Input
Macbook Wheel (The Onion)

http://www.youtube.com/watch?v=9BnLbv6QYcA
iPod Wheel
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 input devices are optimized for specific tasks
• Problems?

General input devices adapted to many tasks
• Problems?

Overall, input is about two specific tasks: Text input and spatial input
• Exceptions now (blackberry vs iphone).
QWERTY is designed to space “typebars” to reduce jams and speed typing up, and *not* designed to slow typists down.

[1874 QWERTY patent drawing]

http://www.daskeyboard.com
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.
Alternative layout for two-handed keyboard
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.
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
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 a problem than Dvorak vs Qwerty keyboards
• Many ergonomic problems
• Feedback, resting of hands significantly compromised
• However, increases the aesthetics of device by reducing thickness, overall size, and weight
• Good option when input can be significantly limited (e.g. mobile device, iPad as media consumption device)
• Bad if device requires text input (e.g. Surface pro: buy the type cover)
Keyboard Variants

Thumb keyboards
- virtual (ultra-mobile PC c. 2006)
- Surface Pro soft keyboard

One-handed keyboards
- Frogpad
- Hold down space to shift hands

UMPC thumb keyboard
Surface thumb keyboard
Frogpad
Englebart’s NLS Keyboard
- Multiple keys together produce letter
- Very fast -- no targeting

Thad Starner’s Twiddler
- for wearable computing input
Graffiti / Unistroke Gestures

- map single strokes to “enter letter” commands

Natural Handwriting recognition

- dictionary-based classification algorithms
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
ShapeWriter
http://www.shuminzhai.com/shapewriter_research.htm

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

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

Etch-A-Sketch
http://youtu.be/hq3Et9gOlSI

Skedoodle
http://youtu.be/ic1rbF GhJ8g

Position Input

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

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
• also called “isometric” (force) versus “isotonic” (displacement) sensing
• elastic isometric devices vs. “pure” isometric
- force sensing (isometric) should be mapped to rate
- displacement (isotonic) sensing should be mapped to position
Absolute versus Relative Position

Absolute position is a direct mapping of input device position to a display input position
  • Examples?

Relative position maps changes in input device position to changes in display input position
  • Examples?

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

Absolute Direct

Relative Indirect
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):

$$CD_{\text{gain}} = \frac{V_{\text{pointer}}}{V_{\text{device}}}$$
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 Absolute and Relative Pointing

http://youtu.be/FZmOB1g5KjM
Gestures map movements to commands

- instead of pressing button, “wave your hand”
- problems?
- map position of body part to display input position

**BB10 Swipe Gestures**
Kinect Position and Text Input (Xie and Lio)

http://youtu.be/sVRRi-Z9t9M