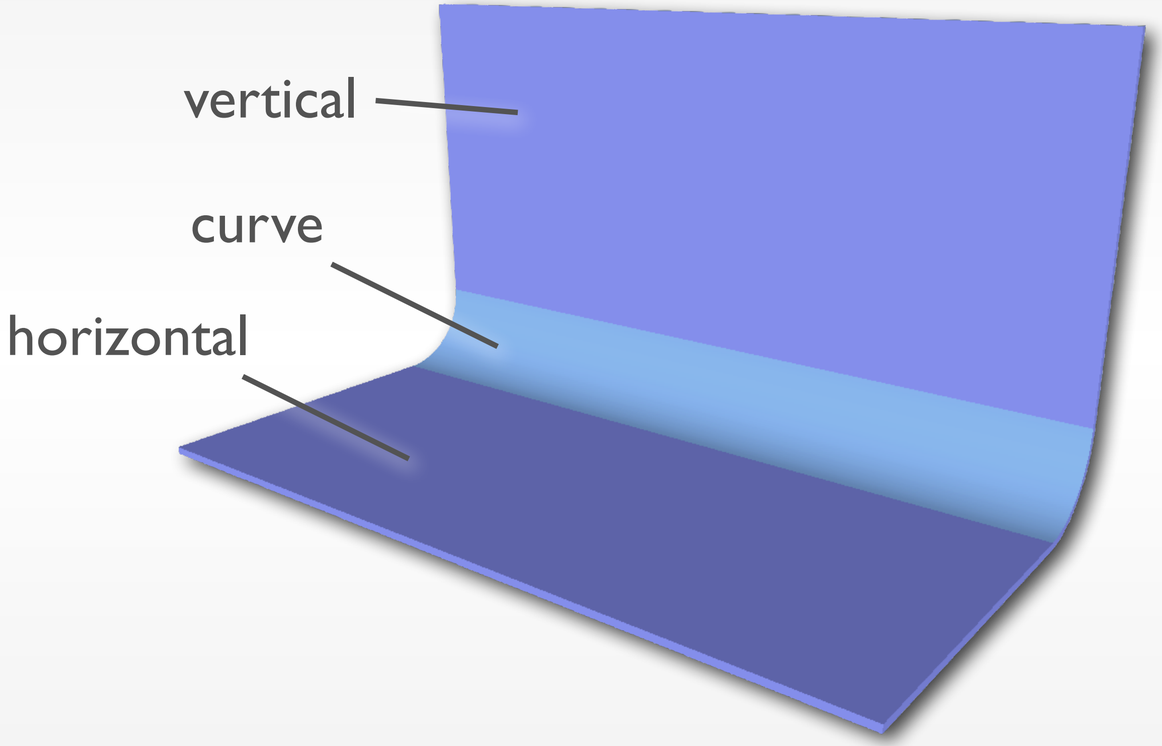
Sun Starfire (Tognazzini, CHI ’94)

BendDesk (Weiss , ITS ’10)

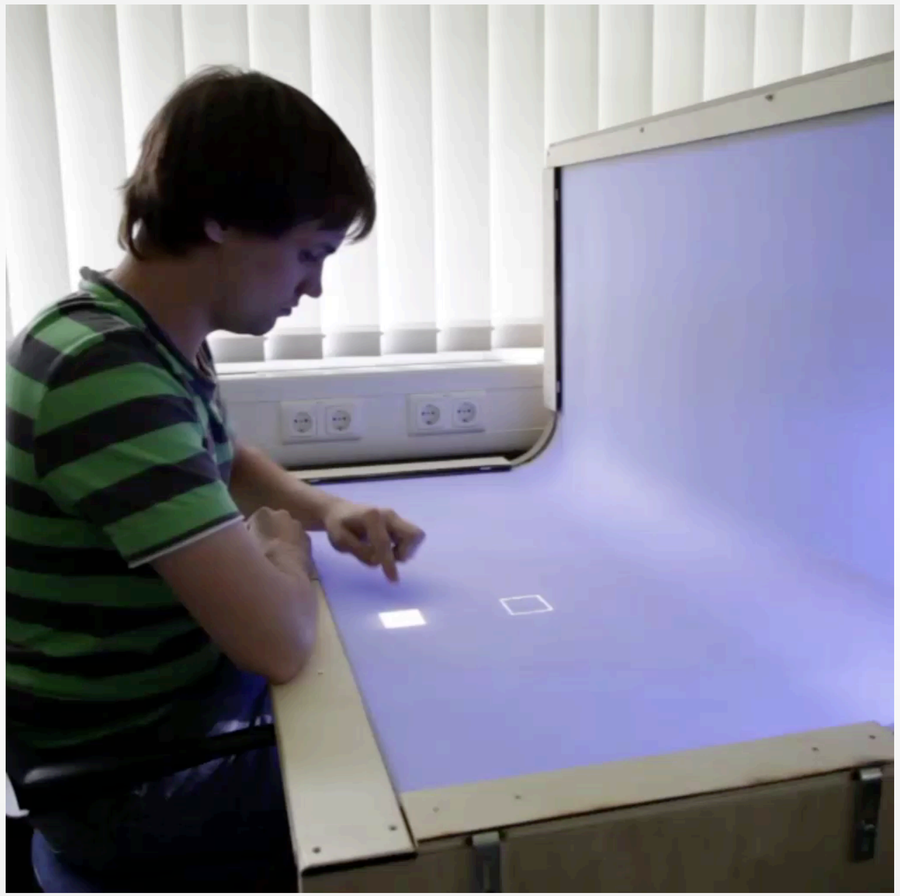
Curve (Wimmer, NordiCHI ’10)

