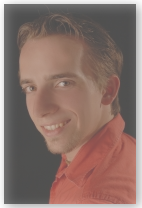
Interacting on Surfaces

Surfaces@i10

Max Möllers

Simon Völker



Malte Weiss

Multi-touch Surfaces

- Technologies
- Workplaces
- Haptics and Tangible Input
- Tangible Output

Why Multi-touch Surfaces?

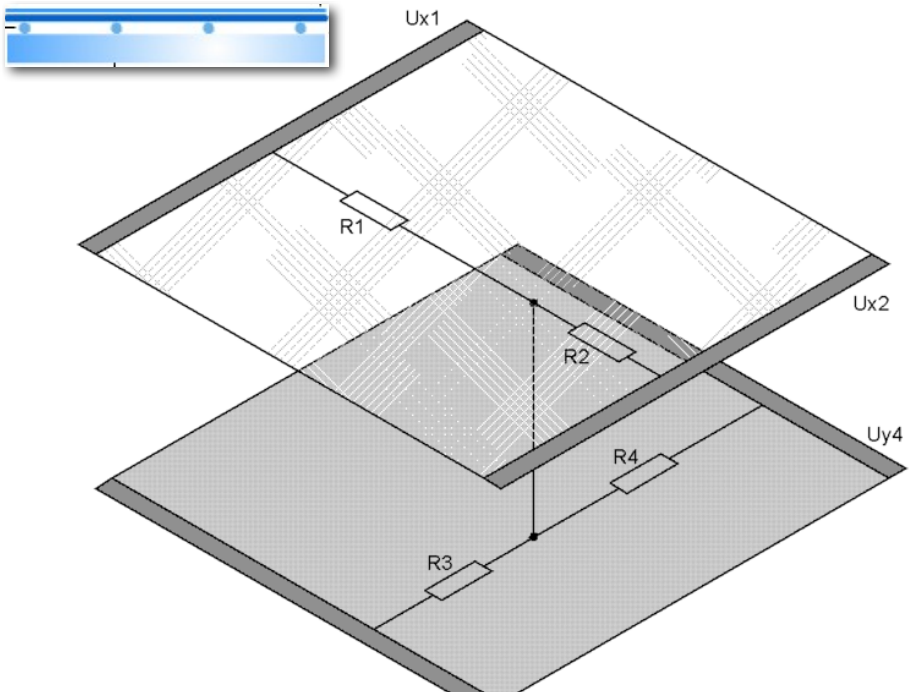
- Single-touch is already very intuitive
  - Touch at locus of attention (direct touch)
  - No additional device is necessary
- Richer and more natural interactions
  - Multiple fingers of one hand
  - Two-handed interaction
- Further step towards Ubiquitous Computing
- Enables multi-user interaction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

Technologies

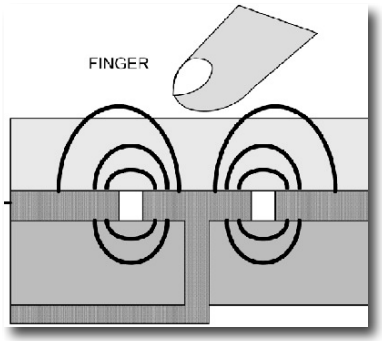
- Resistive
- Capacitive
- Vision-based
  - Frustrated Total Internal Reflection (FTIR)
  - Diffuse Illumination (DI)
  - Excursus: Endlighten
- Other technologies

Resistive touch

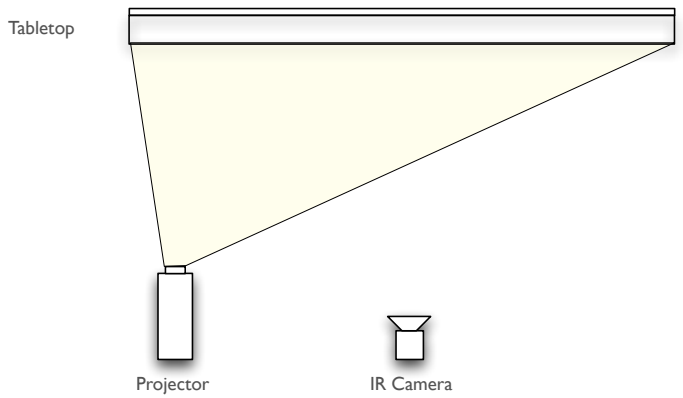
- Flexible hard-coated outer membrane
- Conductive coating
- Insulating spacer dots
- Conductive coating
- Glass substrate



Capacitive touch



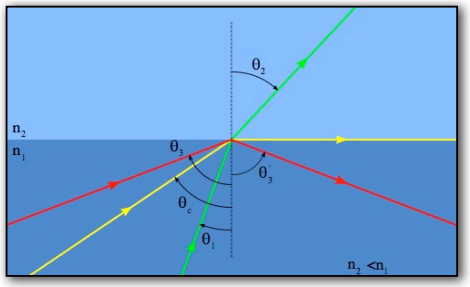
Vision-based technologies



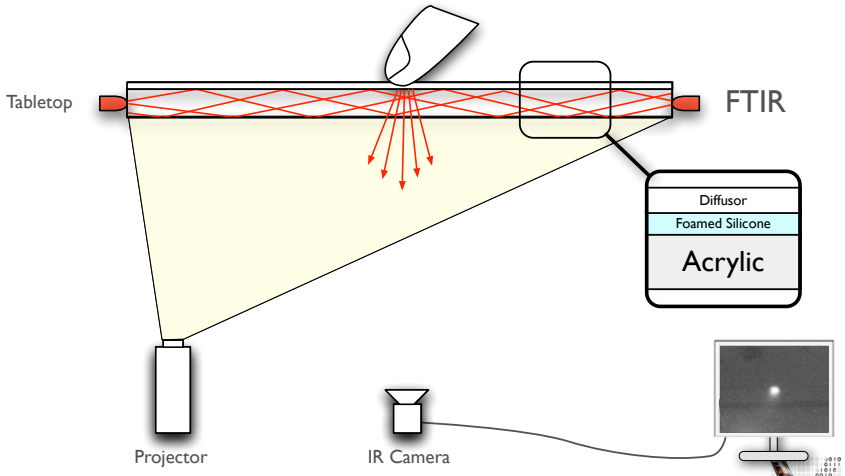
Frustrated Total Internal Reflection (FTIR)

