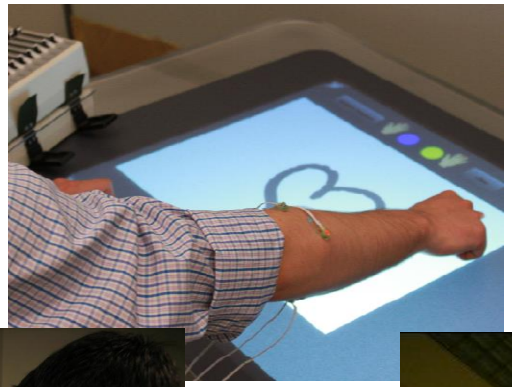
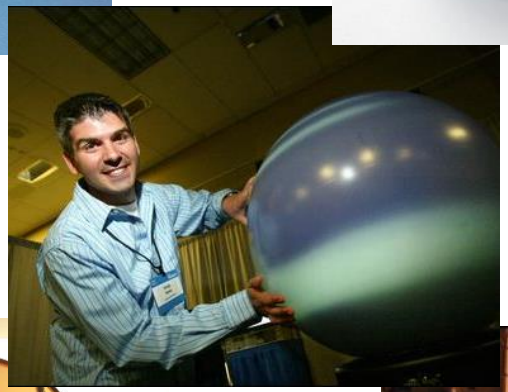
Multi-touch Interactions on Small Input Devices

Hrvoje Benko

Researcher
Microsoft Research

My research





Multi-touch Interactions

Computing Today

Touch/ Buttons | Touch | Touch | Keyboard & Touchpad | Keyboard & Mouse | Remote controller

Computing Today

Touch **"No" Touch**

Touch/ Buttons | Touch | Touch | Keyboard & Touchpad | Keyboard & Mouse | Remote controller

Why “no” touch?

Ergonomics

Interaction at a distance

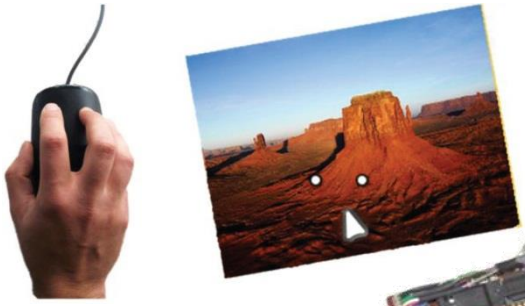
Existence of good input devices

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

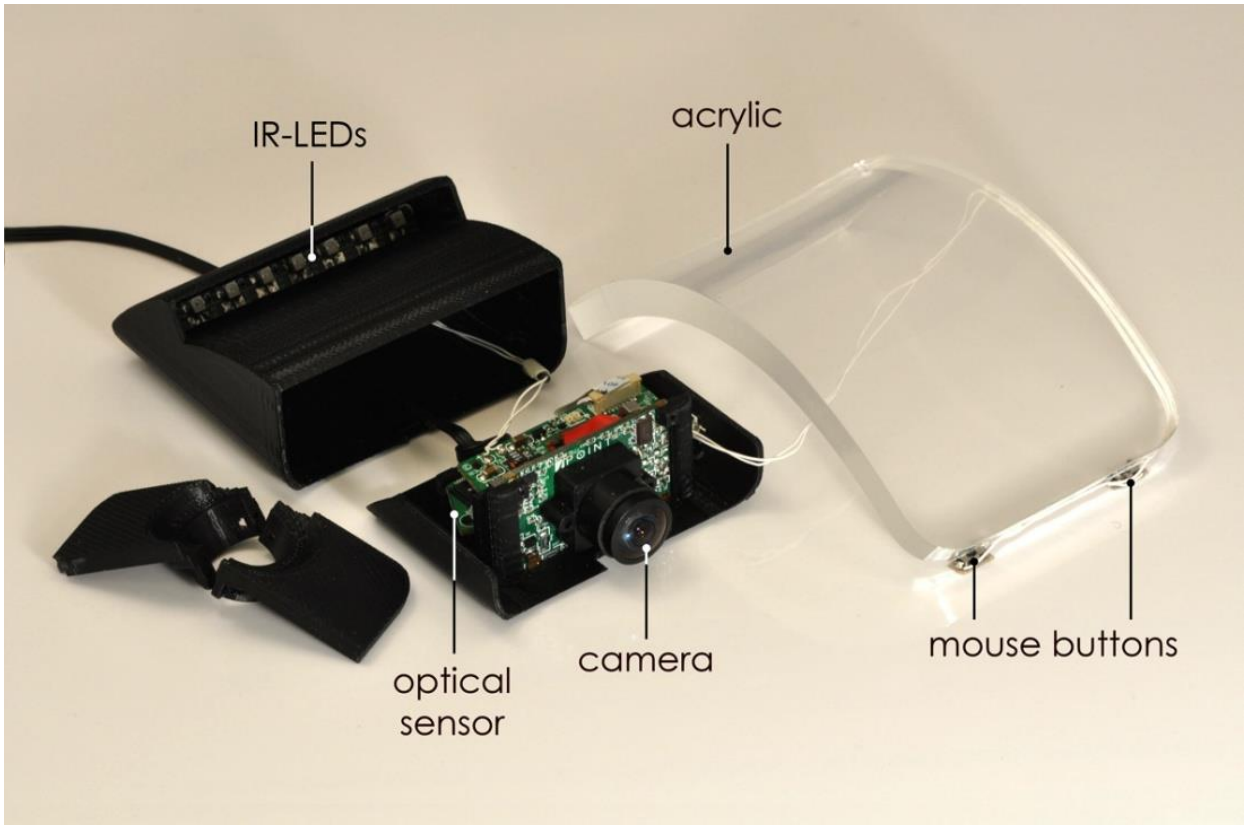
SENSING HARDWARE

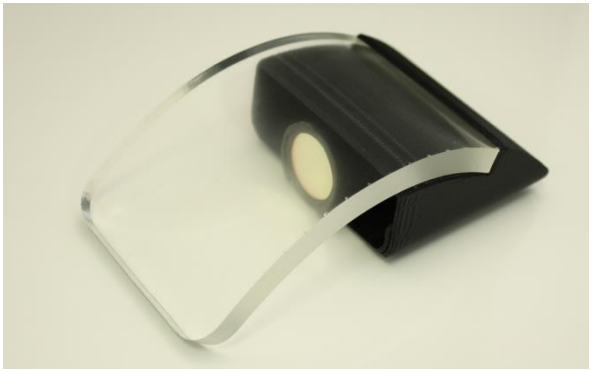
Five mouse prototypes

Mouse 2.0: Multi-touch meets the mouse. UIST 2009

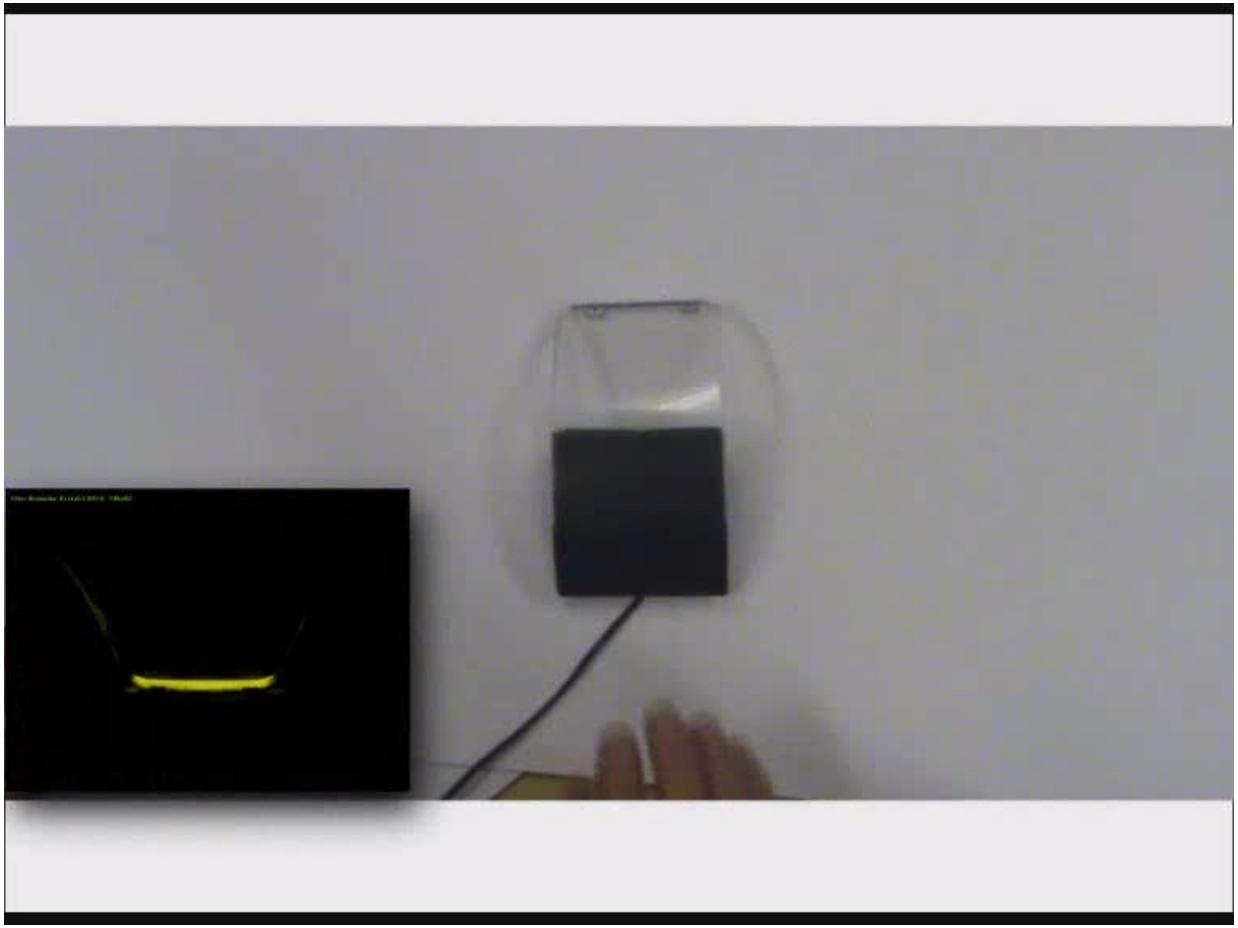
Nicolas Villar, Shahram Izadi, Dan Rosenfeld, John Helmes, Jonathan Westhues, Steve Hodges, Eyal Ofek, Alex Butler, Xiang Cao, Billy Chen