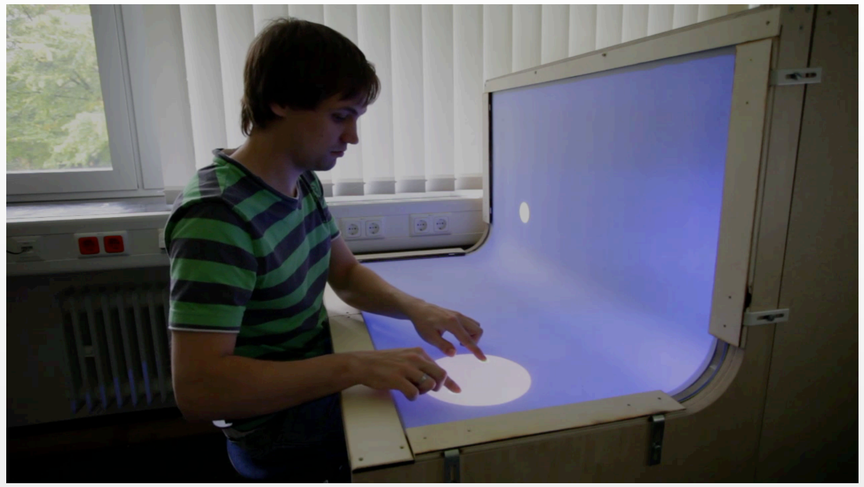
BendDesk System Overview





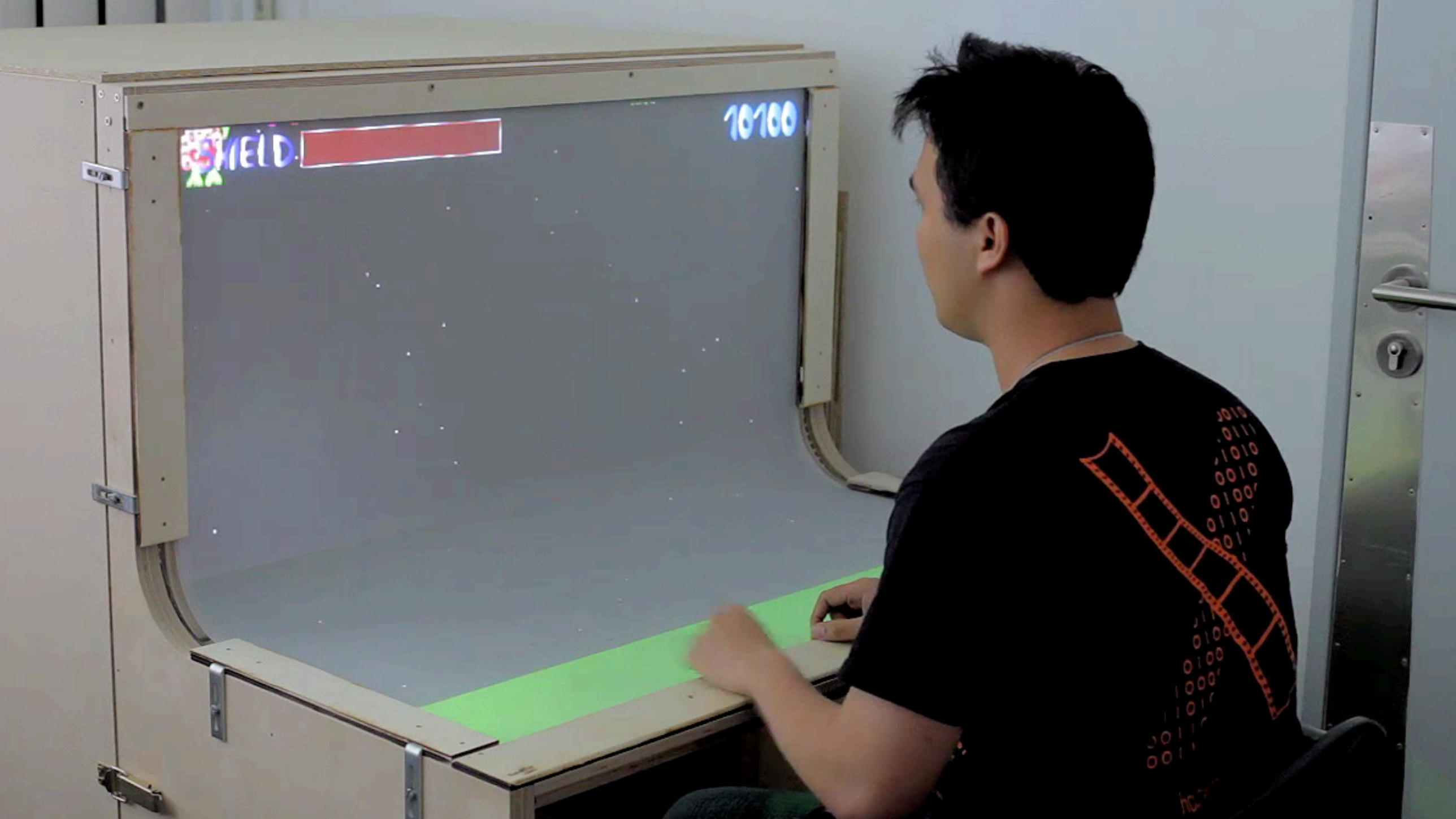
Interaction on Curved Surface



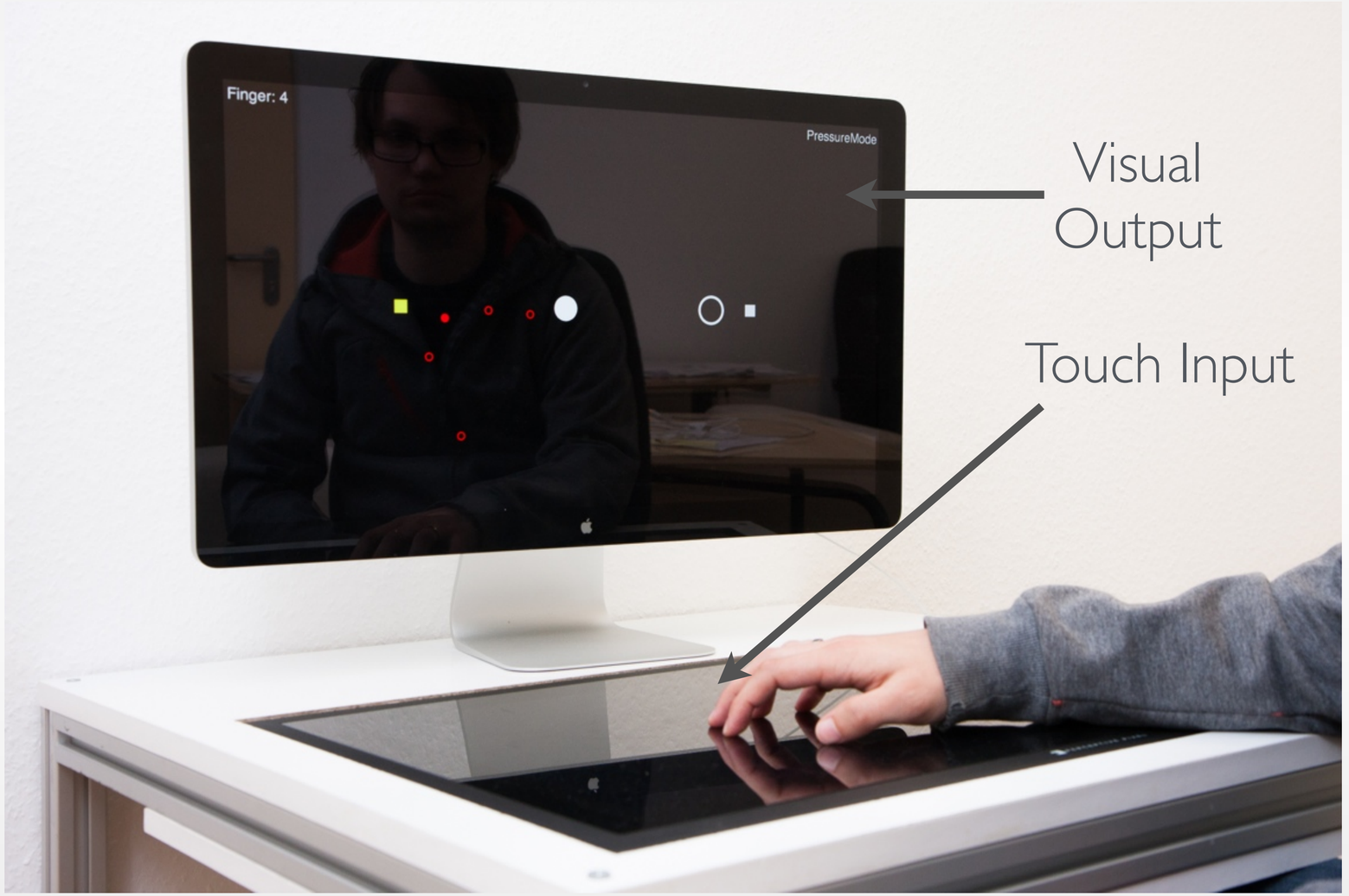


Interaction on Curved Surface

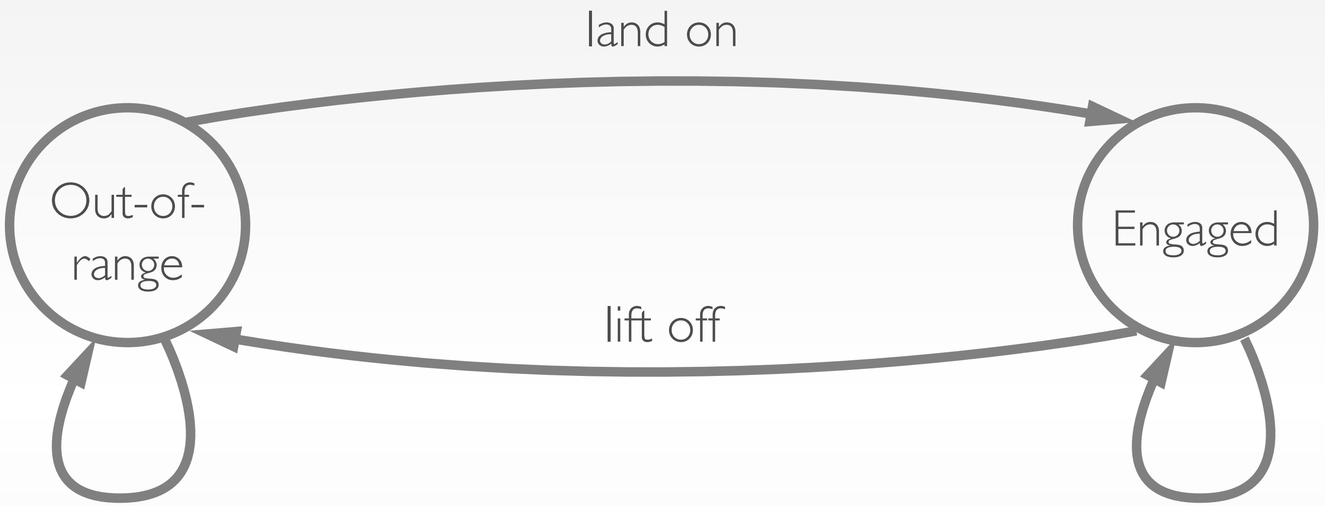
- Curve influences dragging performance
- Body mechanics matter
- Continuous gestures work, but haptic barrier
- Different cognitive mappings between 2D vs. 3D space
- **Vision-based touch screen!**