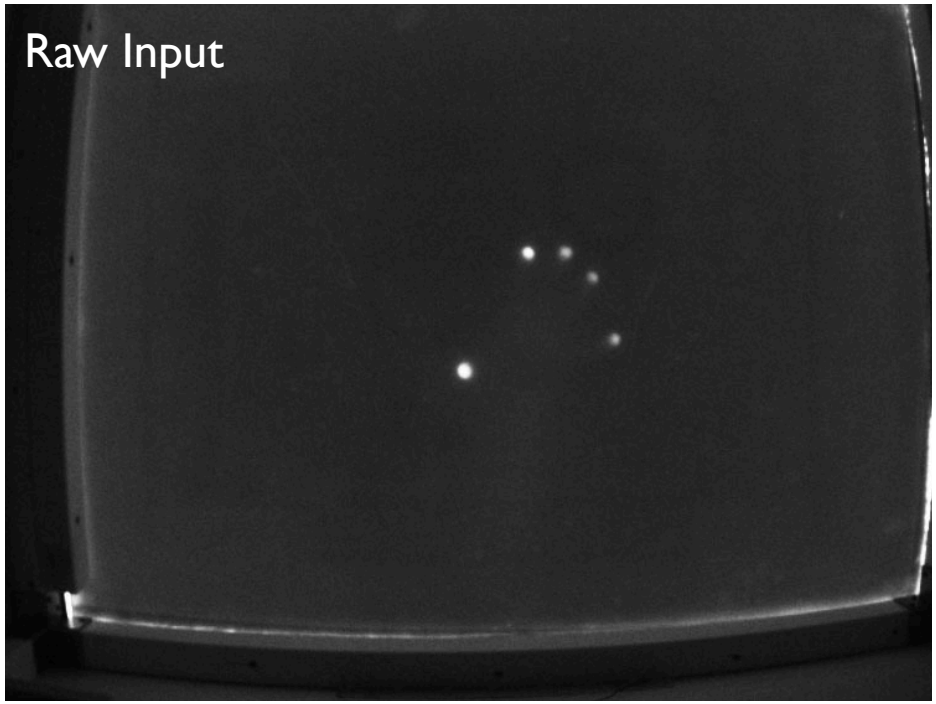
Snell's Law

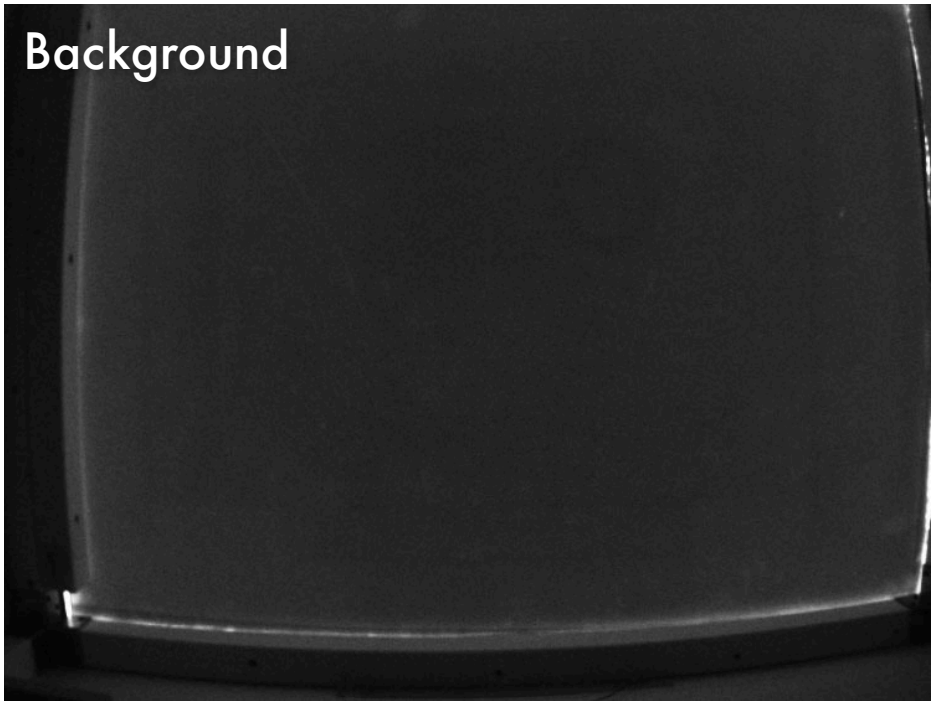
$$\frac{sin\theta_1}{sin\theta_2} = \frac{n_2}{n_1}$$

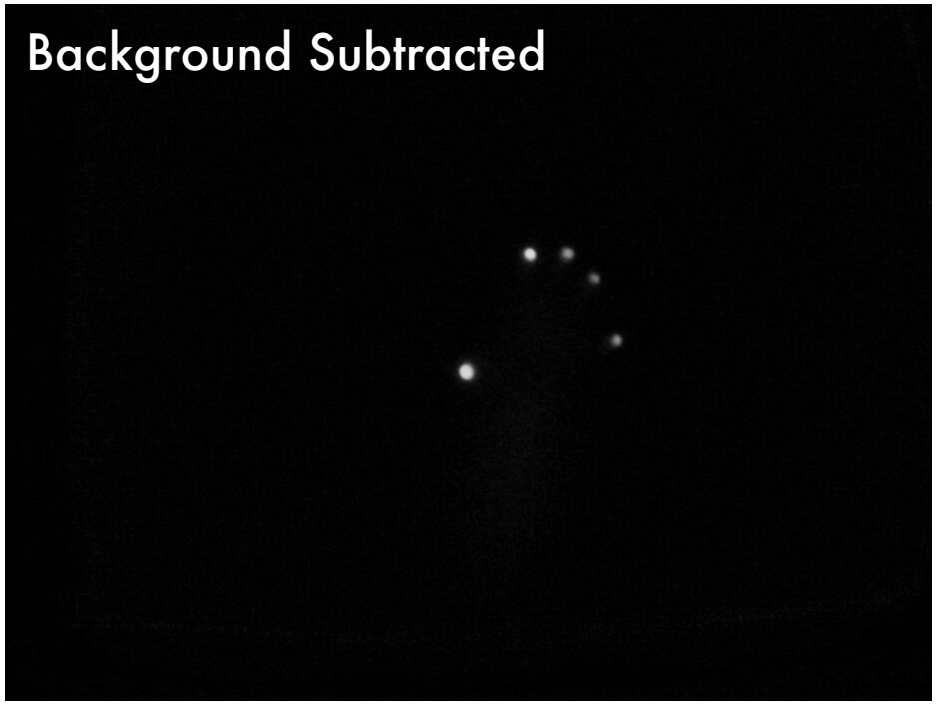


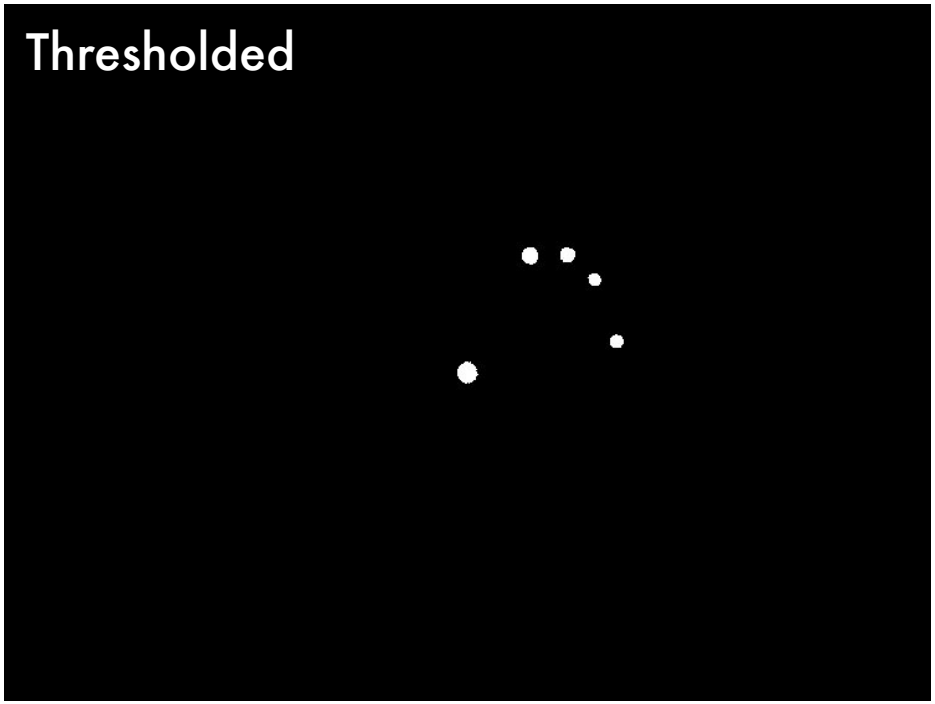
Frustrated Total Internal Reflection (FTIR)

