Input Output devices

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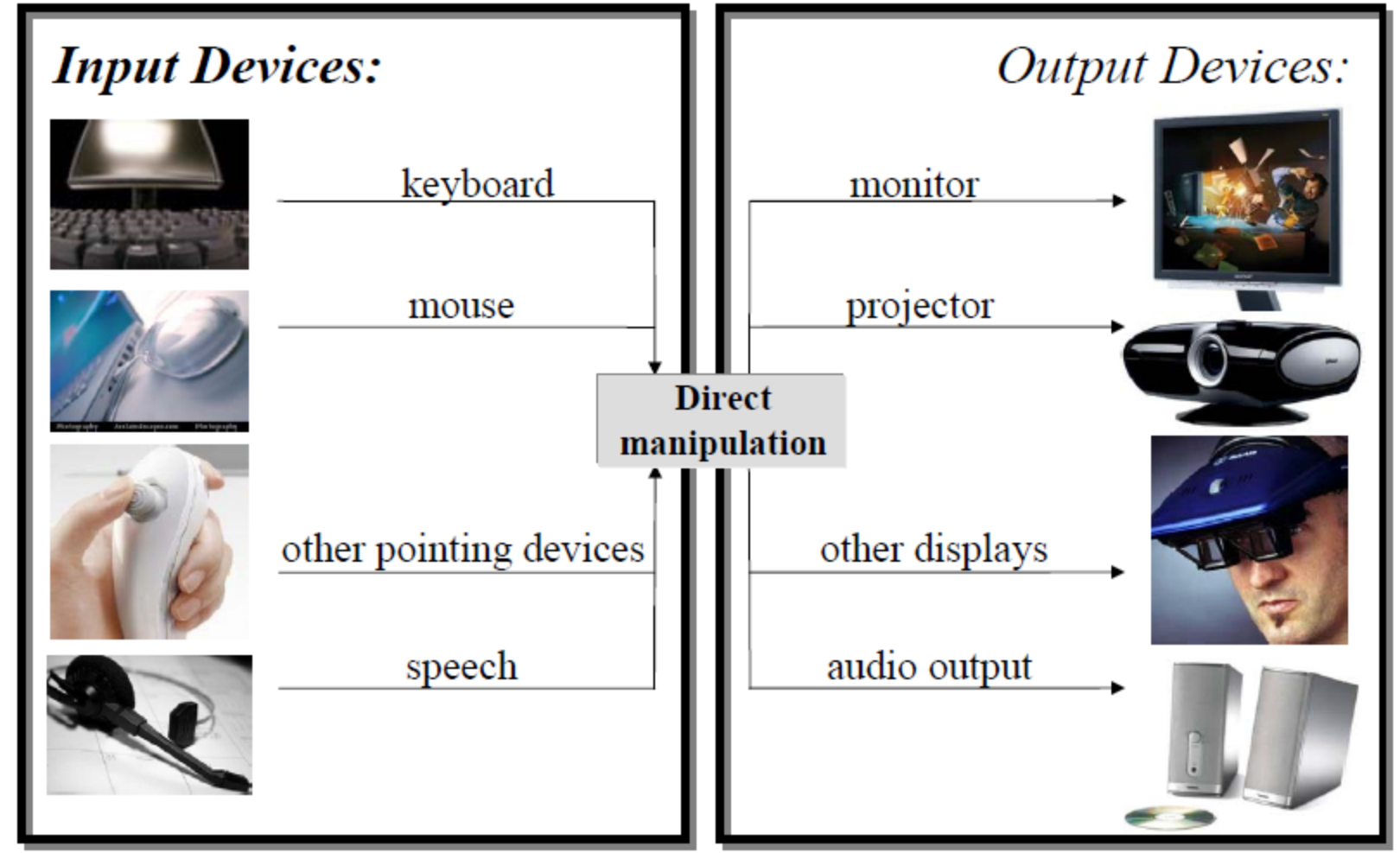
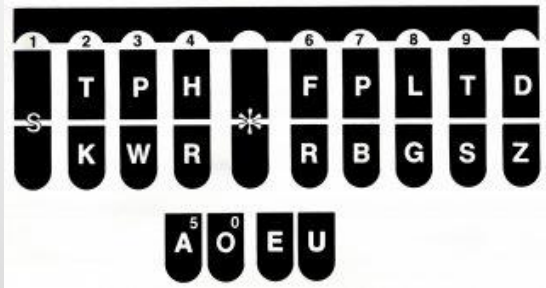
Spring 2023

