

Input

Managing text and positional input

iPod Wheel



Macbook Wheel (The Onion)



<http://www.youtube.com/watch?v=9BnLbv6QYcA>

Classifying Computer Input

Sensing Method

- mechanical (e.g., switch, potentiometer)
- motion (e.g., accelerometer, gyroscope)
- contact (e.g., capacitive touch, pressure sensor)
- signal processing (e.g., computer vision, audio)

Continuous vs. Discrete

Degrees of Freedom (DOF)



Specific vs. General Device

Specific input devices are optimized for specific tasks

- Problems?

General input devices adapted to many task

- Problems?

Input typically focuses on two specific tasks: Text input and spatial input

- Smartphones/tablets support different forms of interaction, but still need to handle the same types of input (e.g. text, activating widgets)



Text Input

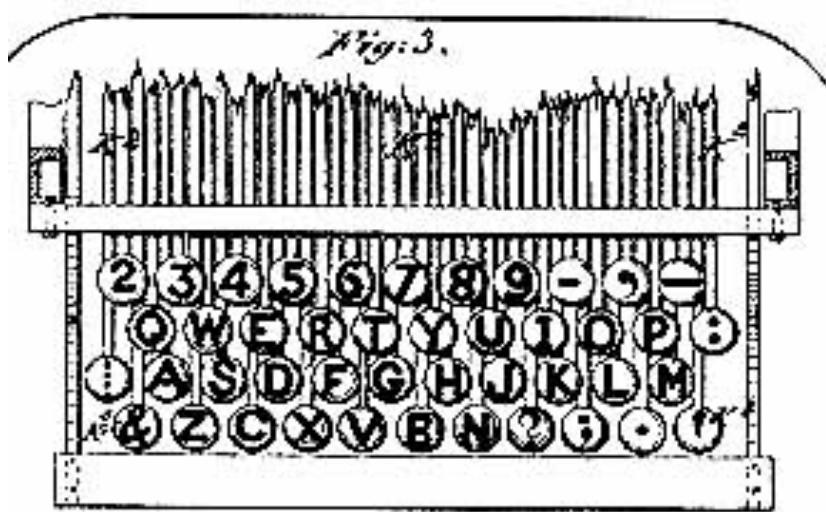
QWERTY, keyboard variants, mobile text entry



Typewriters and Qwerty

Origin of QWERTY keyboard

- QWERTY is designed to space “typebars” to reduce jams and speed typing up, and *not* designed to slow typists down.



1874 QWERTY patent drawing



Remington Mode I (1867)

<http://www.daskeyboard.com>

Perceived Qwerty Problems

Intuitively, the most optimal way to type is with your hands positioned over “home row”, to minimize hand and finger movement.

QWERTY is *perceived* to violate this principle:

- Many common letter combinations
 - require awkward finger motions (e.g., tr)
 - require a finger to jump over the home row (e.g., br)
 - are typed with one hand (e.g., was, were)
- Most typing is done with the left hand, which for most people is the weaker hand.
- About 16% of typing is done on the lower row, 52% on the top row and only 32% on the home row.



Dvorak

Alternative layout for two-handed keyboard

Dvorak



Qwerty



Dvorak Corrections

- Letters should be typed by alternating between hands
- For maximum speed and efficiency, the most common letters and digraphs should be the easiest to type. Thus, about 70% of keyboard strokes are on home row.
- The least common letters should be on the bottom row, which is the hardest row to reach.
- The right hand should do more of the typing, because most people are right-handed.



Qwerty vs Dvorak

Corrections?

- Problems are frequently perceived versus actual, and are based on a naïve model of typing
- Example: When you leave the home row, it can be good to stay off the home row

Speed differences?

- Sometimes one faster, sometimes the other faster, majority of the time no difference
- If you know anything about science, this exactly implies that there is no discernible difference, and it is very highly probable that there is no difference at all

<http://home.earthlink.net/~dcrehr/whyqwert.html>



August Dvorak

Speed is not the only (or even the most important) factor in selecting a keyboard layout.

