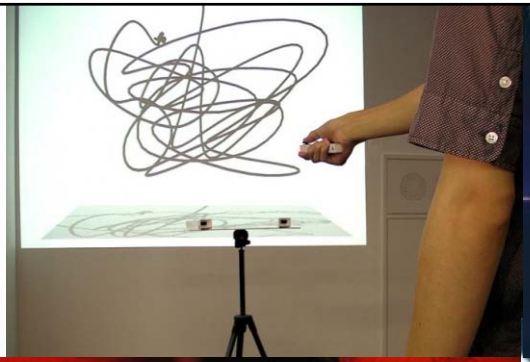
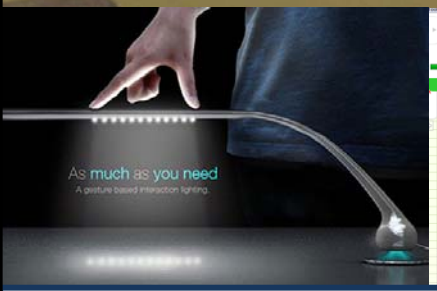
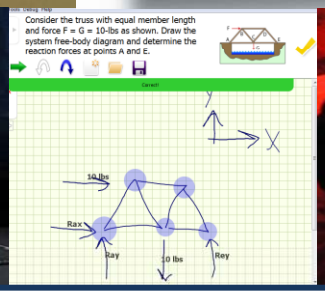
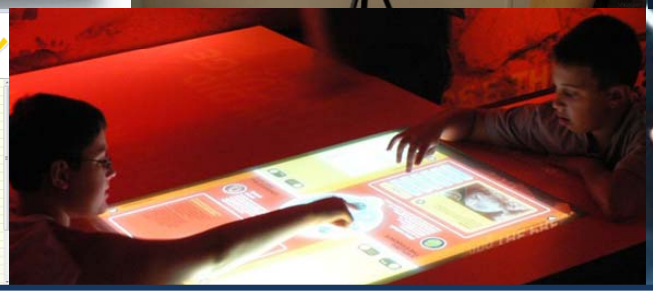



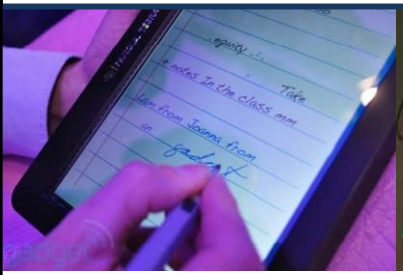
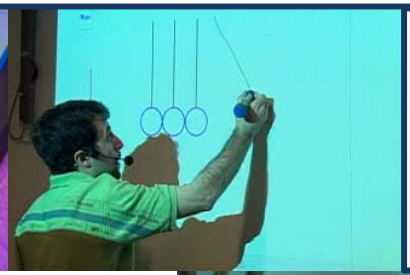







Gestural Technologies and Gesture Interaction



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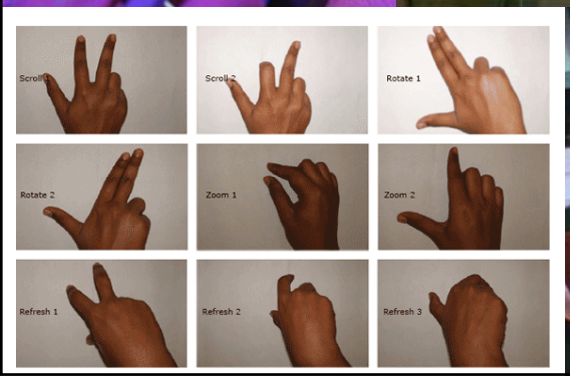