Interaction Devices

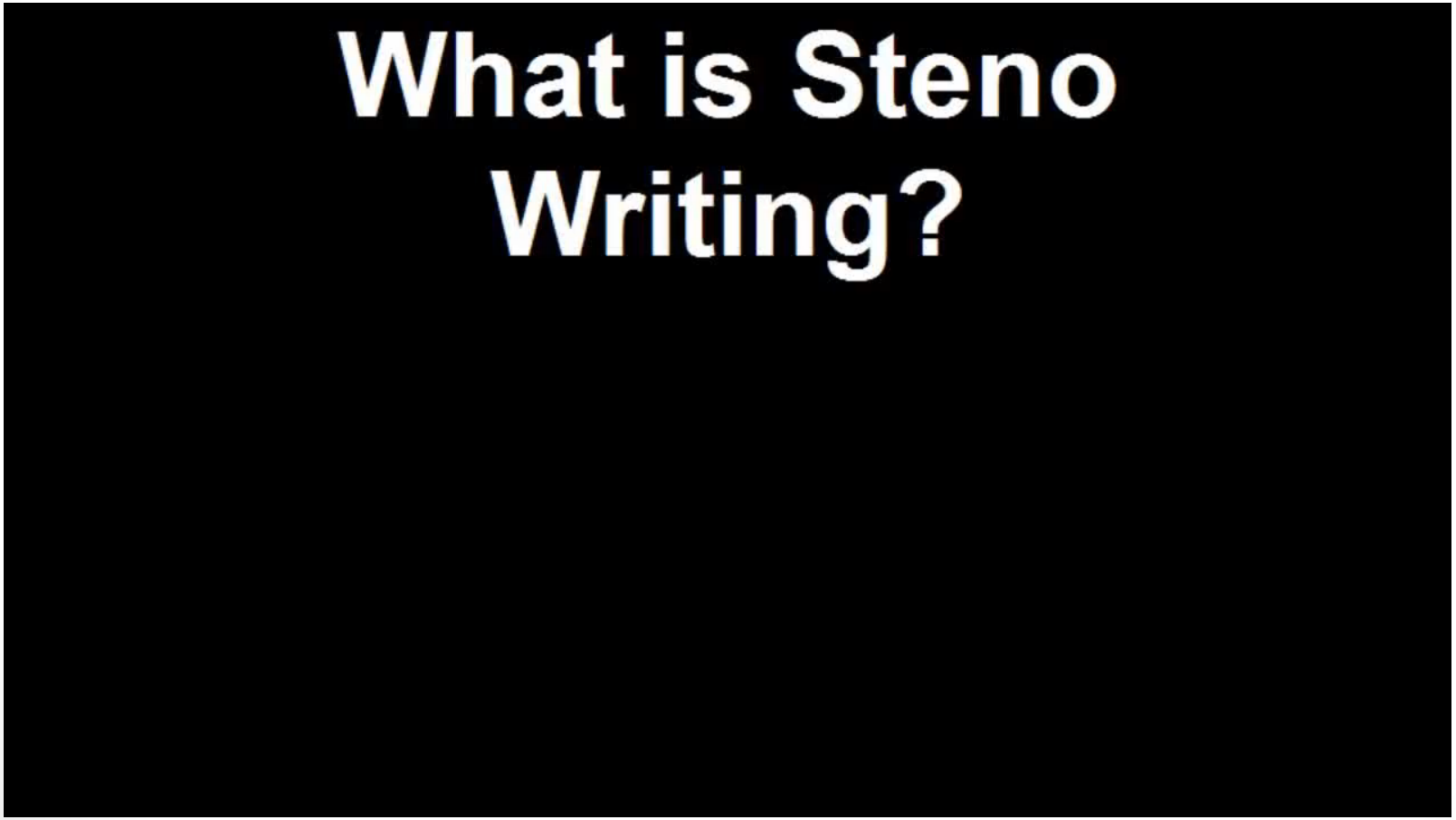


Keyboards

- The keyboard is the primary mode of textual data entry.
- **Contemporary keyboards**
  - – one keypress at a time
  - (except when combined with SHIFT, ALT, CTRL)
  - – trained users: up to 150 words per minute
- **Chord keyboards (StenoType Machine)**
  - – several keys can be pressed simultaneously
  - – small size: 31 signs can be represented by only 5 keys
  - – trained users: up to 300 words per minute
  - – months of training and frequent use are needed



Chord Keyboard



Keyboards

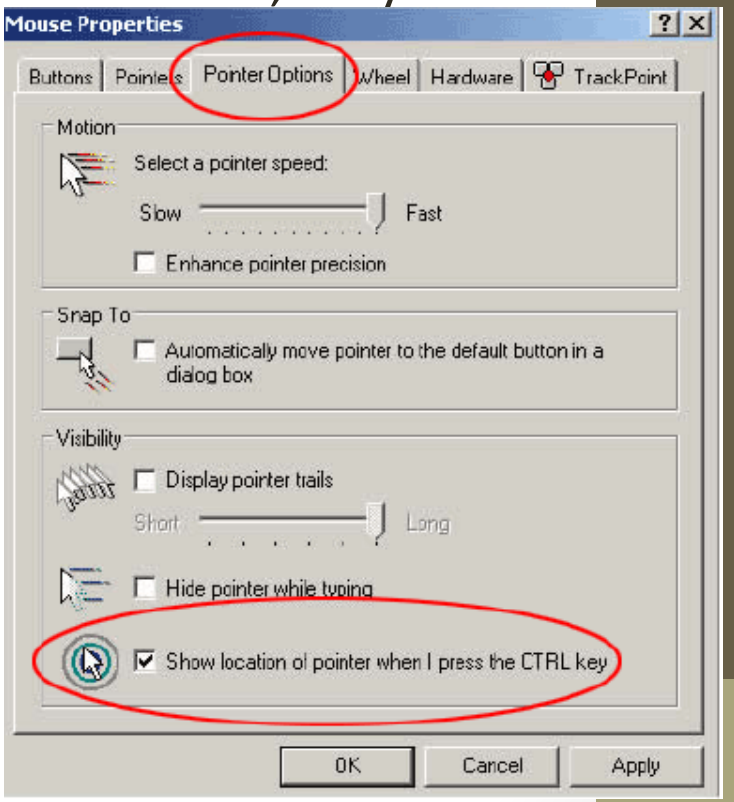
- **Contemporary keyboard layouts**:
- **QWERTY**
  - – layout: frequently used letter pairs far
  - apart (increased finger travel distances)
  - – used by all English-language keyboards
  - – trained users: up to 150 words per minute

- **Dvorak**
  - – layout: vowels on the left, most common
  - consonants ('D','H','T','N','S') on the right
  - – decreased finger travel distances
  - – trained users: up to 200 words per minute
  - – ± 1 week needed to get used to the layout

Modern Keyboards

Pointing devices

- Pointing devices are used to **point** at and **select** items.
- • Direct-manipulation approach – faster, fewer errors, easy to learn
- ⇒ highly satisfactory for the users
- • Pointing devices' tasks:
  - **selecting an item**
  - **dragging and positioning an item**
  - **orienting (rotating) an item**
  - **defining a path / curvature**
  - **text writing / editing**
- • Pointing devices can have:
  - direct control on screen surface
  - indirect control away from screen surface



Pointing devices

- Direct-control pointing devices:
- **Light pens**
  - – can be used for any pointing device task
  - – obscure the screen, cause arm fatigue
- **Touch screens**
  - – early designs (imprecise): physical pressure, interruption of a grid of infrared beams
  - – recent designs (high precision): interruption of ultrasonic waves, optical imaging (touch shows as a shadow), calculating mechanical pressure on the glass
  - – widespread in machine-control systems

- **Stylus (Buttons)**
  - – can be used for any pointing device task
  - – Widespread in PDAs (personal digital assistants)

Johny Lee IR Ideas

ResearchGate Home Questions Jobs Search for research

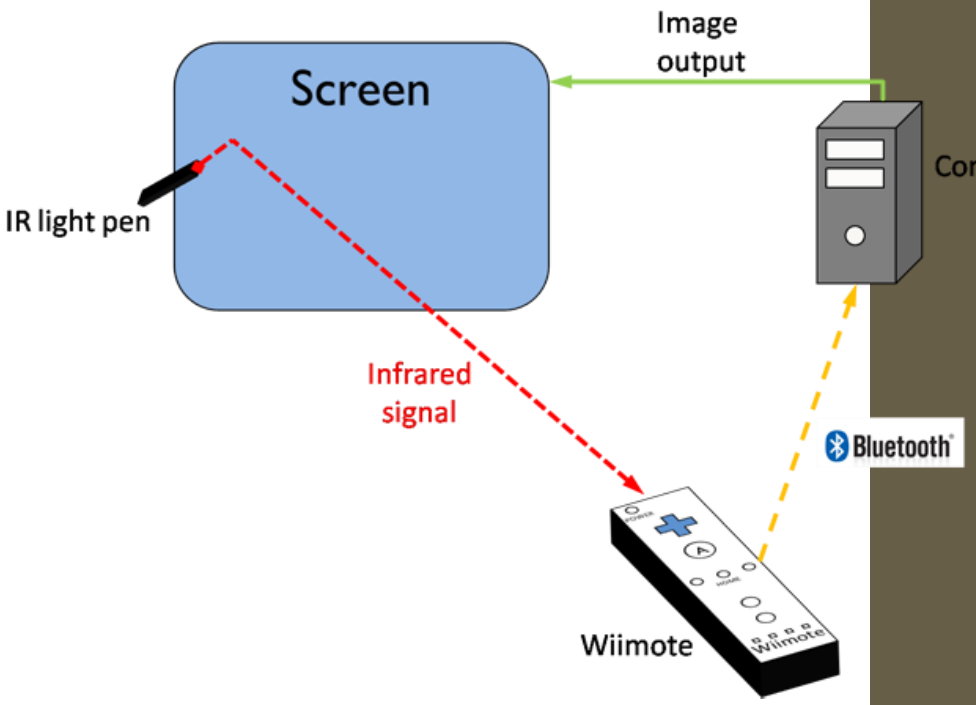
Article

Hacking the Nintendo Wii Remote

August 2008 · IEEE Pervasive Computing 7(3):39-45
DOI: 10.1109/MPRV.2008.53
Source · IEEE Xplore