- Standardized layouts offer additional benefits (approachability)

Mechanical Design of Keyboards

- To increase portability of devices, keyboards are frequently downsized
 - low-profile keys, smaller keys
- All interfere with typing
- Much more significant problem than Dvorak vs Qwerty keyboards



Soft / Virtual Keyboards

Many ergonomic problems

- Feedback, resting of hands significantly compromised

However,

- improves the aesthetics of device,
- reduces thickness, size, and weight,
- increases usable screen space.

Good option ...

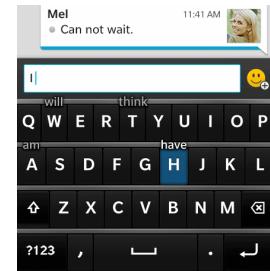
- when input can be significantly limited (e.g. mobile device, iPad used as a media consumption device)

Bad option...

- if device requires frequent text input (e.g. touch-typing on an iPad, or using a Surface Pro - buy the type cover!)



iPhone



z10



iPad



Virtual Keyboard

Keyboard Variants

Thumb keyboards

- Virtual (ultra-mobile PC c. 2006)
- Surface Pro soft keyboard
- iPad split keyboard



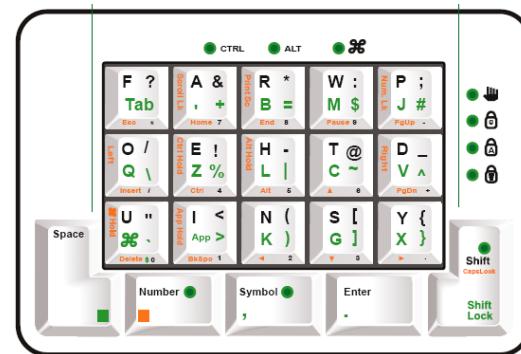
UMPC thumb keyboard



iPad thumb keyboard

One-handed keyboards

- Frogpad
- Hold down space to shift hands



frogpad

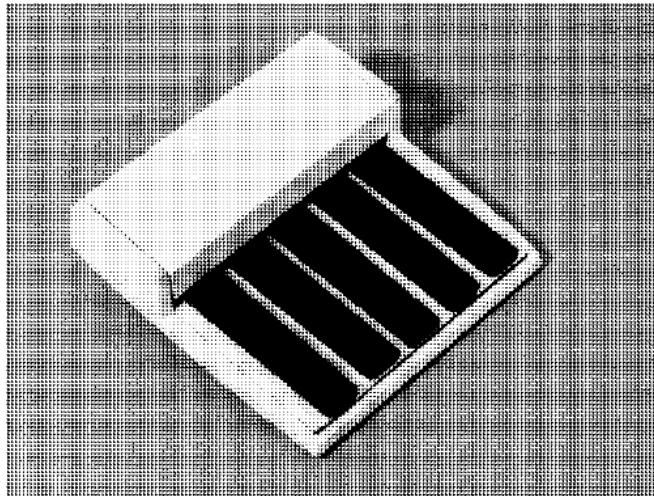
Chording Keyboards

Englebart's NLS Keyboard

- Multiple keys together produce letter
- Very fast -- no targeting

Thad Starner's Twiddler

- For wearable computing input



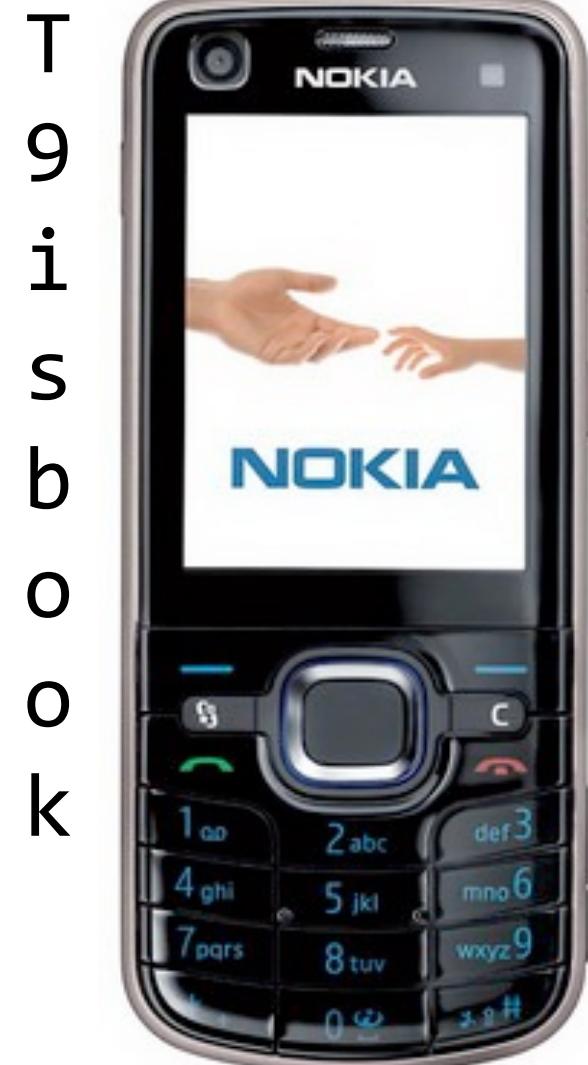
Alt. Predictive Text

Use characteristics of language to speed task

- Given characters typed so far, what letters are most likely to be next?
- Given characters typed so far, what could the word be?

Examples

- T9 input
- Soft keyboard Error Correction



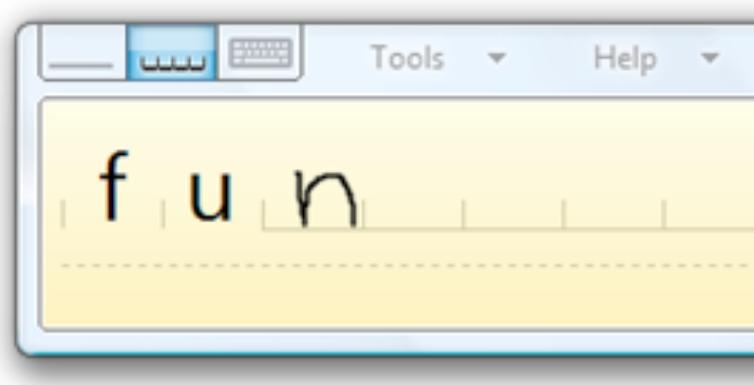
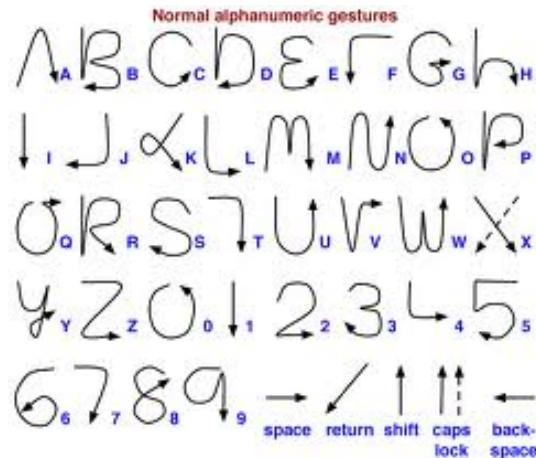
Alt. Gestures & Text Recognition

Graffiti / Unistroke Gestures

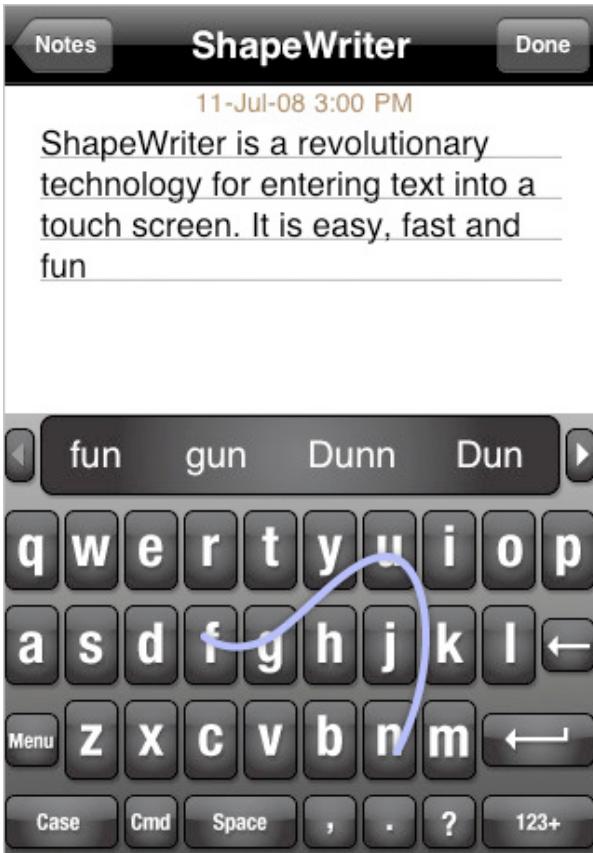
- Map single strokes to “enter letter” commands