Prototype 1: FTIR Mouse

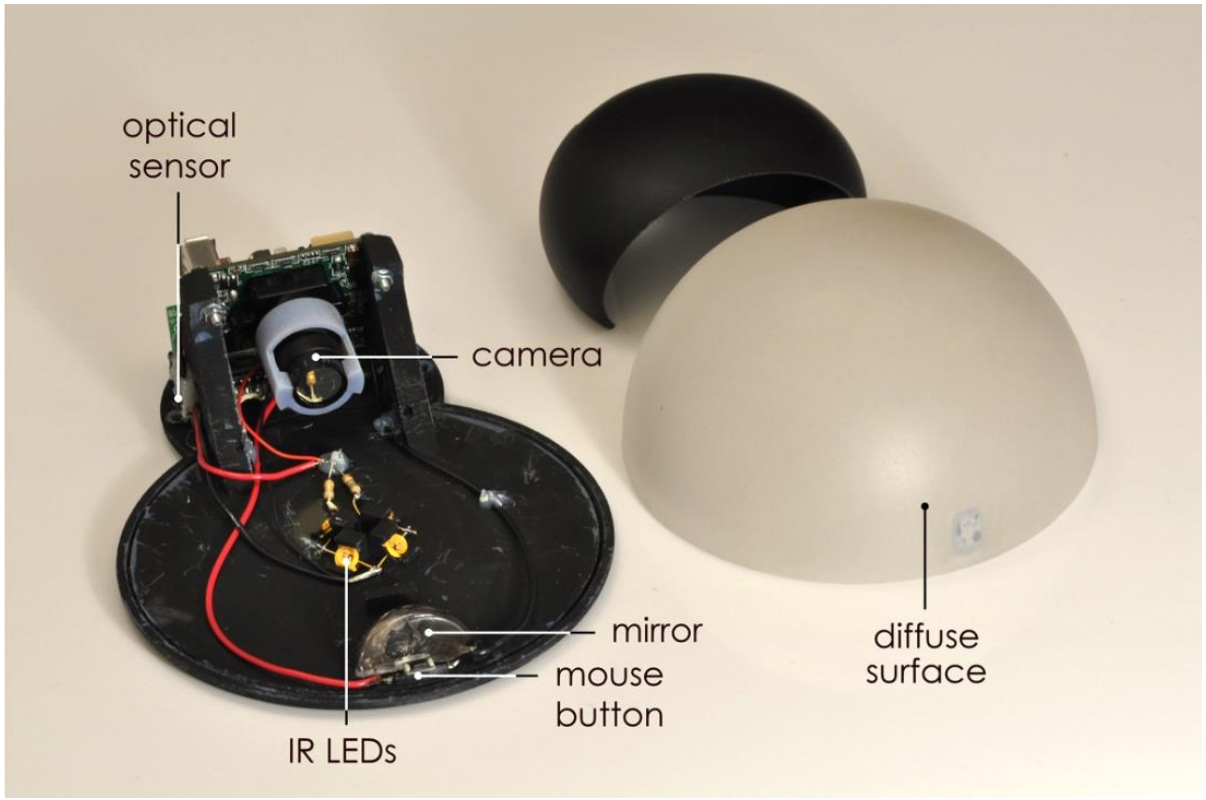




Prototype 1: FTIR Mouse

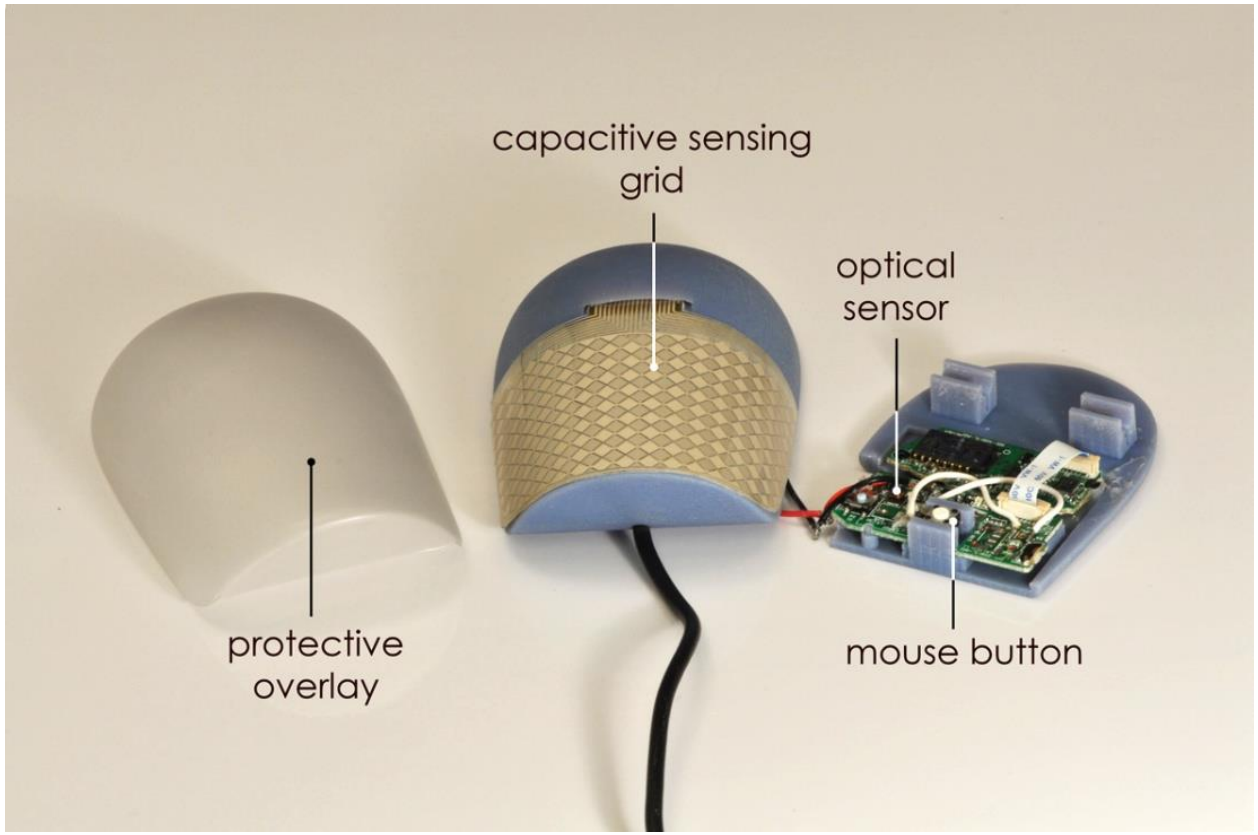


Prototype 2: Orb Mouse

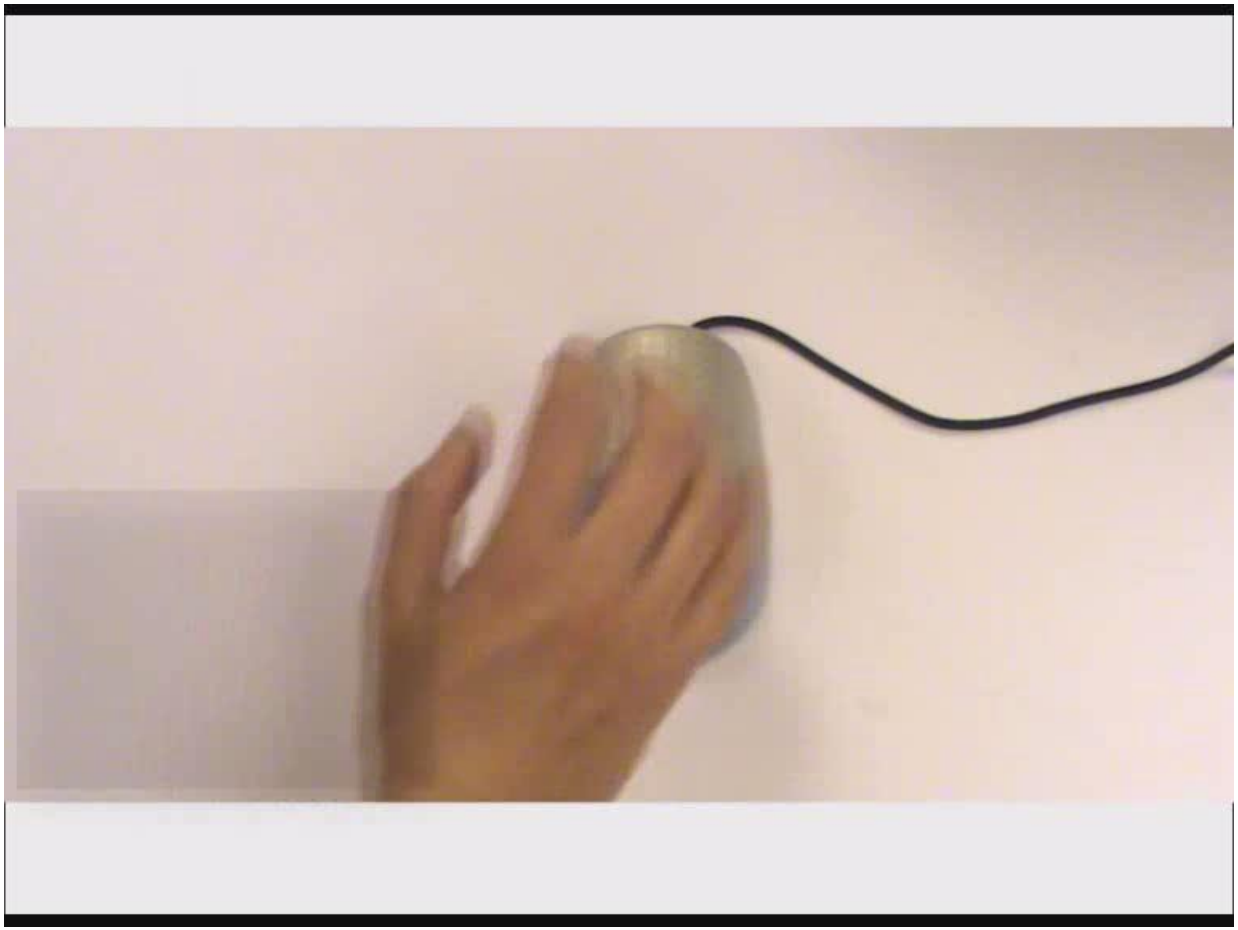


Prototype 2: Orb Mouse

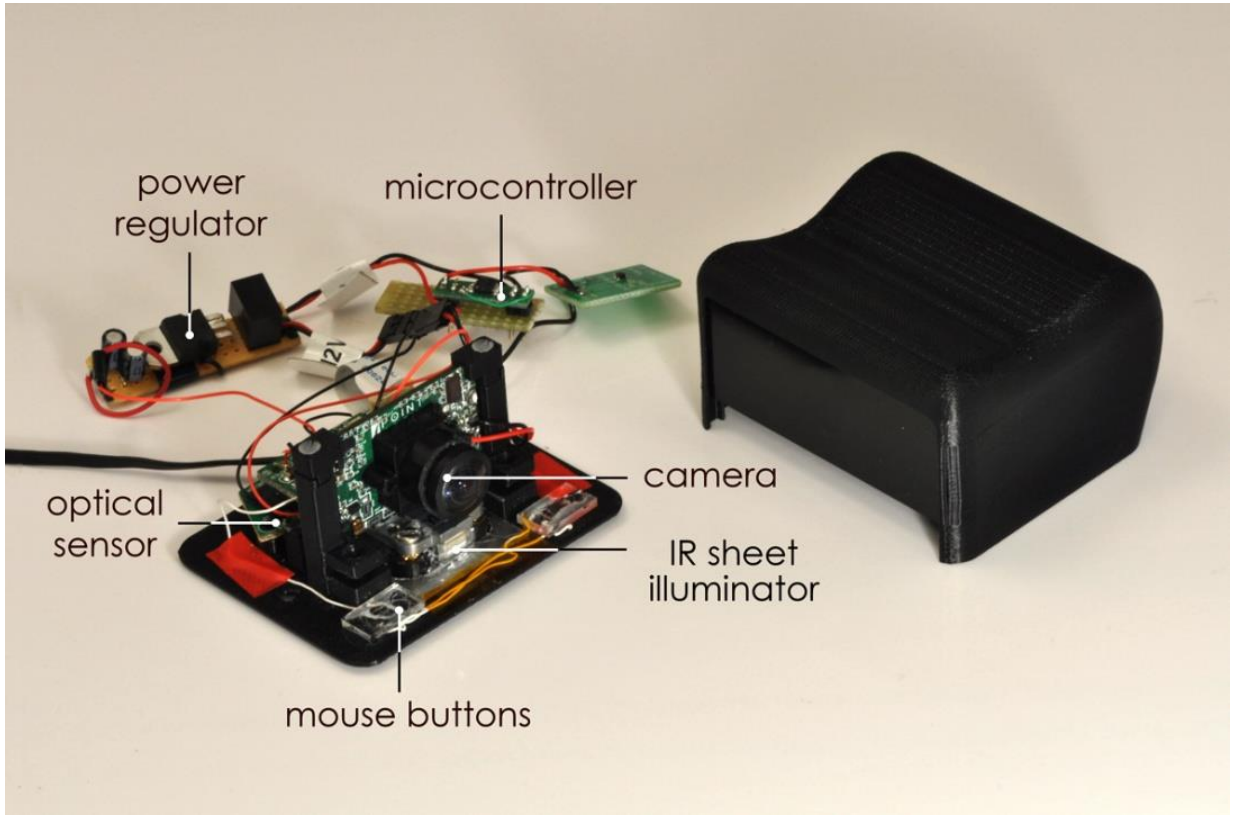
Prototype 3: Cap Mouse



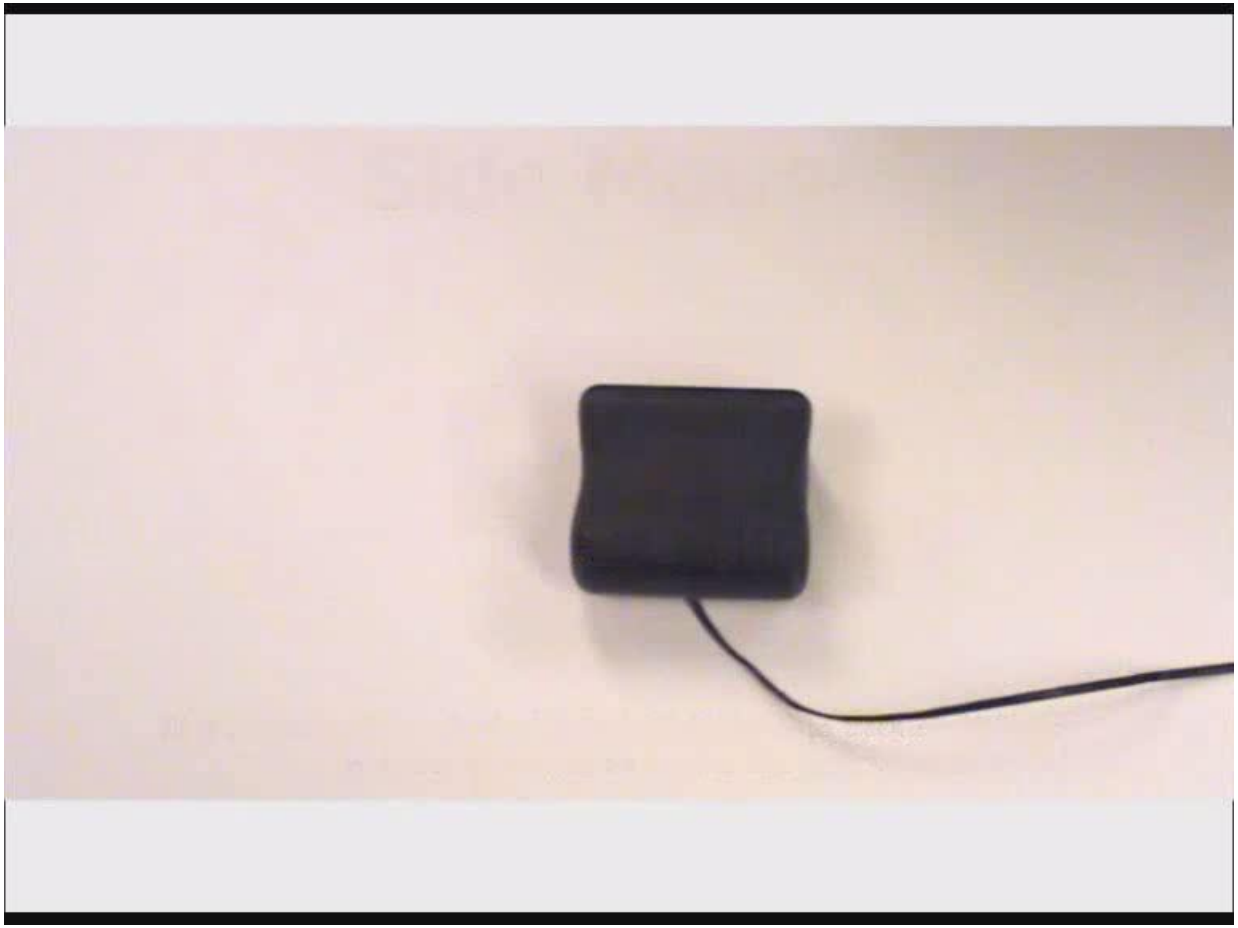
Prototype 3: Cap Mouse



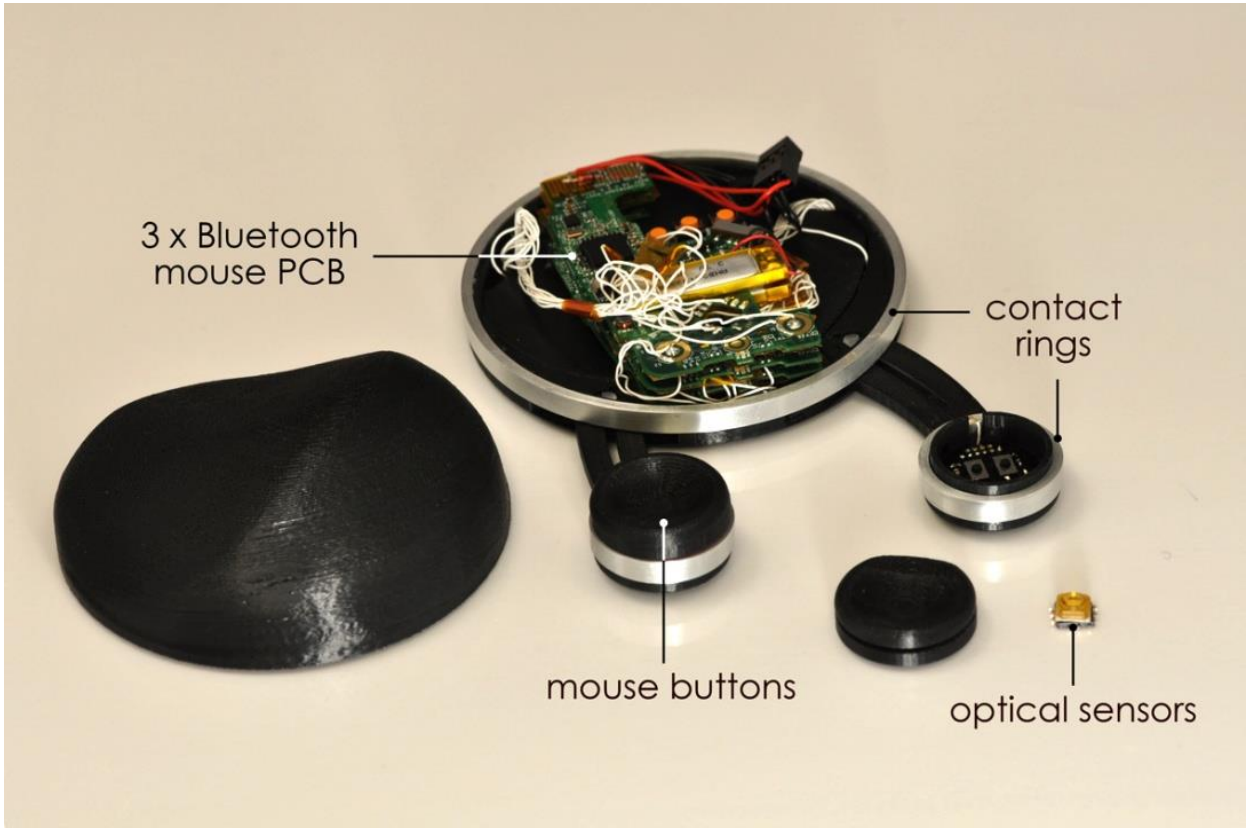