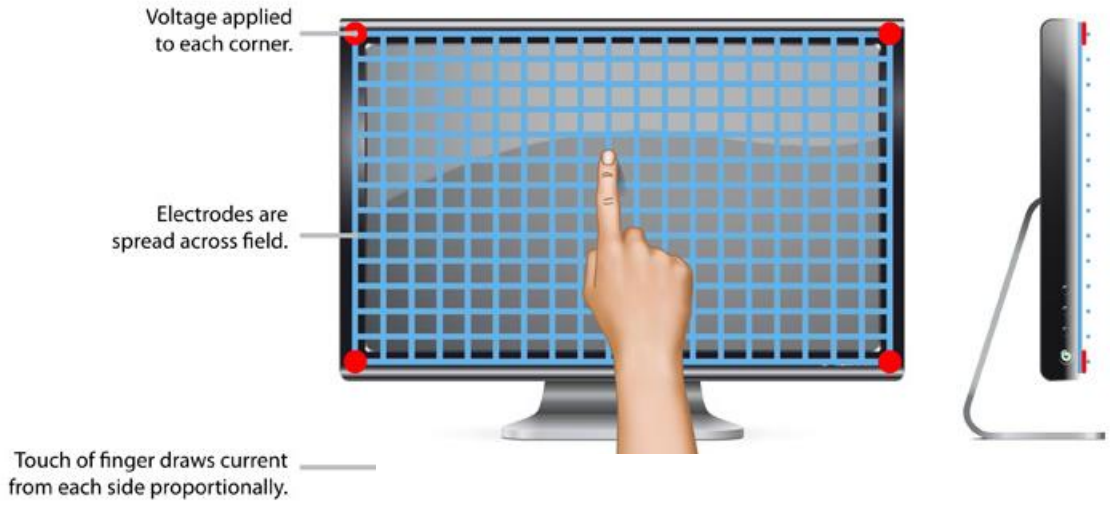
Johnny Chung Lee

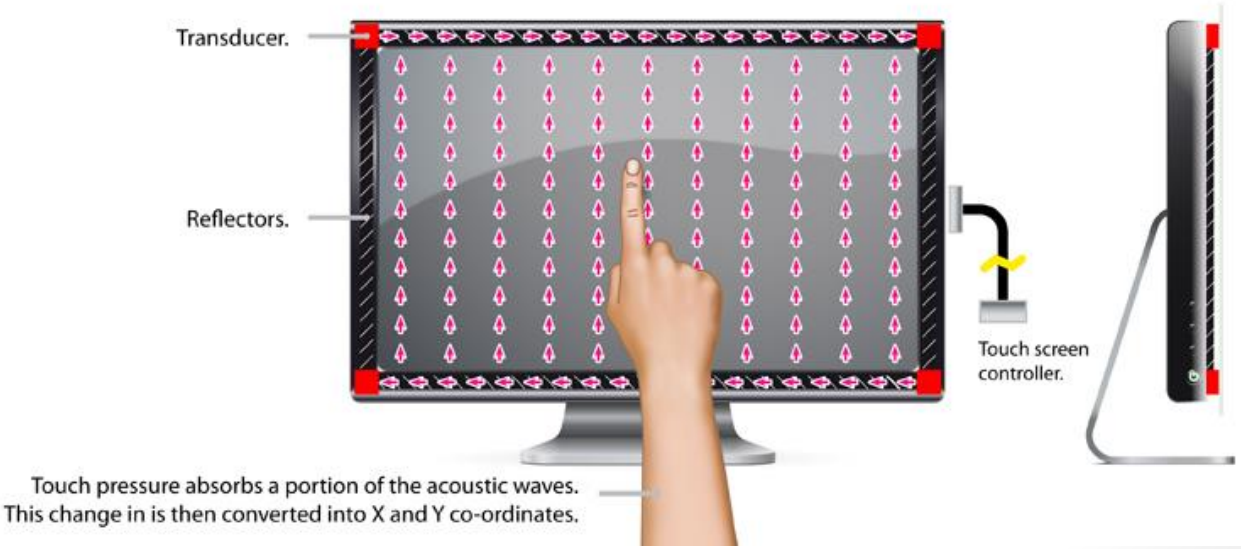
Overview Stats Comments Citations (425) References (7) ...