SHIELD
10100

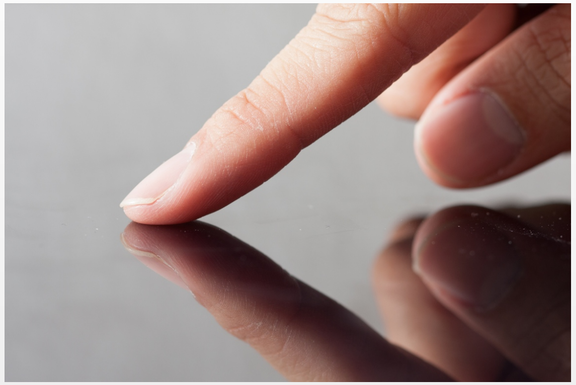
Indirect Touch



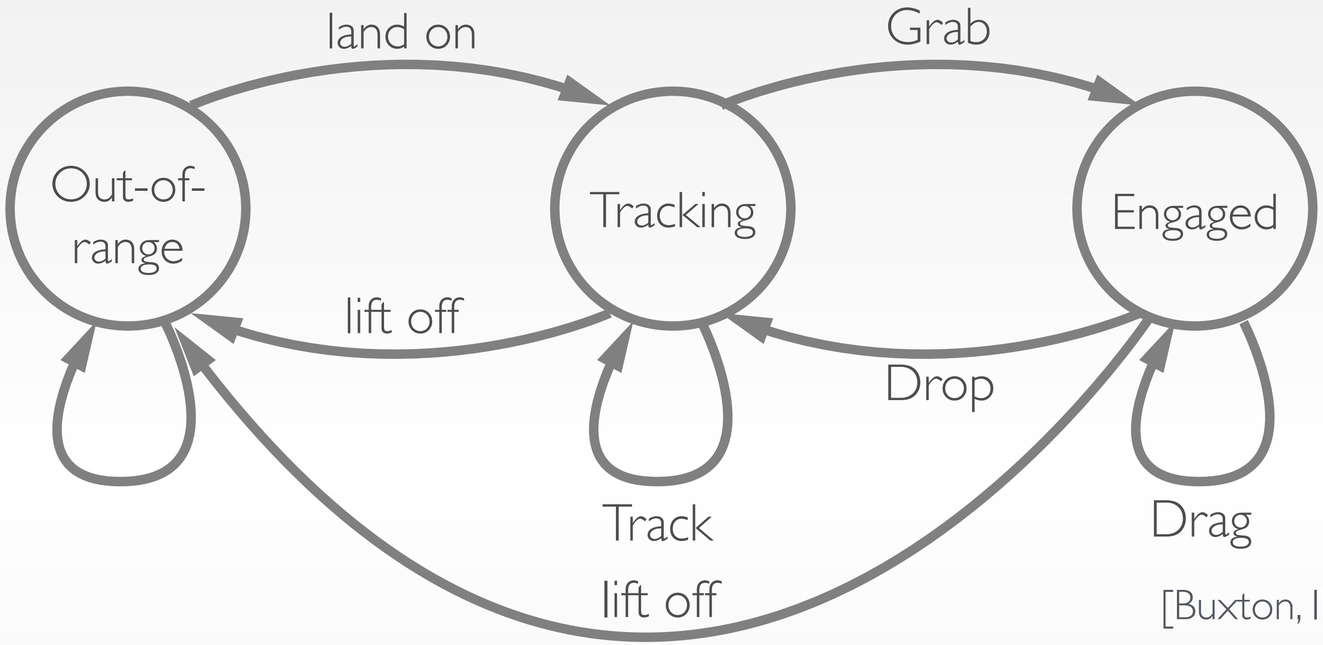
Two-State Touch Model



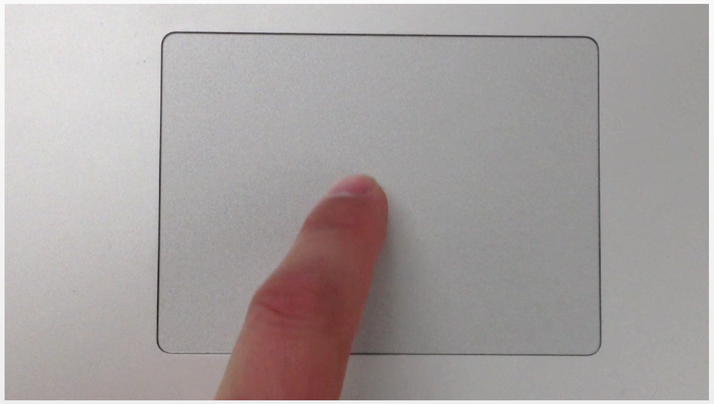
[Buxton, INTERACT '90]



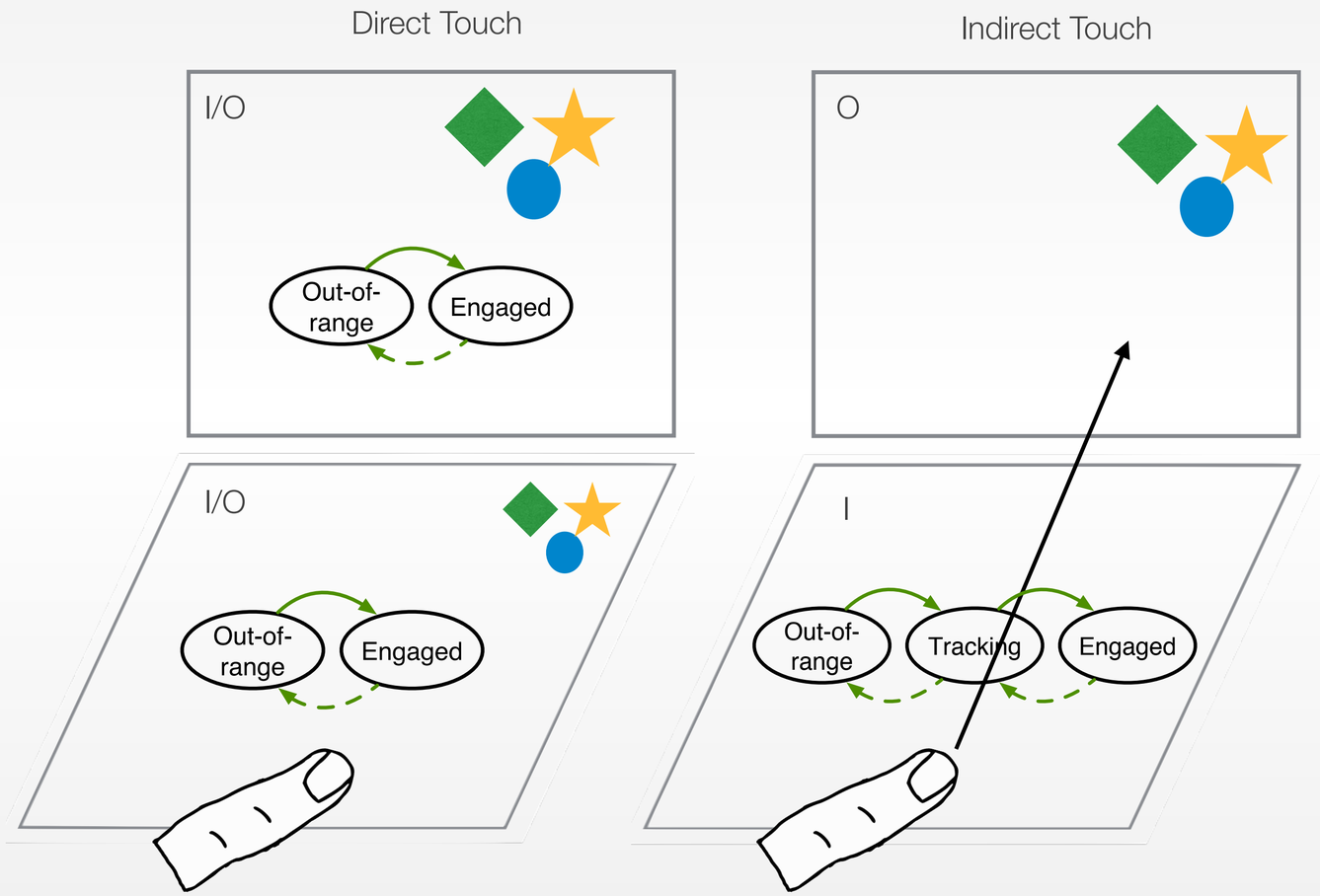
Three-State Touch Model



[Buxton, INTERACT '90]