Natural Handwriting recognition

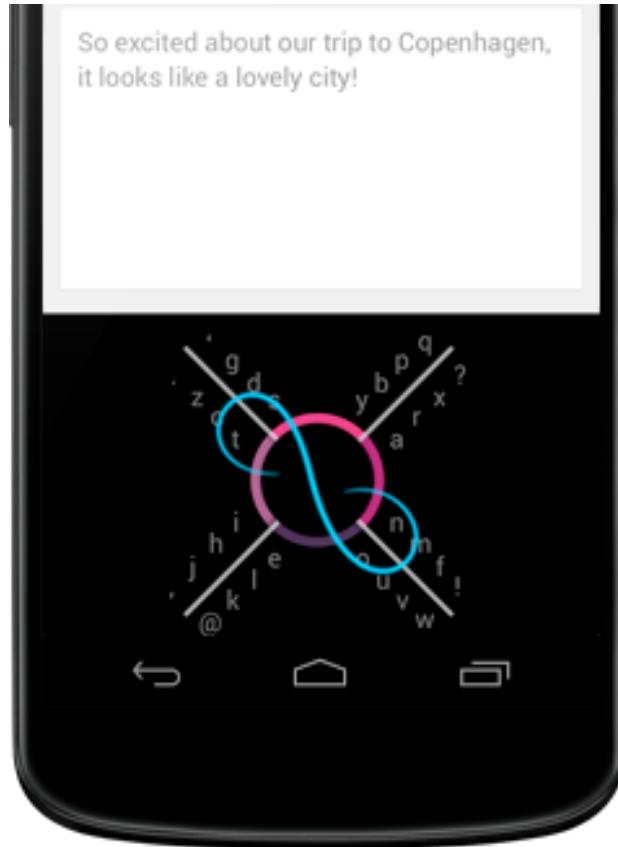
- Dictionary-based classification algorithms



Alt. Gestural Text Input



ShapeWriter
[http://www.shuminzhai.com/
shapewriter_research.htm](http://www.shuminzhai.com/shapewriter_research.htm)



8Pen Keyboard
<http://www.8pen.com/>

See also: Swype, SwiftKey, Fleksy, ...

Alt. Gestural Text Input



Xiaojun Bi, Shumin Zhai (2016) "IJQwerty: What Difference Does One Key Change Make? Gesture Typing Keyboard Optimization Bounded by One Key Position Change from Qwerty". In *Proceedings of CHI 2016 - the SIGCHI Conference on Human Factors in Computing Systems*. To appear. 10 pages.

Text Input Expert-User Input Rates

Device	Input Rates
Qwerty Desktop	80+ WPM typical, record: 150 WPM for 50 minutes
Qwerty Thumb	60 WPM typical with training (Clarkson et al., CHI 2005)
Soft Keyboards	45 WPM
T9	45 WPM possible for experts (Silverberg et al., CHI 2000)
Gestural	~30 WPM 8Pen, ShapeWriter claims 80 WPM (expert)
Handwriting	33 WPM (Wilkund et al., Human Factors Society, 1987)
Graffiti 2	9 WPM (Koltringer, Grechenig, CHI 2004)

Text Input Devices: Summary

A significant fraction of information conveyed to a computer is textual in form

On desktop computers, keyboard is primary text input device

Laptops may alter form, profile, or size in various ways to conserve space, which has drawbacks

There is a tradeoff between portability and speed when it comes to text input devices.

