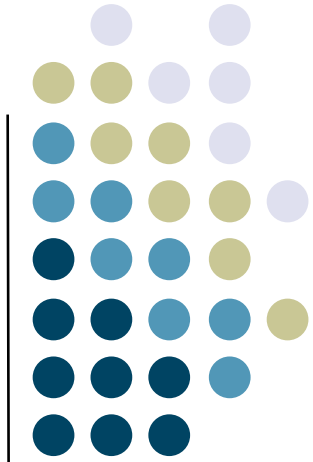
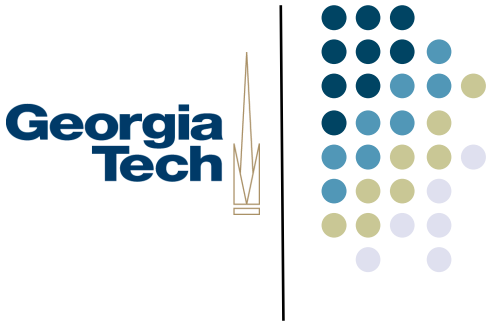
Input (part 1: devices)



Georgia Tech



Where we are...

- Two largest aspects of building interactive systems: output and input
  - Have looked at basics of output
  - Now look at input

Input

- Generally, input is somewhat harder than output
  - Less uniformity, more of a moving target
  - More affected by human properties
  - Not as mature
- Will start with low level (devices) and work up to higher level

Input devices

- Keyboard
  - Ubiquitous, but somewhat boring…
  - Quite mature design
- QWERTY key layout
  - Where did it come from?

QWERTY key layout

- Originally designed to spread out likely adjacent key presses to overcome jamming problem of very early mechanical typewriters
  - Often quoted as "intentionally slowing down" typing, but that's not true
    - Arrangement of letters to keep typebars from getting stuck
    - (Common letter pairs on alternating hands)

QWERTY keyboard layout

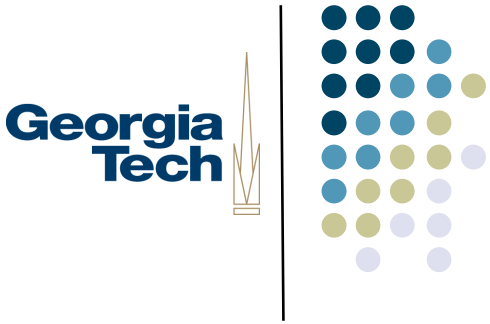
- Other layouts have been proposed
  - Dvorak is best known
  - Widely seen as better
  - Experimental and theoretical evidence casts doubt on this
    - Alternating hands of QWERTY are a win since fingers move in parallel

QWERTY keyboard layout

- Whether or not Dvorak layout is better, it did not displace QWERTY
  - Lesson: once there is sufficient critical mass for a standard it is nearly impossible to dislodge (even if there is an apparently good reason to do so)

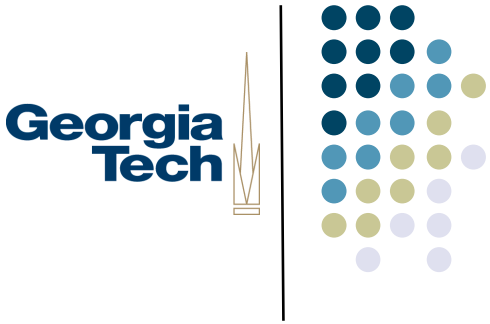
Keyboards

- Repetitive Stress Injury
  - First comes up here, mouse tends to be a little worse for most people
- Take this seriously for yourself!
  - Can be a VERY bit deal
  - Biggest thing: adjust your work environment (e.g. chair height)



Buttons

- Similar to keyboard, but not for typing letters but for symbols
  - separate collection of keys with typically same form but different purpose
  - now see as "function keys" that come standard with keyboards
  - also show up on e.g., mouse



Buttons

- Buttons often bound to particular commands
  - e.g., function keys
  - Improved quite a bit with labels
  - Software changeable labels would be ideal, but we don't typically get this

Valuators

- Returns a single value in range
- Major impl. alternatives:
  - Potentiometer (variable resistor)
    - similar to typical volume control
  - Shaft encoders
    - sense incremental movements
- Differences?