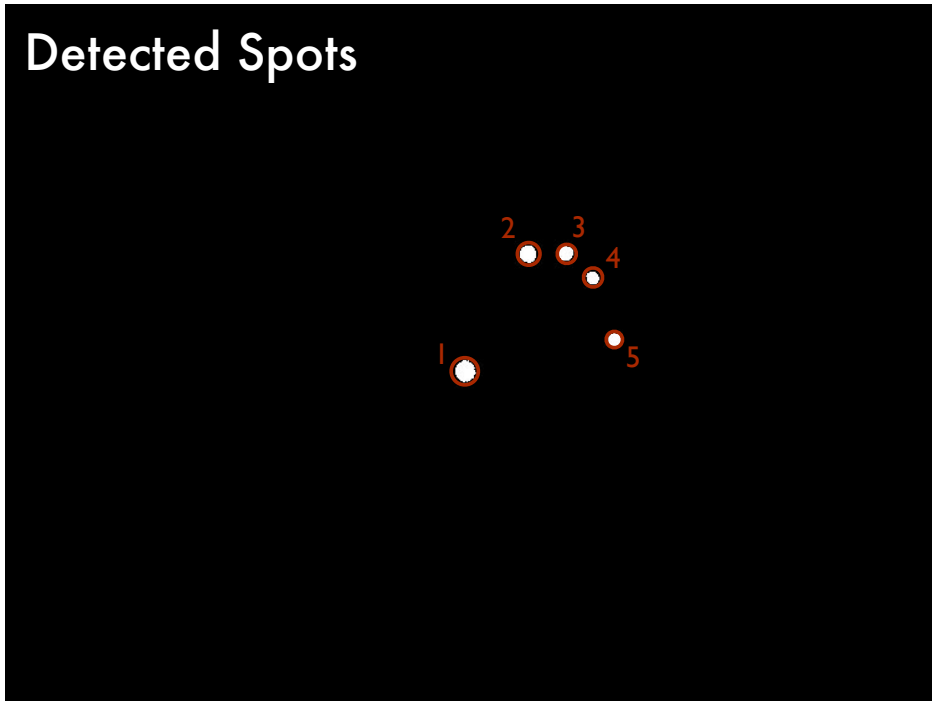




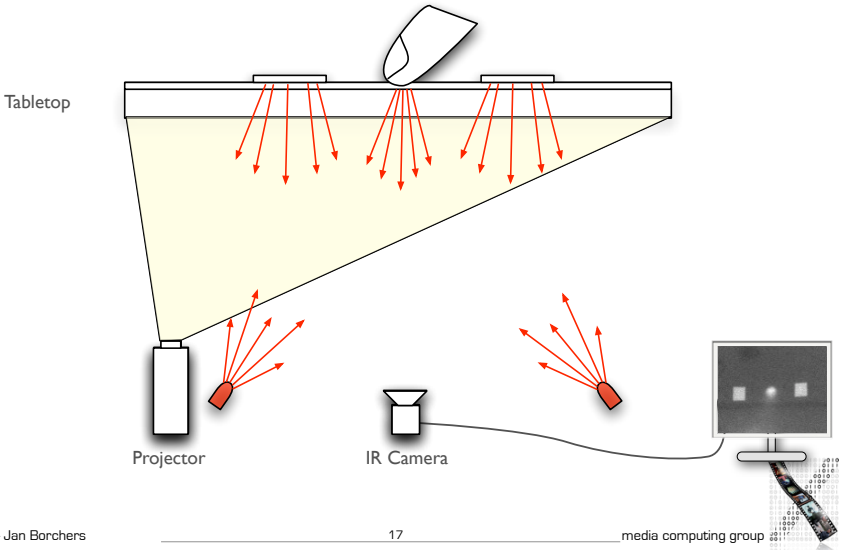

Background


Background Subtracted

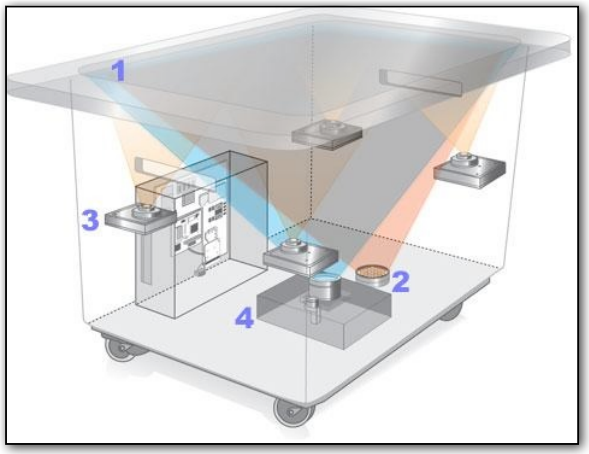

Thresholded


Detected Spots
1
2
3
4
5

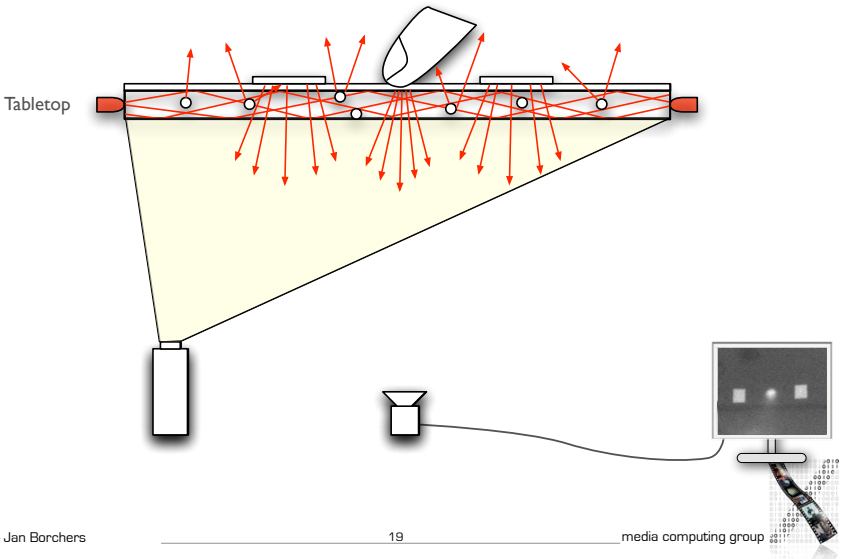
Diffuse Illumination (DI)



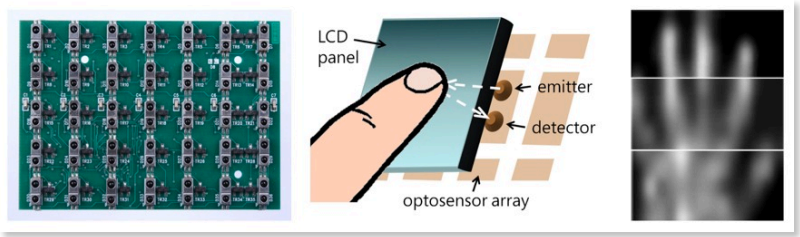
Example of DI: Microsoft Surface



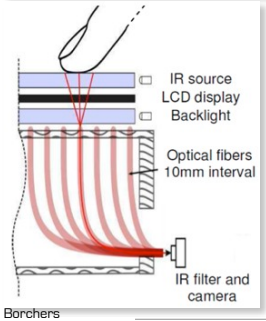
Diffused Surface Illumination



Reduced Form Factor



ThinSight

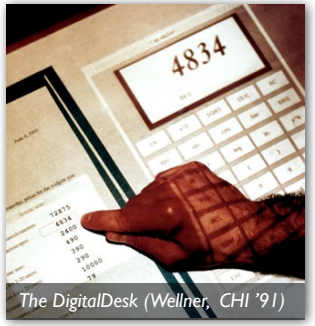


FiberBoard

In-class Exercise: Predicting Future

Will multi-touch interaction replace the desktop metaphor?

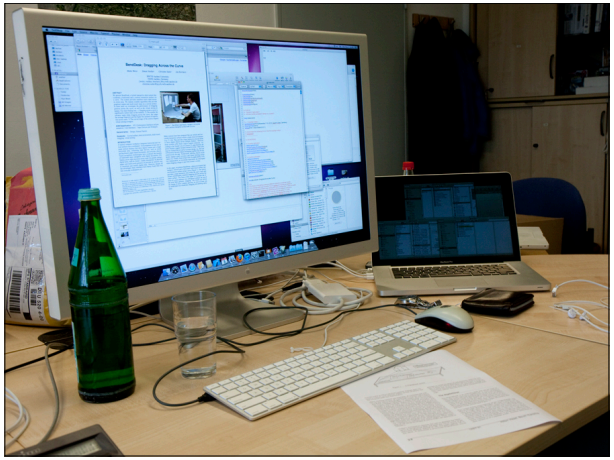
Multi-touch Workspaces



The DigitalDesk (Wellner, CHI '91)

Living with a Tabletop

Multi-touch Workspaces



Vertical vs. Horizontal Surfaces

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

Combining Horizontal and Vertical Surfaces

Tilted Tabletop (Müller-Tomfelde, '08)