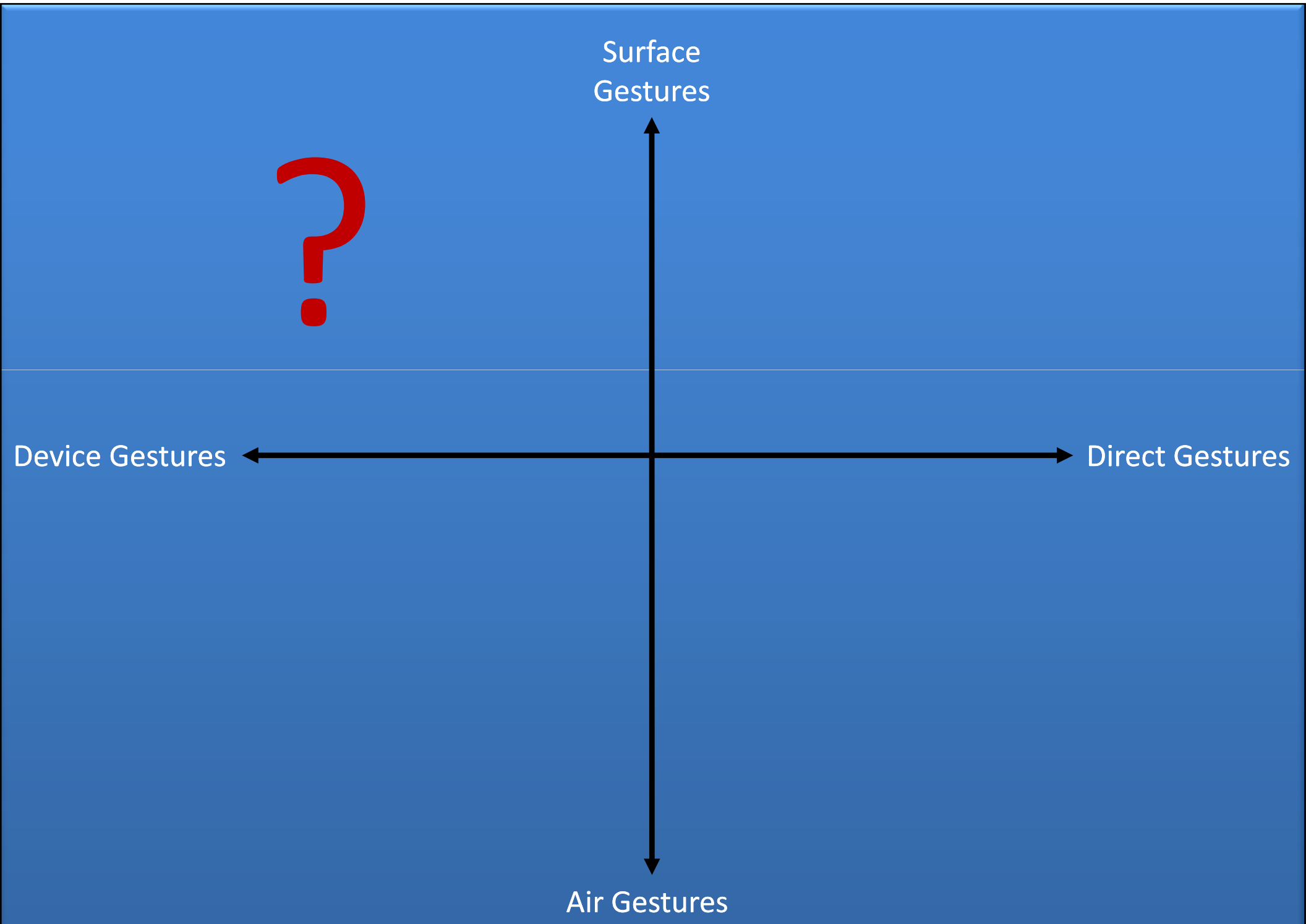
Plan for today

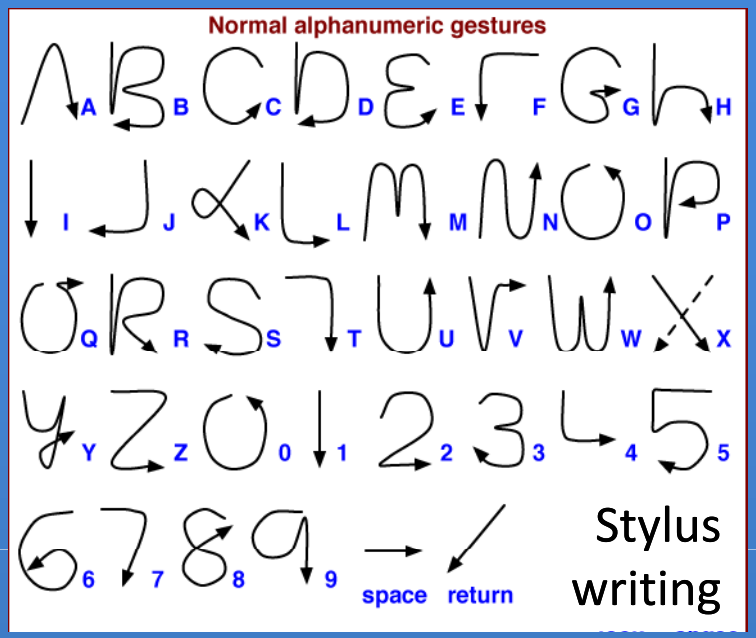
1. What are gestures?
2. Hardware
   - *Sensing gestures made by users*
3. Software
   - *Understanding gestures made by users*
4. Usability
   - *Interaction design concerns for gesture input*
5. Interaction Case Studies
   - *What works and what doesn't work for gesture interaction*
6. Remaining Challenges
   - *New frontiers in gestural technologies & gesture interaction*

1. WHAT DO WE MEAN BY "GESTURES"?

What do we mean by “gestures”?

…definitions? examples?


Surface Gestures
?
Device Gestures
Direct Gestures
Air Gestures



Stylus writing

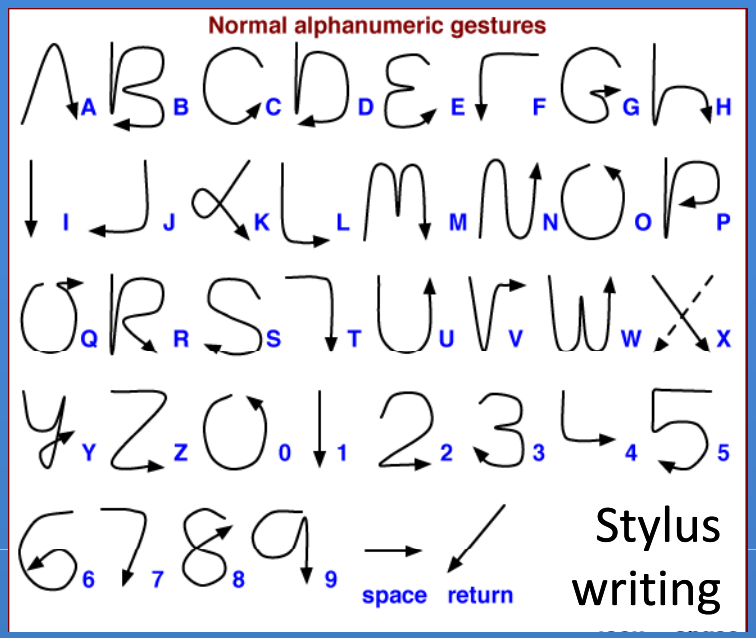
Surface Gestures

?

Device Gestures

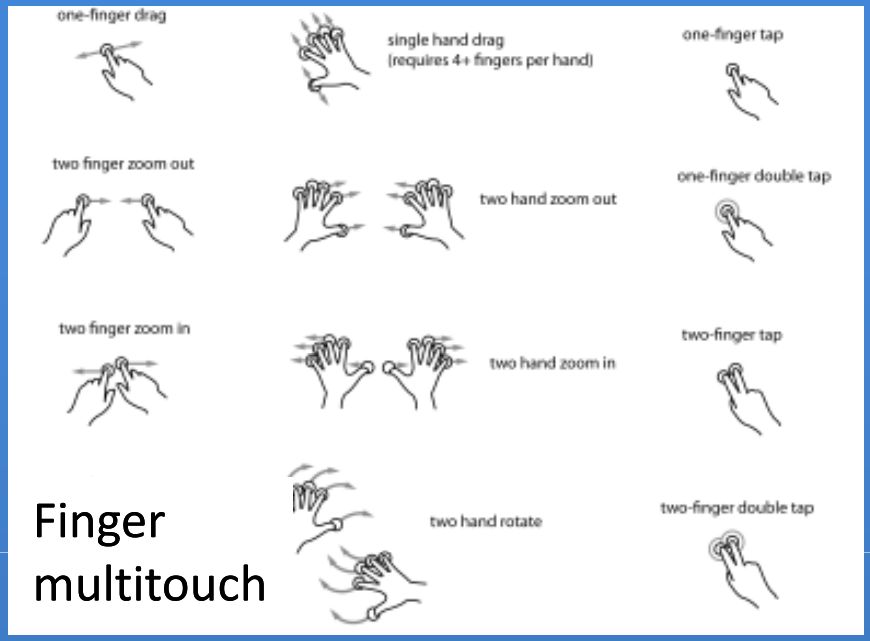
Direct Gestures

Air Gestures



Stylus writing

Surface Gestures



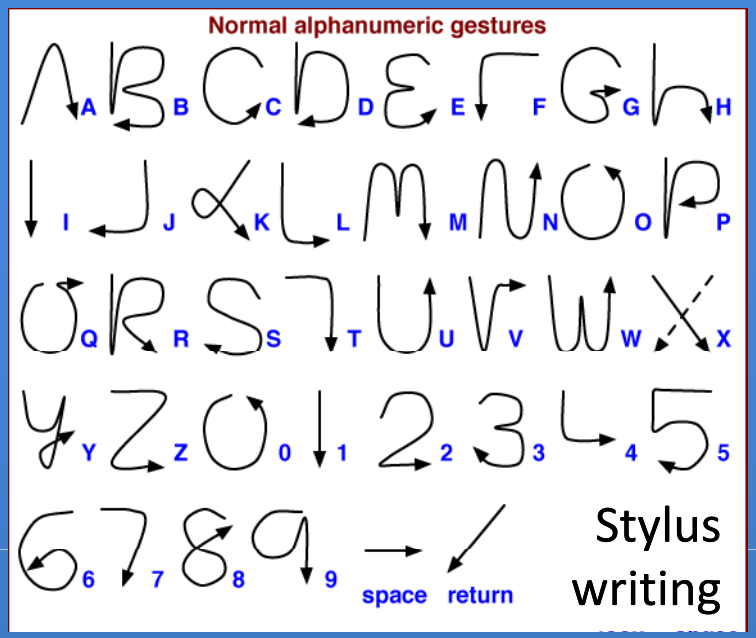
Finger multitouch

Device Gestures

Direct Gestures

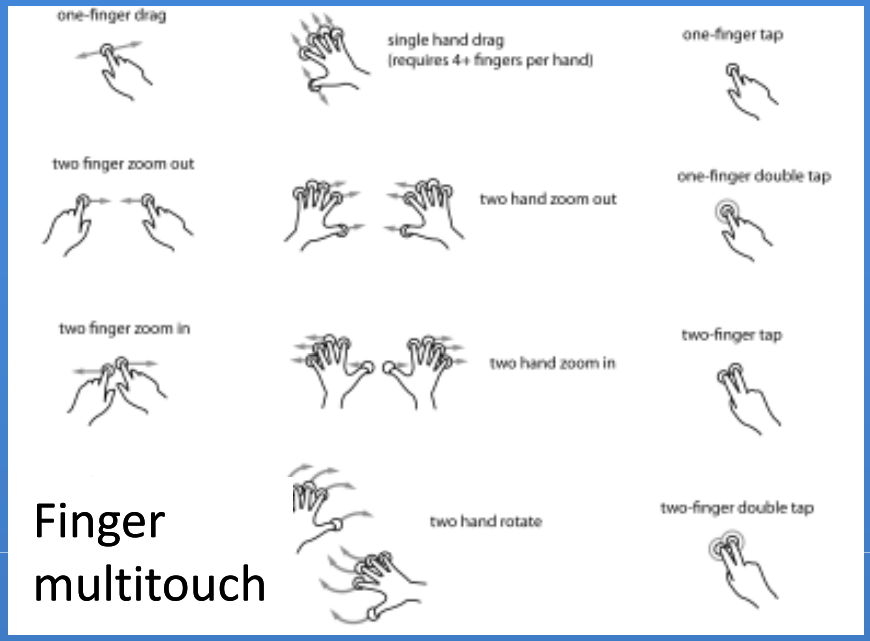
?