Prototype 4: Side Mouse



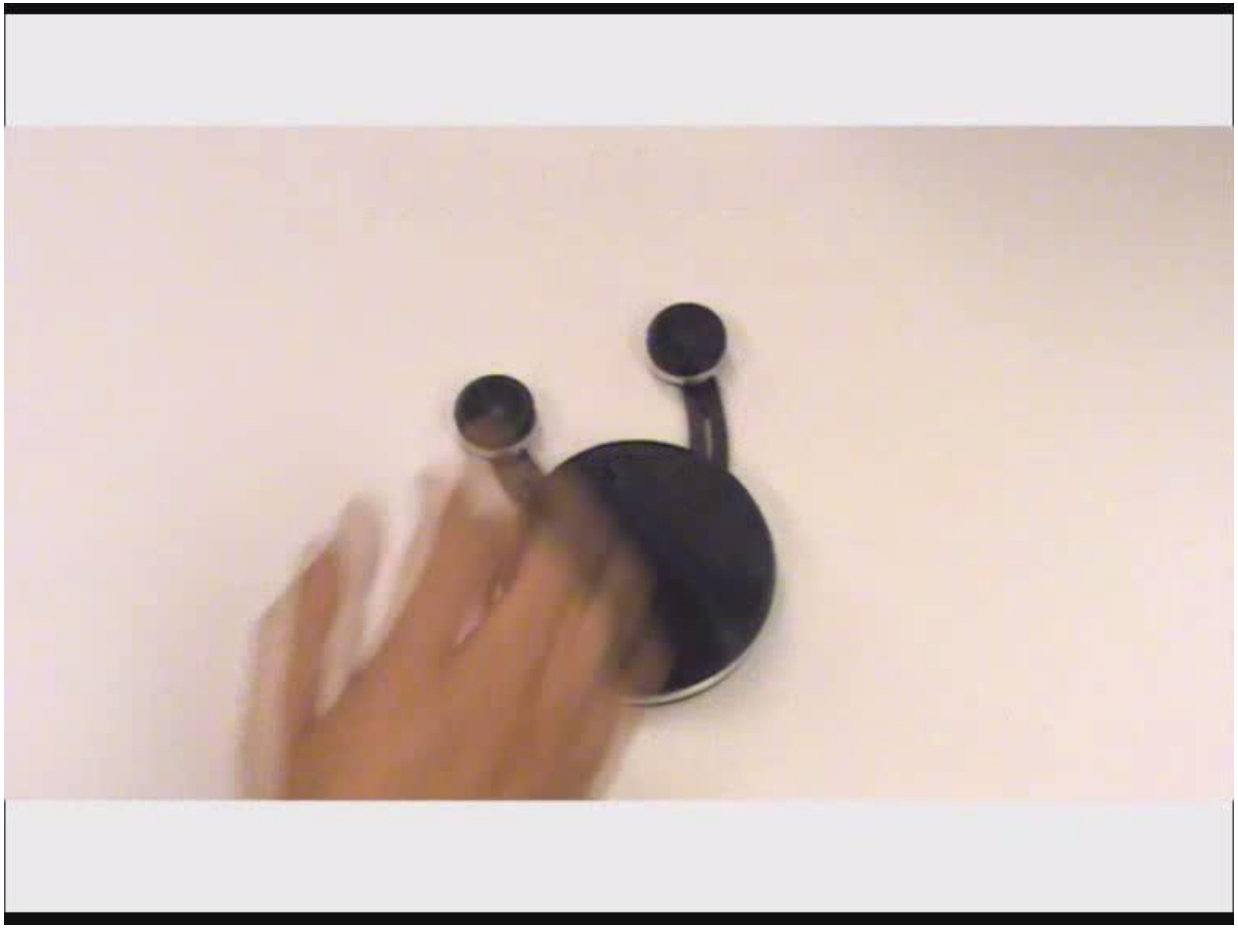
Prototype 4: Side Mouse



Prototype 5: Articulated Mouse



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

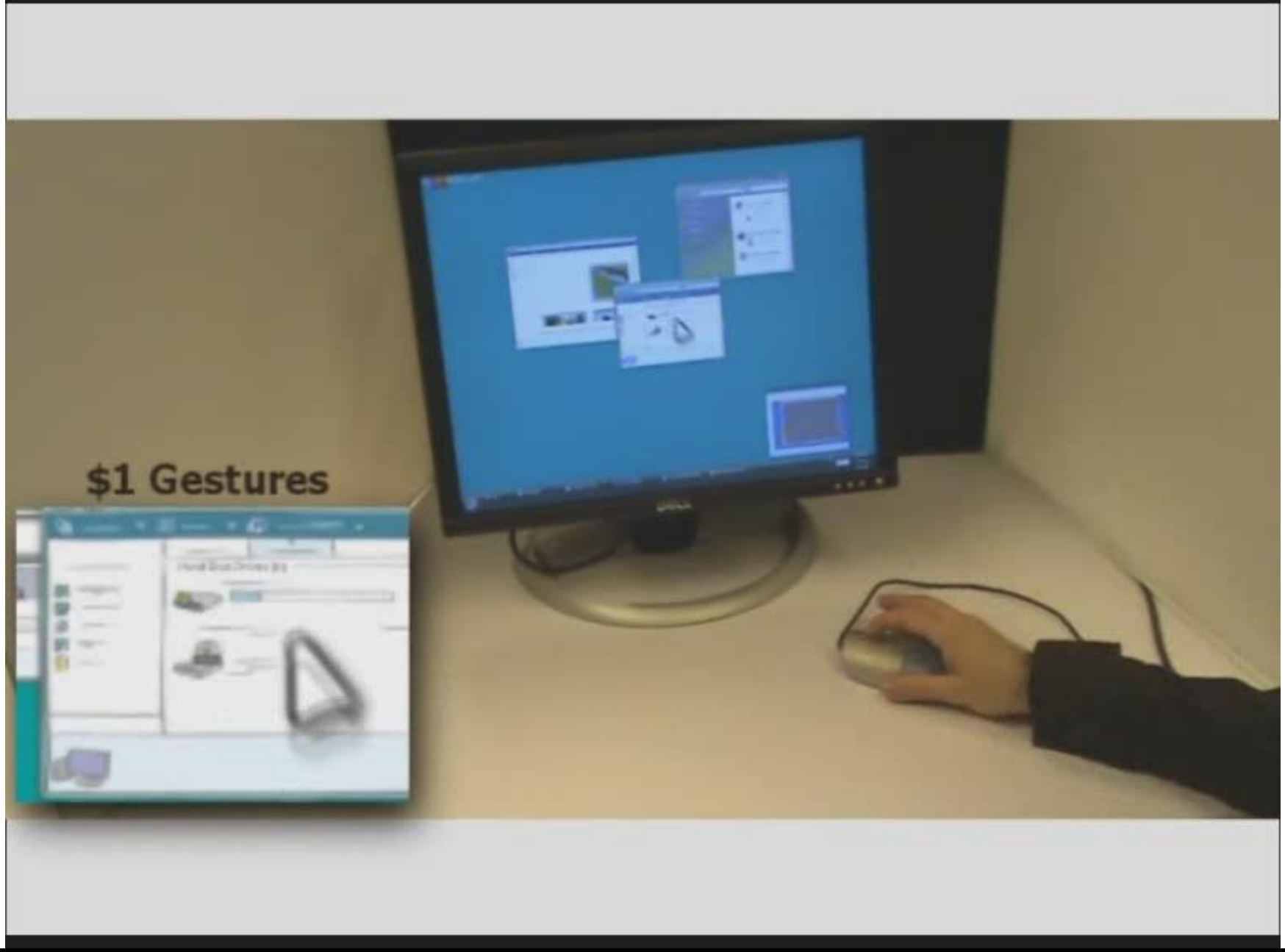
Mouse cursor used for manipulations

Touch used for gesturing

Combined

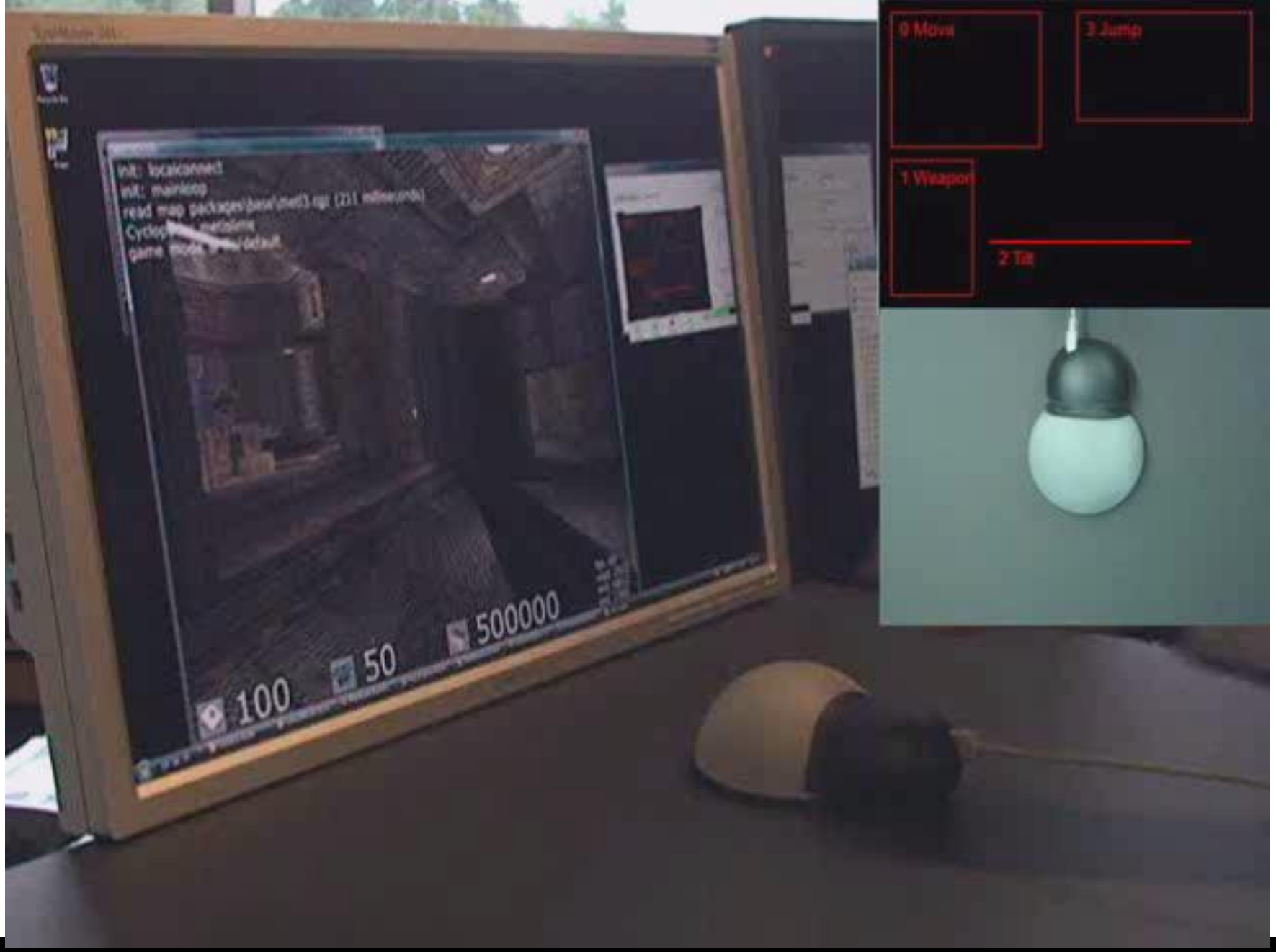
Touches manipulate the on-screen objects in addition to the cursor

INDEPENDENT