Positional input

Properties of positional input devices: isotonic vs. isometric
Transfer functions, Absolute vs. relative positioning,
Clutching, CD gain

Position Input



Etch-A-Sketch
<http://youtu.be/hq3Et9gOISI>



Skedoodle
<http://youtu.be/ic1rbFGhJ8g>

Images from <http://research.microsoft.com/en-us/um/people/bibuxton/buxtoncollection/browse.aspx>

Position Input



<http://www.pdp8.net/tek4010/tek4010.shtml>
Tektronix 4010



From Buxton, et al, Human Input to Computer Systems: Theories, Techniques, and Technologies (not yet published)

Properties of Positional Input Devices

Force vs. Displacement Sensing

- (most) joysticks = force
- mouse = displacement



Position vs. Rate Control

- (most) joysticks = rate
- mouse = position

Absolute vs. Relative Positioning

- touchscreen = absolute
- mouse = relative



Direct vs. Indirect Contact

- direct = touchscreen
- indirect = mouse

Dimensions Sensed

- 1 = dial, 2 = mouse, 3 = Wiimote



Force versus Displacement Sensing

Resistance or motion when using the devices.

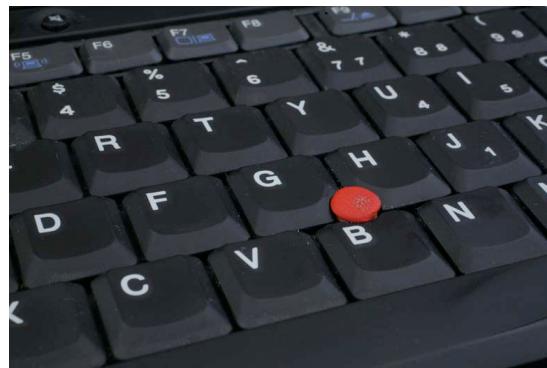
- Isometric (force) vs. isotonic (displacement) sensing



Isotonic sense displacement from starting point

Elastic isometric devices vs. “pure” isometric

- Elastic “snaps” back to centre when released (e.g. track point)
- Pure doesn’t snap back (e.g. some joysticks)