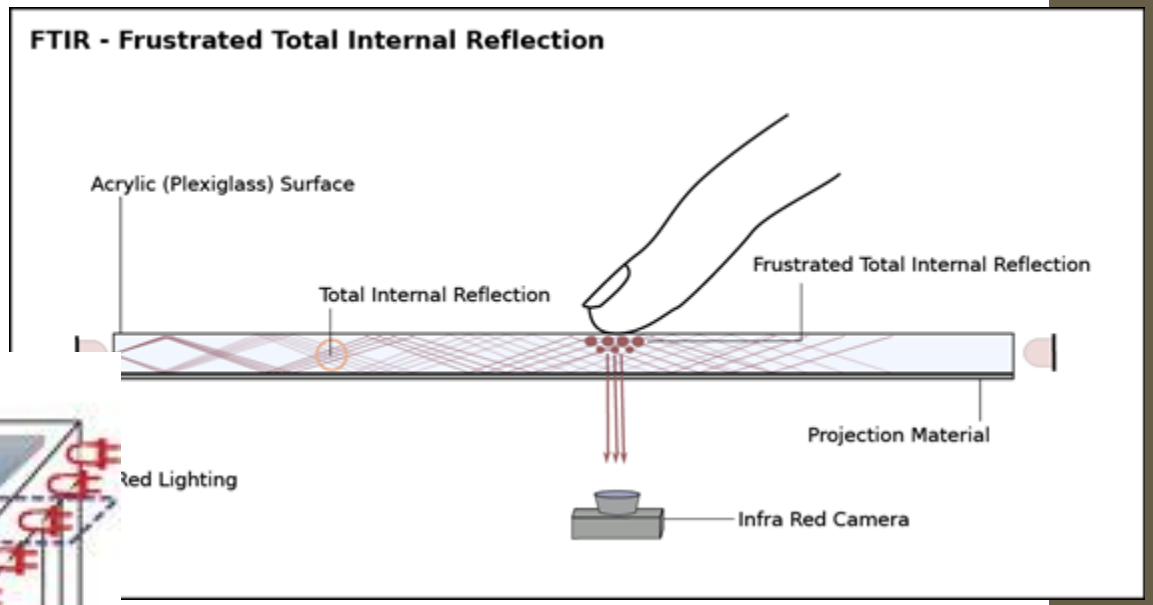
Motion Tracking Suit

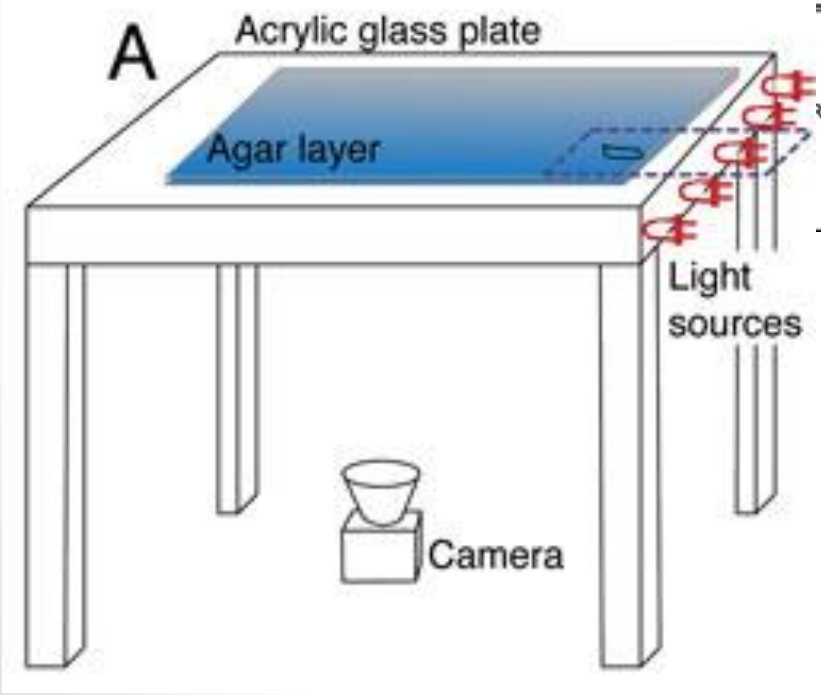
Touch Surface



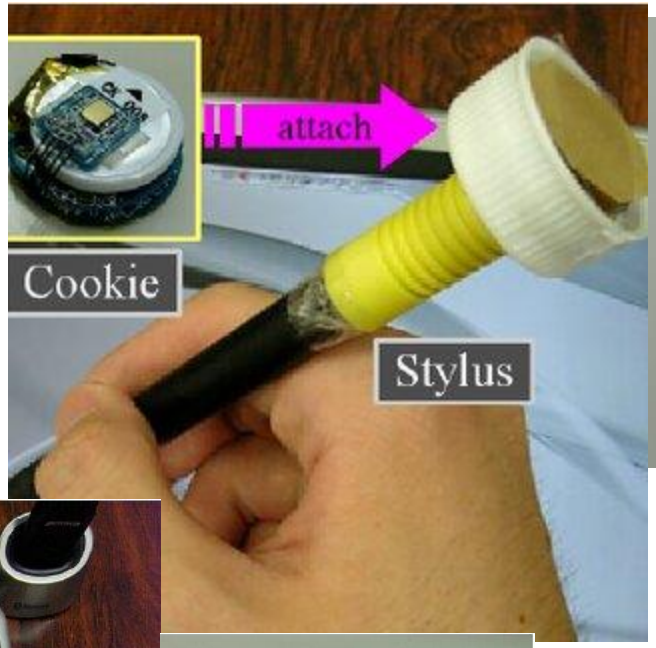


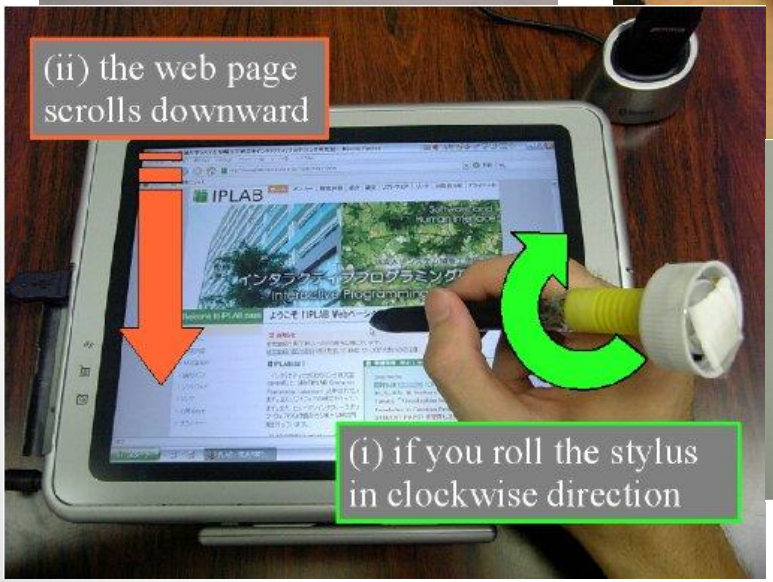
FTIR (Frustrated Total Internal Reflection)

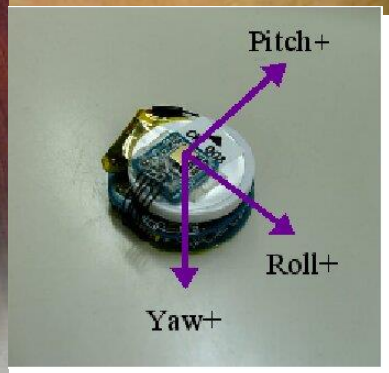




Stylus Pen


attach
Cookie
Stylus


(ii) the web page scrolls downward
IPLAB
(i) if you roll the stylus in clockwise direction


Pitch+
Roll+
Yaw+

Pointing devices

Indirect-control pointing devices:

- Mice
  - accurate, do not obscure the screen, cause less arm fatigue
  - hand-eye coordination necessary, desk space assumed
- Trackballs
  - accurate, fast tracking performance (preferred for games)
  - longer usage causes arm fatigue
- Joysticks & Touchpads
  - accurate, fast tracking performance (preferred for games)
  - many different designs (trackpoint, Wii)
- Graphics Tablets
  - touch-sensitive surface operated by finger, stylus
  - typically used for drawing (preferred for CAD)

Pointing devices design goals

- Goal: fast and accurate pointing, easy-to-learn, causing least arm fatigue
- Other considerations: cost, durability, compatibility, space requirements
- Speed and accuracy of pointing can be measured in terms of time needed for precision pointing (Fitts' Law):

  $time = C_1 + C_2\ (difficulty\text{-}measure) + C_3 \log_2 (C_4 / W)$, where

  $difficulty\text{-}measure = \log_2 (2D / W)$,

  W is the width of the target, D is the distance to the target, and

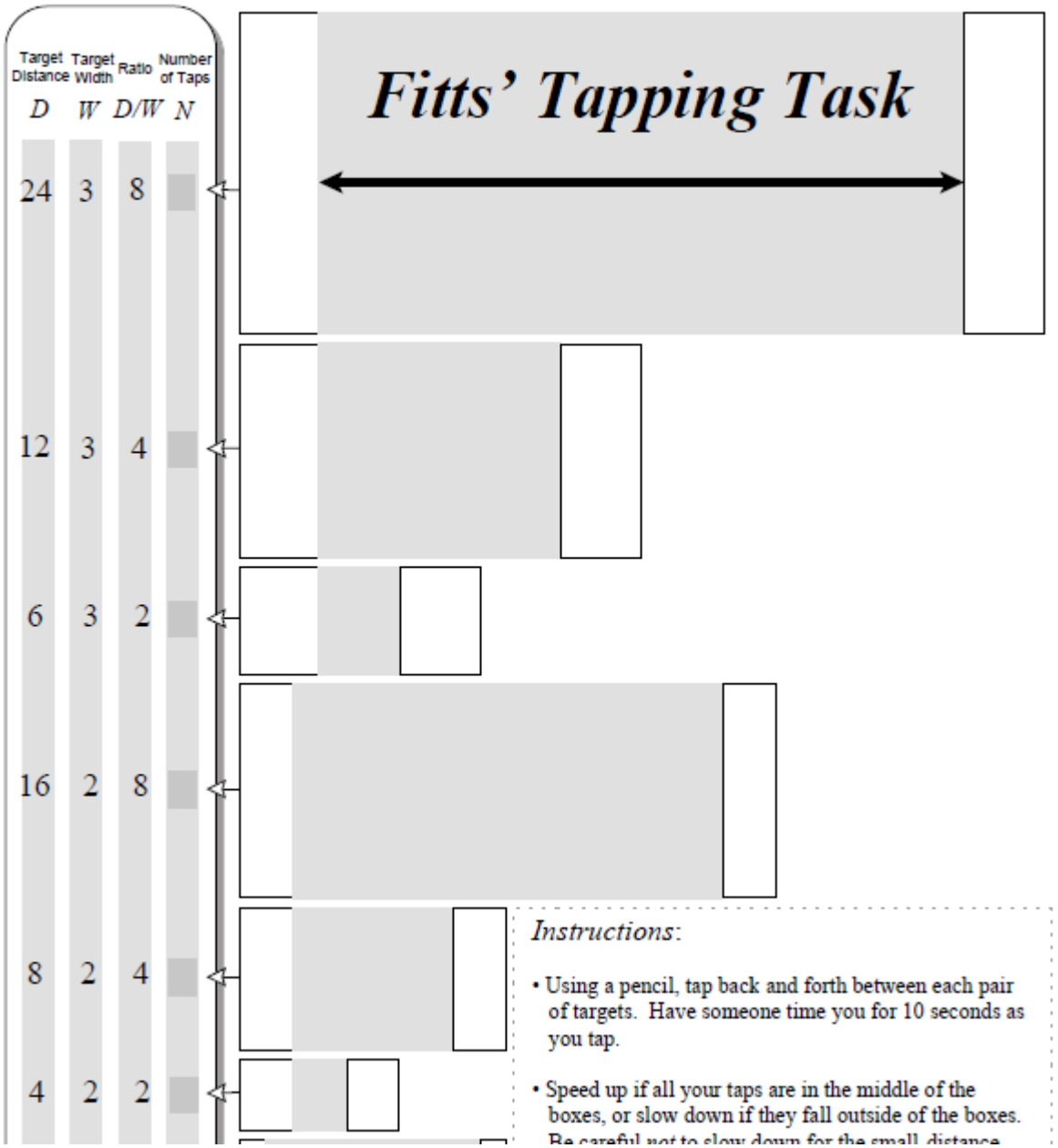
  C_1, C_2, C_3, C_4, are constants depending on the pointing device