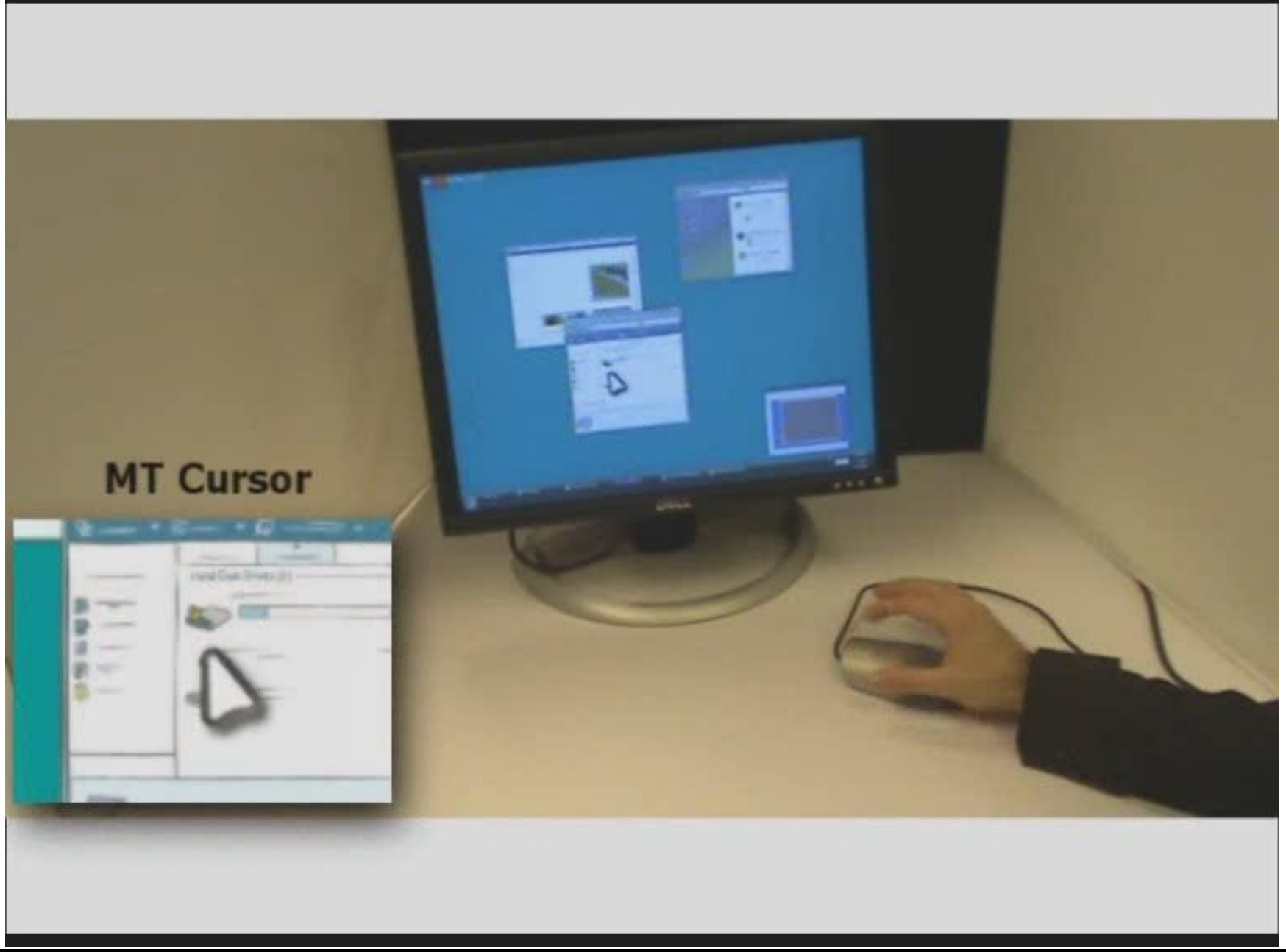
Microsoft Research

INDEPENDENT

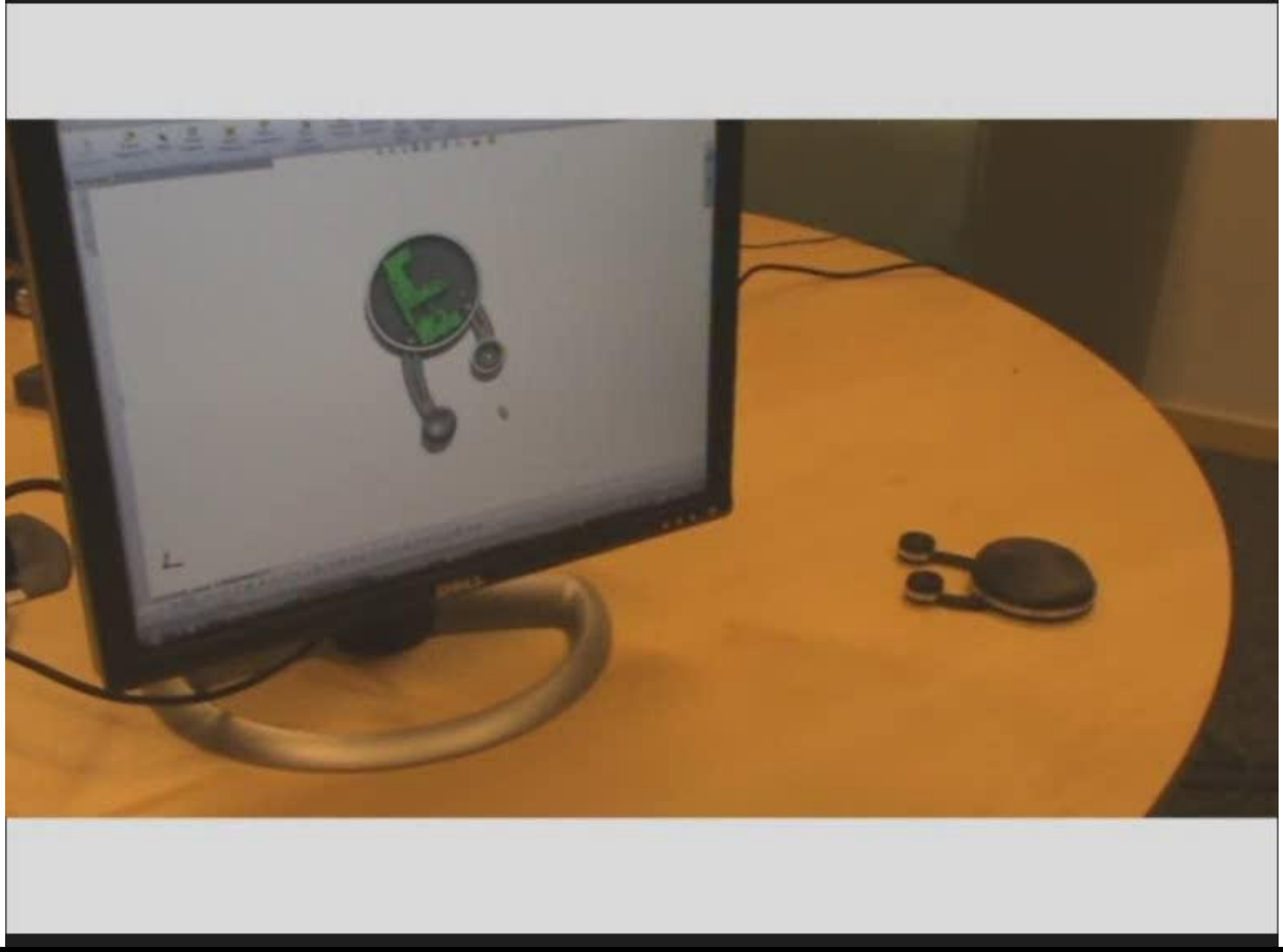


Microsoft
Research

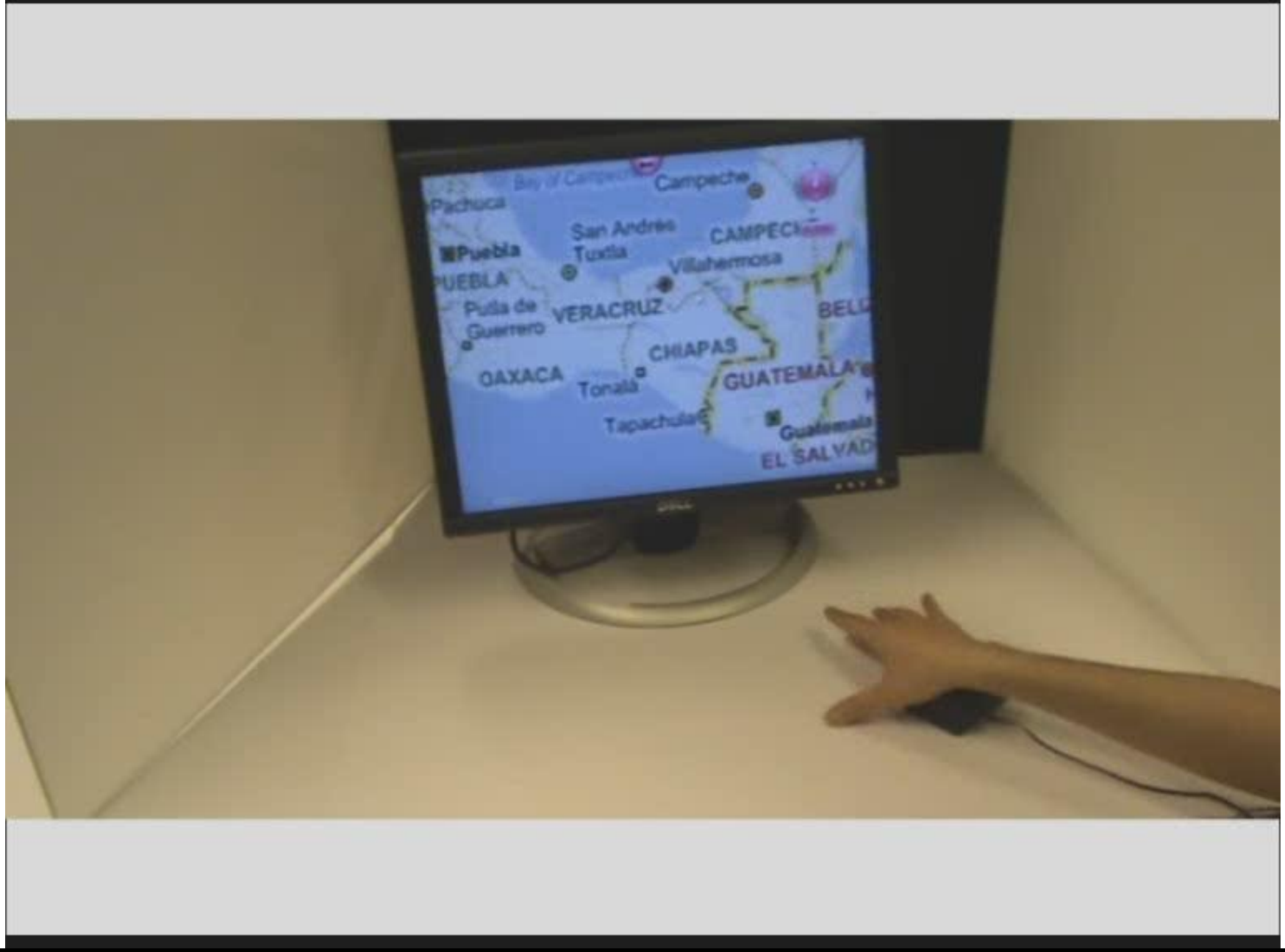
COMBINED



COMBINED

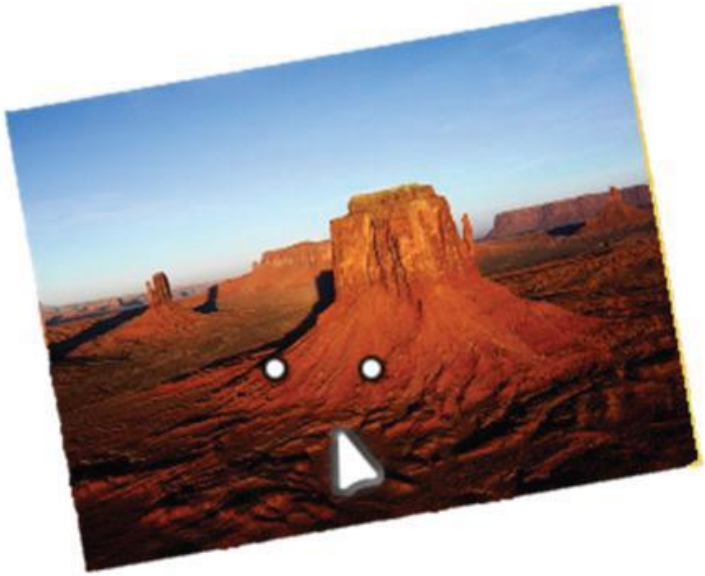


COMBINED


Campeche
Pachuca
San Andrés
Tuxtla
Puebla
Villahermosa
PUEBLA
VERACRUZ
Pulla de
Guerrero
CHIAPAS
OAXACA
Tonalá
GUATEMALA
Tapachula
Guatemala
EL SALVAD