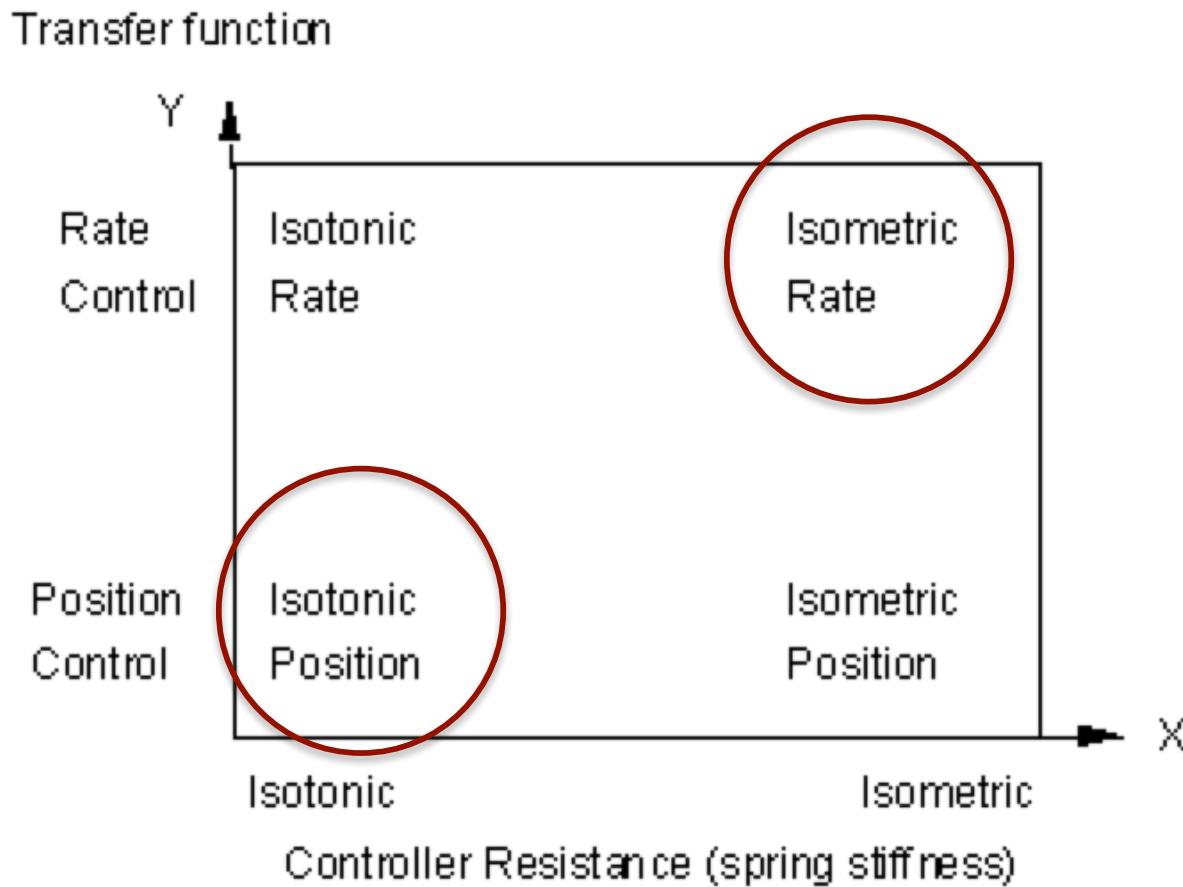
Elastic Isometric
returns to center



Pure Isotonic doesn’t
move when released

Position versus Rate Control Transfer Function

- Displacement sensing (isotonic) should be mapped to position
- Force sensing (isometric) should be mapped to rate (esp. elastic)



Absolute versus Relative Position

Absolute position is a direct mapping of input device position to an output position

- e.g. Touchscreen, where input and output are the same surface

Relative position maps changes in input device position to changes in output position

- e.g. Mouse, where you move the mouse to affect movement of the cursor on an output device/screen.

Relative doesn't guarantee a 1:1 mapping between input and output space

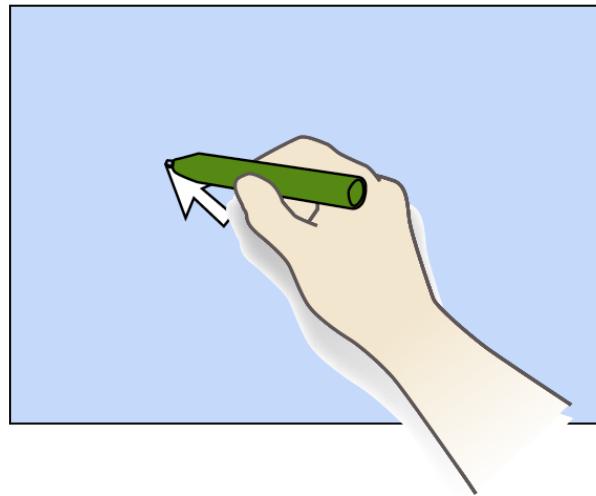
- What do you do when the mouse reaches the edge of your desk?

To make relative position work, you need a “clutch”

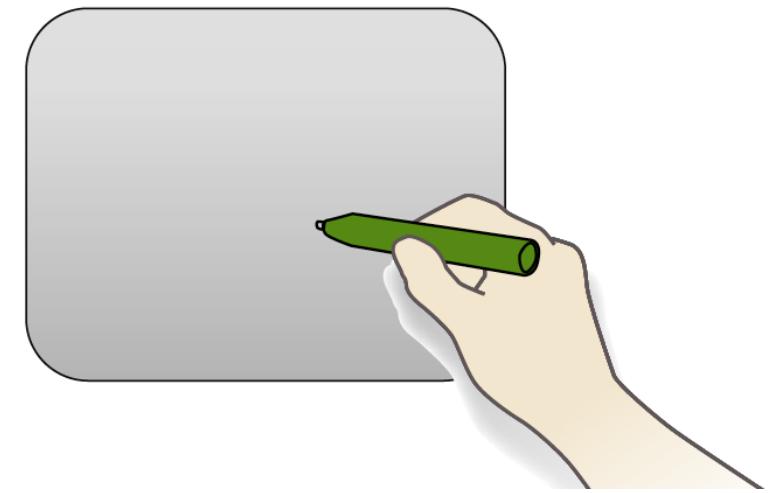
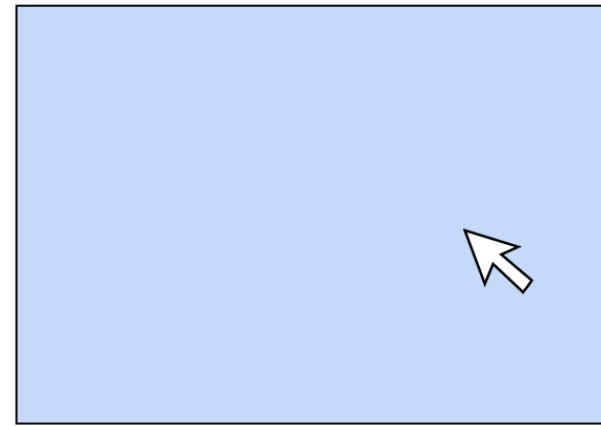
- Clutching is the panning action taken to continue moving a relative input device.