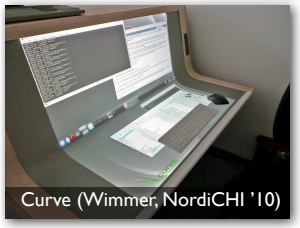
ViCat (Chen, Tabletop '06)

Problem: two spatially separated displays

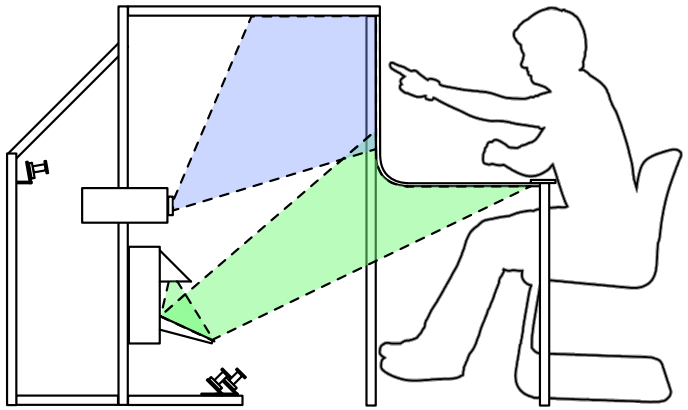
Curved Surfaces

Sun Starfire (Tognazzini, CHI '94)

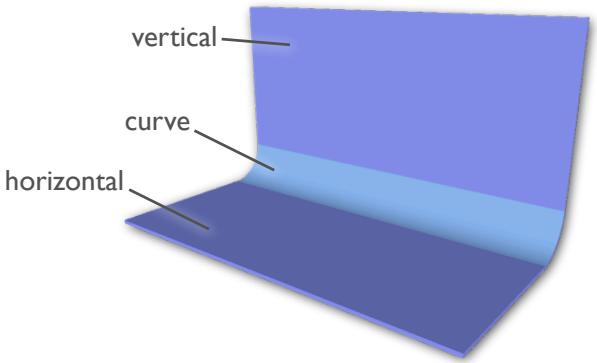
BendDesk (Weiss , ITS '10)


Curve (Wimmer, NordiCHI '10)

BendDesk System Overview



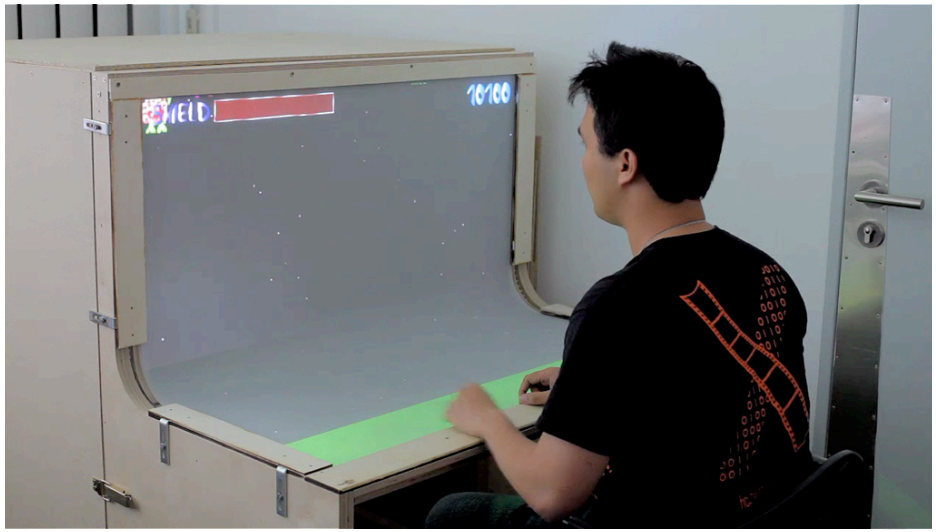
BendDesk System Overview



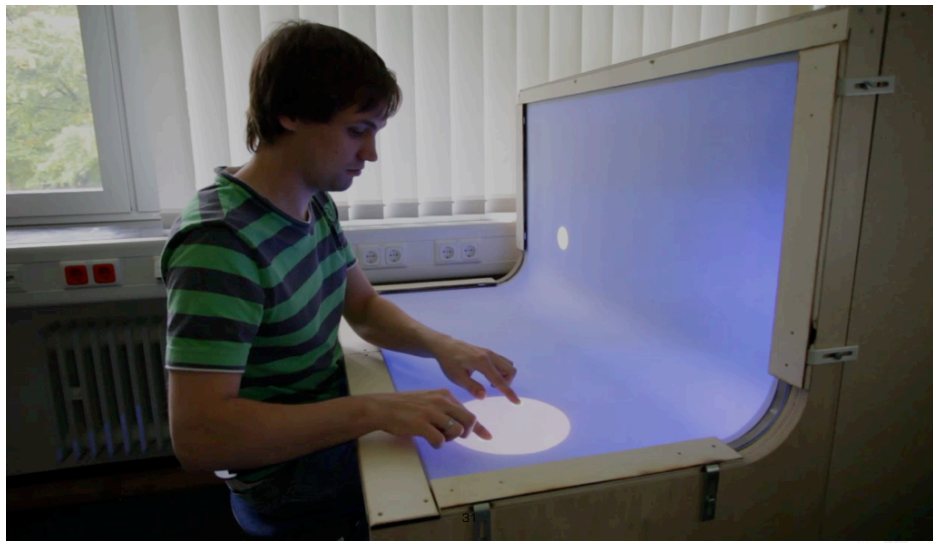
Research Questions

1. Curved surfaces as office workspaces?
2. How do people perceive object on the curved surfaces?
3. How do people interact with these surfaces?

1. Office Workspace



2. Perception



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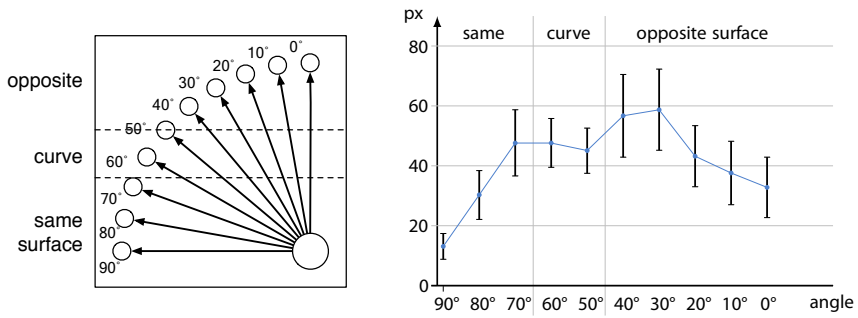

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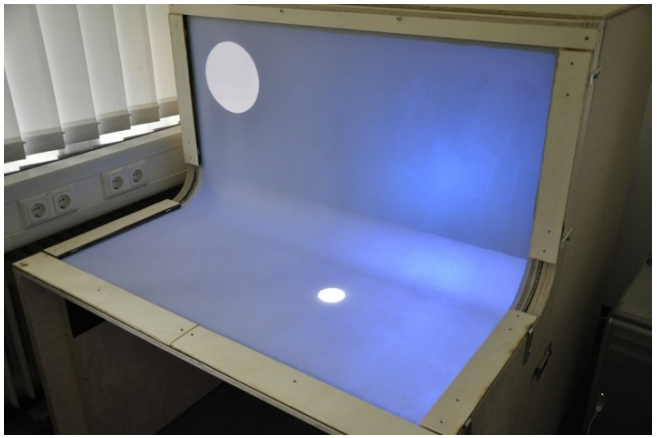
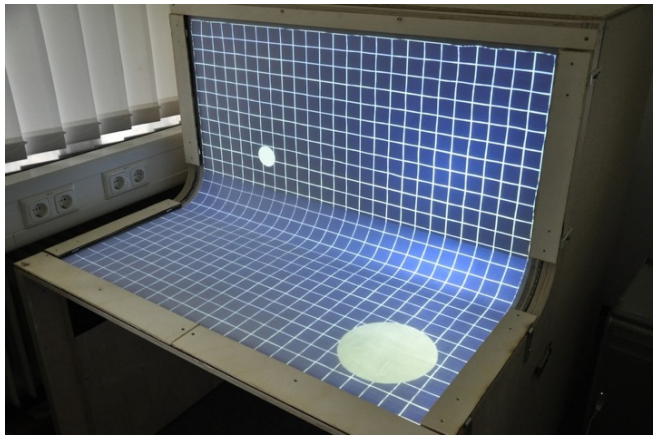