Air Gestures



Stylus writing

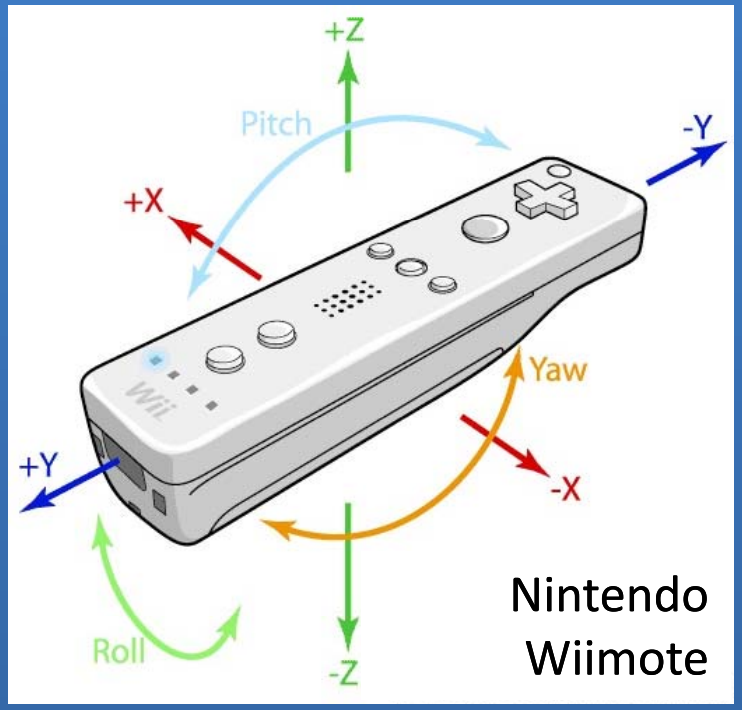
Surface Gestures



Finger multitouch

Device Gestures

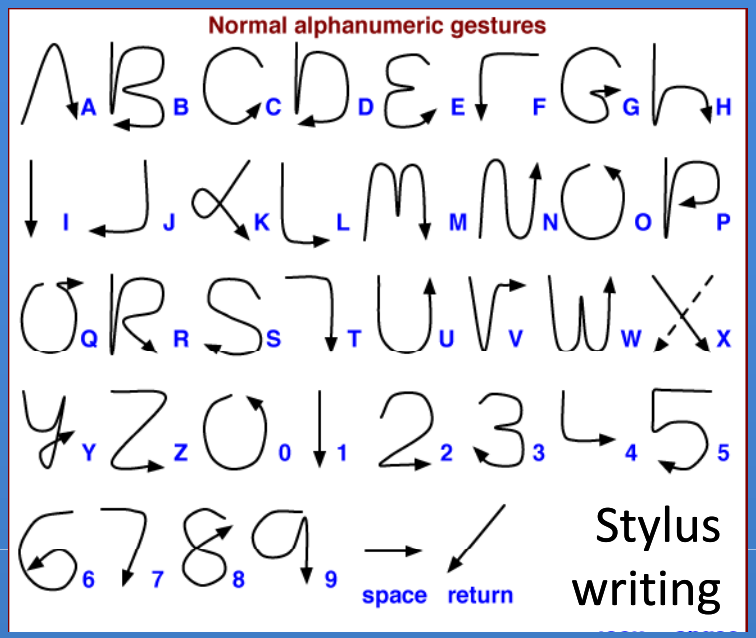
Direct Gestures



Nintendo Wiimote

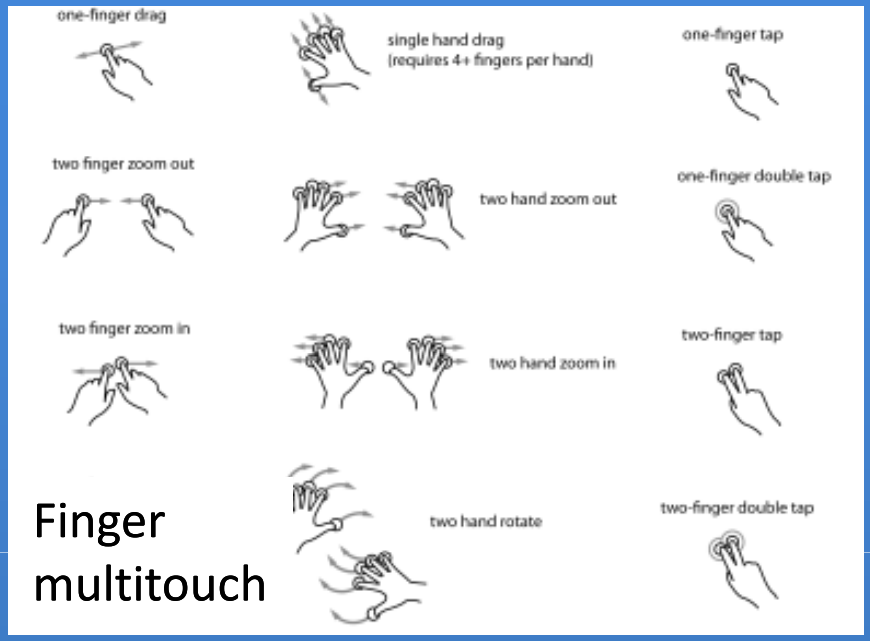
?

