Multi-Touch surfaces

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Multi-touch Workspaces

The DigitalDesk (Wellner, CHI ’91)

Living with a Tabletop ’04
Interactive tables and walls

Interactive wall

Interactive tabletop

Microsoft Surface
Multi-touch Workspaces
Combining Horizontal and Vertical Surfaces

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
BendDesk System Overview

vertical

curve

horizontal
Perception
Perception

opposite

curve

same surface

px

90° 80° 70° 60° 50° 40° 30° 20° 10° 0°

angle

0°

10°

20°

30°

40°

50°

60°

70°

80°

90°

same

curve

opposite surface
Interaction
Interaction

0°  25°  45°
Interaction

0°

45°
Indirect Touch System

Visual Output

Touch Input
Two-State Touch Model

Out-of-range  \[\rightarrow\] land on  \[\rightarrow\] Engaged

lift off  \[\rightarrow\]

[Buxton, INTERACT '90]
Three-State Touch Model

Out-of-range

Tracking

Engaged

land on

Grab

Drop

lift off

Track

Drag

[Buxton, INTERACT '90]

Simon Voelker
Multiple State Machines

Input

Output
Multiple State Machines

In class:
What is the best state-switching method for indirect multitouch system?
Properties of Each Individual Finger

[Wang and Ren, CHI '09]

- Position
- Motion
- Event Properties
  - Tap
  - Hold
  - Flick
- Physical Properties
  - Pressure
  - Size of the Contact Area
  - Orientation
  - On/off the surface

$(x, y)$
Properties of Each Individual Finger

[Wang and Ren, CHI ’09]

- Position
- Motion
- Event Properties
  - Tap
  - Hold
  - Flick
- Physical Properties
  - Pressure
  - Size of the Contact Area
  - Orientation
  - On/off the surface
Evaluation

Hold

Pressure Switch

Lift-and-Tap
[Buxton SIGGRAPH '85]

Pressure Quasimode
[Buxton SIGGRAPH '85]
Lift-and-Tap
[Buxton, SIGGRAPH '85]
What to do with it?
Museum Exhibitions

[Hinrichs and Carpendale, CHI '11]
Single-user Applications

Eden: A Professional Multitouch Tool for Constructing Virtual Organic Environments

[Kin et al., CHI '11]
The eLabBench

[Tabard et al. ITS '11]
The eLabBench

[Tabard et al. CHI ’12]
Physical Object on the table?

[Tabard et al. ITS ’11]
Limited Haptic Feedback
SLAP Widgets

Keyboard

Sliders

Keypads

Knob

[Weiss et al. CHI '09]
SLAP Keyboard
SLAP Knob

jog wheel mode

menu/value mode
SLAP Knob

value
jog wheel
menu
hue
Multi-Focus Policy
Pairing
Pairing
Multi-Touch Table

Tabletop → Projector → IR Camera → FTIR

raw → background subtracted → connected components → oriented spots
Widget Detection

Tabletop view

IR camera view
(640x480, 120fps)
Widget Detection

Keyboard

Slider

Keypad

Knob
Unidirectional Interaction

SLAP Widget

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

SLAP Widget

Physical

Tracking

Actuation

Digital
Magnetic Widgets
actuation
Actuation
Actuation
Actuation
Tracking

IR LEDs

Endlighten
Screen
EL foil
Magnets
Fiber optics
IR camera
Tracking

~ 5mm
Tracking

Array

Cameras
Malte Weiß – Bringing Haptic General-Purpose Controls to Interactive Tabletops

“Knob”

(x, y, α)

150°
Gradient Markers
Tracking
Applications

- Physical-visual consistency
  - Load/save, undo/redo
  - Remote tangible collaboration
- Height
- Power transfer
PUCs Bridge
Transmitting Electrodes

Receiving Electrodes
<table>
<thead>
<tr>
<th>Glass Surface</th>
<th>Receiver</th>
<th>Gap</th>
<th>Transmitter</th>
<th>LCD Display</th>
</tr>
</thead>
</table>

The diagram illustrates a layered structure with a finger pressing down. The layers include a glass surface, a receiver, a gap, a transmitter, and an LCD display, with blue lines indicating the path or signal flow.
LCD Display

Transmitter

Gap

Receiver

Glass Surface

LCD Display
Multi-Touch Summary

- Form factor matters
- Rethink applications
- Tangible can help!