Multi-touch Interactions on Small Input Devices

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Microsoft Research
My research
Multi-touch Interactions
Computing Today

Touch/Buttons → Touch → Touch → Keyboard & Touchpad → Keyboard & Mouse → Remote controller
Computing Today

Touch

Touch

Touch/Buttons

Touch

Touchpad

Keyboard &

Touch

Keyboard &

Mouse

Remote

controller

“No” Touch
Why “no” touch?
Ergonomics
Interaction at a distance

focus is NOT on the device
Existence of good input devices
Rather than replace the existing input devices with touchscreens, augment them with touch sensing to enable novel interactive possibilities.
4 parts

1. Sensing hardware
2. Interactions
3. Grip vs. gesture
4. Making a product
Part 1

SENSING HARDWARE
Five mouse prototypes

Mouse 2.0: Multi-touch meets the mouse. UIST 2009
Nicolas Villar, Shahram Izadi, Dan Rosenfeld, John Helmes, Jonathan Westhues, Steve Hodges, Eyal Ofek, Alex Butler, Xiang Cao, Billy Chen
Prototype 1: FTIR Mouse
Prototype 1: FTIR Mouse
Prototype 2: Orb Mouse
Prototype 2: Orb Mouse
Prototype 3: Cap Mouse

- Capacitive sensing grid
- Optical sensor
- Protective overlay
- Mouse button
Prototype 3: Cap Mouse
Prototype 4: Side Mouse
Prototype 4: Side Mouse
Prototype 5: Articulated Mouse

3 x Bluetooth mouse PCB

contact rings

mouse buttons

optical sensors
Prototype 5: Articulated Mouse
What is the best HW solution?

• Biggest sensor area – Orb
• Best touch resolution – FTIR
• Most robust – Cap
• Most precise – Arty
• Dual purpose – Side
Part 2

INTERACTIONS
How to treat mouse + touch streams?

**Independent**
Mouse cursor used for manipulations
Touch used for gesturing

**Combined**
Touches manipulate the on-screen objects in addition to the cursor
$1 Gestures
MT Cursor
How effective are multi-touch manipulations on a mouse?

Design and Evaluation of Interaction Models for Multi-touch Mice. GI 2010
Hrvoje Benko, Shahram Izadi, Andrew D. Wilson, Xiang Cao, Dan Rosenfeld, and Ken Hinckley
What is the focus model?
What is the activation model?

Touchscreen (implicit)

Mouse (explicit)
## User Study Conditions

<table>
<thead>
<tr>
<th>Cond.</th>
<th>Technique Name</th>
<th>Focus</th>
<th>Activation</th>
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<tbody>
<tr>
<td>IT</td>
<td>MT Mouse Independent Touches</td>
<td>No</td>
<td>Implicit</td>
</tr>
<tr>
<td>HC</td>
<td>MT Mouse Hover Cursor</td>
<td>Yes - Transient</td>
<td>Implicit</td>
</tr>
<tr>
<td>CH</td>
<td>MT Mouse Click ‘n’ Hold</td>
<td>Yes - Transient</td>
<td>Explicit</td>
</tr>
<tr>
<td>CS</td>
<td>MT Mouse Click Selection</td>
<td>Yes - Persistent</td>
<td>Explicit</td>
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</table>
MT Mouse Click ‘n’ Hold

Focus: Yes

Activation: Explicit
Baseline 1: Regular Mouse
User Evaluation

- 12 participants (6 female)
- 2 tasks
- 90 min

6 techniques
× 2 rotations (± 60°)
× 2 scales (± 20%)
× 4 repetitions
= 96 trials/participant
MT Mouse techniques were...

... slower,

... more error-prone,

... and less preferred!
Negative results
Lessons learned

- MT mice interactions are better with focus and explicit touch activation
- Combining mouse and touch to facilitate Surface-like interactions does not yield a good experience
- Dexterity is in the thumb and index finger
Lessons learned (2)

- Controlling accidental activation is key to user satisfaction
- Interactions that treat mouse and touch streams *independently* do not suffer from same problems
PART 3

GRIPS AND GESTURES
The device is continuously held while interacting!
Fingers serve a dual purpose: to grip and to gesture
Screen = interactive (touch)

Bezel = Non-interactive (grip, hold, support)
However,…

When the entire device is touch sensitive one can sense the context of use!

– Engagement
– Handedness
– Different grips
Hyunyoung Song, Hrvoje Benko, Francois Guimbretiere, Shahram Izadi, Xiang Cao, and Ken Hinckley
Grip vs. Gesture

Raw

Dynamic

Pixel Sum of the RawImage
<table>
<thead>
<tr>
<th>Grip</th>
<th>Hand Image</th>
<th>Sensor Image</th>
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</thead>
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<td><img src="image2.png" alt="Tripod Sensor Image" /></td>
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<td><img src="image8.png" alt="Wrap Sensor Image" /></td>
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</table>
Multi-Touch Pen Implementation
Part 4
MAKING A PRODUCT
Microsoft Touch Mouse

Combines the virtues of a mouse with the rich natural language of gesture, bringing multi-touch gestures to Windows 7.
My role…

“Product Vision Lead” (?!?)

– Control end-to-end experience
– Design contact tracking and gesture recognition algorithms
Great mouse +

Grip

Click

Gesture
Finding the right form
Form explorations
Design lineage

Arc Mouse  Arc Touch  Microsoft Touch Mouse
Curved Wireless Capacitive Sensor
Gesture vocabulary

1 FINGER
Manage documents

2 FINGERS
Manage windows

3 FINGERS
Manage desktop
Gesture vocabulary = 1, 2, 3

1 FINGER = Manage document
Scroll, pan, and flick

2 FINGERS = Manage windows
Maximize, minimize, restore, dock

1 THUMB = Manage documents
Page forward, back

3 FINGERS = Manage desktop
Show desktop, show Instant Viewer
Color, material, finish
Reducing accidental activation

- Gesture recognition
- Contact tracking
- Understanding how the user holds the device
Best of CES 2011

Best peripheral

Microsoft Touch Mouse
How often does a badass Microsoft Research gadget go straight into production? Not often enough, but come June, $80 will buy your Windows PC's new best friend. Apple fanboys will probably just see a Magic Mouse with a hump, but these multitouch gestures put that surface to shame -- two fingers snap windows into place, three fingers quickly switch tasks, and your thumb can move forwards and backwards through websites, photos and documents.
In stores Summer 2011 - $79
Opportunity
To augment existing devices with multi-touch sensing:

- Extend interaction vocabulary
- Sense the context of their use
- Solve difficult problems (palm rejection)
Thanks to my collaborators

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