COMBINED

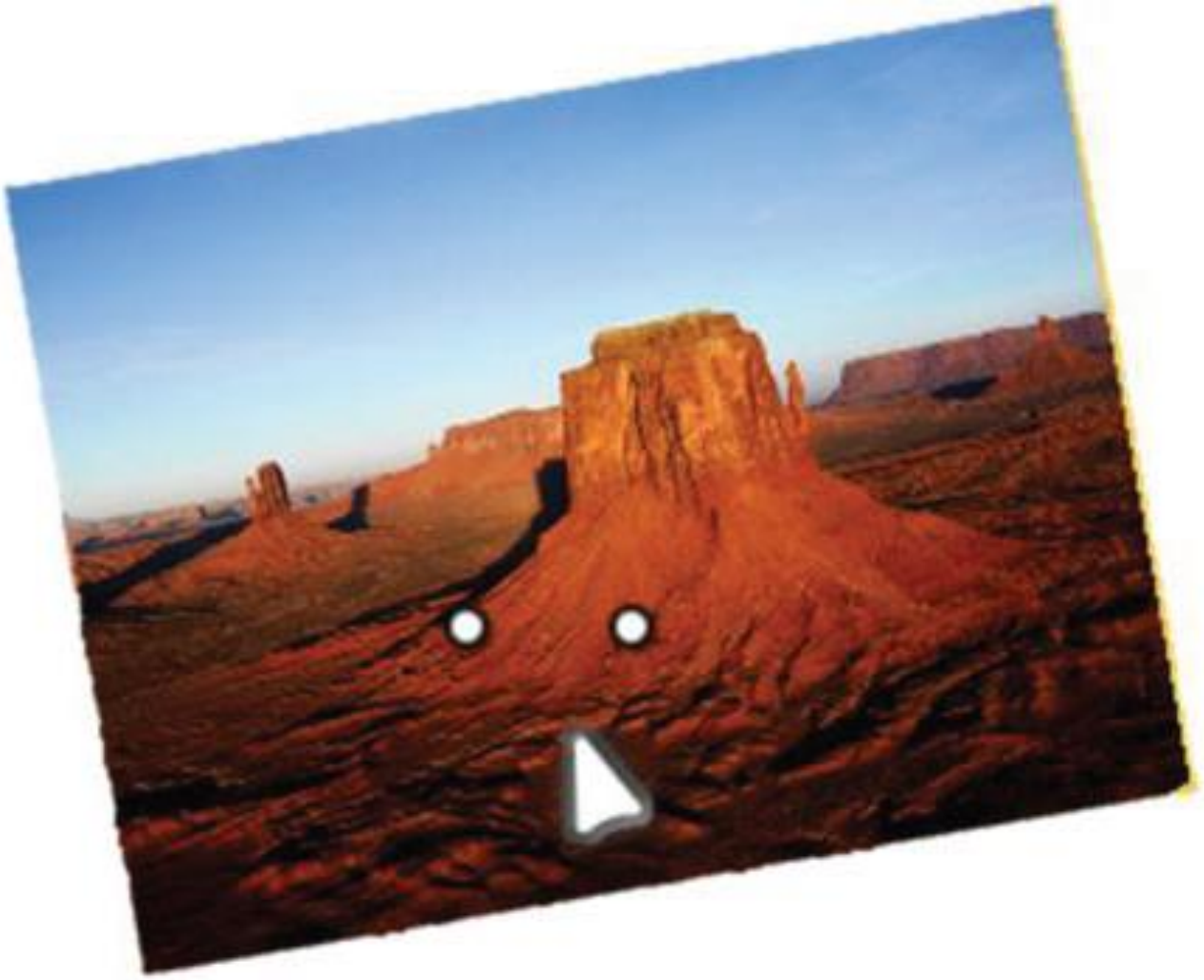
How effective are multi-touch manipulations on a mouse?



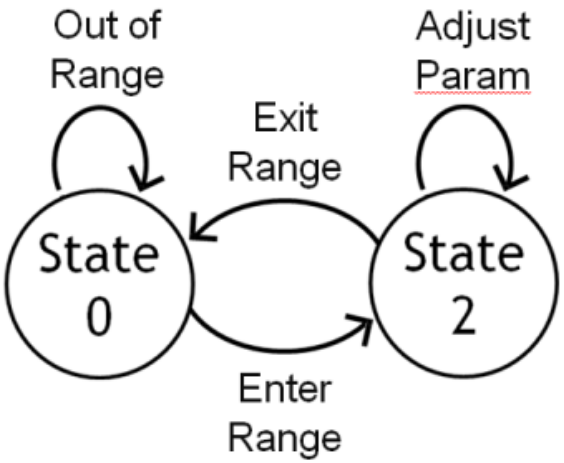
Design and Evaluation of Interaction Models for Multi-touch Mice. GI 2010

Hrvoje Benko, Shahram Izadi, Andrew D. Wilson, Xiang Cao, Dan Rosenfeld, and Ken Hinckley

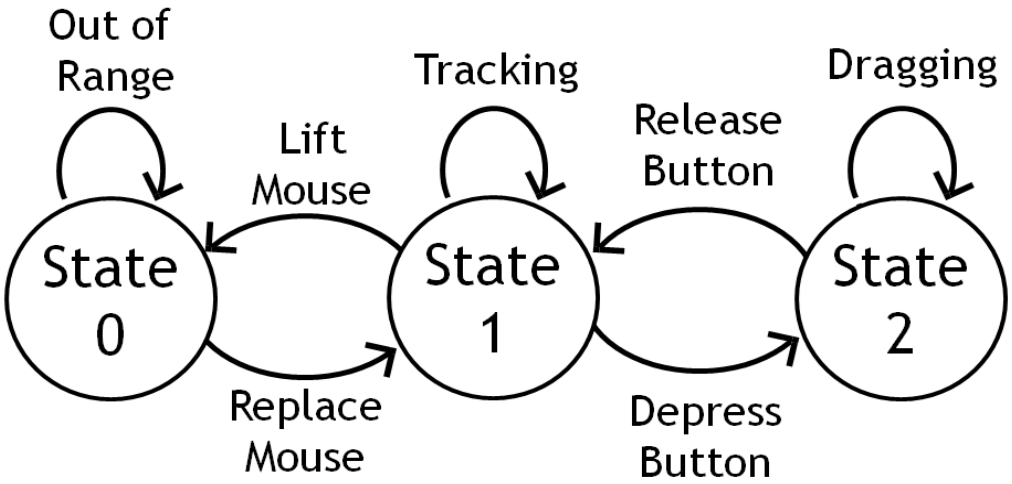
What is the focus model?



What is the activation model?



Touchscreen (implicit)



Mouse (explicit)

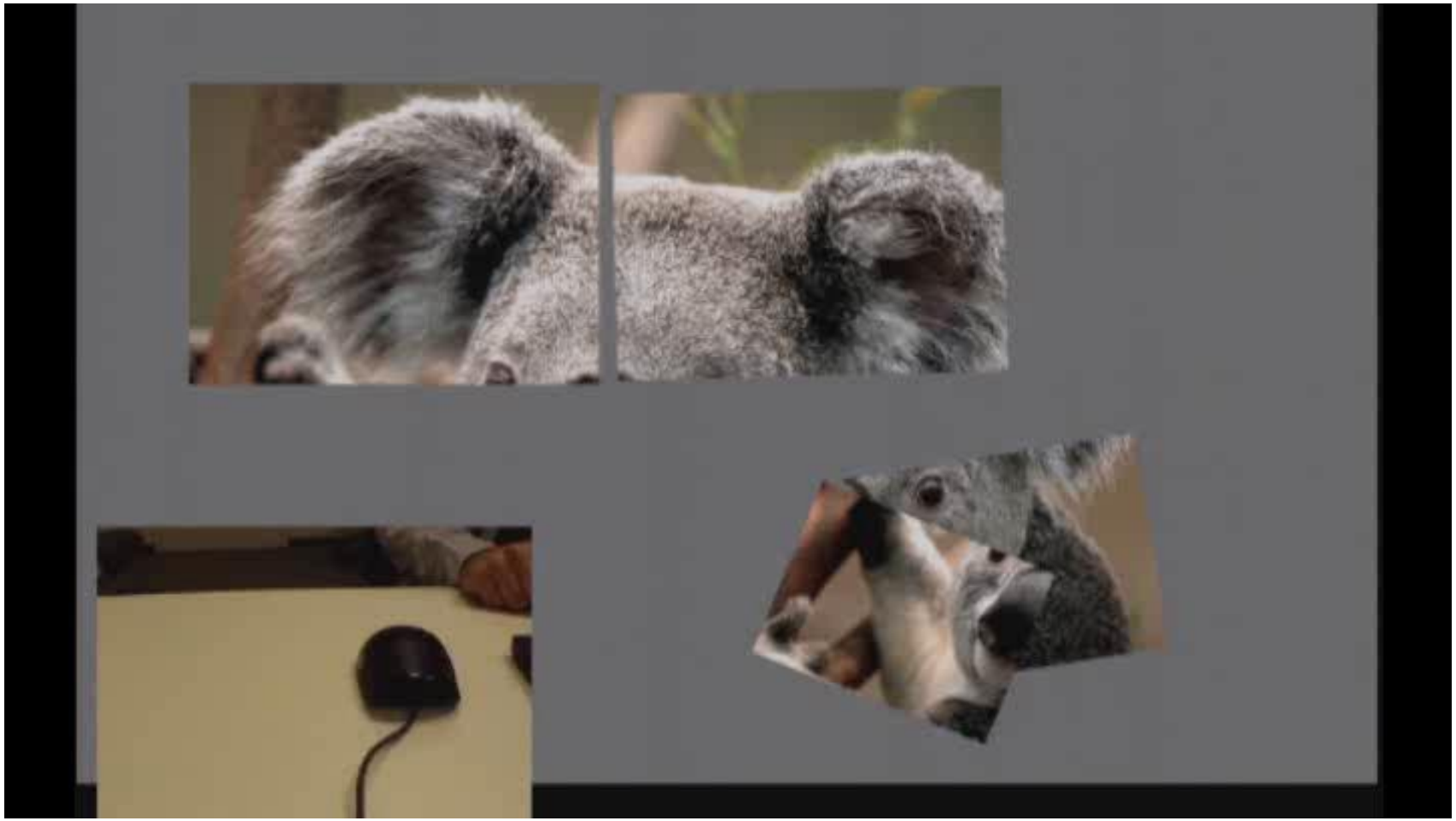
User Study Conditions

Cond.	Technique Name	Focus	Activation
IT	MT Mouse Independent Touches	No	Implicit
HC	MT Mouse Hover Cursor	Yes - Transient	Implicit
CH	MT Mouse Click ‘n’ Hold	Yes - Transient	Explicit
CS	MT Mouse Click Selection	Yes - Persistent	Explicit