Valuator alternatives

- Potentiometer
  - normally bounded range of physical movement (hence bounded range of input values)
  - Keeps residual position in device
- Shaft encoder
  - Unbounded range of movement
  - No residual position in device

Locators (AKA pointing devices)

- Returns a location (point)
  - two values in ranges
  - usually screen position
- Examples
  - Mice (current defacto standard)
  - Track balls, joysticks, tablets, touch panels, etc.

Locators

- Two major categories:
  - Absolute vs. Relative locators

Absolute locators

- One-to-one mapping from device movement to input
  - e.g., tablet
  - Faster
  - Easier to develop motor skills
  - Doesn't scale past fixed distances
    - bounded input range
  - less accurate (for same range of physical movement)

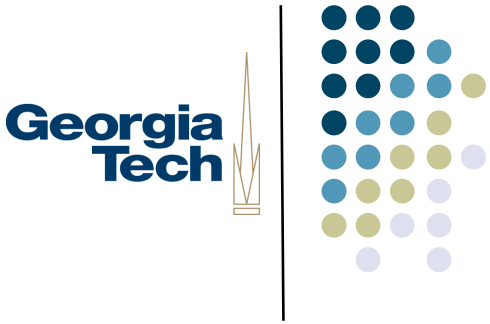
Relative locators

- Maps movement into rate of change of input
  - e.g., joystick (or TrackPoint)

Relative locators

- More accurate (for same range of movement)
- Harder to develop motor skills
- Not bounded (can handle infinite moves)

Q: is a mouse a relative or absolute locator?



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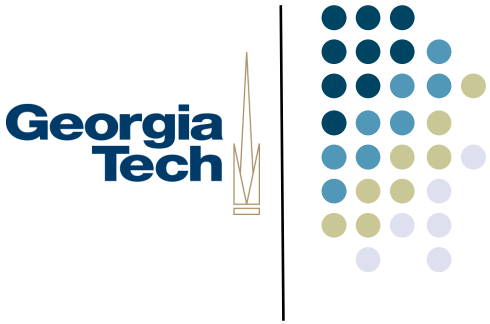


- Answer: No
- Third major type:
  "Clutched absolute"
  - Within a range its absolute
  - Can disengage movement (pick it up) to extend beyond range
    - picking up == clutch mechanism

Clutched absolute locators

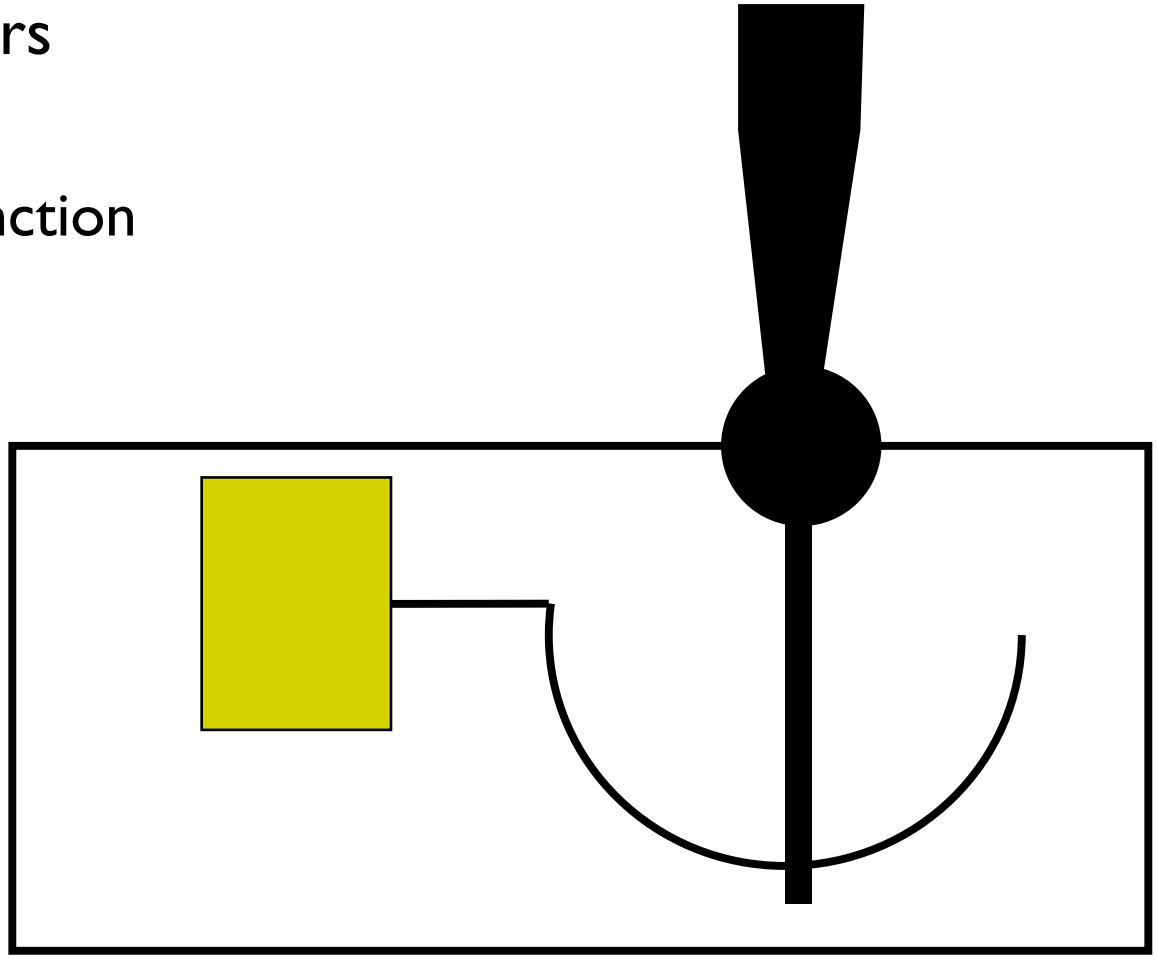
- Very good compromise
  - Get one-to-one mapping when "in range" (easy to learn, fast, etc.)
  - Clutch gives some of benefits of a relative device (e.g., unbounded)
- Trackballs also fall into this category