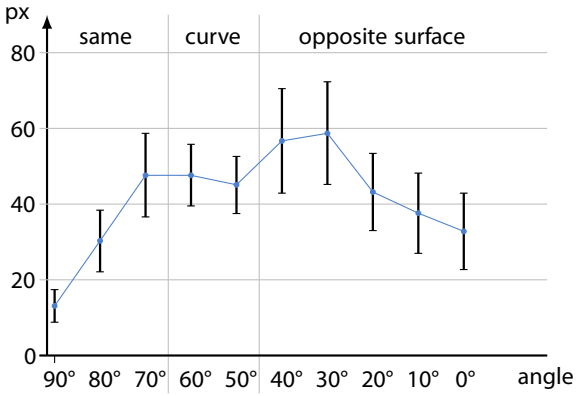
2. Perception



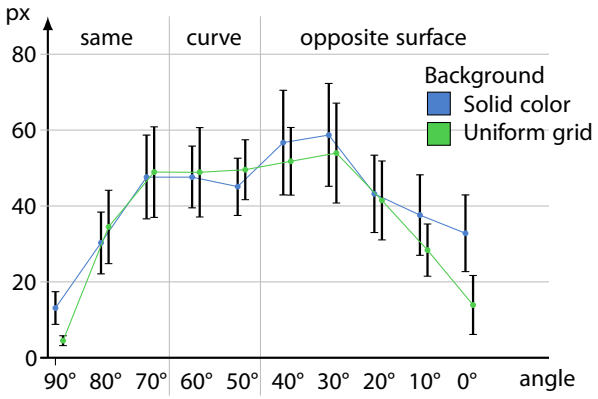
In-class Exercise: Predict Results

How does angle affect the offset?

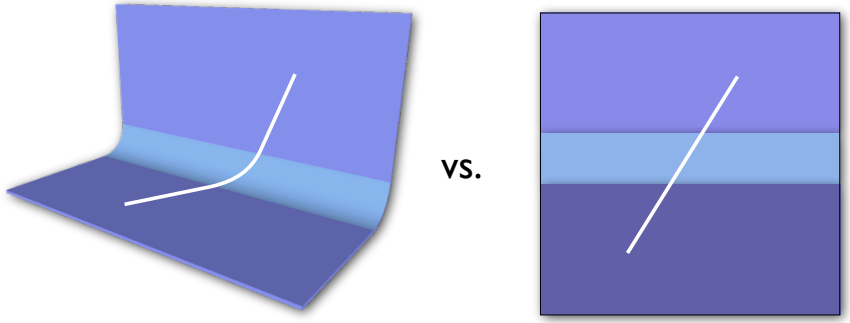
2. Perception



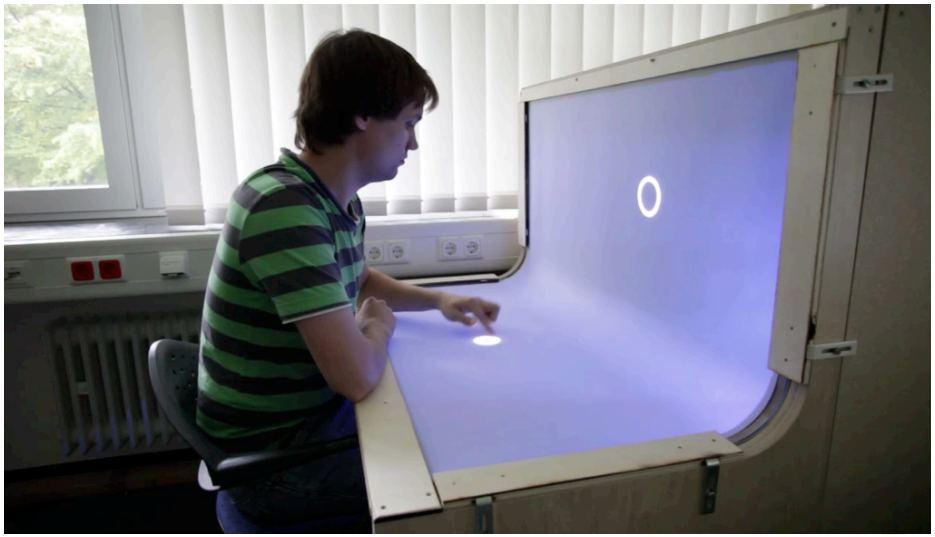
2. Perception



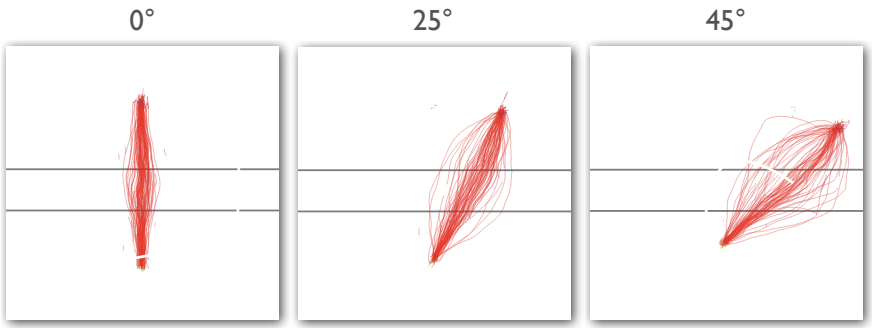
2. Perception



3. Interaction



3. Interaction



Conventional Controls

Graphical User Interfaces

Graphical User Interfaces

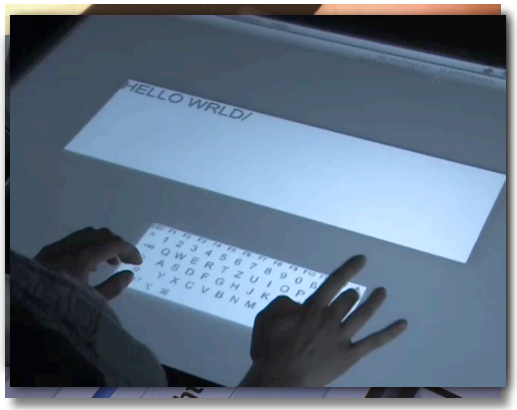
Interactive Surfaces

Interactive tabletop

Microsoft Surface

Apple iPad

Limited Haptic Feedback



Goal

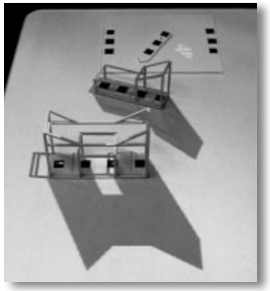
Bringing **haptics** back to interactive tabletops.

Goal

General-purpose controls for interactive tabletops that combine the **haptic qualities** of physical controls with the **flexibility** of graphical user interfaces.