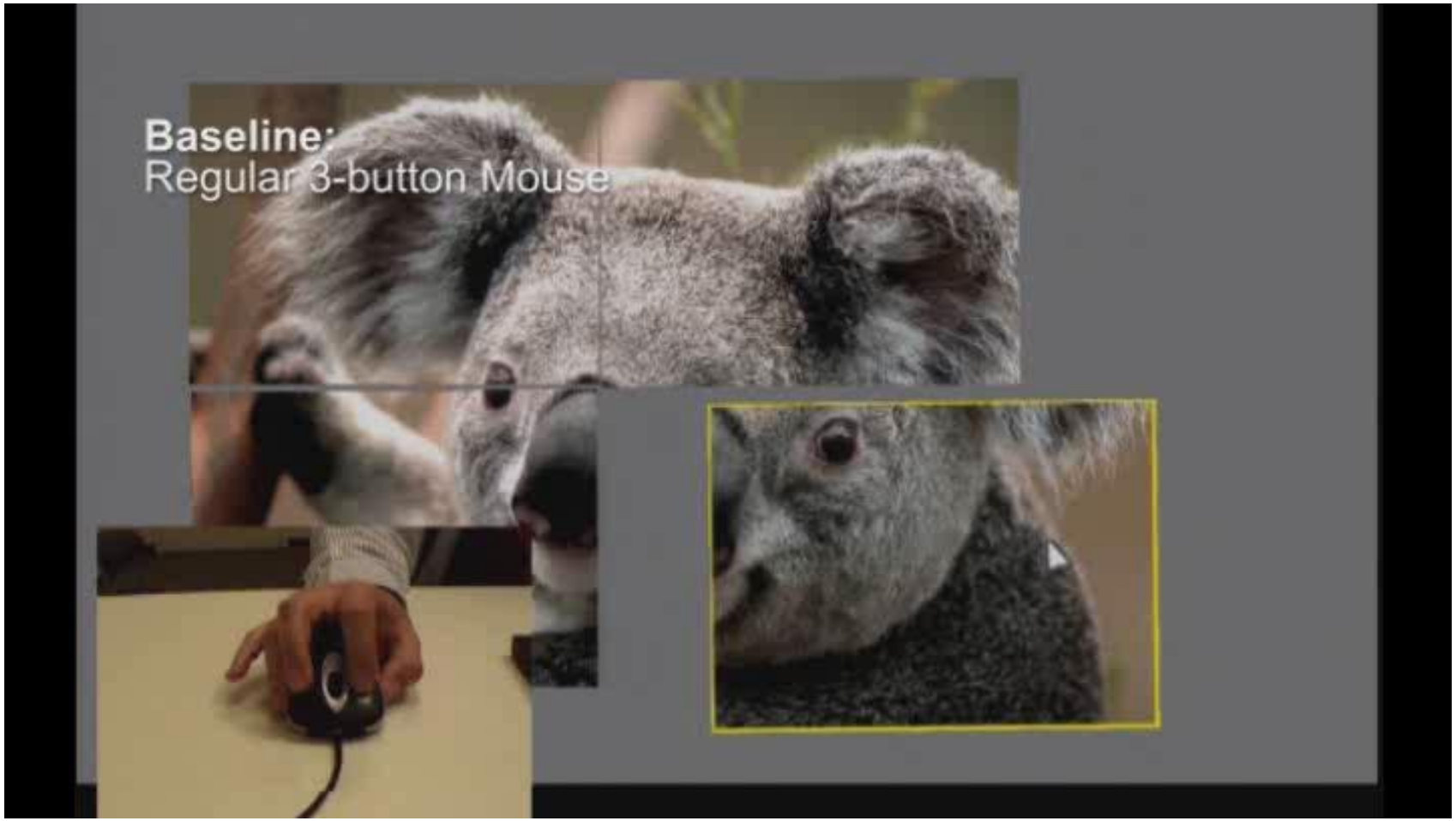
MT Mouse Click ‘n’ Hold

Focus: Yes

Activation: Explicit

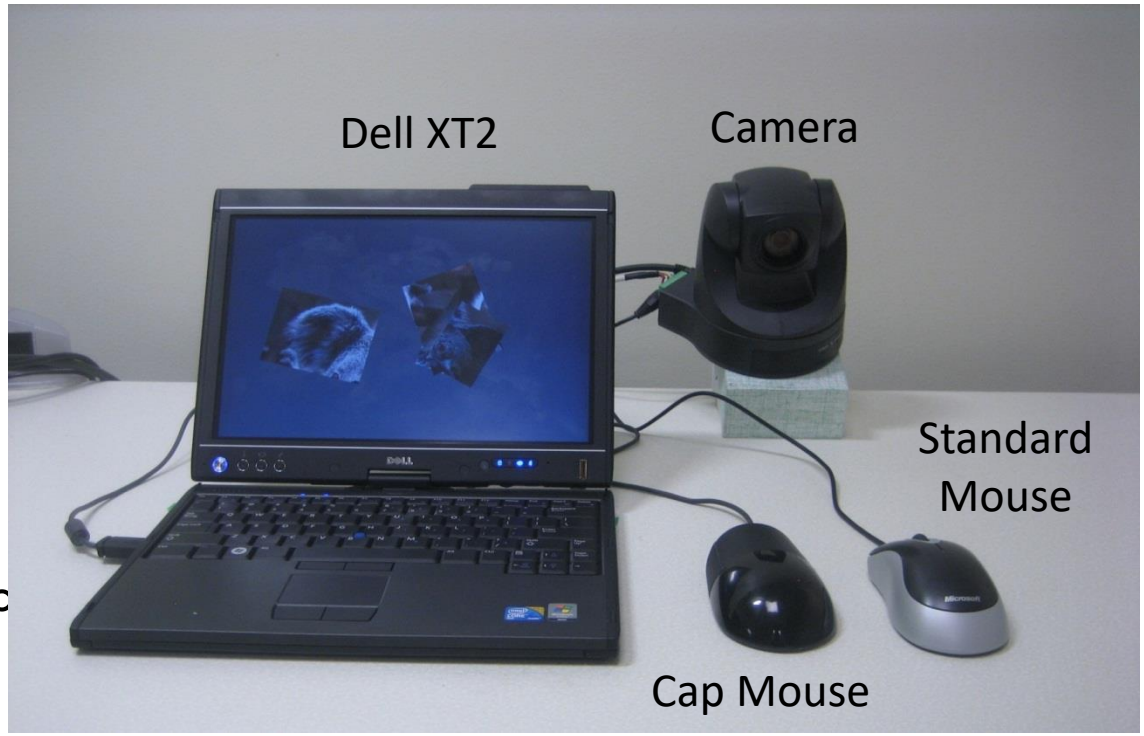


Baseline 1: Regular Mouse



User Evaluation

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



6 techniques
x 2 rotations (± 60°
x 2 scales (± 20%)
x 4 repetitions
= 96 trials/participant

MT Mouse techniques were…

… slower,

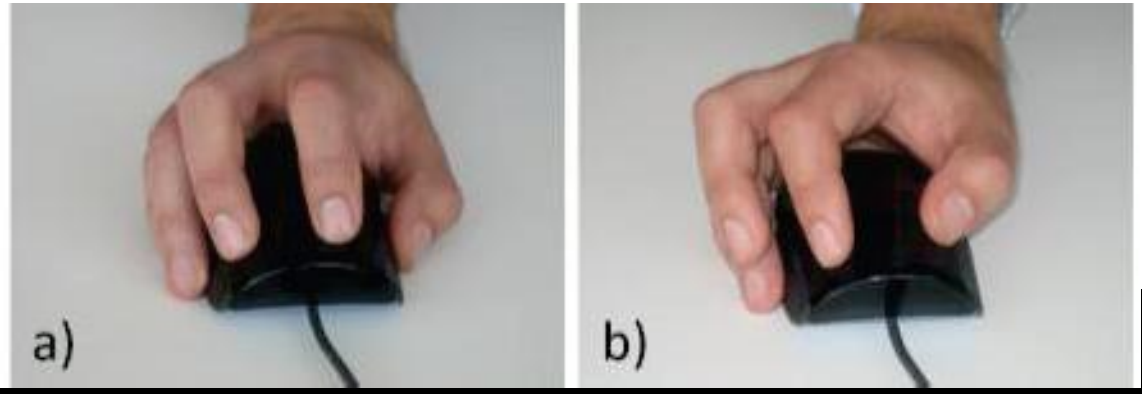
… more error-prone,

… 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

Challenge & Opportunity

The device is continuously held while interacting!

Fingers serve a dual purpose: to grip and to gesture

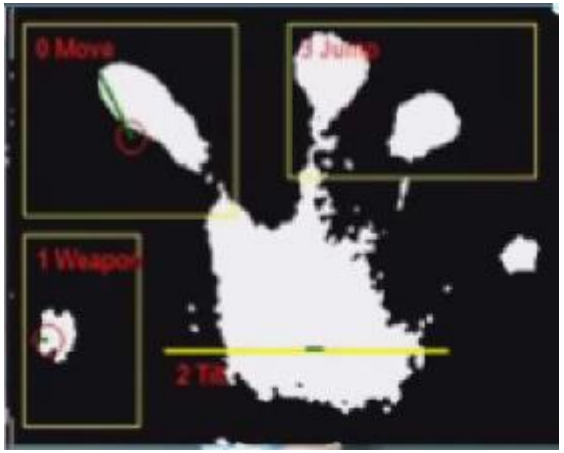
Screen = interactive (touch)

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

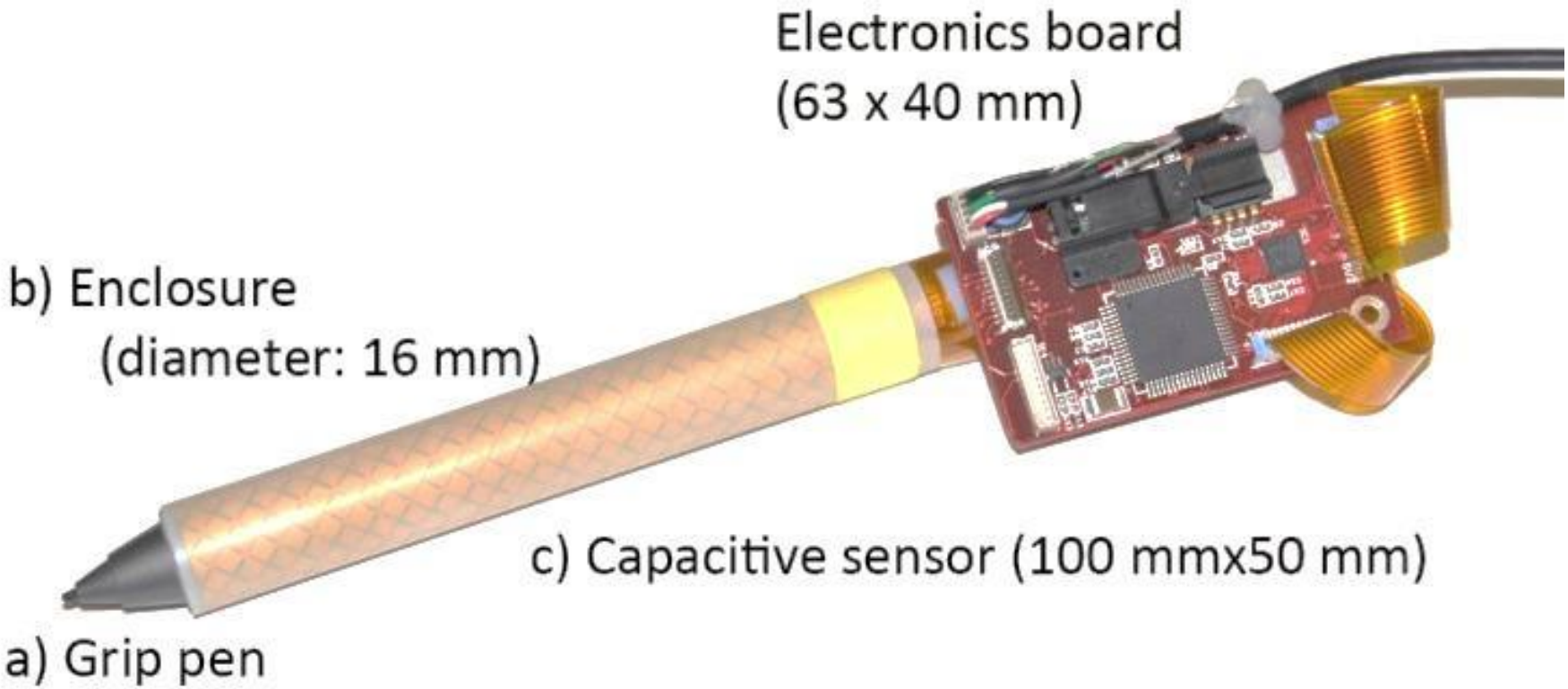
However,…

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

- Engagement
- Handedness
- Different grips



MTPen



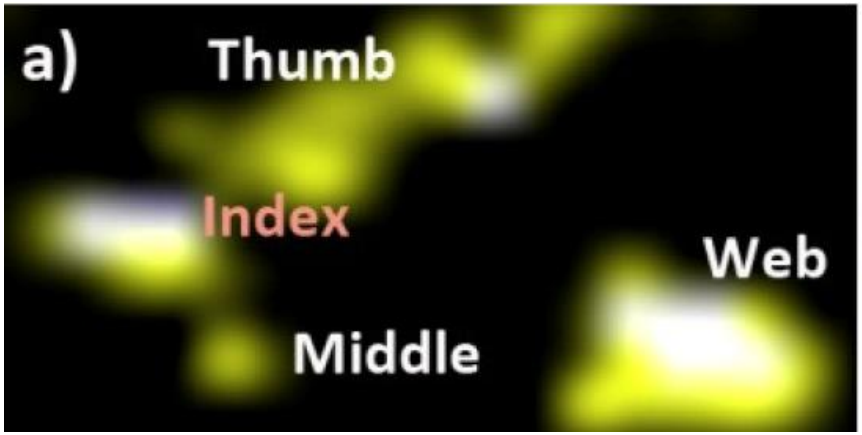
Grips and Gestures on a Multi-touch Pen. To appear in CHI 2011.