Air Gestures



Stylus writing

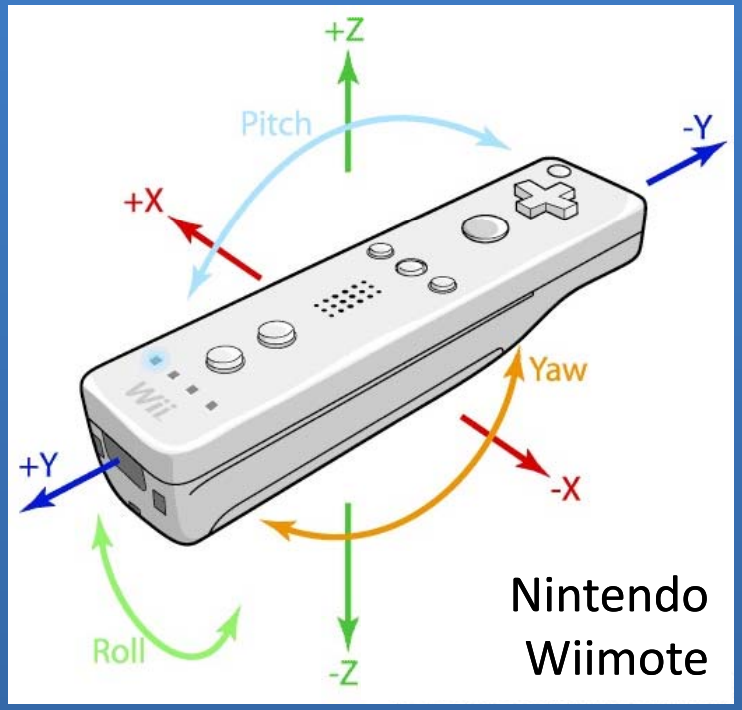
Surface Gestures



Finger multitouch

Device Gestures

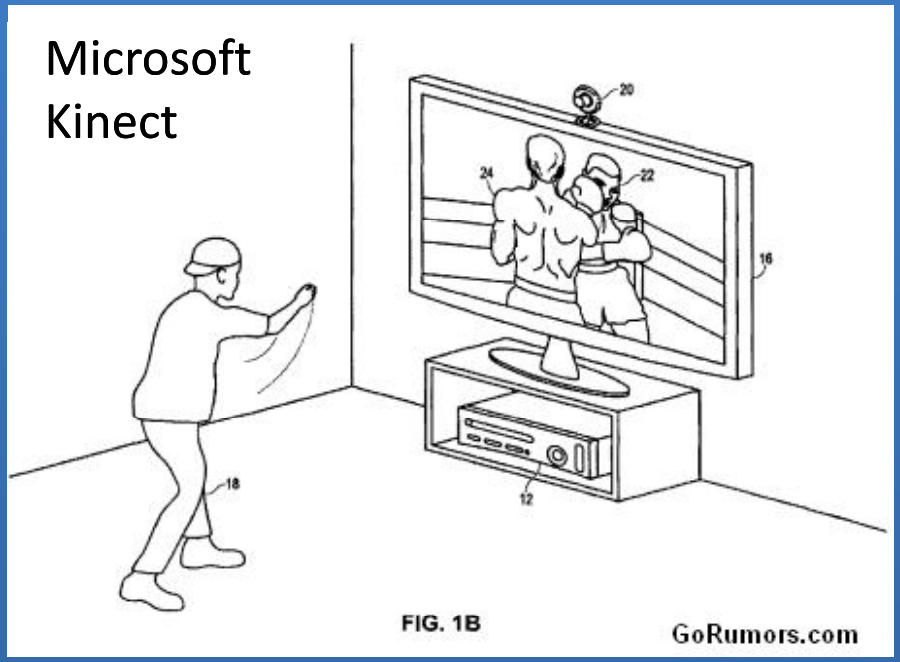
Direct Gestures

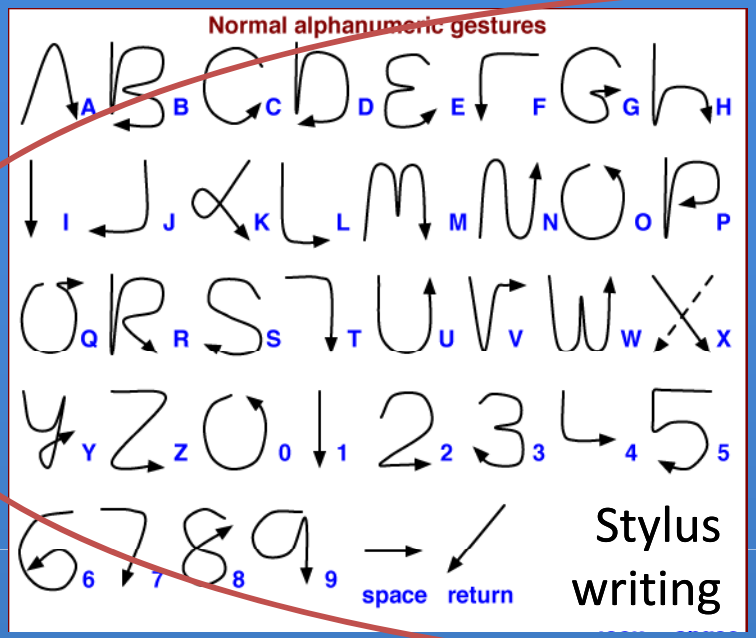


Nintendo Wiimote

Air Gestures

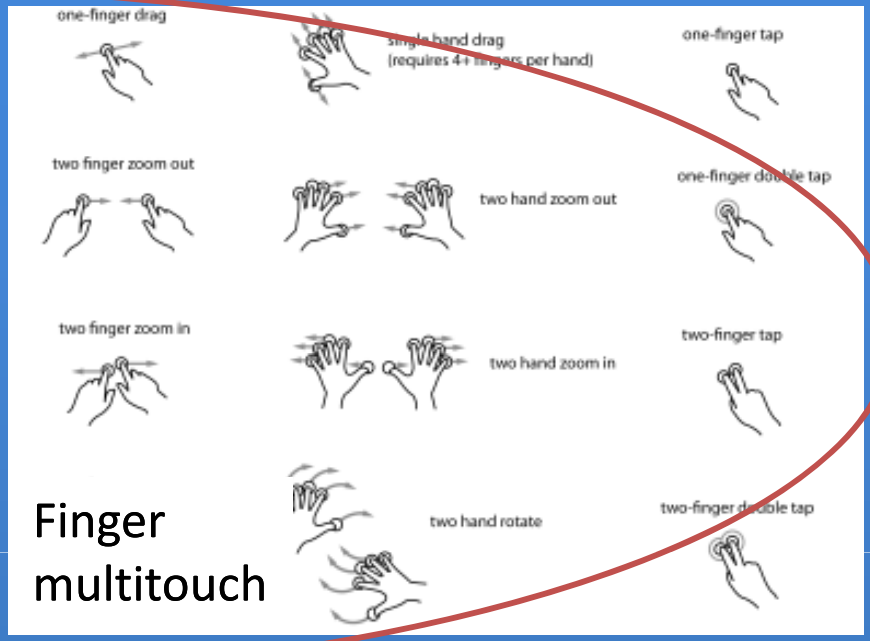
Microsoft Kinect





Stylus writing

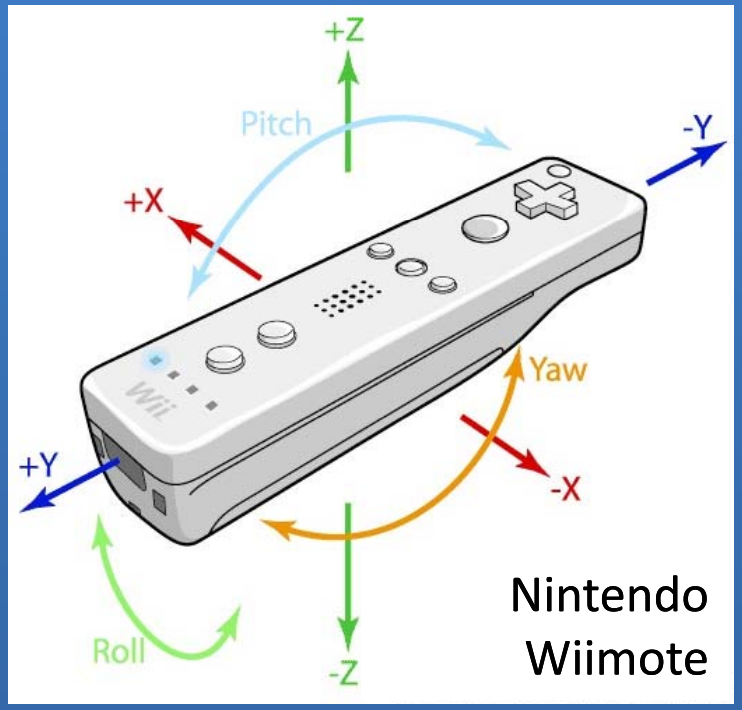
Surface Gestures



Finger multitouch

Device Gestures

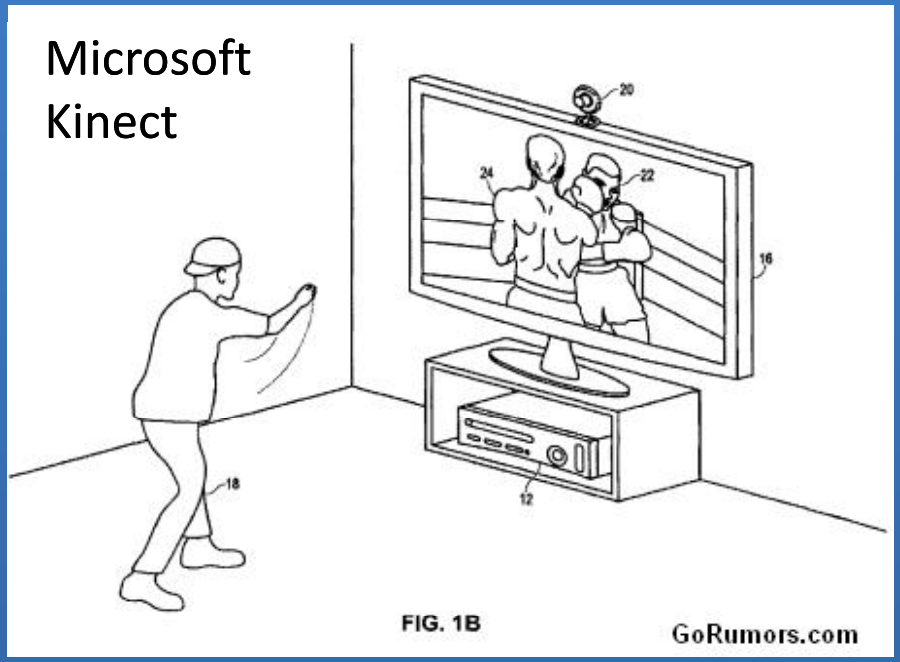
Direct Gestures



Nintendo Wiimote

Air Gestures

Microsoft Kinect



Sensing gestures made by users

2. HARDWARE

Types of sensing surfaces

Technology	How it works	Accepted input devices	Real-world examples
Capacitive touchscreen	Conductive material; when touched by human finger (a conductor), electrostatic field is distorted measurably.	Finger, active stylus	iPhone, iPod, iPad
Resistive touchscreen	Two layers of material; when touched, they press together and location of touch is registered by gridlines on material.	Finger, passive stylus, whole hand	LG Optimus, Nokia N97
Surface acoustic wave	Sound waves are passed along surface of material; when touched, sound waves are distorted measurably.	Finger, active / passive stylus	ATMs, public kiosks
Infrared / optical imaging	Grid of LED beams are projected over surface; breaks in the beams correspond to touch locations.	Finger, active / passive stylus	Microsoft Surface

(surface gestures only; other approaches also exist but these are the most common)

Understanding gestures made by users

3. SOFTWARE

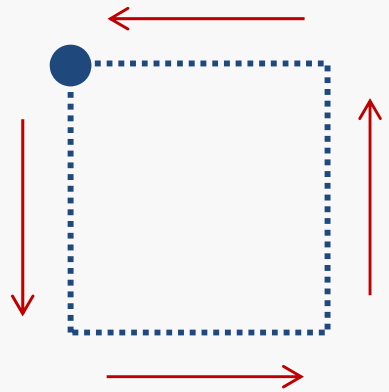
Capturing surface gesture input

Input events are series of (X, Y) coordinates