Direct versus Indirect

Absolute Direct



Relative Indirect



Control-Display Gain (CD Gain)

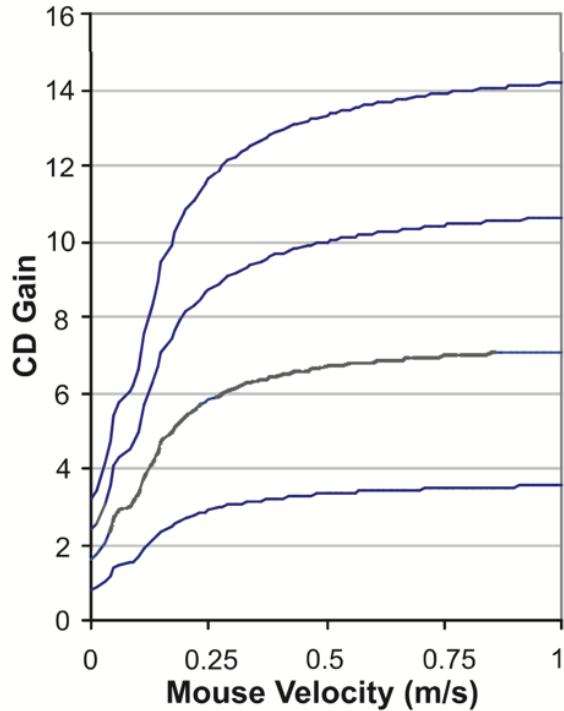
Can add a scale factor when mapping the input device (the “control”) to the display

A ratio of display movement to control movement called “gain”, often in terms of input device velocity (so works with rate and position controls):

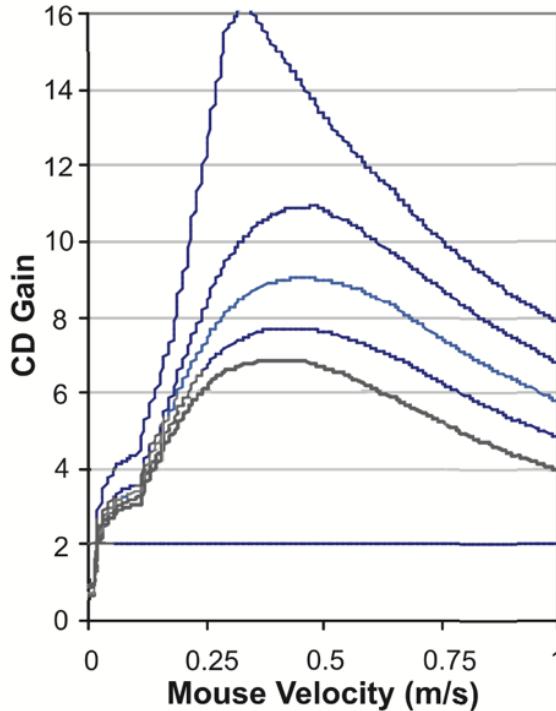
$$CDgain = \frac{V_{pointer}}{V_{device}}$$