Hyunyoung Song, Hrvoje Benko, Francois Guimbretiere, Shahram Izadi, Xiang Cao, and Ken Hinckley

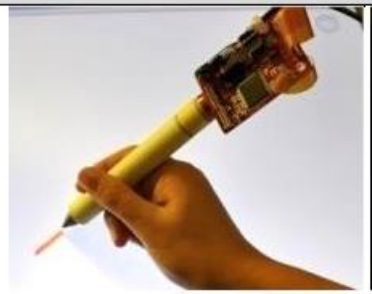
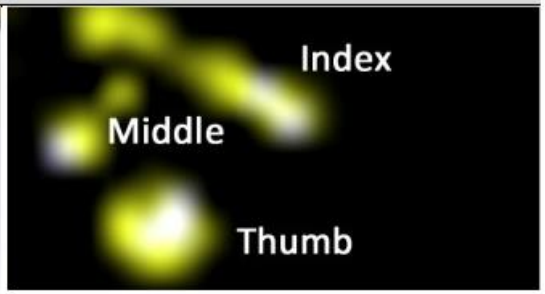
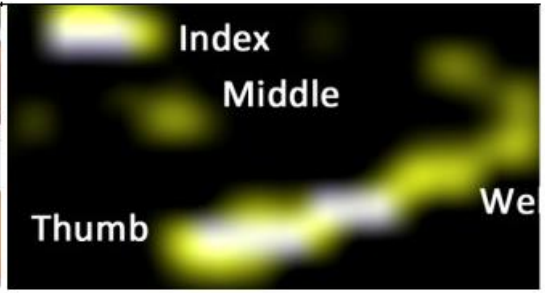
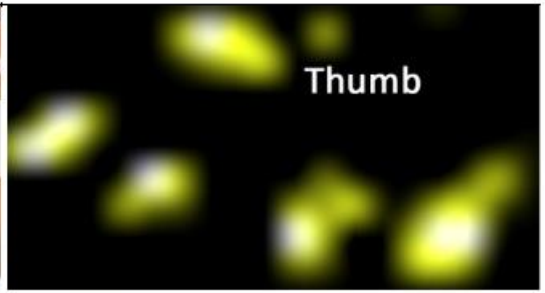
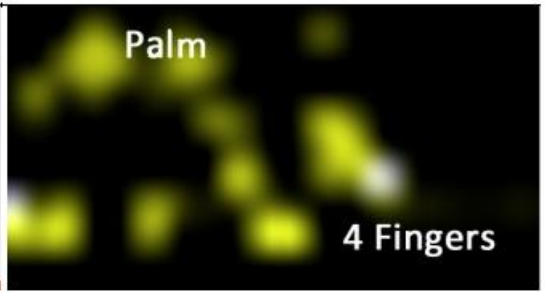
Grip vs. Gesture

Raw

Dynamic



Pixel Sum of the RawImage

Grip	Hand Image	Sensor Image
Tripod		
Relax		
Sketch		
Wrap		

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.

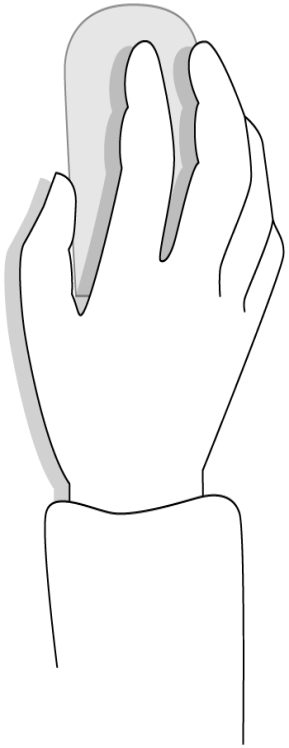
Microsoft Research

My role…

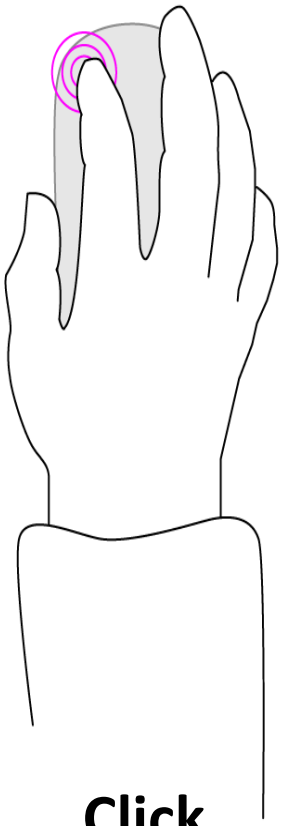
"Product Vision Lead" (?!?)

- Control end-to-end experience
- Design contact tracking and gesture recognition algorithms