Goal: design devices that produce small C_1, C_2, C_3, C_4

This scientific law predicts that the time required to rapidly move to a target area is a function of the **ratio** between the distance to the target and the width of the target

Visualize Fits Law

- http://simonwallner.at/ext/fitts/

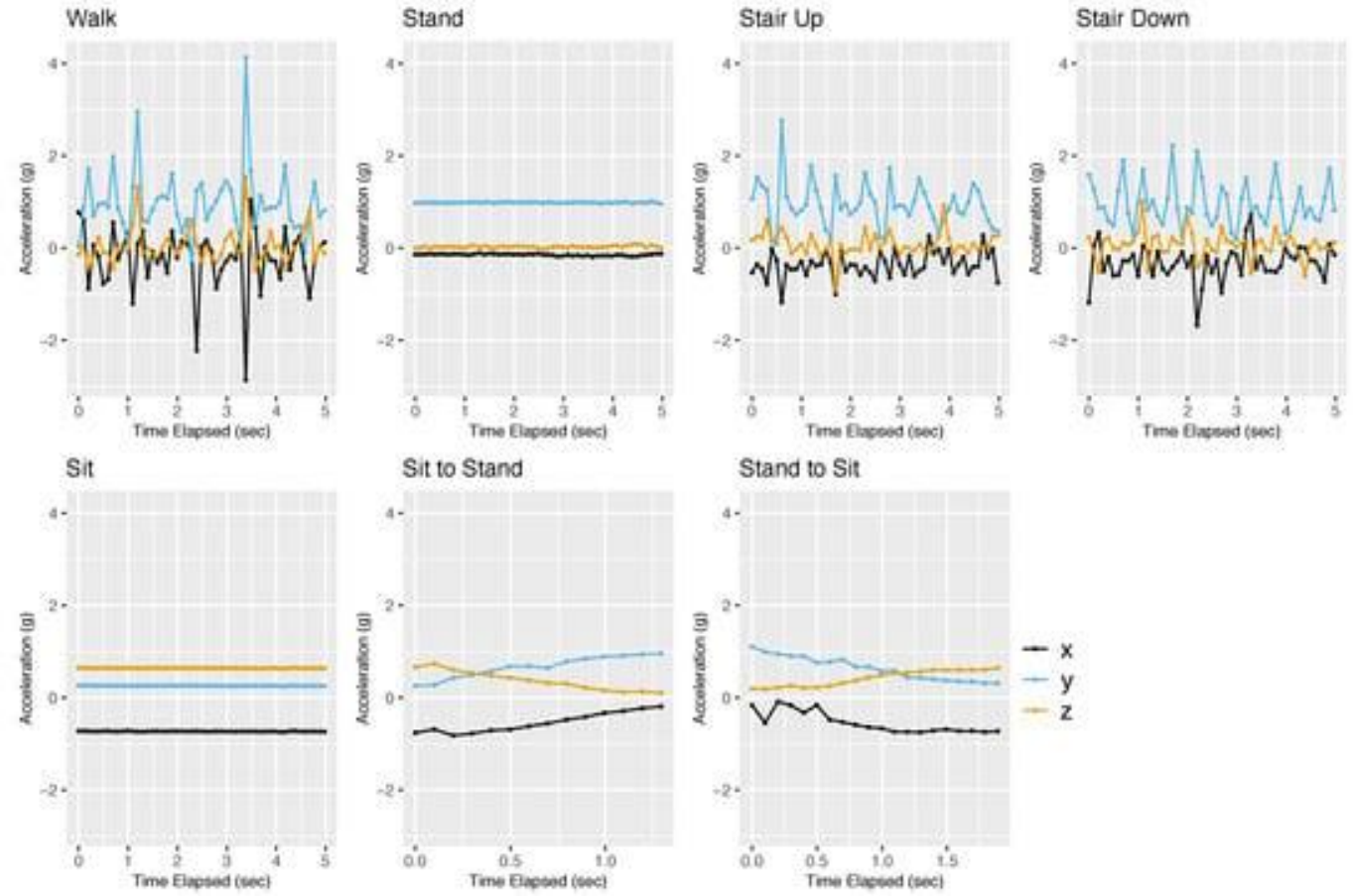

Fitts' Tapping Task
Target Distance D
Target Width W
Ratio D/W
Number of Taps N
24 3 8
12 3 4
6 3 2
16 2 8
8 2 4
4 2 2
Instructions:
• Using a pencil, tap back and forth between each pair of targets. Have someone time you for 10 seconds as you tap.
• Speed up if all your taps are in the middle of the boxes, or slow down if they fall outside of the boxes. Be careful not to slow down for the small distance

Novel devices

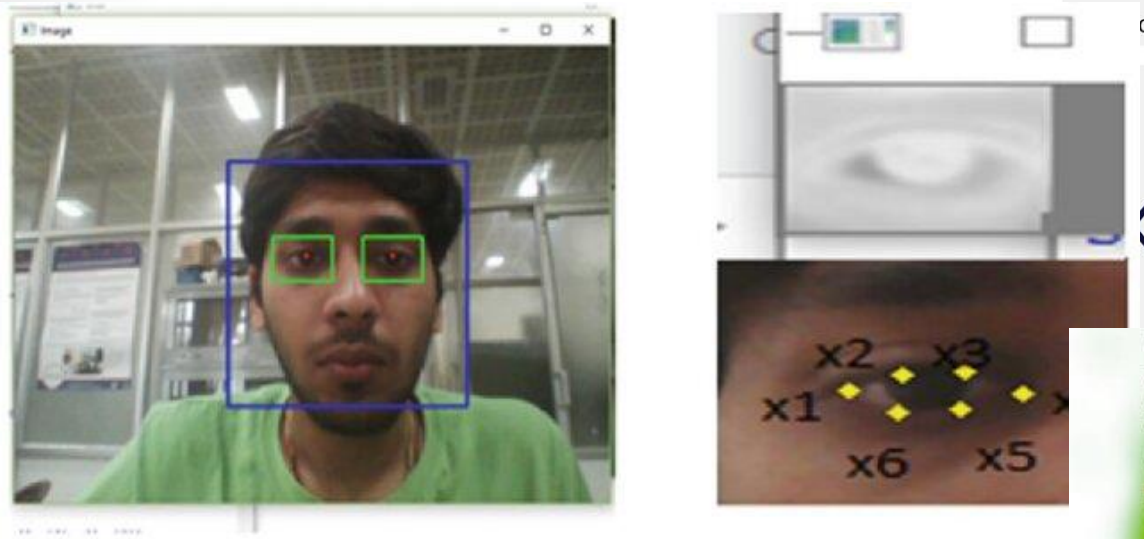
- Pointing Devices
  - DataGloves
  - Gaze trackers
  - Hand Gesture Recognizers
- Multimedia Input
  - Wearable devices
  - Biosensors
  - Biometrics
  - Speech
  - Scanners