Pointer Acceleration

For relative pointing, can change CD Gain based on velocity



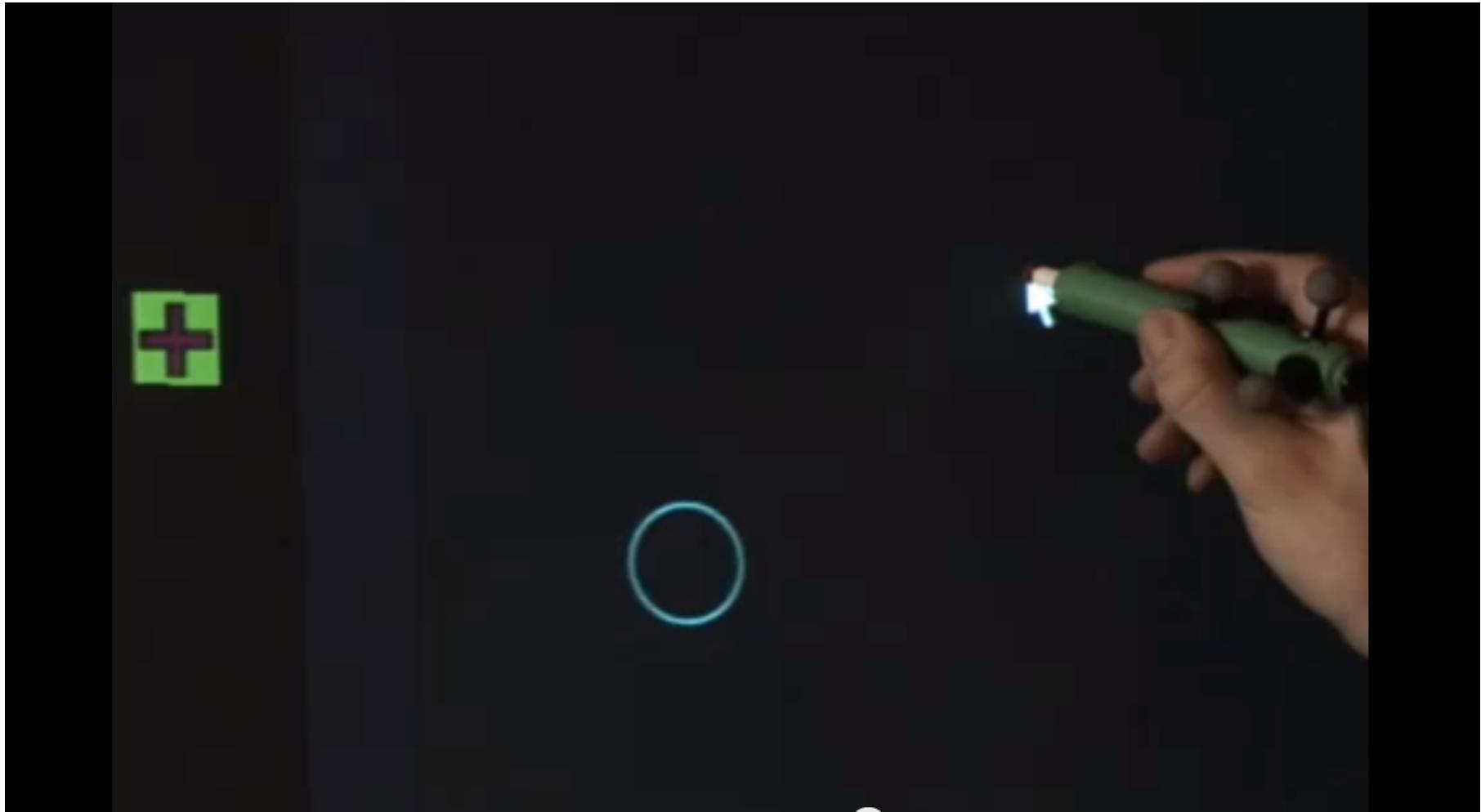
(b) Windows XP/Vista
levels 0.25 to 1.0 corresponding to
positions on preference slider



(c) Mac OSX
levels 0.0 to 0.875 corresponding to
positions on preference slider

Casiez et al. (2008)

Hybrid Technique



Hybrid Absolute and Relative Pointing

<http://youtu.be/FZmOBIG5KjM>