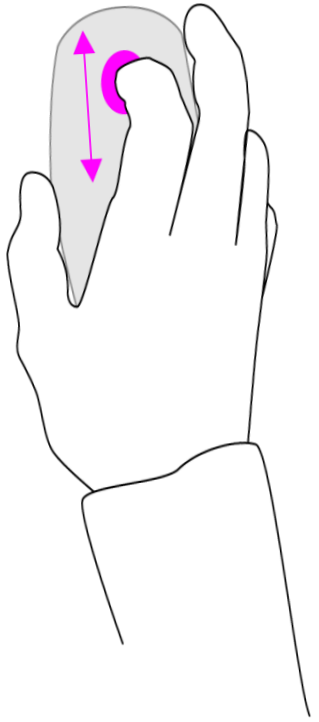
Great mouse +



Grip



Click



Gesture

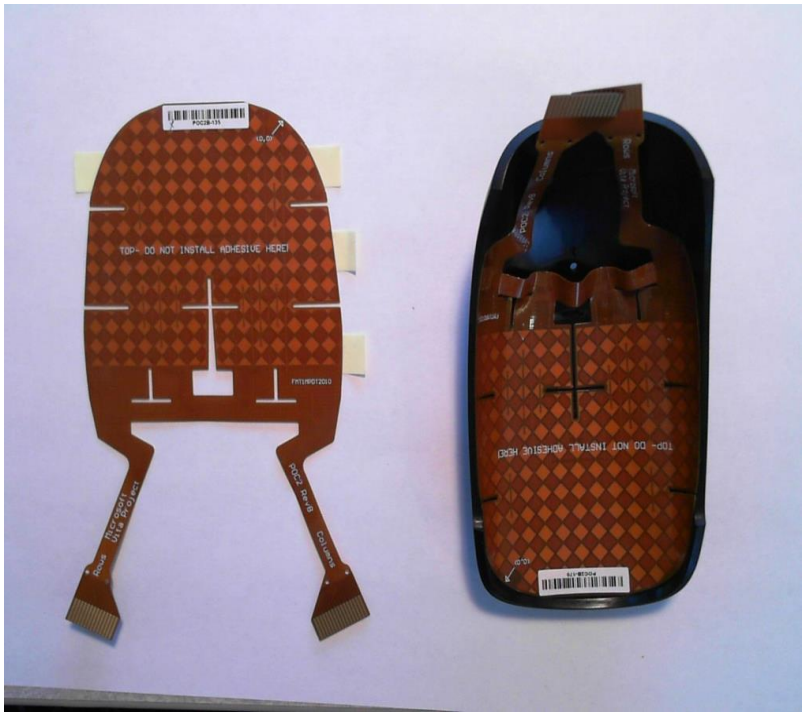
Finding the right form

Form explorations

Design lineage

Arc Mouse **Arc Touch** **Microsoft Touch Mouse**

Curved Wireless Capacitive Sensor



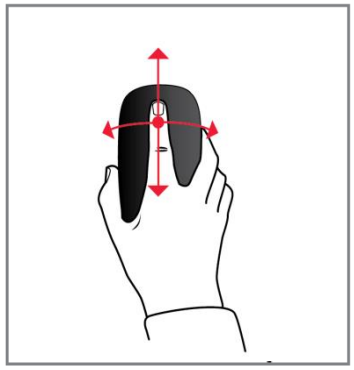
Gesture vocabulary

1 FINGER
Manage documents

2 FINGERS
Manage windows

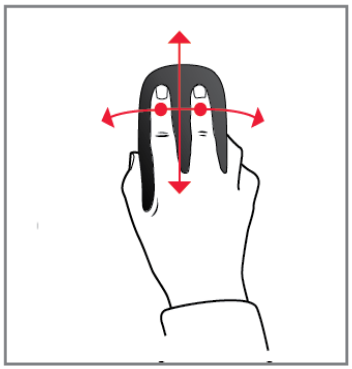
3 FINGERS
Manage desktop

Gesture vocabulary = 1,2,3



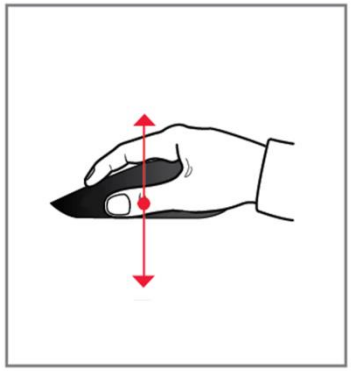
• **1 FINGER** = Manage document

Scroll, pan, and flick



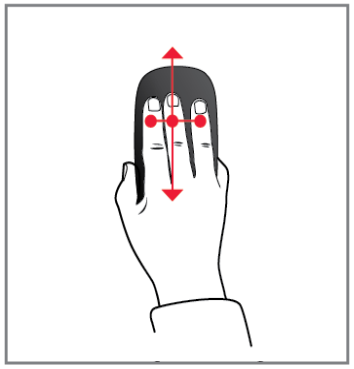
•• **2 FINGERS** = Manage windows

Maximize, minimize, restore, dock



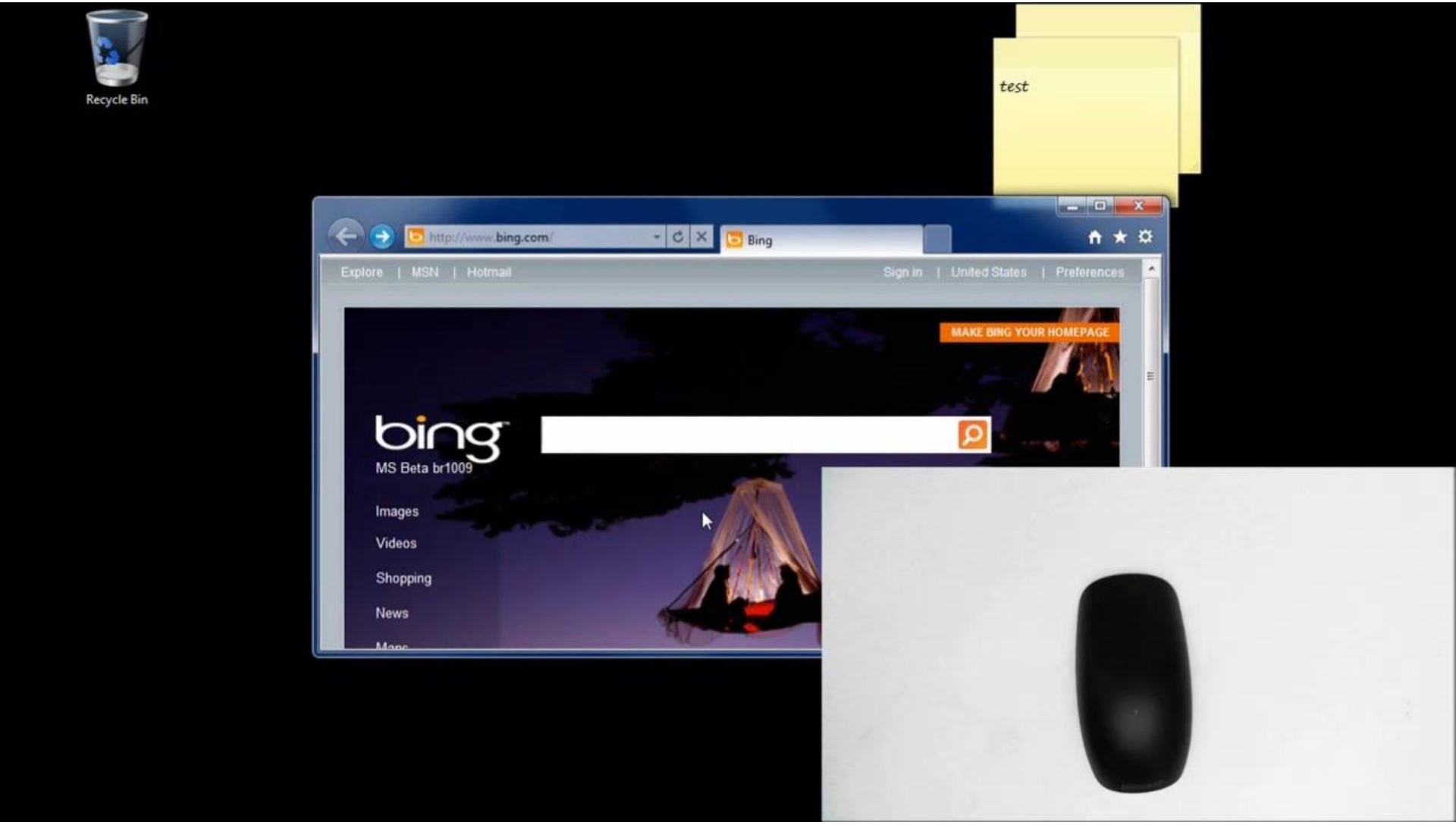
• **1 THUMB** = Manage documents

Page forward, back

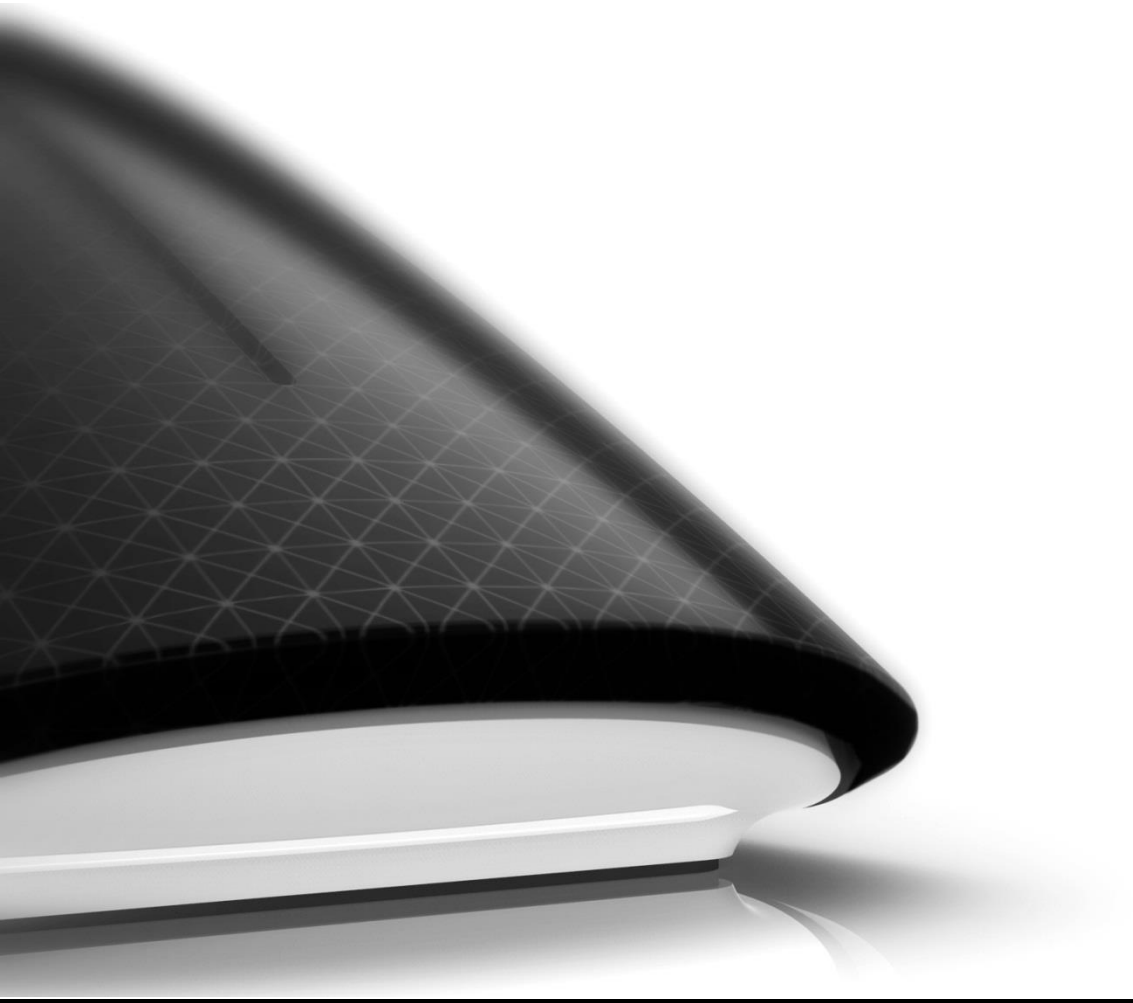


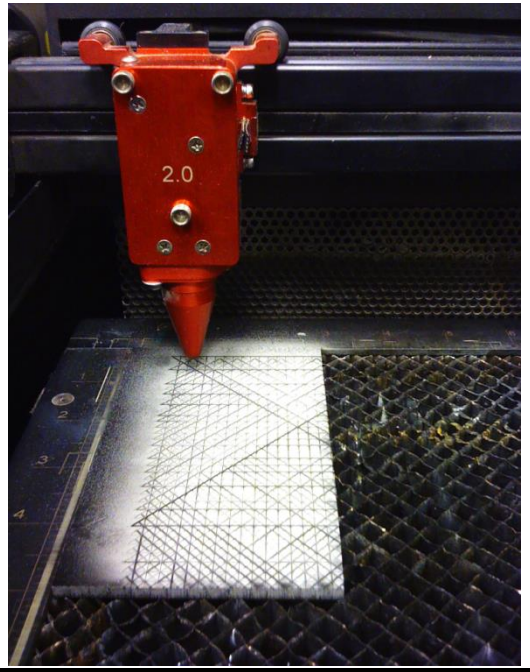
••• **3 FINGERS** = Manage desktop

Show desktop, show Instant Viewer


Recycle Bin
test
http://www.bing.com/
Bing
Explore | MSN | Hotmail
Sign in | United States | Preferences
MAKE BING YOUR HOMEPAGE
bing
MS Beta br1009
Images
Videos
Shopping
News

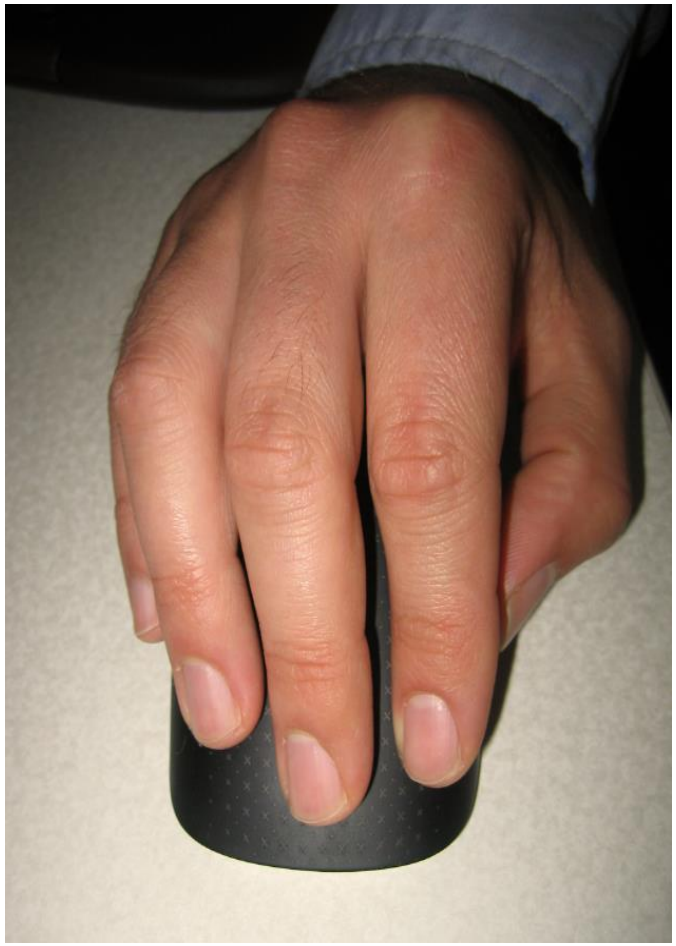
Color, material, finish

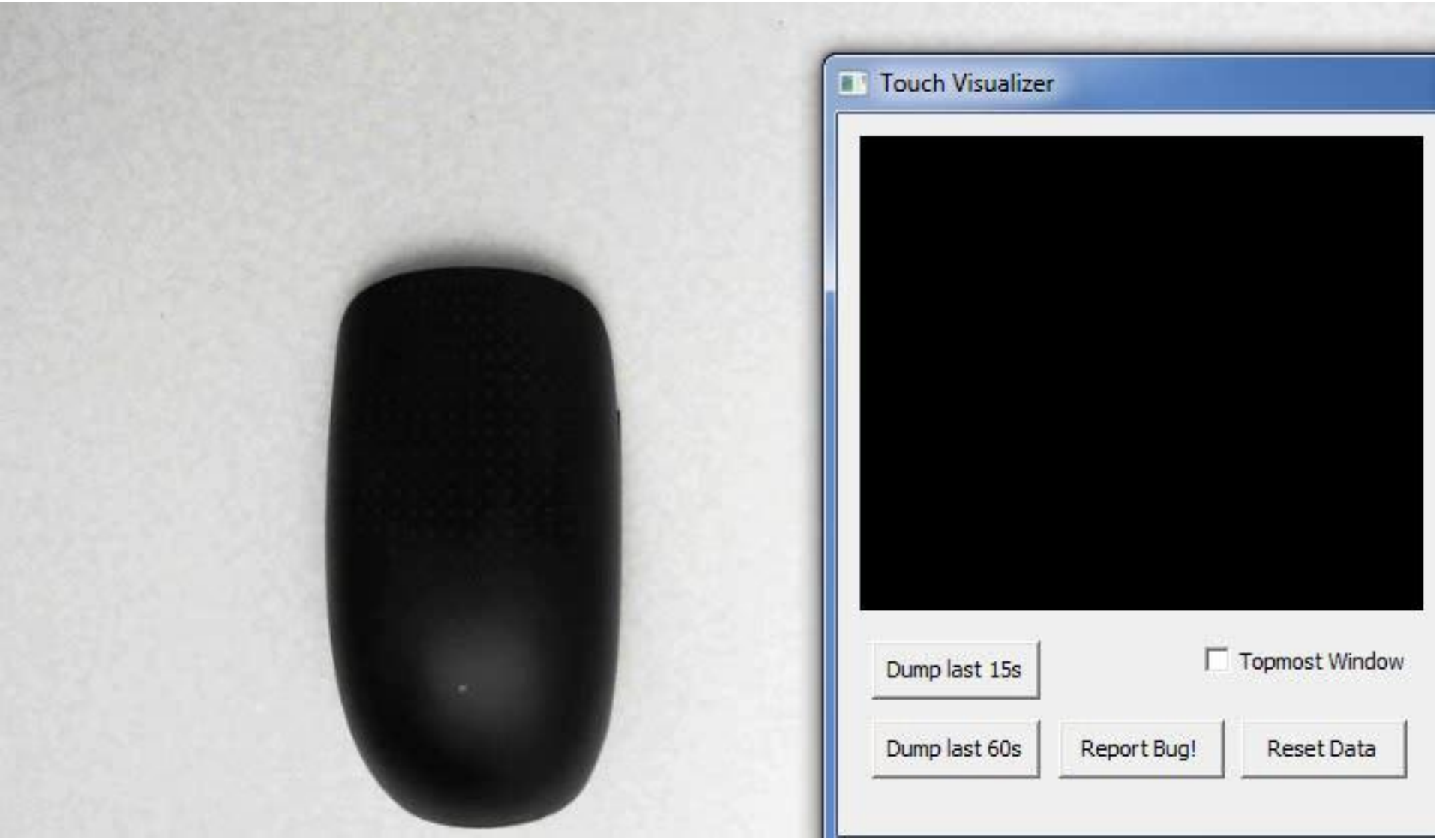




Reducing accidental activation

- Gesture recognition
- Contact tracking
- Understanding how the user holds the device




Touch Visualizer
Dump last 15s
Topmost Window
Dump last 60s
Report Bug!
Reset Data

engadget

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

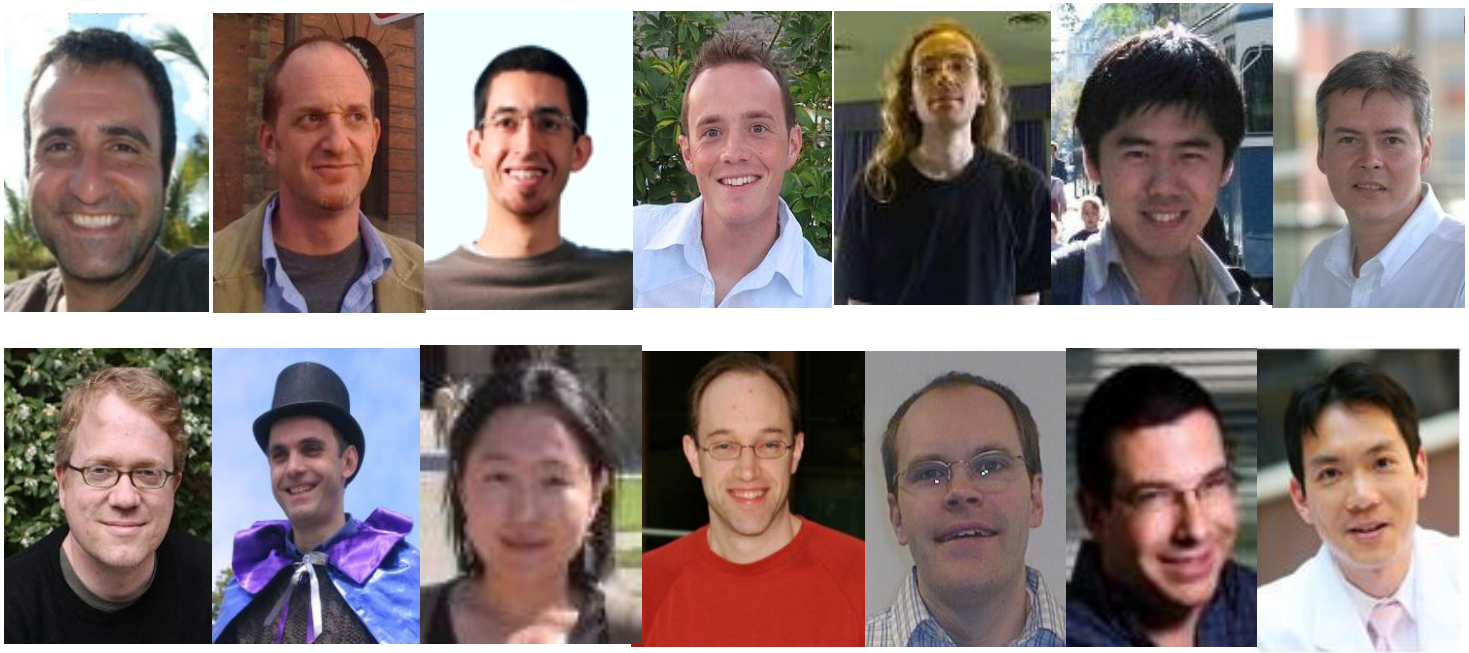
SUMMARY

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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http://research.microsoft.com/~benko