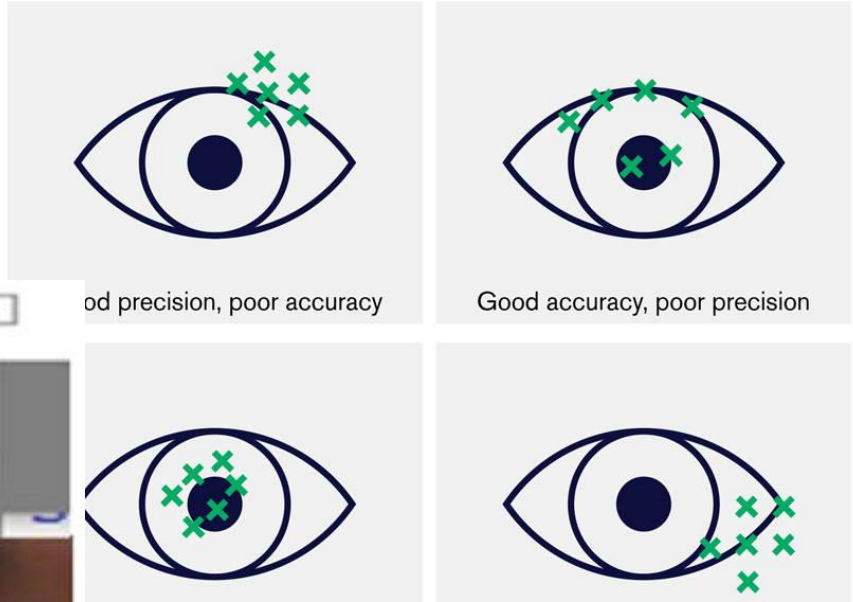
Hand Gestures Data Gloves

- Camera Based
- Accelerometer based (Sensor)