- Sometimes time or pressure can also be sensed for each point

Stroke = {Pen Down, $Point_1$, … $Point_n$, Pen Up}

Language	Listeners	Events
Java	MouseListener: MousePressed, MouseDragged, MouseReleased	MouseEvent {MOUSE_PRESSED, MOUSE_DRAGGED, MOUSE_RELEASED}
C#	System.Windows.Forms.MouseEvent Handler: MouseDown, MouseMove, MouseUp	MouseEventArgs
Android	View.OnTouchListener.OnTouch	MotionEvent {ACTION_DOWN, ACTION_MOVE, ACTION_UP}



Approaches to gesture recognition

Situational approaches

Online vs. offline

Unistroke vs. multistroke

Segmented vs. free-form

Trainable model vs. fixed model

Mixed model vs. single model

Size of vocabulary

Algorithmic approaches

Machine learning

- Finite state machines
- Hidden Markov Models (HMMs)
- Neural networks
- Statistical classifiers

Dynamic programming

Template matching

Heuristic recognizers

$1 and $N recognizers

(Anthony & Wobbrock, 2010)

Template matchers

$1: unistroke, $N: multistroke

Open-source (C#, Java, more)

Figure 2. Steps in the $1 matching process and the aligning of a candidate and template. GSS means *Golden Section Search*.

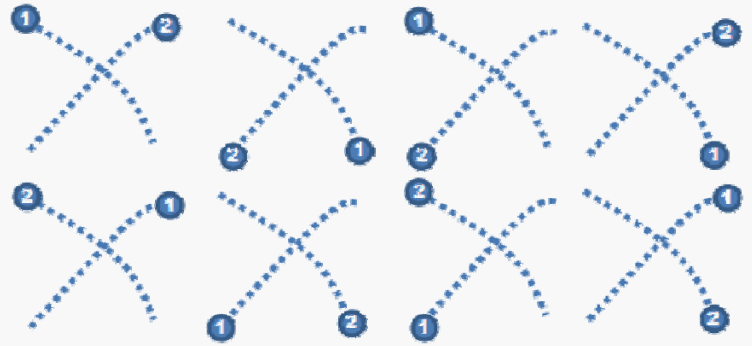


Figure 3. The 8 possibilities for a two-stroke "x". The numbered dots indicate stroke order and beginnings.

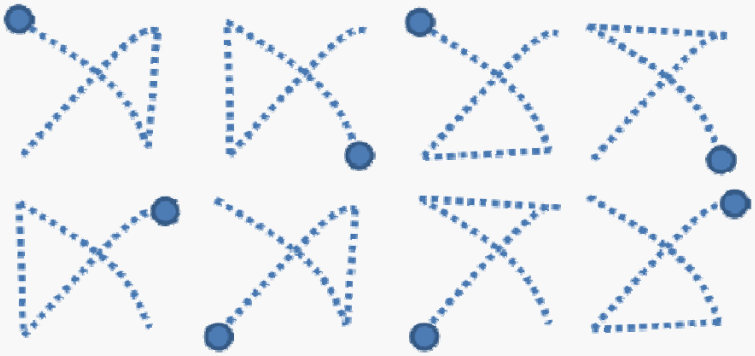


Figure 4. The 8 unistroke permutations for a two-stroke "x" based on the two-stroke gestures in Figure 3.

(how $N represents multistrokes)

Improving recognition accuracy

Limited vocabulary set

Boxed character entry

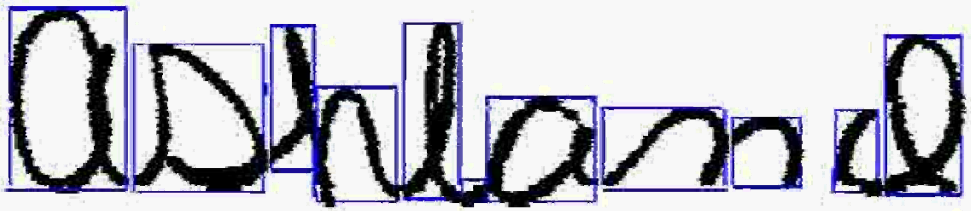
User-specific training examples

Use of context (domain-specific)

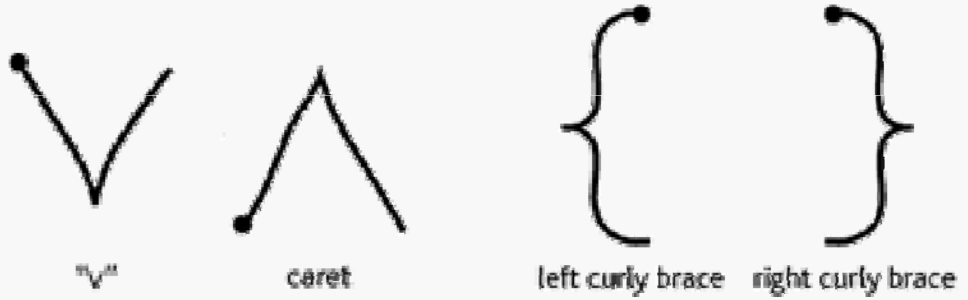
…others?