+

Tangible User Interfaces

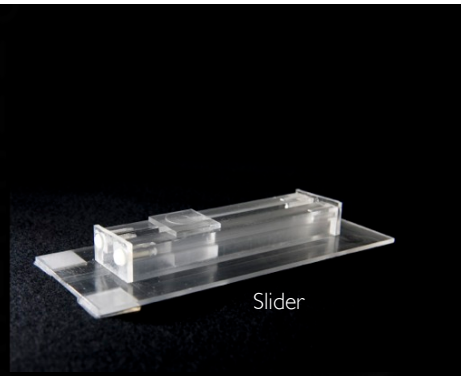


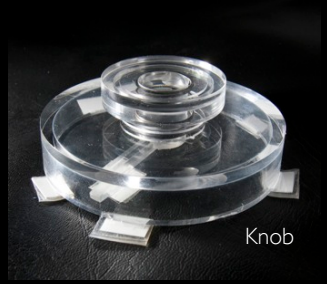
Urp
Underkoffler, Ishii
CHI' 99

Requirements

- General-purpose controls for interactive tabletops
  - Strong physicality
  - Scalability
  - Ad hoc use
  - Unobtrusive
  - Easy to prototype and robust

SLAP Widgets

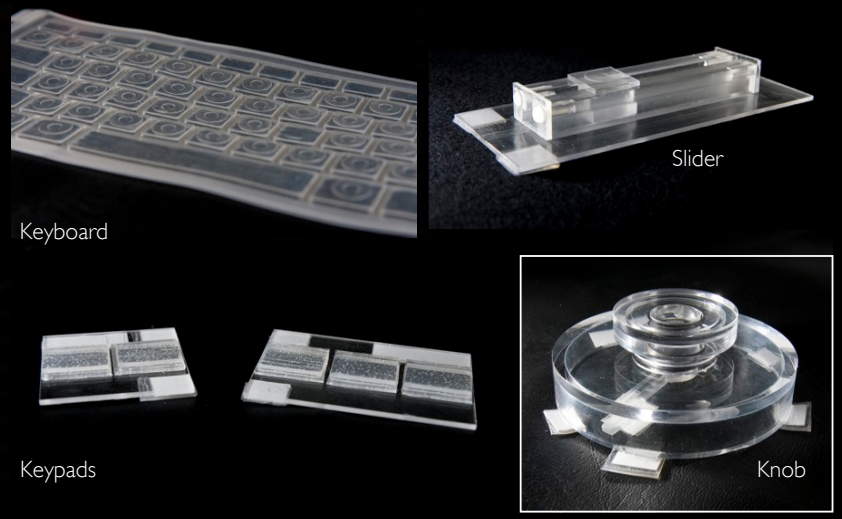




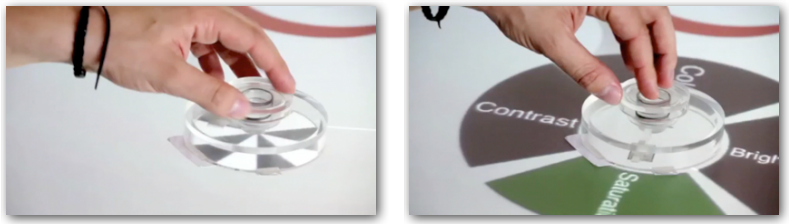
Regular Keyboard

SLAP Keyboard

SLAP Widgets

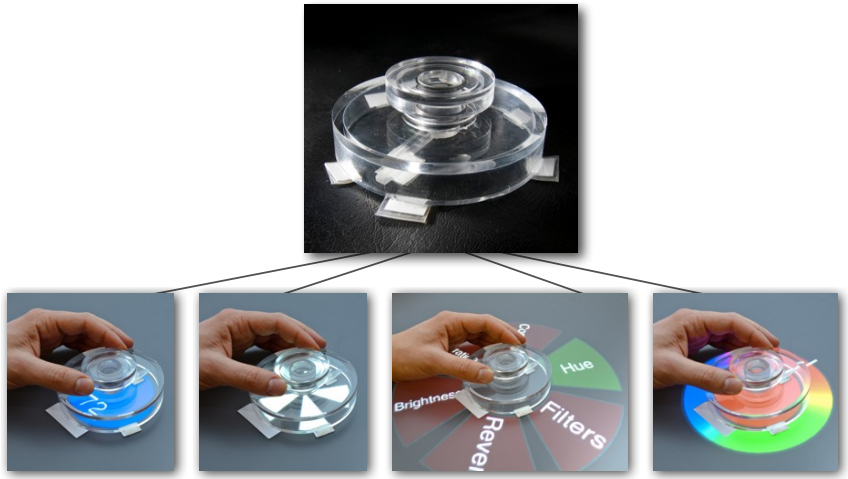


SLAP Knob



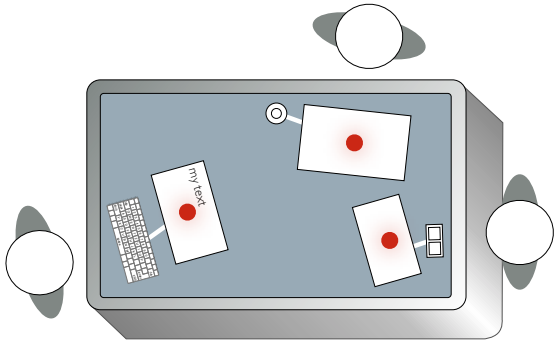
jog wheel mode menu/value mode

SLAP Knob



value jog wheel menu hue

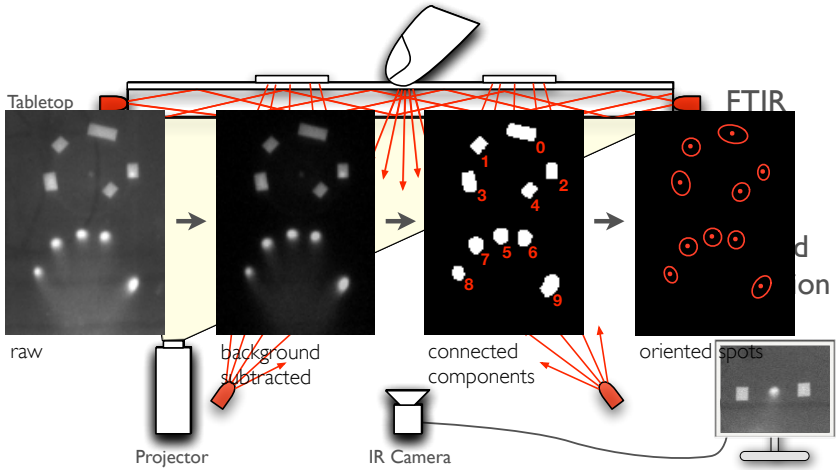
Multi-Focus Policy



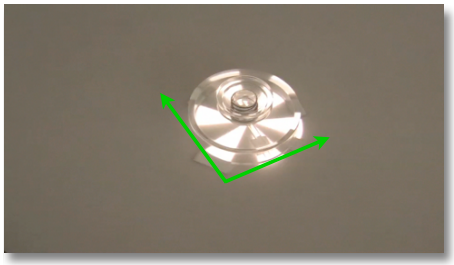
Pairing

Pairing

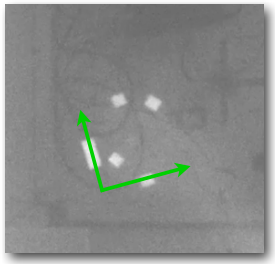
Multi-Touch Table



Widget Detection



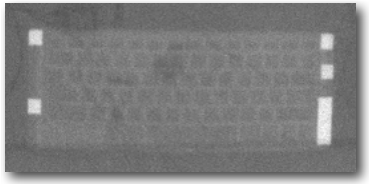
Tabletop view



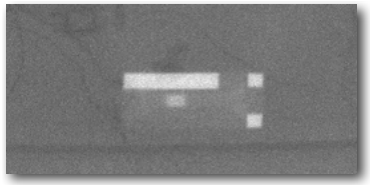
IR camera view
(640x480, 120fps)