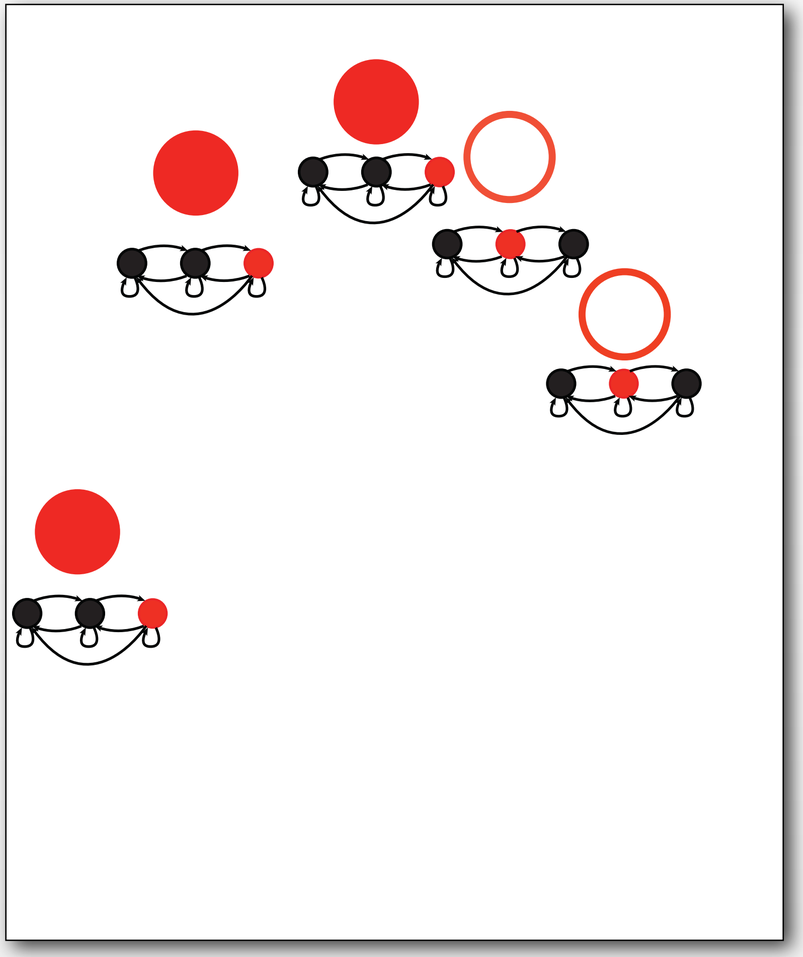
Direct vs. Indirect Touch



Multiple State Machines

Input

Output



Multiple State Machines

Input

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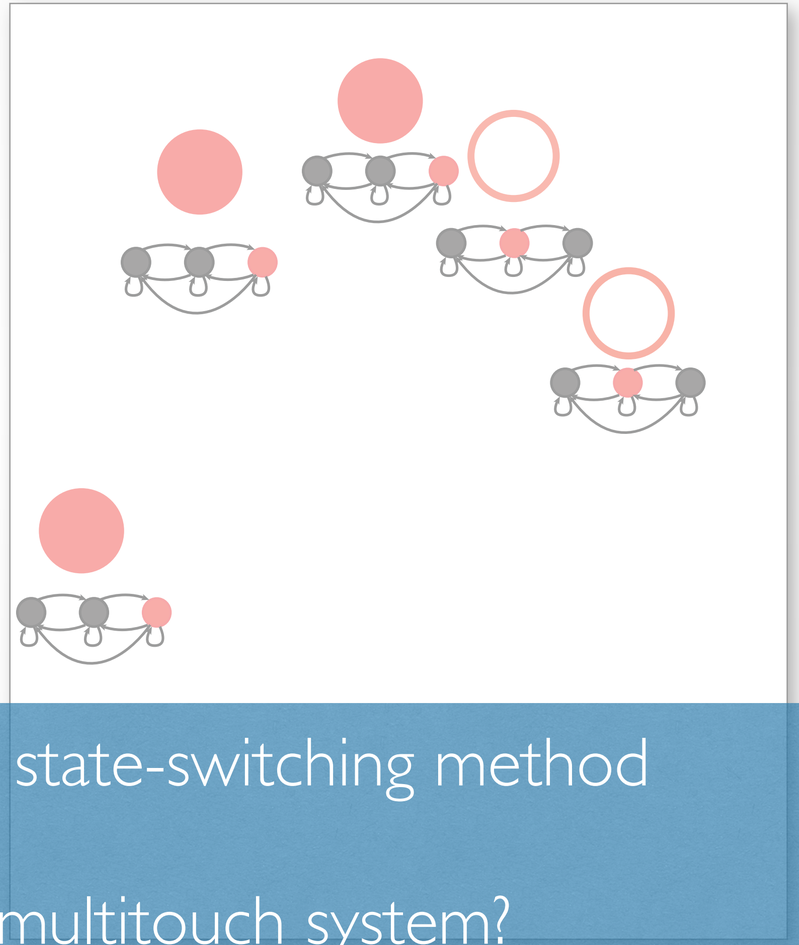
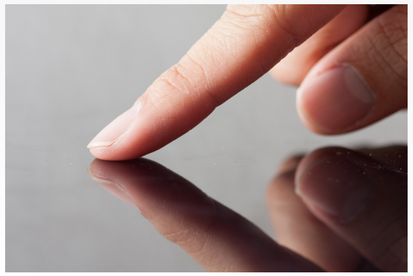


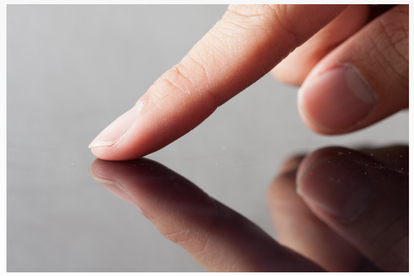
What is the best state-switching method

for indirect multitouch system?