Recognition challenges

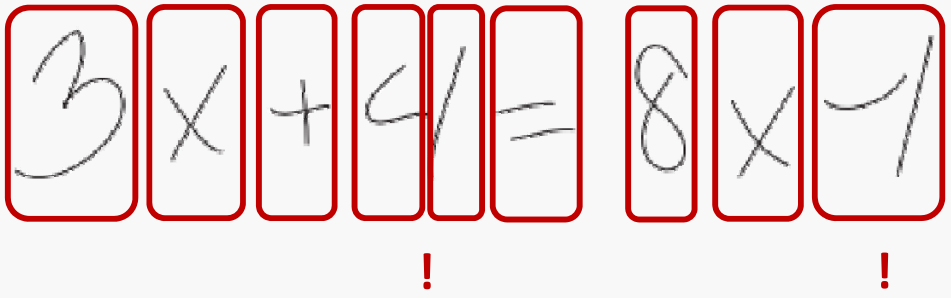
Segmentation: Overlapping symbols



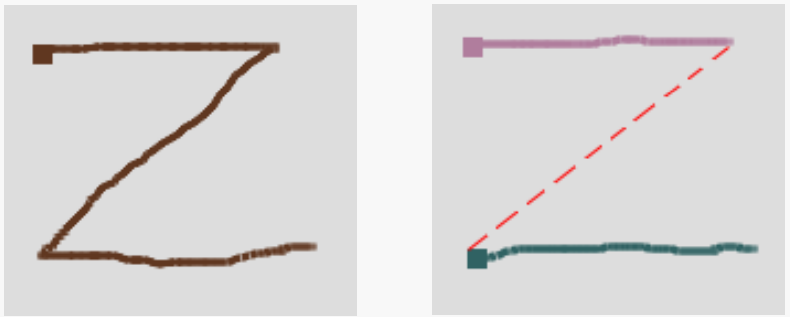
Orientation of symbols



Segmentation: Multistroke symbols



Confusable symbols



Operating system integration

Google Android open-source toolkit (Li, 2009)

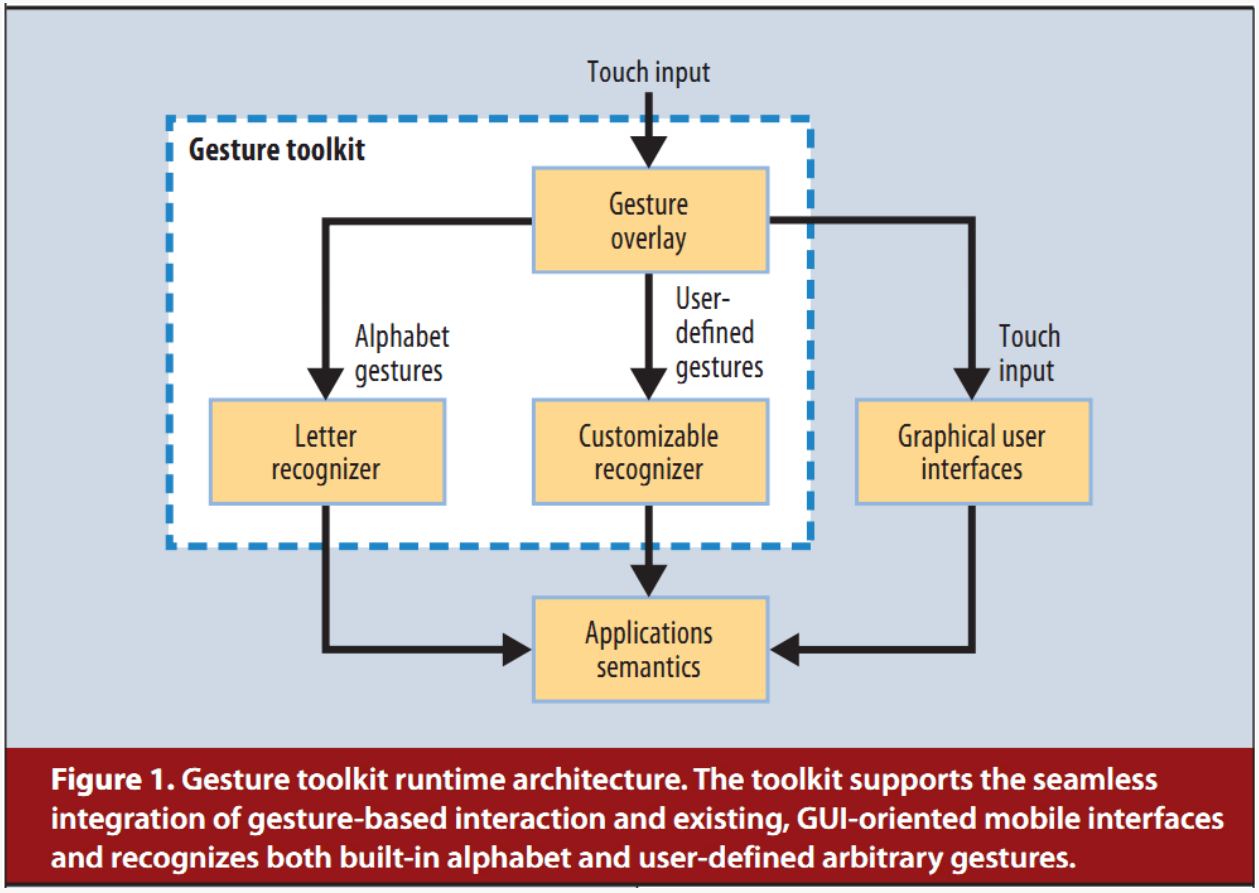


Figure 1. Gesture toolkit runtime architecture. The toolkit supports the seamless integration of gesture-based interaction and existing, GUI-oriented mobile interfaces and recognizes both built-in alphabet and user-defined arbitrary gestures.

Interaction design concerns for gesture input

4. USABILITY

Usability and interaction concerns

…ideas?

Deciding what gestures to support

(Morris et al, 2010)