Widget Detection

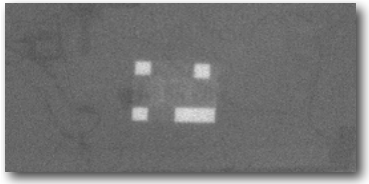
Keyboard



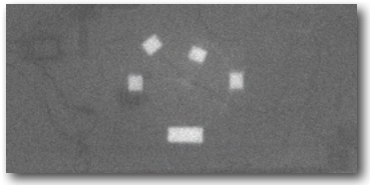
Slider



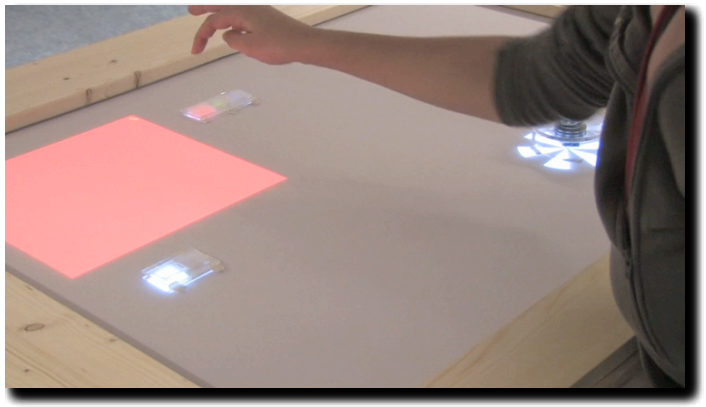
Keypad



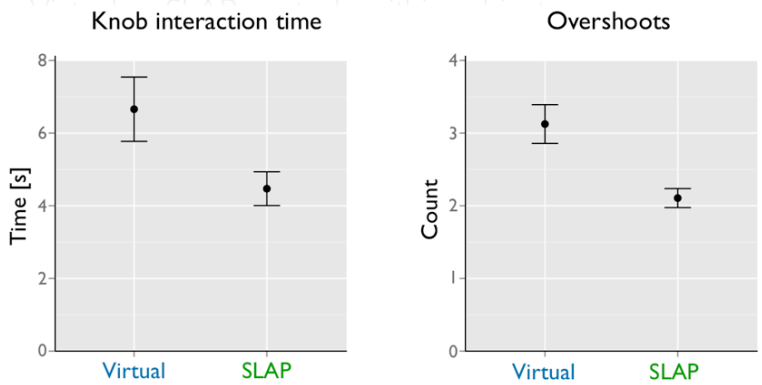
Knob



Evaluation: Knob Performance



Evaluation: Knob Performance



In-class Exercise: What is missing?

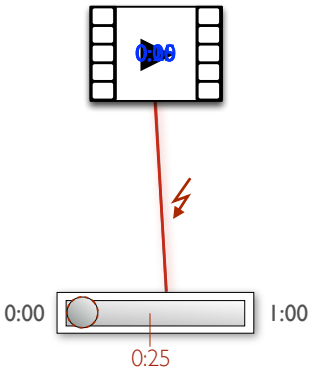
What do GUIs have that a ``SLAPed'' Tabletop doesn't?

Unidirectional Interaction

Physical Digital

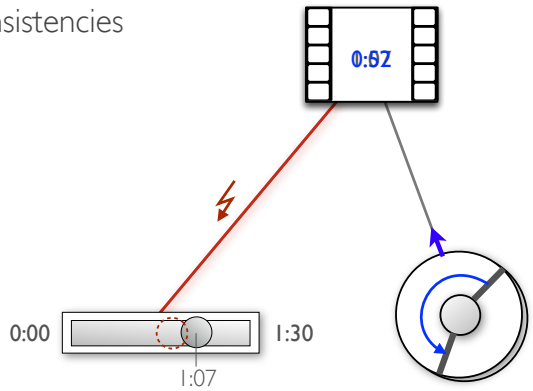
Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
  - Internal update



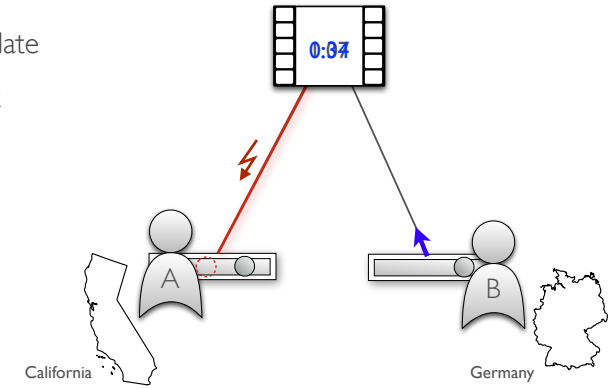
Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
  - Internal update
  - Inter-widget



Unidirectional Interaction

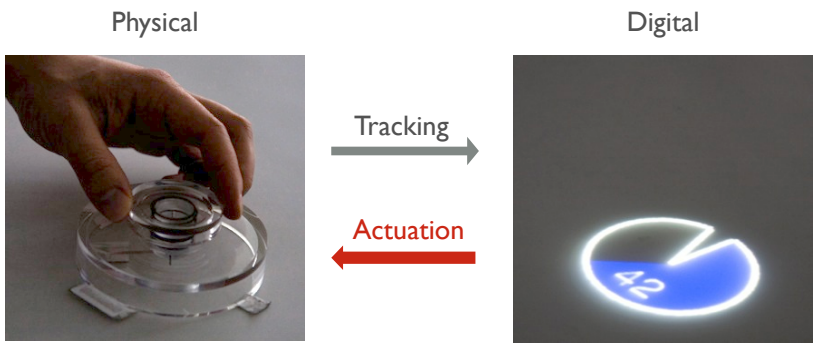
- Software cannot change physical UI
- Physical-visual inconsistencies
  - Internal update
  - Inter-widget
  - Remote



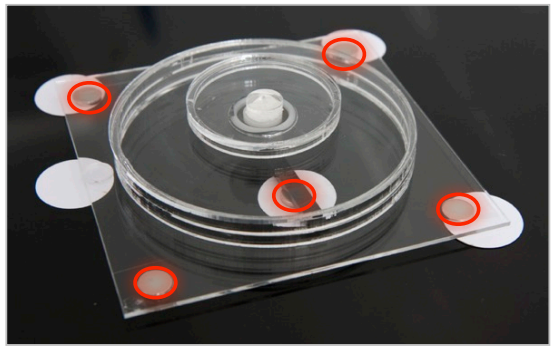
Unidirectional Interaction

- Software cannot change physical UI
- Physical-visual inconsistencies
  - Internal update
  - Inter-widget
  - Remote
- SLAP Widgets require **exclusive access** to parameters
- No UI adaption, load/save, undo/redo, ...
- **Software** should be able to change **physical** UI