Device specifics: joysticks

- self centering
- relative device
- possible to have absolute joysticks, but scaling is bad

Joystick construction

- Two potentiometers
  - x and y
  - resistance is a function of position



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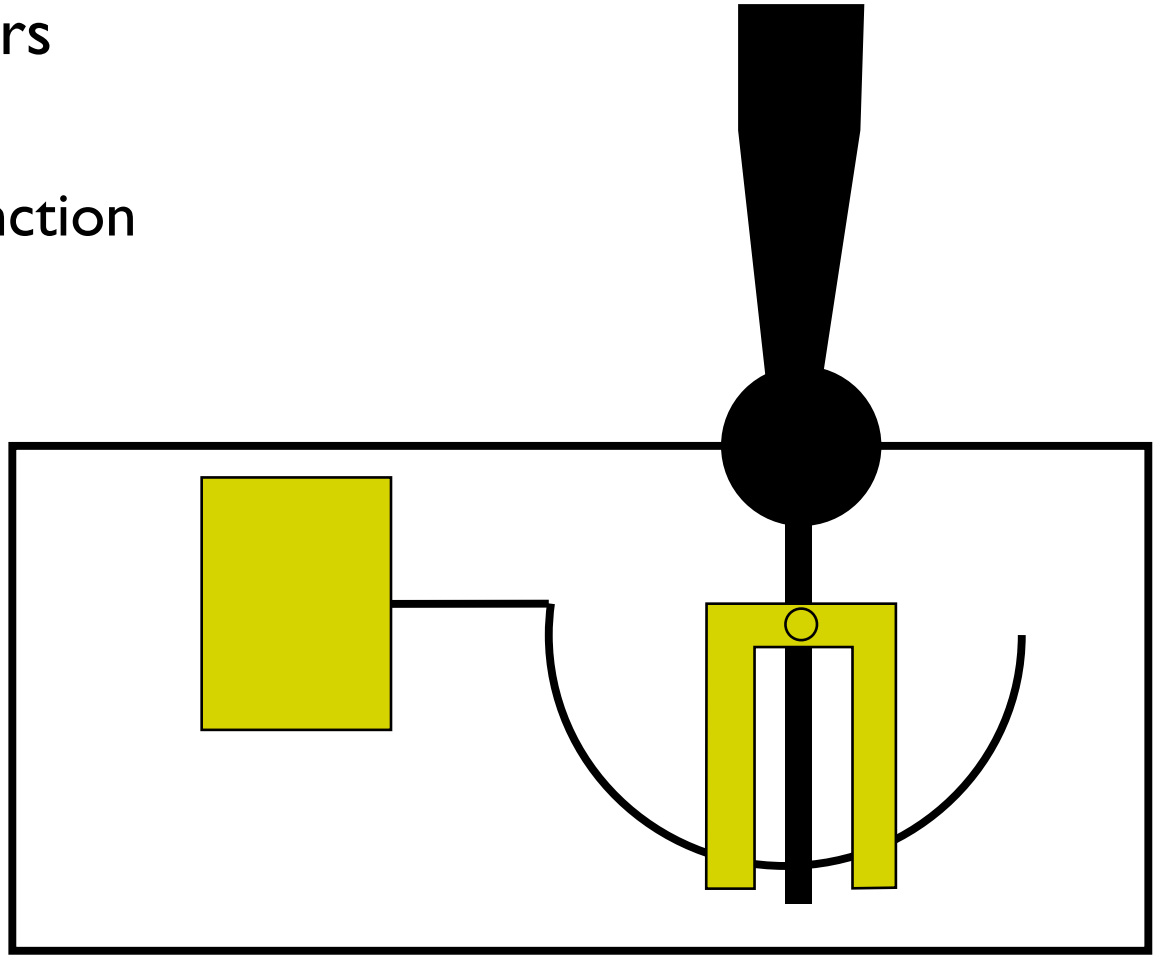
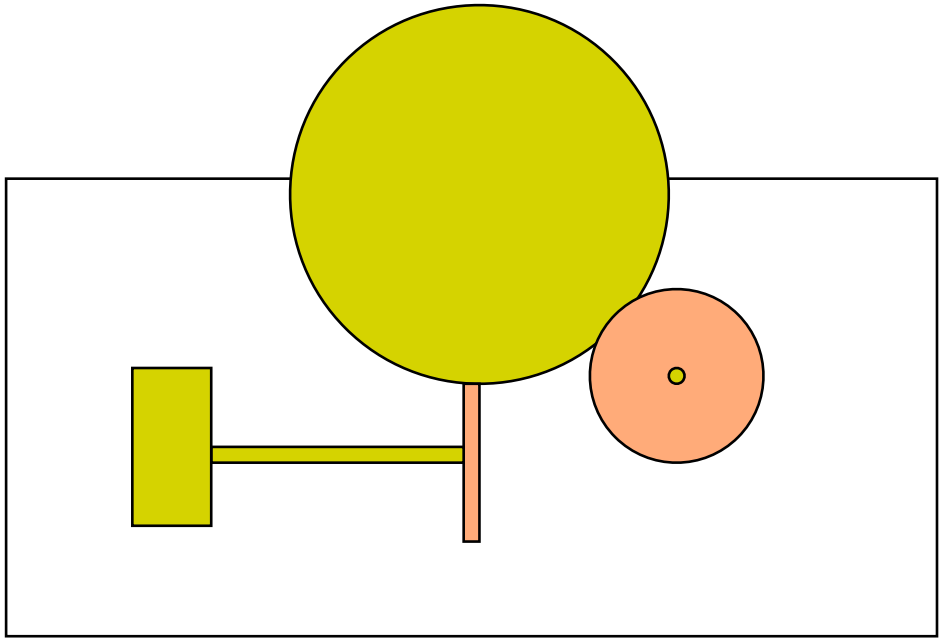


Joystick construction

- TrackPoint (IBM technology)
  - uses strain gauge sensors
- Also can be implemented with switches
  - one in each direction
  - Fixed speed of movement

Trackballs

- (Typically large) ball which rolls over 2 wheels



Trackballs

- Clutched absolute
  - but with small movement range
- Infinite input range, etc.
- Properties vary quite a bit
  - scaling of movements
  - mass of ball
    - high mass ball can act as a relative device by spinning it

Mouse

- Clutched absolute
  - infinite range, etc.
- How is it constructed?

Mouse

- Clutched absolute
  - infinite range, etc.
- How is it constructed?
  - Turn a trackball upside down

Mouse

- Current dominant device
  - so much so that some people call any pointing device a "mouse"
  - overall a very good device

Mouse

- Invented by Douglas Engelbart et al. ~1967

http://sloan.stanford.edu/MouseSite/Archive/AugmentingHumanIntellect62/Display1967.html

Touch panel

- What kind of a device?