Application specific vs. platform / interaction standards

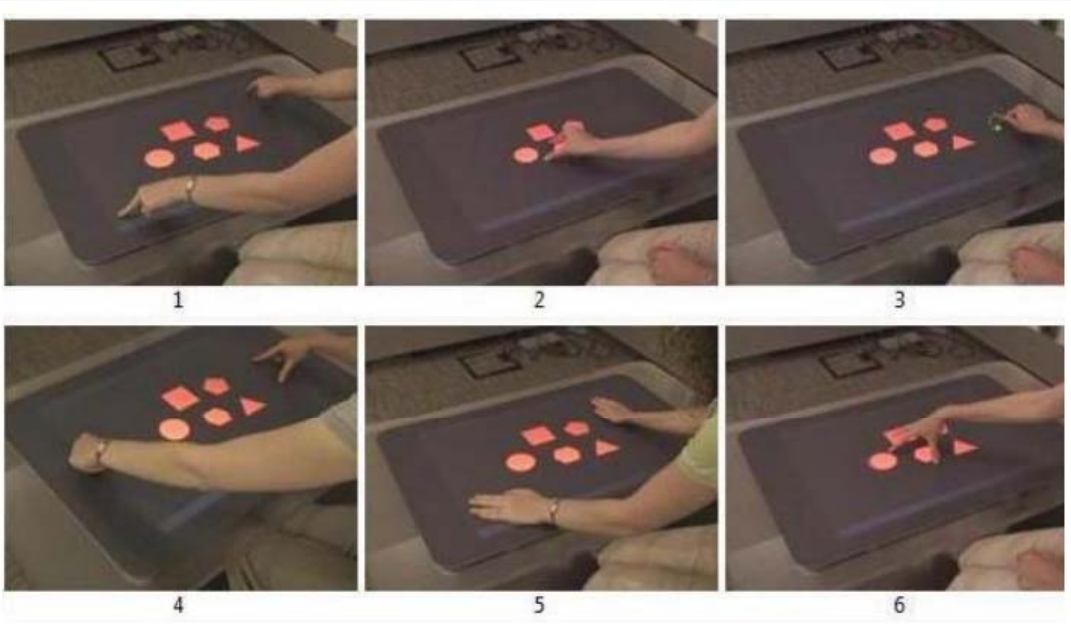
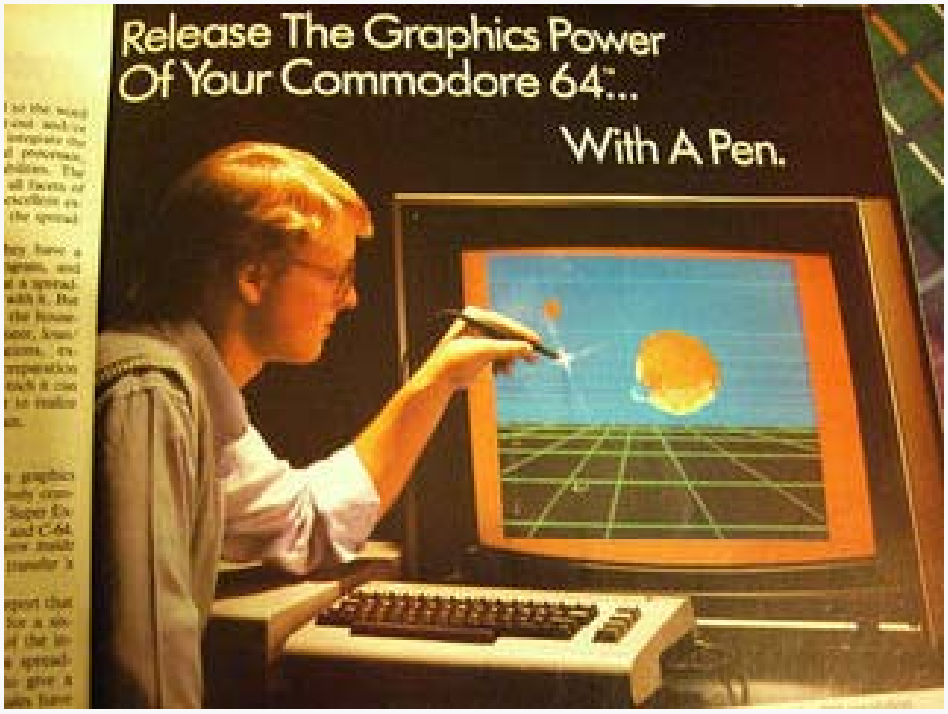


Figure 2. After viewing, imitating, and rating all of the gestures for a particular command, participants were presented a screen of thumbnail images depicting each of the proposed gestures, and were asked to select which one was the best for that command. This figure depicts the six alternatives shown for "zoom out." Any gesture could be replayed at this stage.

Ergonomics and comfort

…issues with long-term use of surface, air gestures?

…how is gesture interaction different than using a keyboard and mouse?



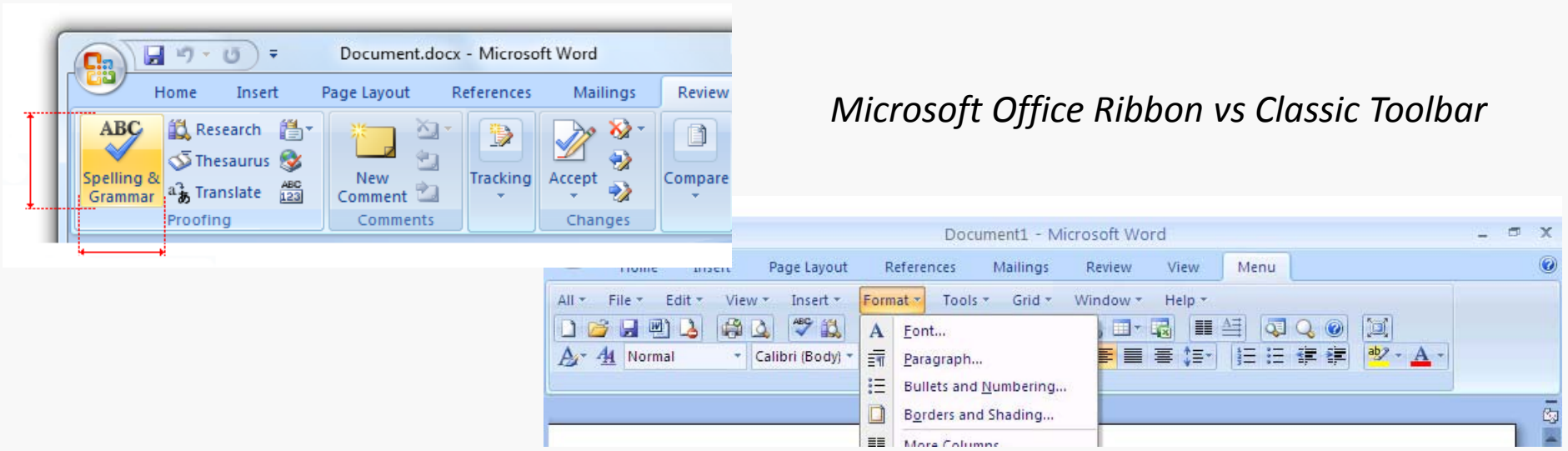
Beware the dreaded gorilla arm!

Precision and touch point size

Stylus vs. finger use affects desired size of interactors

Recommendations on touch point size differ by platform:

- Apple: 44 pixels x 44 pixels (164ppi)
- Windows Phone: 9 mm x 7 mm
- Nokia: 1 cm x 1cm

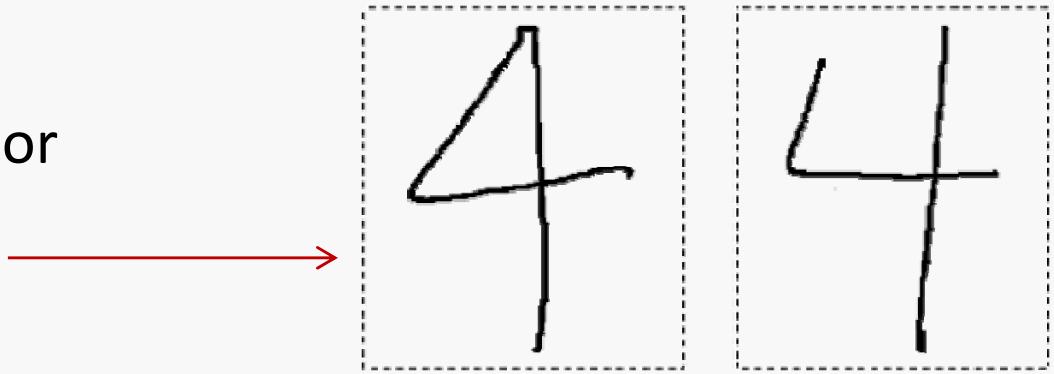


Microsoft Office Ribbon vs Classic Toolbar

Recognition tolerance and errors

Gesture input tolerance:

- Size, orientation, speed, tremor
- Multiple styles for symbols



Gesture delimitation:

- How do you know the user is making a gesture vs. just moving their arms?
- Mode switching, hardware buttons, special gestures, returning to "home" position…others?