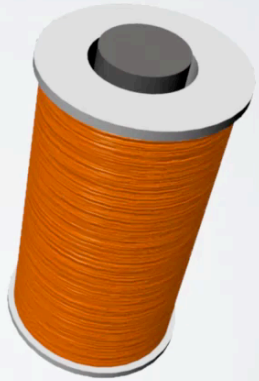
Bidirectional Interaction



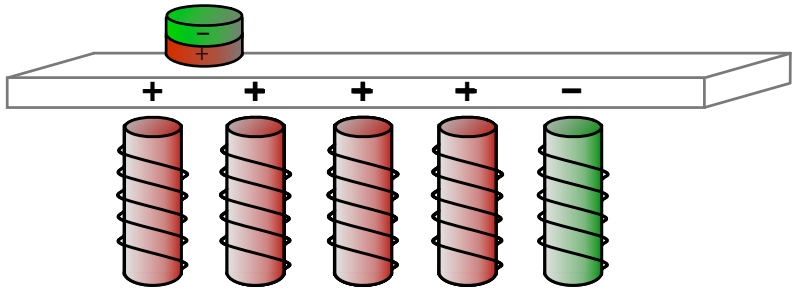
Magnetic Widgets



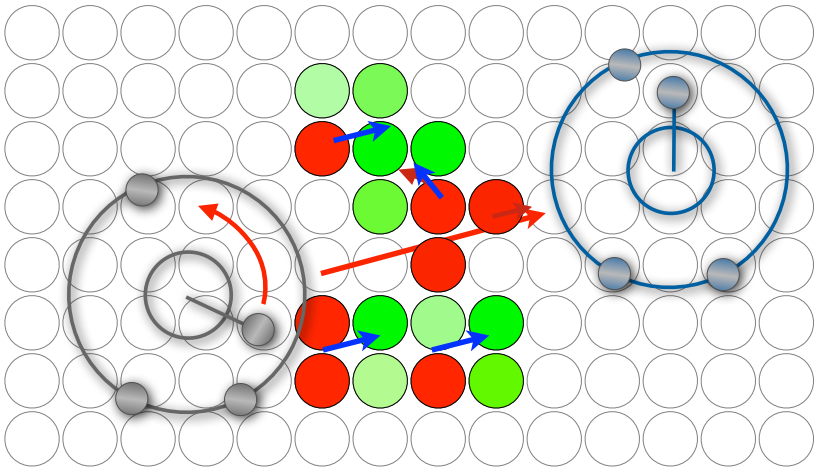
Actuation



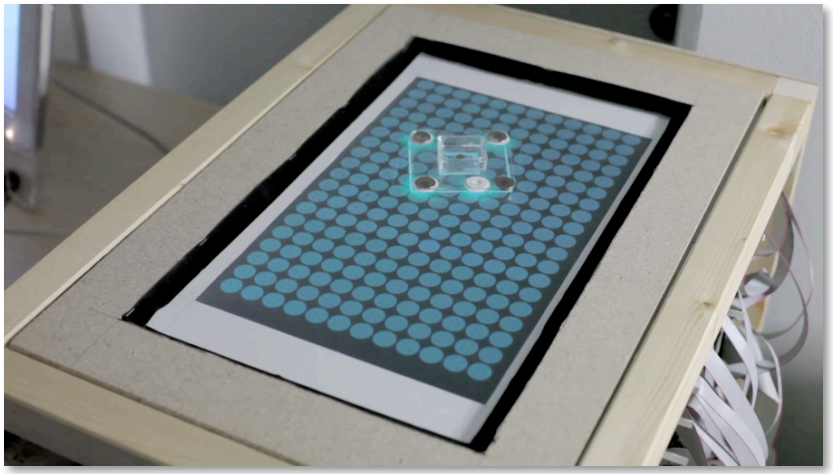
Actuation



Actuation

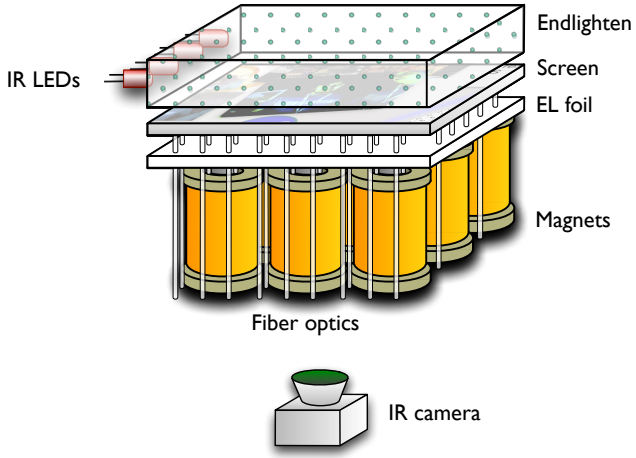


Actuation

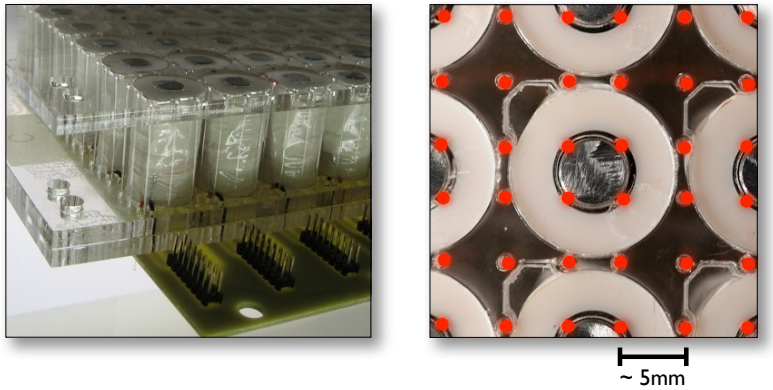


Display

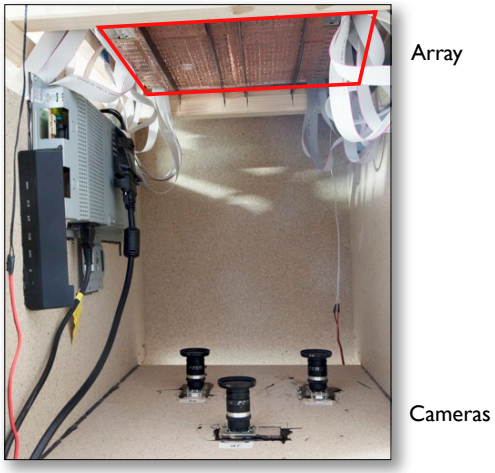
Tracking

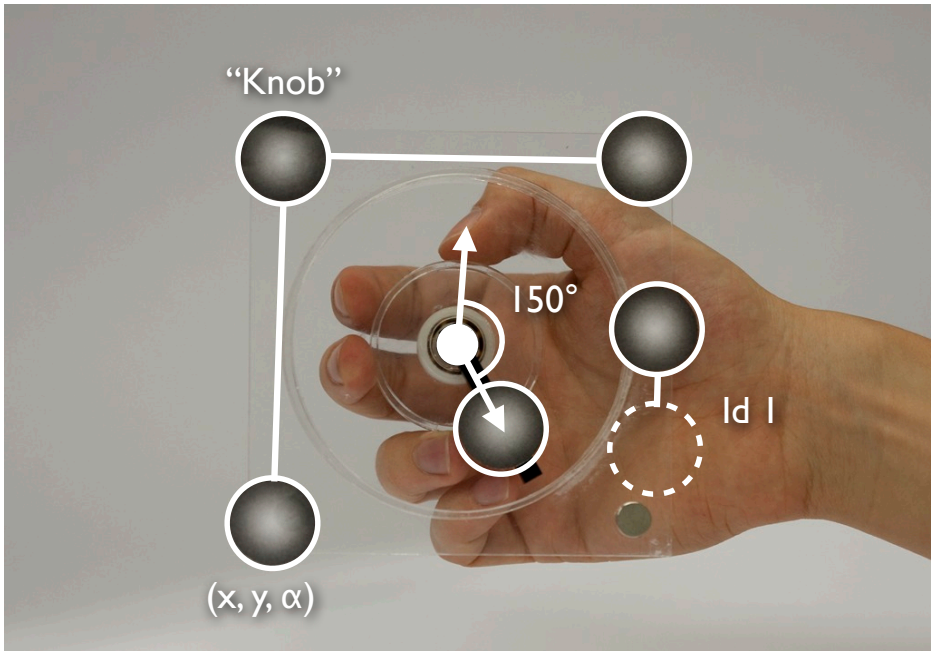


Tracking

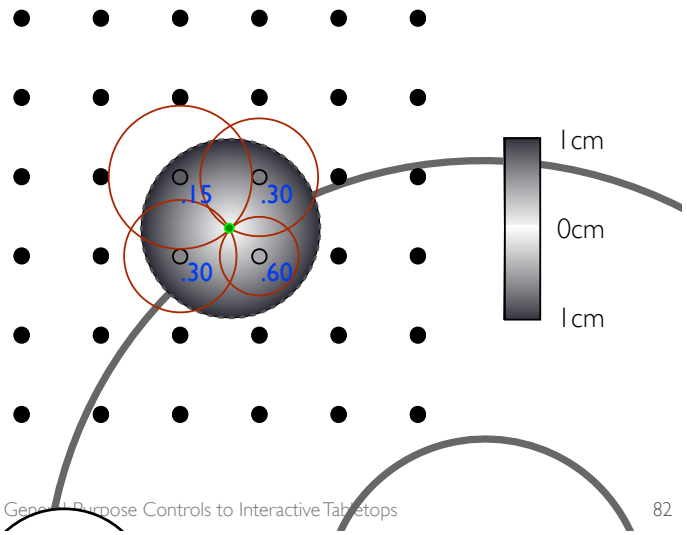


Tracking

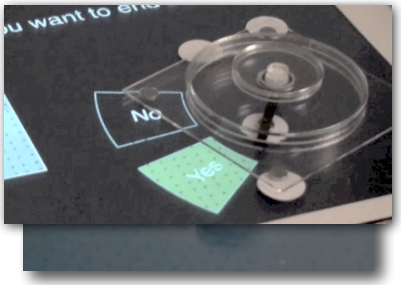
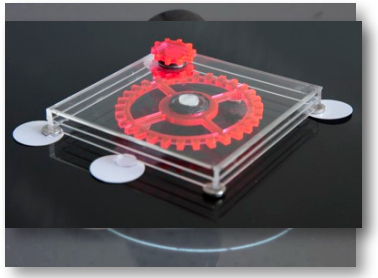




Gradient Markers



Tracking

Applications

- Physical-visual consistency
  - Load/save, undo/redo
  - Remote tangible collaboration
- Height
- Power transfer
- Vibration feedback