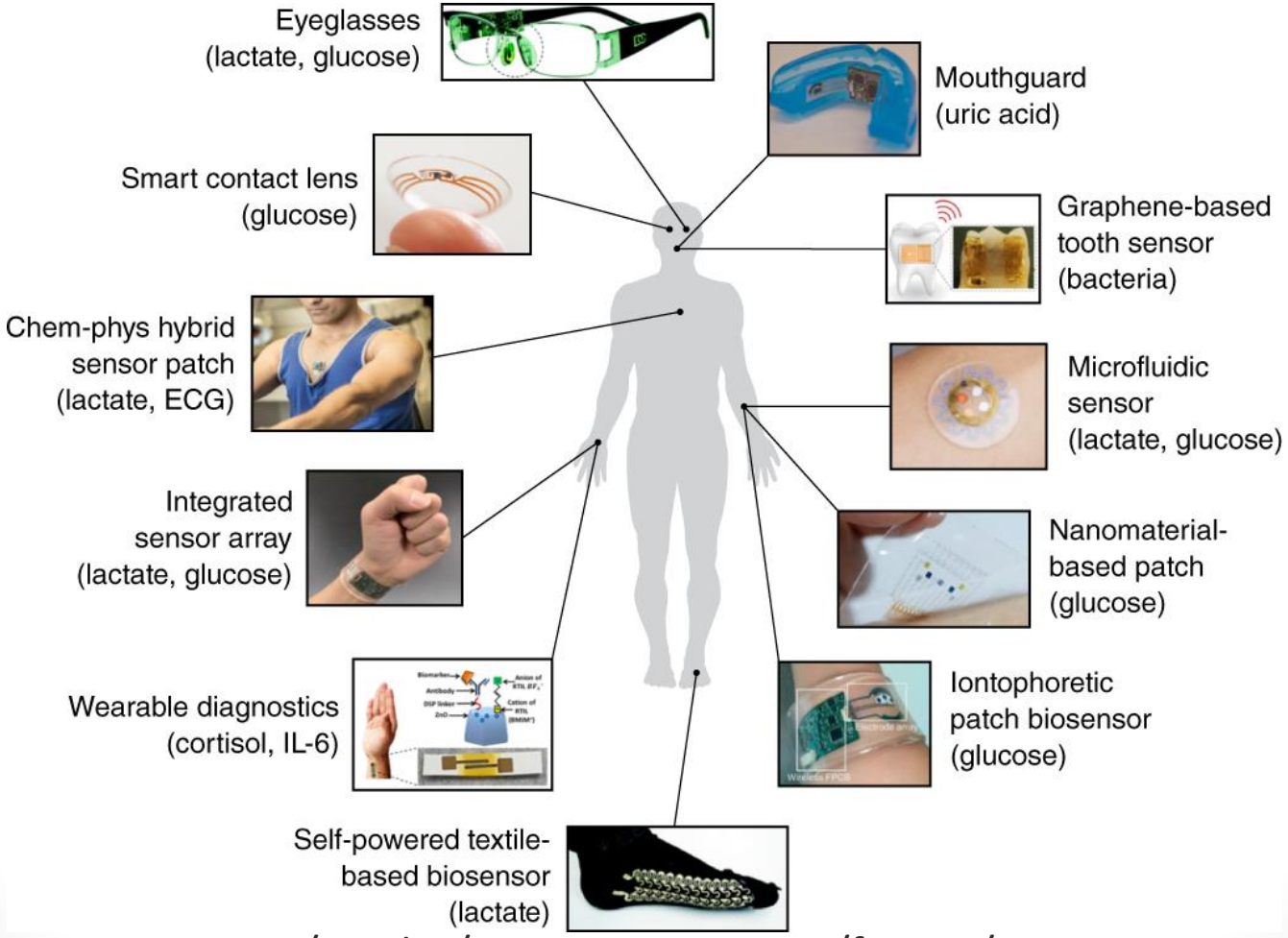
Gaze Tracker





Bio Sensors

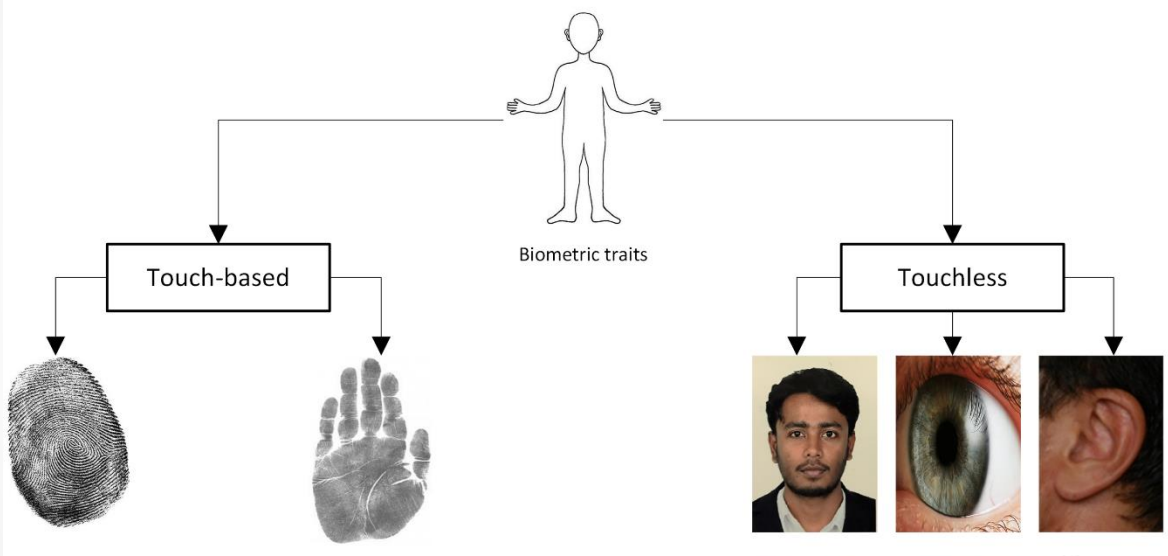
- All sensors measures human data

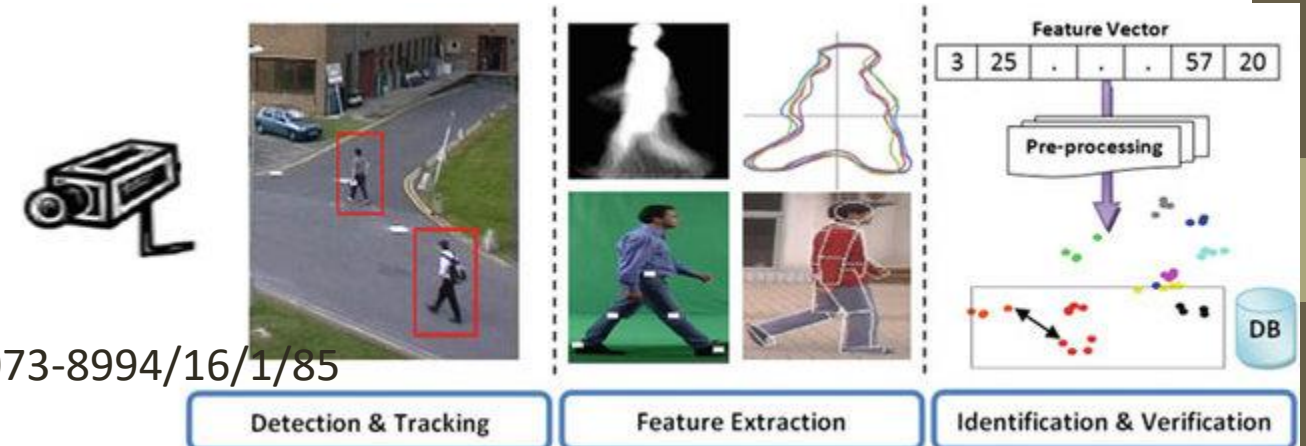


https://www.nature.com/articles/s41587-019-0045-y/figures/2

Biometric data

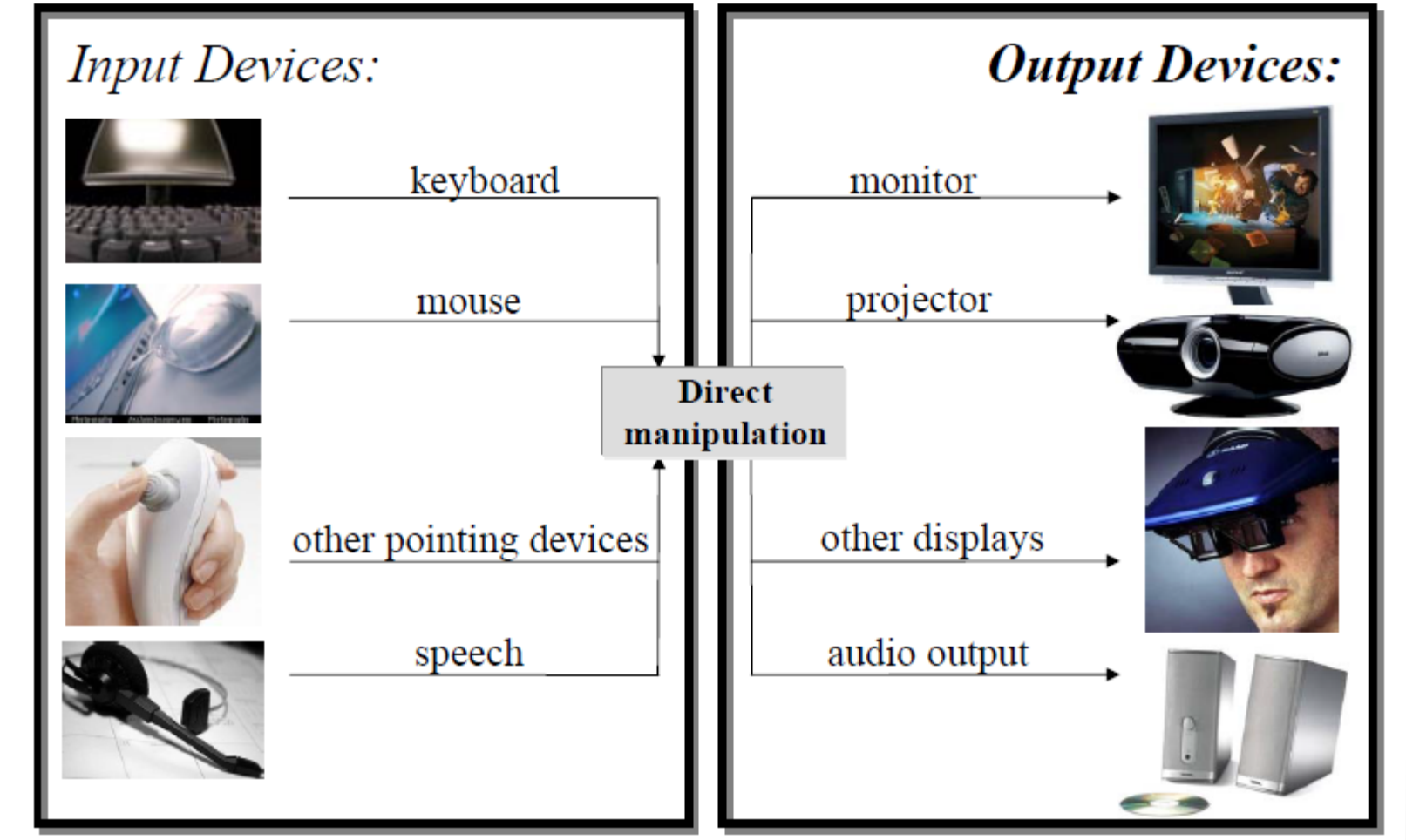
- All unique data for humans





https://www.mdpi.com/2073-8994/16/1/85

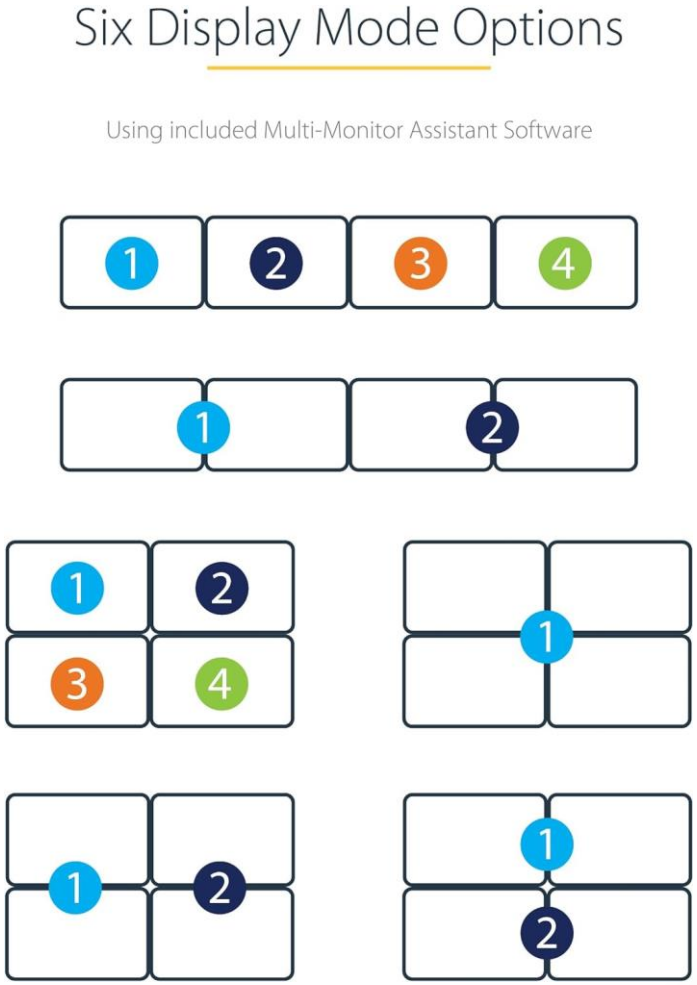
Output Devices



Output devices

- The visual display is the primary source of feedback from the computer.
- • Visual display technologies include:
  - Cathode-Ray Tube (CRT) displays
  - Liquid-Crystal Display (LCD)
  - Plasma display
  - Surface-conduction Electron-emitter Display (SED)
  - light-emitting diodes LEDS
- • Advantages / Disadvantages of a technology:
  - size (thinness, weight), refresh rate, resolution, width of viewing angle;
  - brightness, contrast, sharpness;
  - provision of user control of some of these attributes

Big Display Screens



Pros / Cons

- The visual display is the primary source of feedback from the computer.
- • Visual display technologies include:
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  - Plasma display
- • Advantages / Disadvantages of a technology:
  - size (thinness, weight), refresh rate, **resolution**, width of viewing angle;
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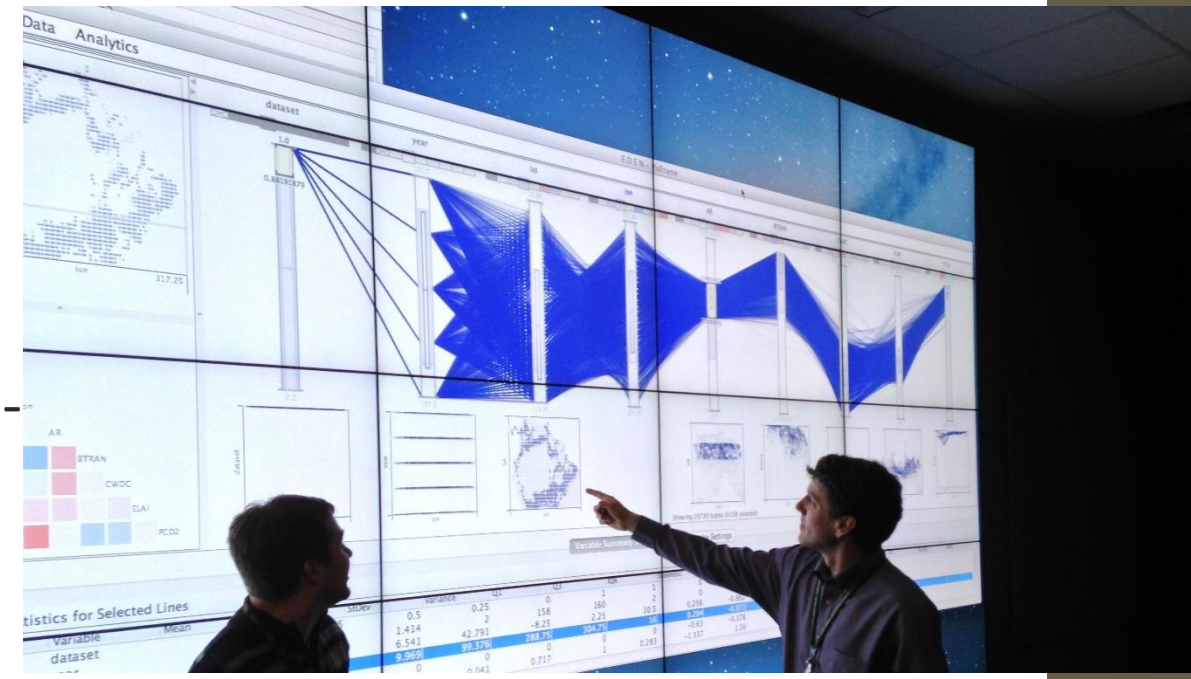
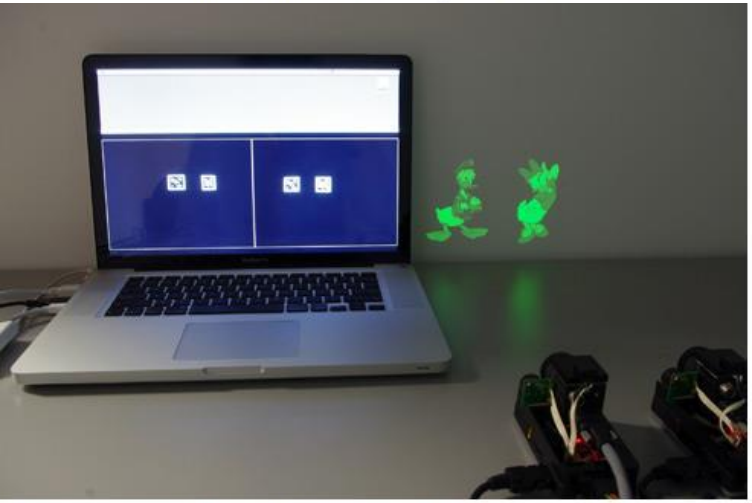
Big display screen issues

- Physical Reach
- Precise interaction can
- Information Density
- Cognitive Load
- Collaboration and Co-located Interactions
- Software and Interface Design Adapting



Novel Ideas – Side by Side

A two-player boxing game using the SideBySide system. Projected characters from each device are aware and responsive to each other.



Projecting visible and IR images in a single stream. The characters are visible to the user,

rch

Interaction Devices: Task / User-Profiled Selection

- People are so different, there can be no image of an 'average' user.
- User diversity:
  - perceptual abilities (vision, hearing, reflexes, disabilities)
  - cognitive abilities (long-term memory, learning, attention, search, scanning) (affected by: stress, fatigue, monotony, aging, etc)
  - preferences (graphics vs. textual, dense vs. sparse, etc.)
  - cultural background
  - computer-related knowledge





successful HCI designs ⇔ task- & user-profiled HCI designs (adopting appropriate interaction devices / types / preferences)