Error recovery:

- How much should we ask the user to help correct system input?
- Depends on context, e.g., students learning math vs. mathematicians

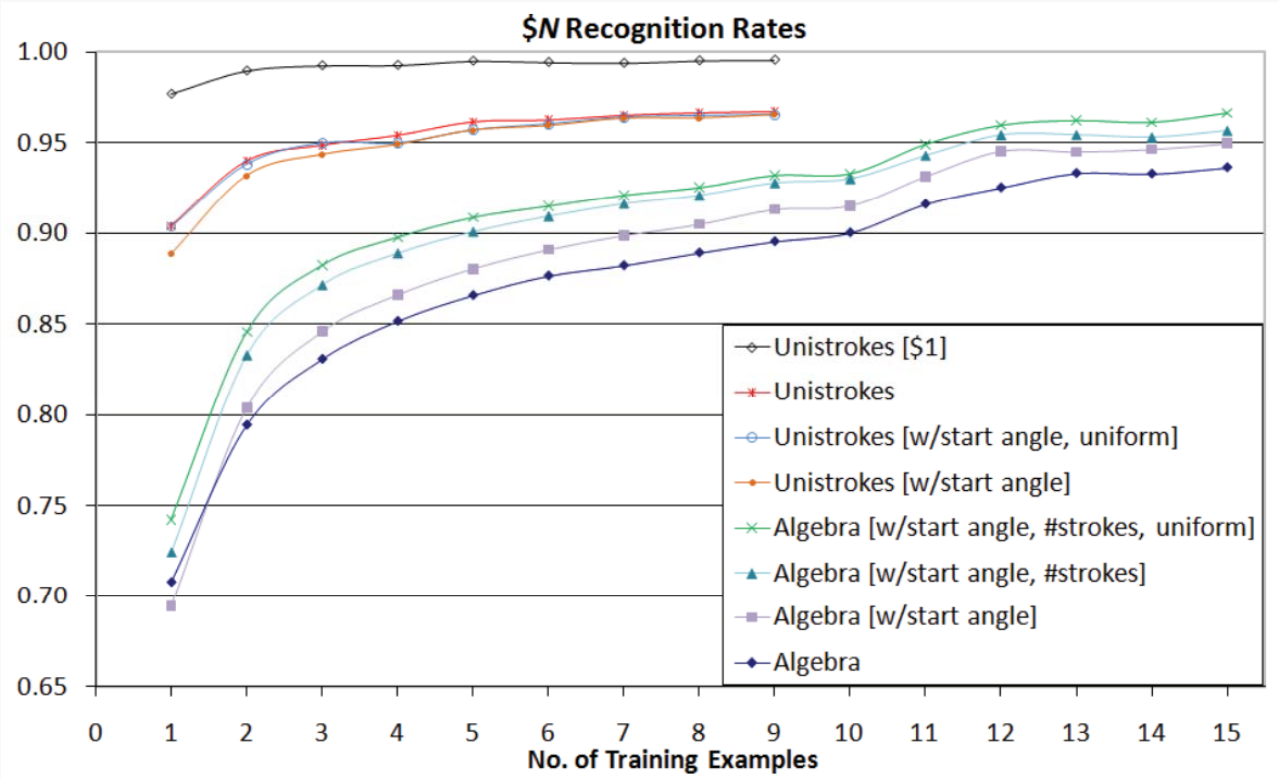
Gesture recognition feedback

Method	When would you use it?	When would you not use it?
Immediately after receiving single stroke (**eager**)		
Recognition in background, waiting for enough information (**lazy**)		
Upon **user request** (e.g., tap, special gesture, menu item)		
Never (e.g., store raw strokes only)		

To train or not to train?

User-dependent vs. user-independent

When to collect data to train the gesture recognizer?



$N recognition rates with more training examples (Anthony & Wobbrock, 2010)

What works and what doesn't work for gesture interaction

5. INTERACTION CASE STUDIES

Minority Report demonstration

1. Type of gesture input:
   - Surface / Air
   - Device / Direct
2. Pros:
3. Cons:
4. Other comments:

http://www.youtube.com/watch?v=NwVBzx0LMNQ

Air Guitar Hero demonstration

1. Type of gesture input:
   - Surface / Air
   - Device / Direct
2. Pros:
3. Cons:
4. Other comments:

http://www.youtube.com/watch?v=pktVSTwC8qo

Hands-on Math demonstration

1. Type of gesture input:
   - Surface / Air
   - Device / Direct
2. Pros:
3. Cons:
4. Other comments:

http://www.acm.org/uist/archive/videos/2010/p17-zeleznik.wmv

Double Flip demonstration

1. Type of gesture input:
   - Surface / Air
   - Device / Direct
2. Pros:
3. Cons:
4. Other comments:

http://www.youtube.com/watch?v=NuN_d-DiAKs

Iron Man demonstration

1. Type of gesture input:
   - Surface / Air
   - Device / Direct
2. Pros:
3. Cons:
4. Other comments:

http://www.youtube.com/watch?v=PYjlMflhysc

Mouse Gestures demonstration

1. Type of gesture input:
   - Surface / Air
   - Device / Direct
2. Pros:
3. Cons:
4. Other comments:

http://www.youtube.com/watch?v=WUYyCituz_U

Kinect Sign Language demonstration

1. Type of gesture input:
   - Surface / Air
   - Device / Direct
2. Pros:
3. Cons:
4. Other comments:

http://www.youtube.com/watch?v=qFH5rSzmgFE

New frontiers in gestural technologies and gesture recognition

6. REMAINING CHALLENGES

Remaining Challenges

…ideas about the future of gesture interaction?

Combining gestural technologies

(Hinckley et al, 2010)

Design considerations:

- Pen vs Touch
- Differentiated vs Interchangeable task assignment
- Nonpreferred vs Preferred hand assignment
- Unimodal vs Multimodal input
- Mobile vs Stationary use
- Unimanual vs Bimanual interaction
- Interleaved vs Simultaneous input
- Ink vs Command mode
- Elementary input vs Phrases

"Pen writes, touch manipulates"

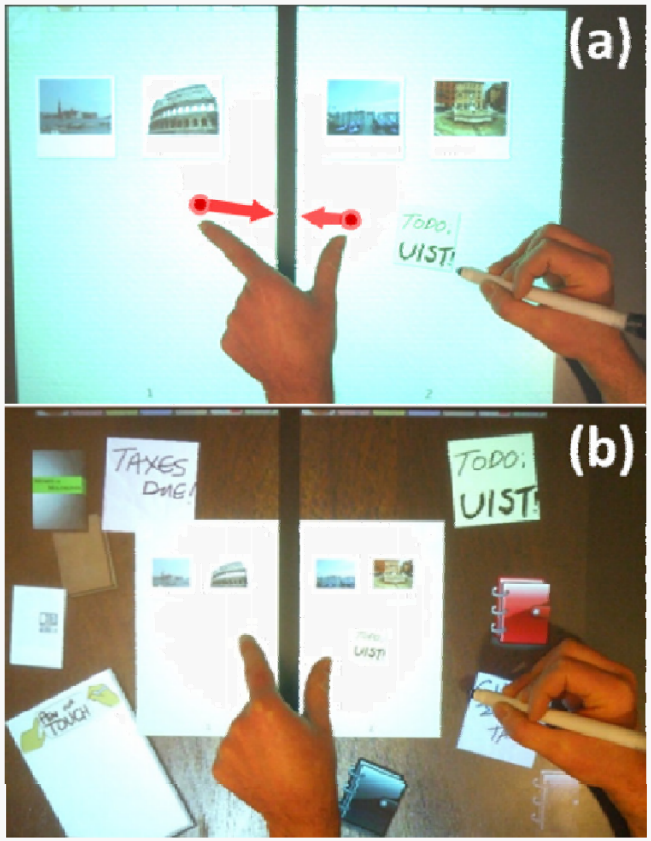


Fig. 11. Pinching across the pages in 2-up view supports semantic zooming to the "desk view" extended workspace.

New tools and workflow enhancements are possible

Questions?

Contact:

- Lisa Anthony, PhD
- lanthony@umbc.edu

Resources:

- Buxton, Bill. (2011). “Some Milestones in Computer Input Devices: An Informal Timeline.” http://billbuxton.com/inputTimeline.html
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- Yang Li. (2009). "Beyond Pinch and Flick: Enriching Mobile Gesture Interaction." IEEE Computer 42, 12 (December 2009), pp. 87-89.
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- Hinckley, K., Yatani, K., Pahud, M., Coddington, N., Rodenhouse, J., Wilson, A., Benko, H. & Buxton, B. (2010). Pen + Touch = New Tools. Proceedings of the 23nd annual ACM symposium on User interface software and technology (UIST'10), 27-36.