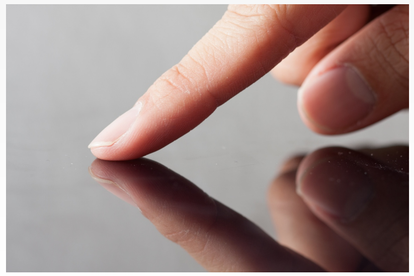
State Switching Methods

Lift-and-Tap

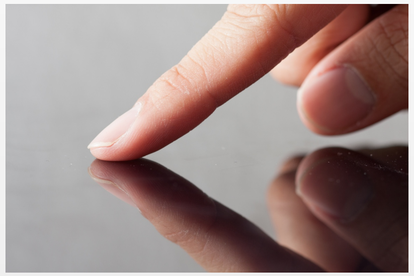




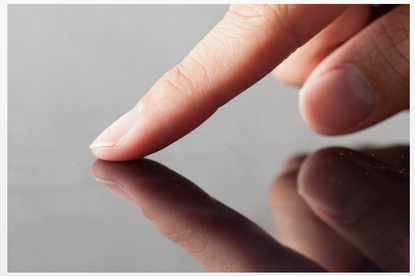
Hold

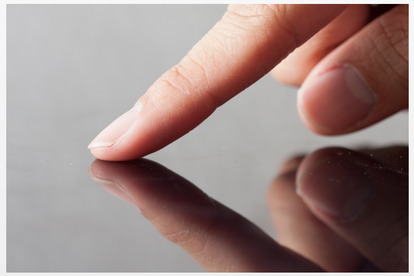


Pressure Quasimode

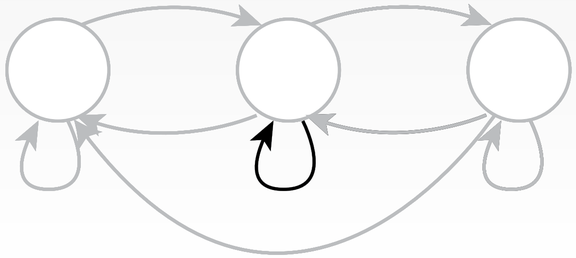


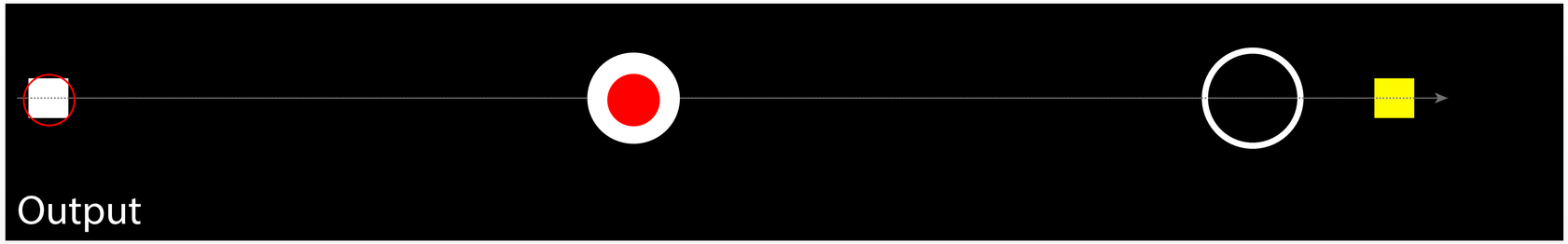

Pressure Switch

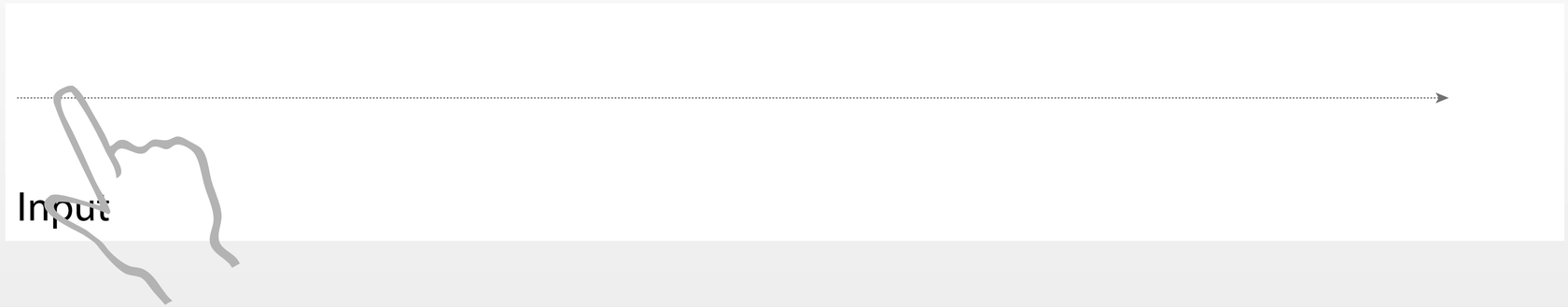




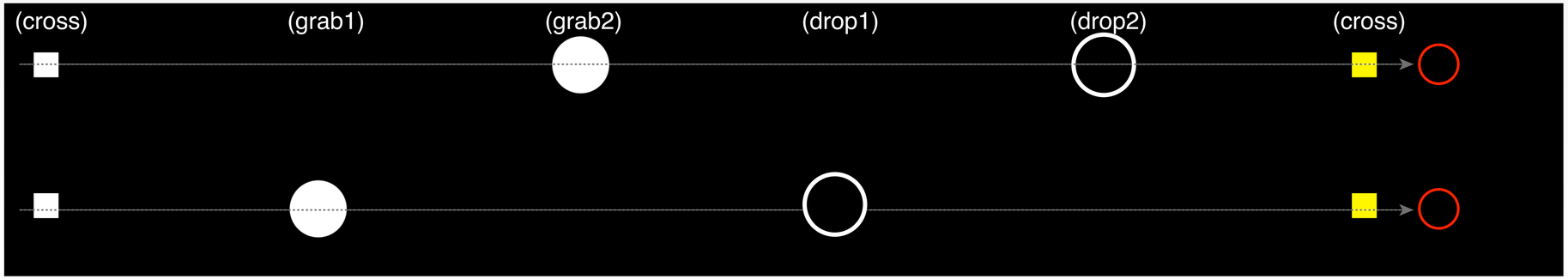
Study 1: Single Finger

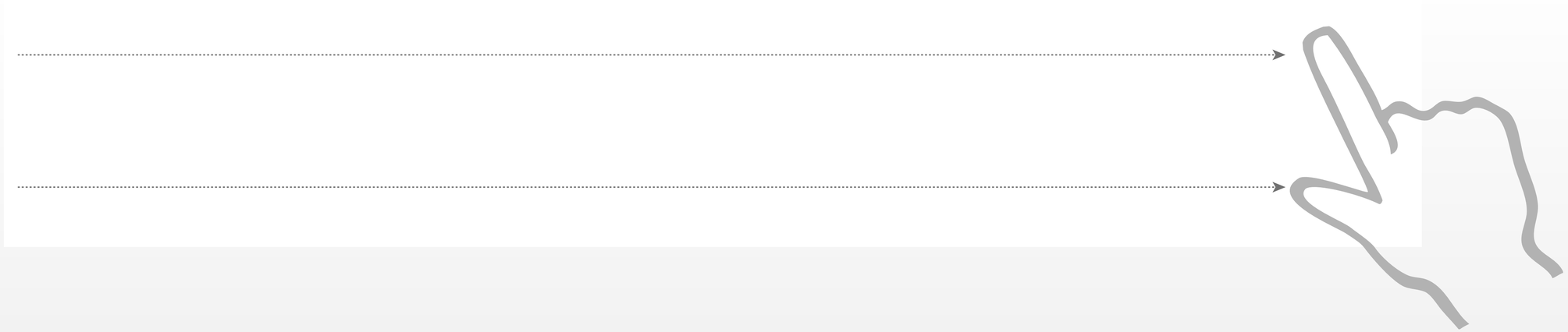




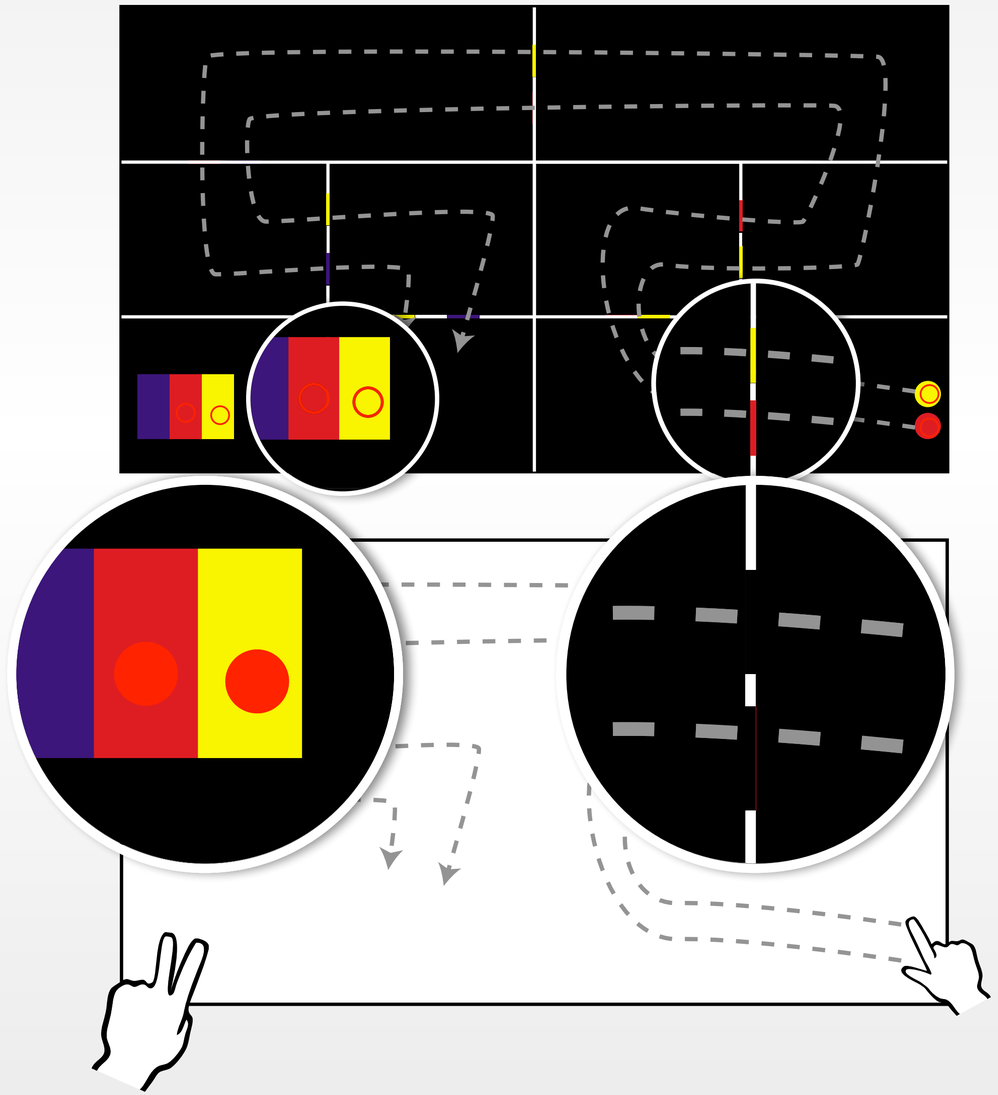


Study 2: Two Fingers

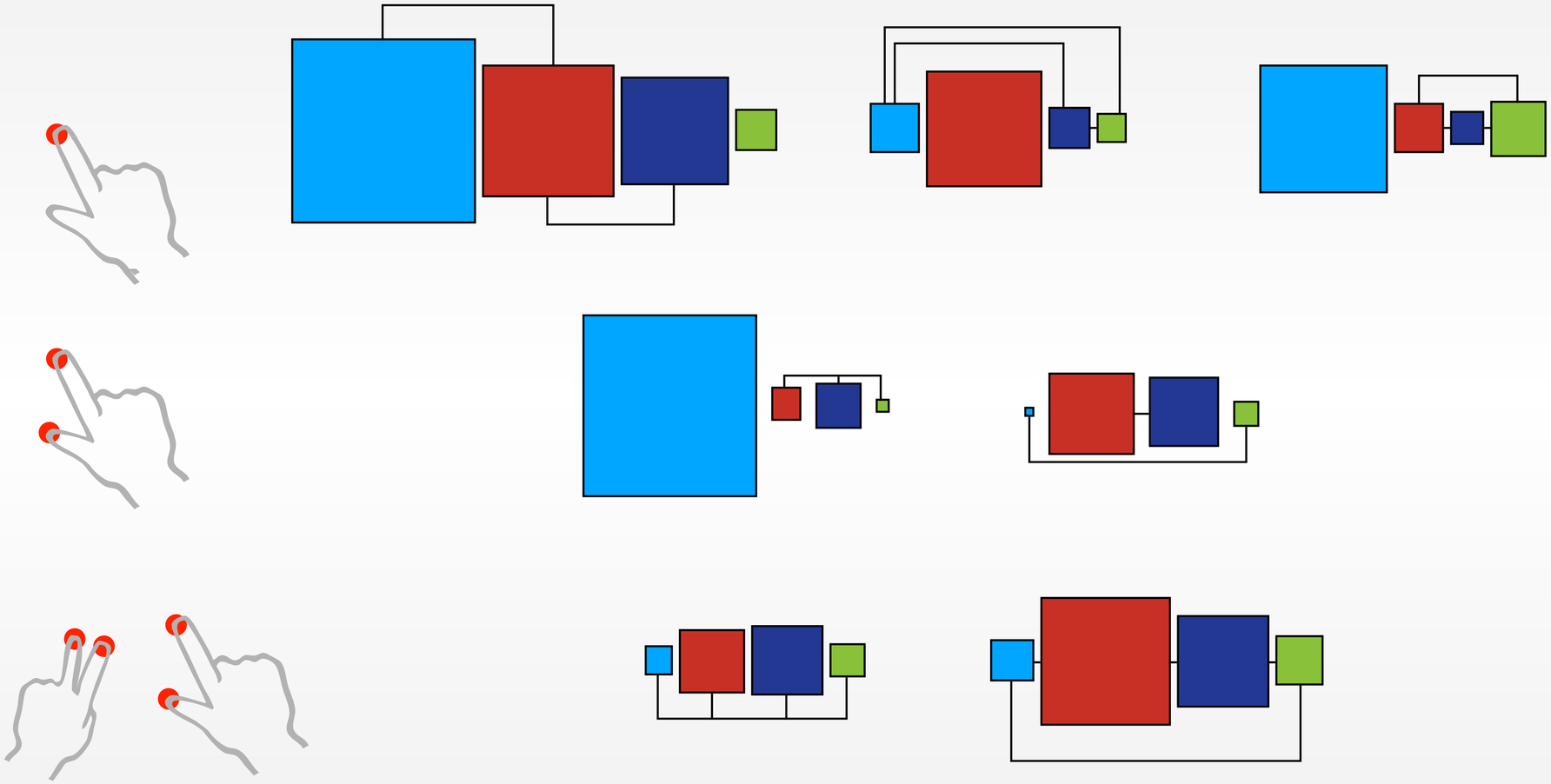




Study 3: Two Hands



Indirect Touch: Errors



Combining Direct and Indirect Touch

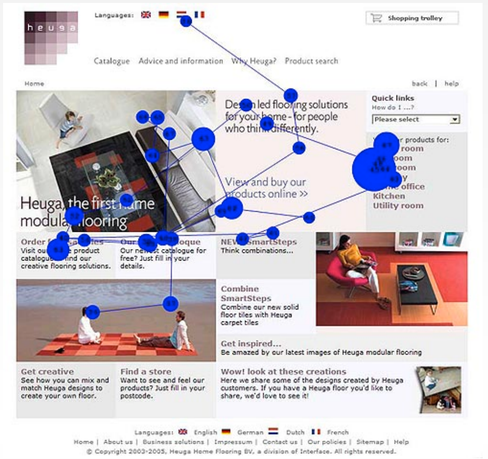
Possible Solution: Eye-Tracking

- The user's gaze:

