Applying Multitouch
• THEORY

• INTERACTIONS

• DEVELOPMENT
Multitouch sound synthesis

Davidson and Han, 2006
Multitouch Collaborative Design

Wu and Balakrishnan, 2003
Parallelism

Independent

Cooperative

Expressiveness

Working together
Common low-level, spatial goal
<table>
<thead>
<tr>
<th>THEOREY</th>
<th>INTERACTIONS</th>
<th>DEVELOPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parallelism</td>
<td>Expressiveness</td>
<td>Independent</td>
</tr>
<tr>
<td>Symmetric</td>
<td>Cooperative</td>
<td>Asymmetric</td>
</tr>
</tbody>
</table>
Parallelism

Independent

Symmetric

Inputs working on same task...

in the same way!

Like stretching a rubber band.
Multitouch
3D Texture Placement
Casalta and Guiard, 1999
Parallelism

Independent  Cooperative

Symmetric  Asymmetric

Complementary, disparate roles.
Like opening a jar.
Or like writing.
The diagram shows a hierarchy of concepts related to parallelism and expressiveness.

- **Parallelism**
  - **Expressiveness**
  - **Independent**
  - **Cooperative**
    - **Symmetric**
    - **Asymmetric**
      - **KC Theory**
• Kinematic Chain Theory.
• For kinematic systems like arms, near (proximal) parts behave differently from far (distal) parts.
• Analogy to bimanual behavior: dominant hand acts like distal component, non-dominant hand acts as proximal.
• So, non-dominant hand:
  • usually moves first
  • sets reference frame
  • Moves larger distances
Expressiveness

Changes meaning of an input point
Makes each input point richer
Can use different hand gestures
Hand shapes in multitouch

Epps, Lichman, Wu, 2006
Precise Selection Techniques

Benko, Wilson, Baudisch, 2006
Hands-on Math

Zeleznik, et al., 2010
Some General Thoughts
First: Touch can be better

Determining the Benefits of Direct-Touch, Bimanual, and Multifinger Input on a Multitouch Workstation, Kin, Agrawala, DeRose
Second: Consider degrees of freedom

People used 3 fingers to control many degrees of freedom.

Shallow-Depth 3D Interaction: Design and Evaluation of One-, Two- and Three-Touch Techniques, Hancock, Carpendale, Cockburn
Second: Consider degrees of freedom

People used 3 fingers to control many degrees of freedom.

Shallow-Depth 3D Interaction: Design and Evaluation of One-, Two- and Three-Touch Techniques, Hancock, Carpendale, Cockburn
Some Cool Interactions
Raising Precision

Cursor sits between fingers.

*Fluid DTMouse: Better Mouse Support for TouchBased Interactions*, Esenther, Ryall
Raising Precision

Push finger down harder for “click.”

*Precise Selection Techniques for Multi-Touch Screens, Benko, Wilson, Baudisch*
Raising Precision

Distance between fingers controls granularity of adjustment.

Multi-Finger and Whole Hand Gestural Interaction Techniques for Multi-User Tabletop Displays, Wu, Balakrishnan
Expressiveness

Layering in 3D using multitouch.

Extending 2D Object Arrangement with Pressure-Sensitive Layering Cues, Davidson, Han
Expressiveness

Edge of hand brings up “secret” dialog box.

Multi-Finger and Whole Hand Gestural Interaction Techniques for Multi-User Tabletop Displays, Wu, Balakrishnan
Text Input

Draw shape corresponding to word.
(no, it’s not touch, but still very cool)

Shorthand Writing on Stylus Keyboard, Zhai, Kristensson
Pen + Touch

Hold things with fingers, cut with pen

Menus

Use pen to open menu at finger.

Shorthand Writing on Stylus Keyboard, Zhai, Kristensson
Menus

Put down palm and 5 fingers to open a menu.

Menus

2x Tap brings up a touch-based pie menu.

Multi-Finger and Whole Hand Gestural Interaction Techniques for Multi-User Tabletop Displays, Wu, Balakrishnan
Many Degrees of Freedom

Using fingers (and pen) to arrange texture map.

A Direct Texture Placement and Editing Interface, Yotam I. Gingold, Philip L. Davidson, Jefferson Y. Han, Denis Zorin
Many Degrees of Freedom

Use fingers to pinch/fold origami.

Many Degrees of Freedom

Use fingers paint with virtual sand.

A Self-Serving Demo...

LiquidText: A Flexible, Multitouch Environment to Support Active Reading, Tashman, Edwards
Some Reflections on Developing Multitouch Software
On the App level, you get points and ID's.
On the App level, you get points and ID’s.

Writing multitouch software is weird.
On the App level, you get points and ID’s. Writing multitouch software is weird.

Don’t just accommodate parallel controls, leverage it.
On the App level, you get points and ID’s.
Writing multitouch software is weird.
Don’t just accommodate parallel widgets, leverage it.

Things get complicated when semantics span widgets…
Gestures on one object changed meaning depending on gestures occurring on another object.

One of LiquidText’s Collapse Interactions
Gestures on one object changed meaning depending on gestures occurring on another object.

There can be many fingers on the display unrelated to a given gesture.

Performing multiple, unrelated gestures.
LiquidText’s Touch Processing Approach
Let each object identify touch configurations of interest.

- List of positive conditions (1 per touch involved in gesture)
- Mutual conditions (true among the touches involved in gesture)
- Negative conditions (true for touches not involved in gesture)

Touch Query Engine

Touch list
There’s more—like event propagation…!
But this is enough for now 😊
Thanks!
Any Questions?