Touch panel

- Absolute device
- Possible to do input and output together in one place
  - actually point at things on the screen
- Resolution limited by size of finger ("digital input")
  - Or requires a pen

Touch panel construction

- Membrane
  - resistive, fine wire mesh
- Capacitive
- Optical
  - finger breaks light beam
- Surface acoustic waves

Drawing tablet

- Absolute or relative?

Drawing tablet

- Absolute device
- Normally used with pen / stylus
  - Allows "real drawing" (try drawing with a mouse vs. a pen)
  - Can often trace over paper images

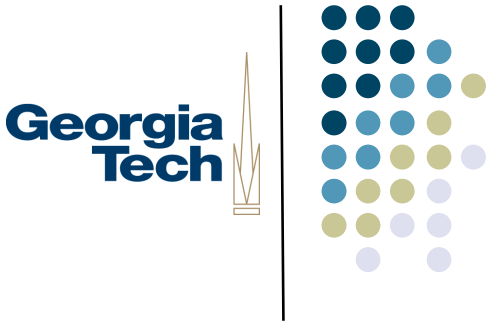
Construction of drawing tablet

- Traditional ("Rand") tablet
  - middle 60's
  - grid of wires (~100 / inch)
  - each wire transmits binary of its coord
  - stylus picks up closest
- Can also make pen transmitter and tablet receiver

Drawing tablet details

- Typically have tip switch
- May also have switch(es) on side of stylus
- Can also support a "puck" with buttons
- Best current devices can support multiple "pens" at the same time and sense rotation of a puck

Alternate Approaches to Tablets



- Old acoustic (sort of a fun device)
  - stylus emits spark
  - strip microphones at edge of tablet
  - difference in arrival time of sound

Interesting device: Virtual Ink Mimio

- Updated acoustic tablet
  - recording whiteboard
  - ultrasonic chirps
  - 100dpi resolution over ~8ft

3D locators

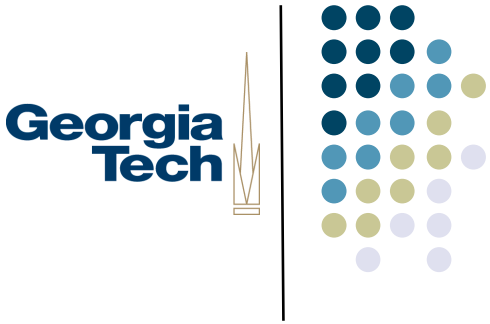
- Can extend locators to 3 inputs
- Some fun older devices
  - 3D acoustic tablet
  - Wand on reels
  - Multi-axis joystick

3D locators

- Typical for VR use: Polhemus
  - 6D device (x,y,z + pitch, roll, yaw)
  - Magnetic sensing technology
    - Doesn't work well near metal
    - Doesn't work well near deflection coils of CRT

Light pen (a very old device)

- A "pick" device
  - returns ID of an "object" on the screen (not a position)
- For vector refresh displays
  - Vector refresh worked with small "display list processor"
  - Add register holding current obj ID
  - Photocell causes interrupt when beam passes (grab and return ID)



Light pen (a very old device)

- Can't really do this anymore
  - on raster display light pen is just a locator
- But its conceptually what we usually want for input: what object the user is pointing at
  - We will simulate in SW ("picking")

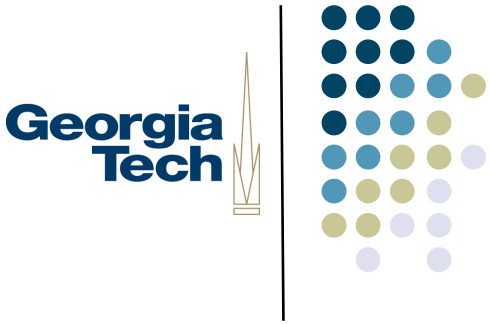
Lots of other devices

- Still mostly KB + mouse, but increasing diversity
  - Cameras!
    - Lots of untapped potential in vision
  - Microphones
    - speech as data
    - speech recognition

Lots of other devices

- Any favorites?

Some interesting ones I know about



- Thumb Wheel
- DataGlove
- Motion detectors (and other sensors)
- Accelerometers
- Fingerprint readers
- RF tags (physical objects as tokens for data/action)
- Sub-gram resolution scales