+ Extremely fast

– Eyes are constantly moving

– Easy to distract



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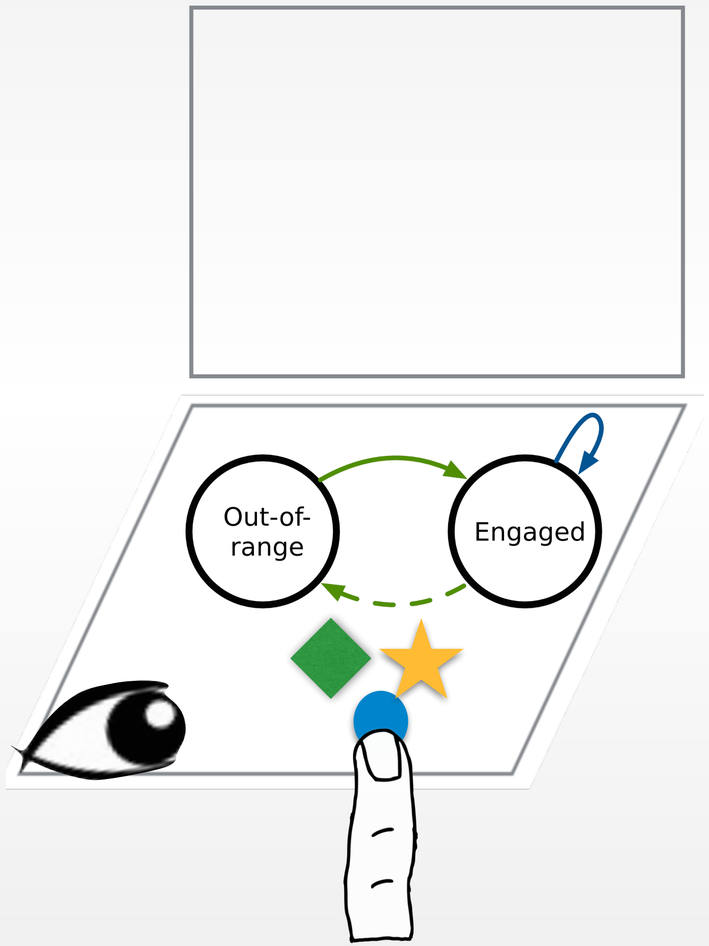
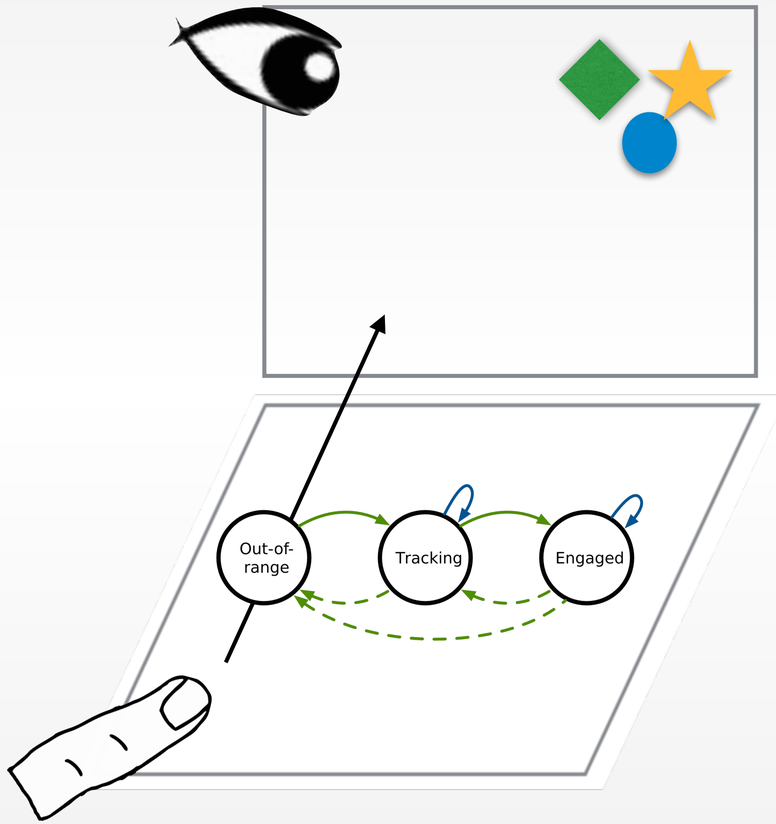
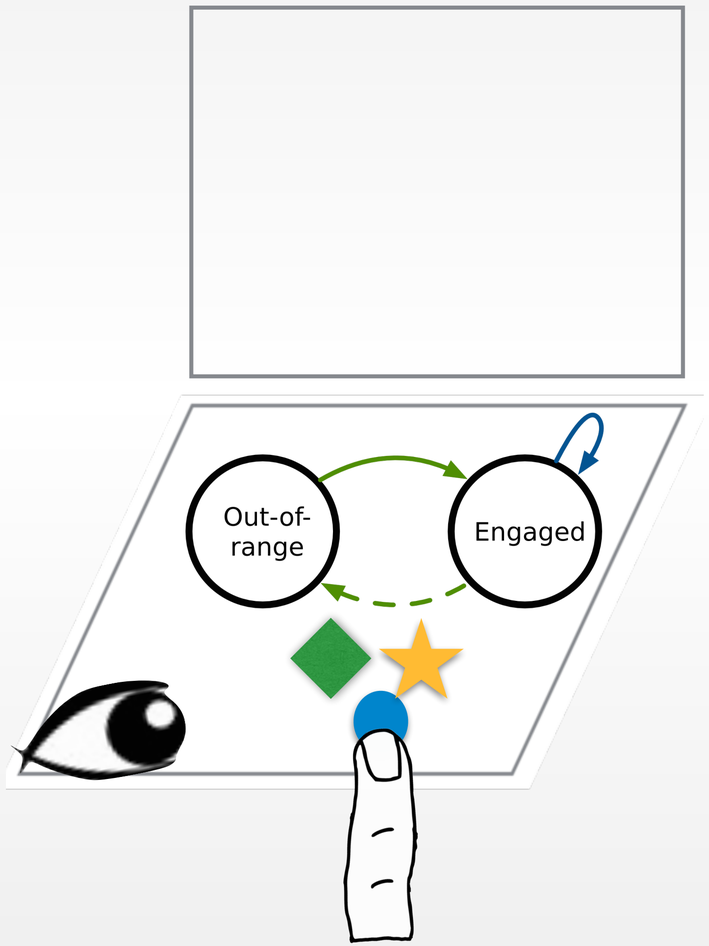
Combining Direct and Indirect Touch



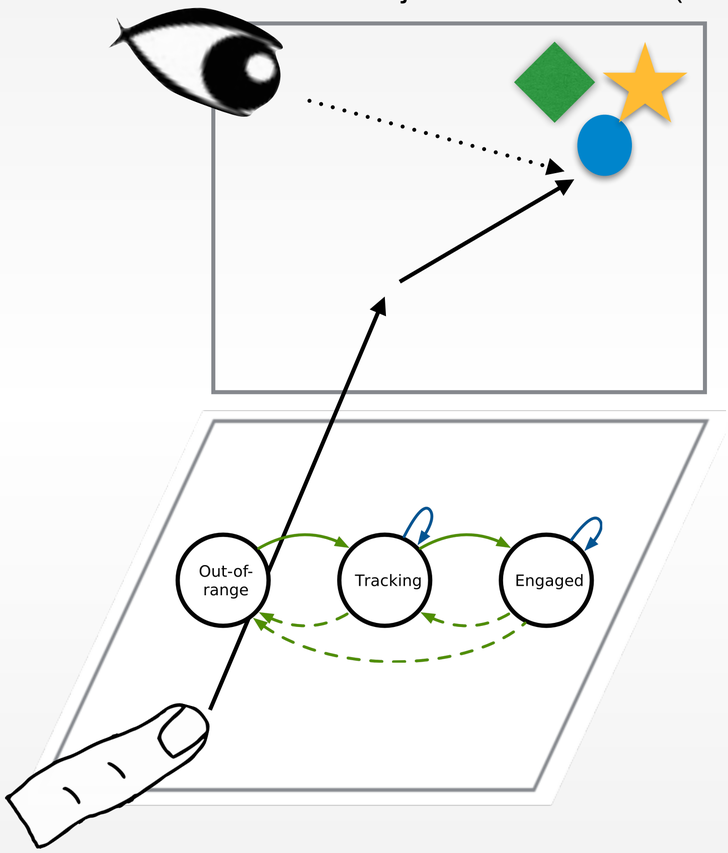
Indirect Touch Surface Selection (ITSS)



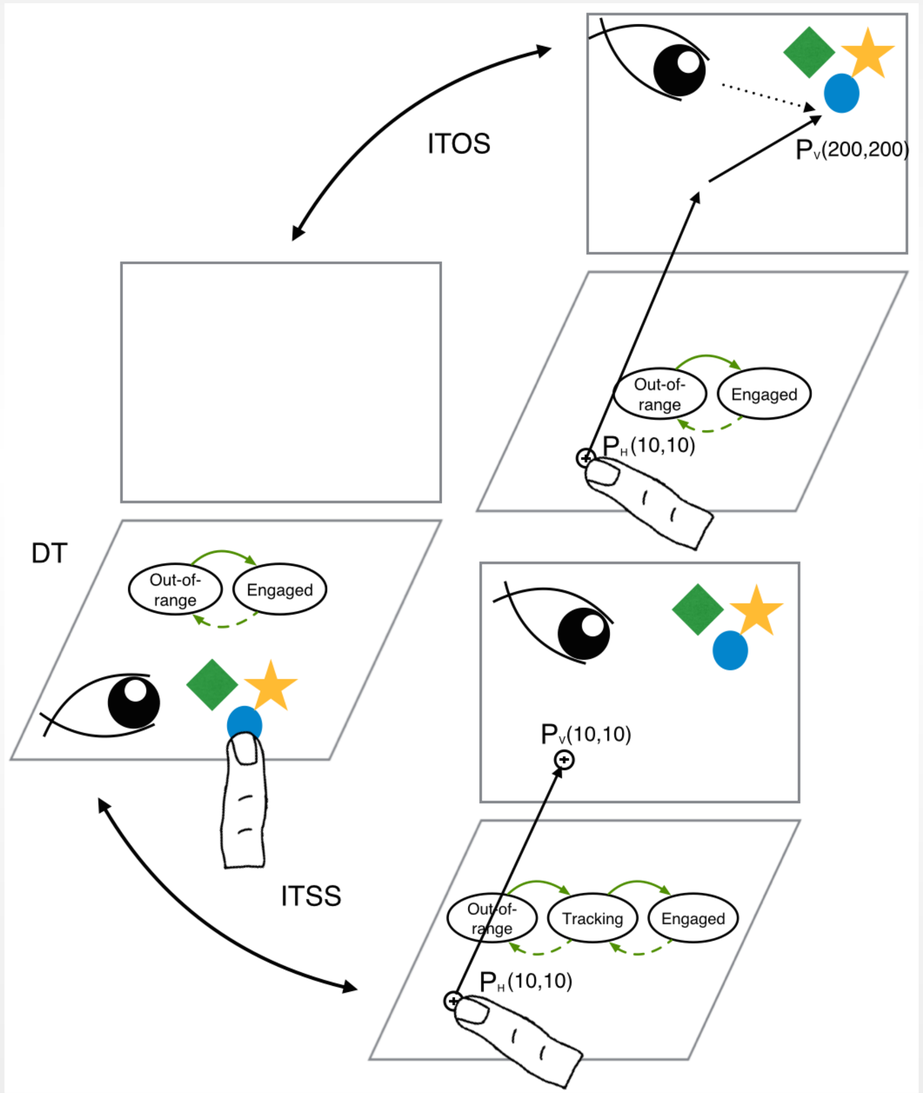
Combining Direct and Indirect Touch

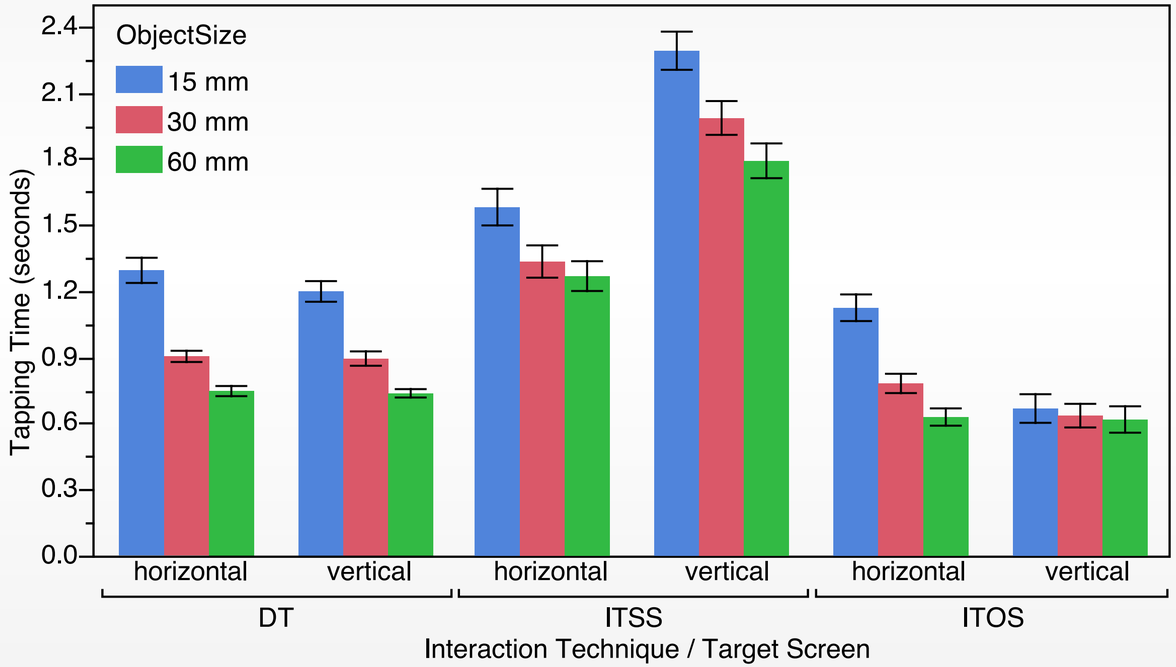


Indirect Touch Object Selection (ITOS)



Combining Direct and Indirect Touch

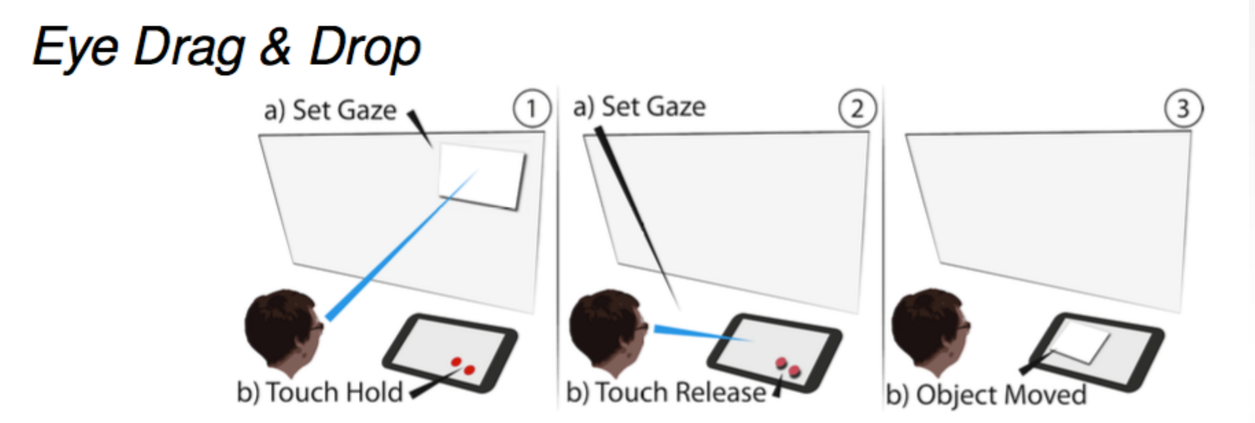


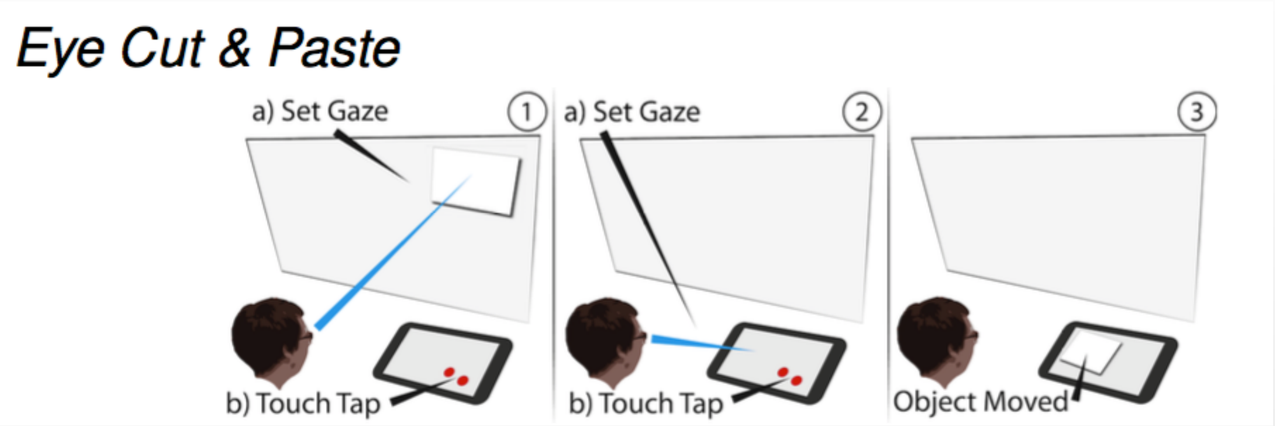


Multiple Screens

Touch + Gaze

Combining Gaze with Manual Interaction to Extend Physical Reach (PETMEI'11)

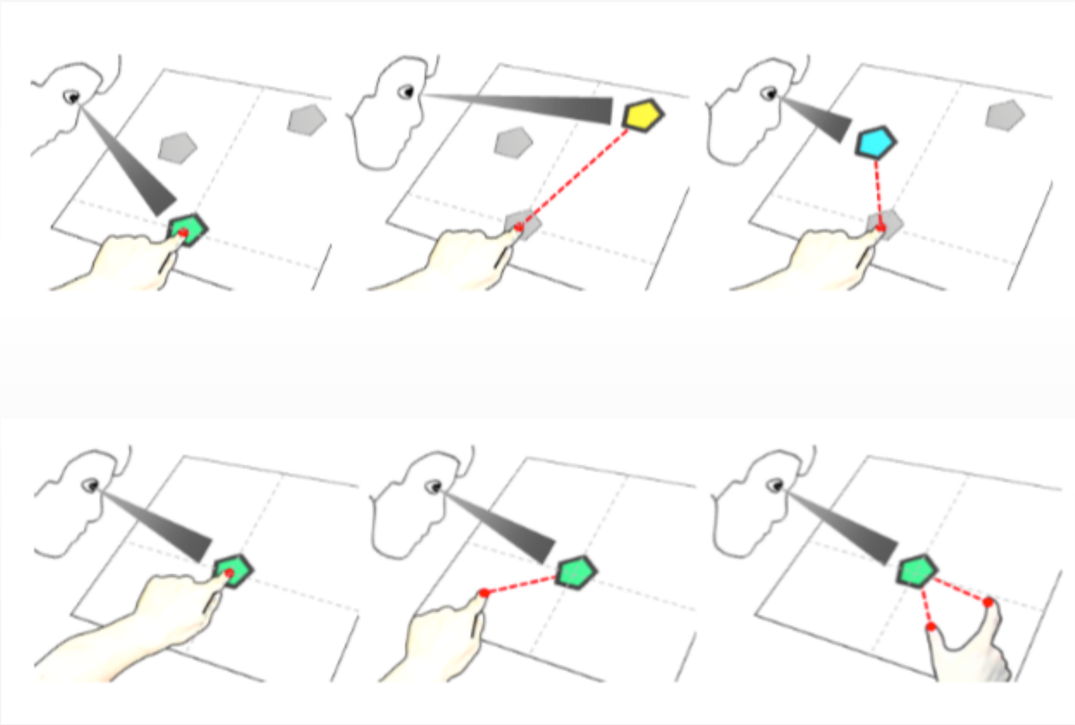




Touch + Gaze

Gaze-touch: Combining Gaze with Multi-touch for Interaction on the Same Surface (UIST 2014)

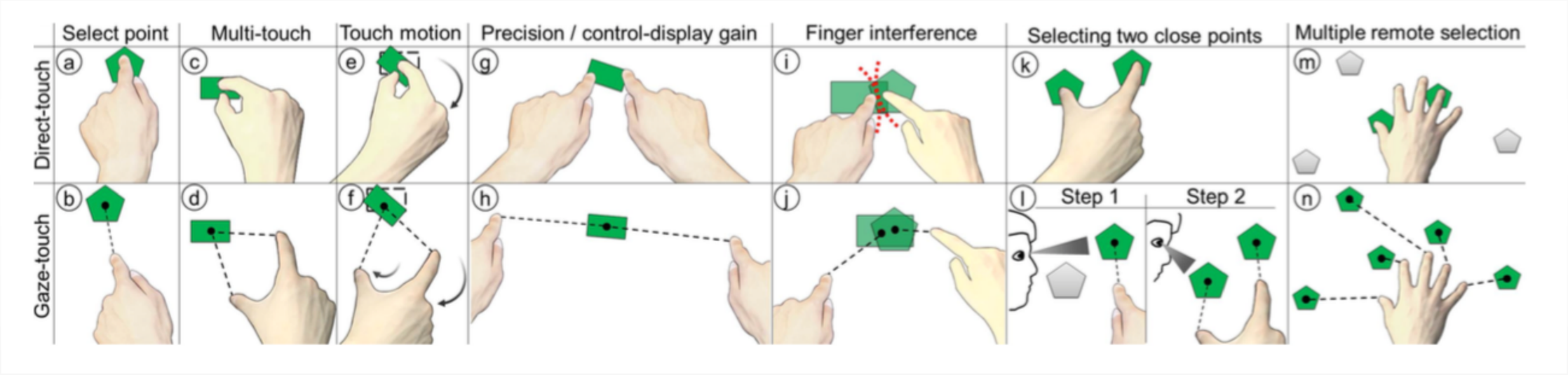
- Concept:
  - gaze selects, touch manipulates
- Addresses Problems:
  - Fat finger problem
  - some ergonomic problems

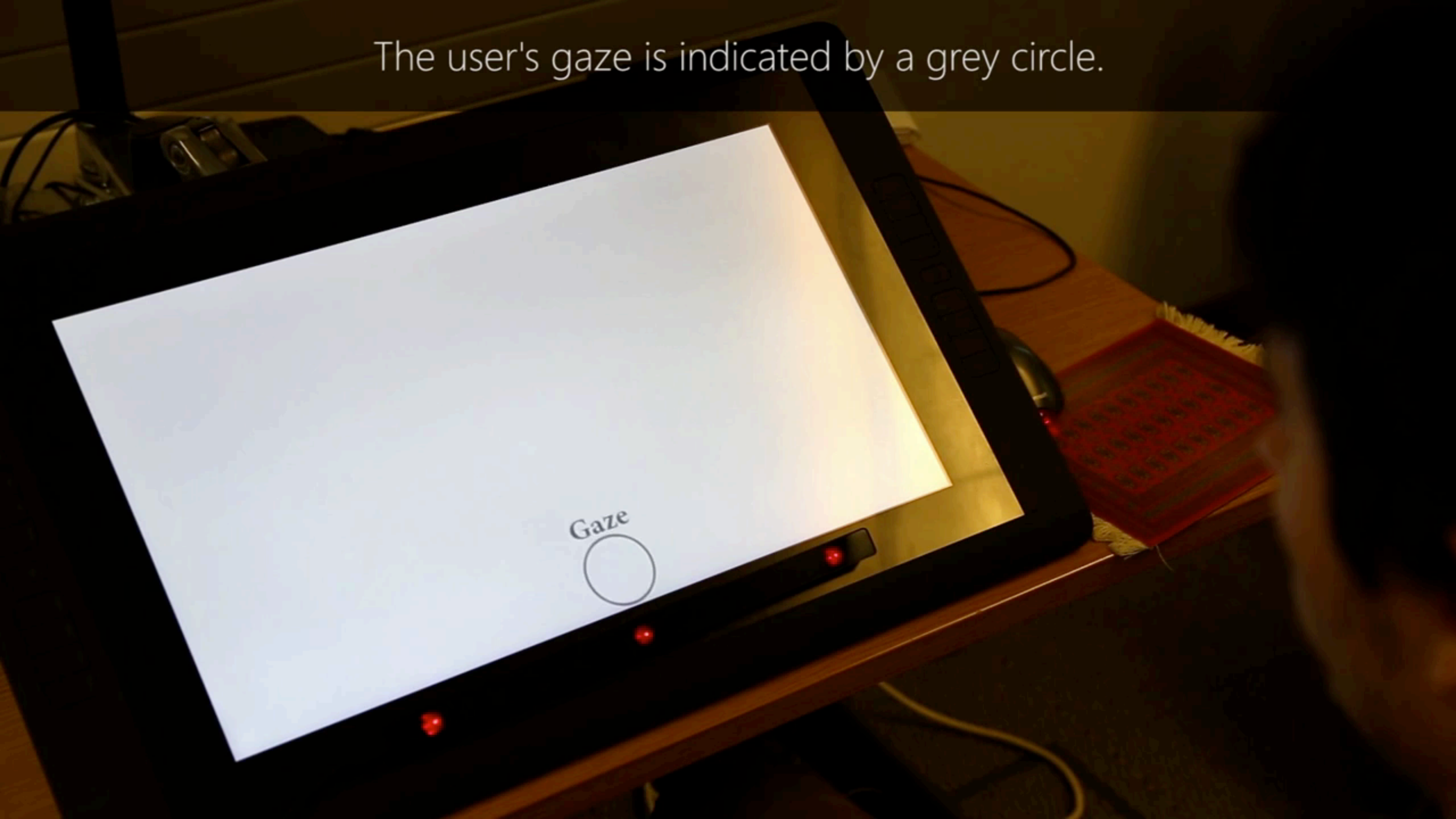


We combine gaze with multi-touch for...

Touch + Gaze

Gaze-touch: Combining Gaze with Multi-touch for Interaction on the Same Surface (UIST 2014)




The user's gaze is indicated by a grey circle.
Gaze

Draw directly, configure pen indirectly

Trace line directly and indirectly

Summary

- Multi-Touch is very intuitive
  - bimanual interaction
- Problems:
  - fat finger (solutions: indirect touch; gaze + touch)
  - inaccurate (solution: indirect touch)
  - ergonomic issues (solutions: indirect touch + gaze)
  - limited haptic feedback (solution: tangibles <= next week)