chapter 2

the computer

The Computer

a computer system is made up of various elements

each of these elements affects the interaction

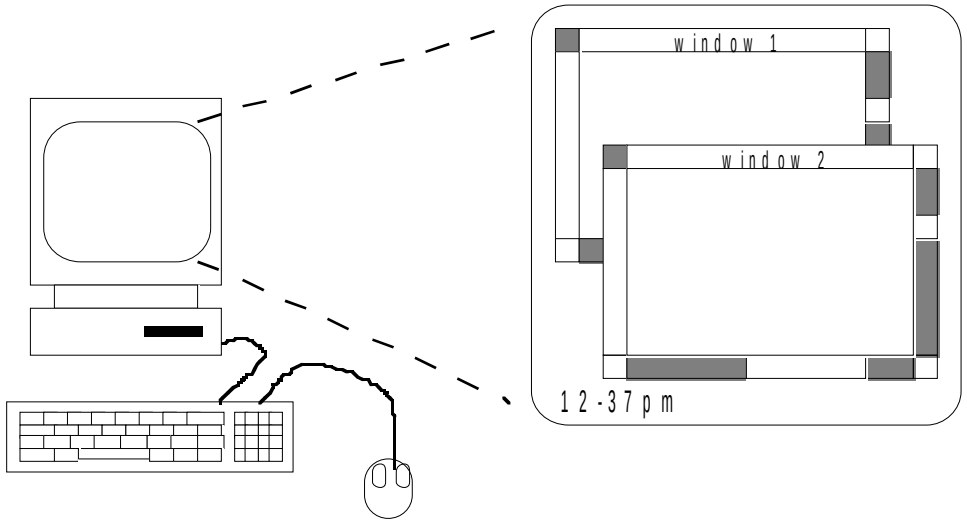
- input devices – text entry and pointing
- output devices – screen (small&large), digital paper
- virtual reality – special interaction and display devices
- physical interaction – e.g. sound, haptic, bio-sensing
- paper – as output (print) and input (scan)
- memory – RAM & permanent media, capacity & access
- processing – speed of processing, networks

A 'typical' computer system

?

- screen, or monitor, on which there are windows
- keyboard
- mouse/trackpad

- variations
  - desktop
  - laptop
  - PDA



the devices dictate the styles of interaction that the system supports

If we use different devices, then the interface will support a different style of interaction

How many computers …

in your house?

- PC
- TV, VCR, DVD, HiFi, cable/satellite TV
- microwave, cooker, washing machine
- central heating
- security system

can you think of more?

in your pockets?

- PDA
- phone, camera
- smart card, card with magnetic strip?
- electronic car key
- USB memory

try your pockets and bags

Interactivity?

Long ago in a galaxy far away … *batch* processing

- punched card stacks or large data files prepared
- long wait ….
- line printer output

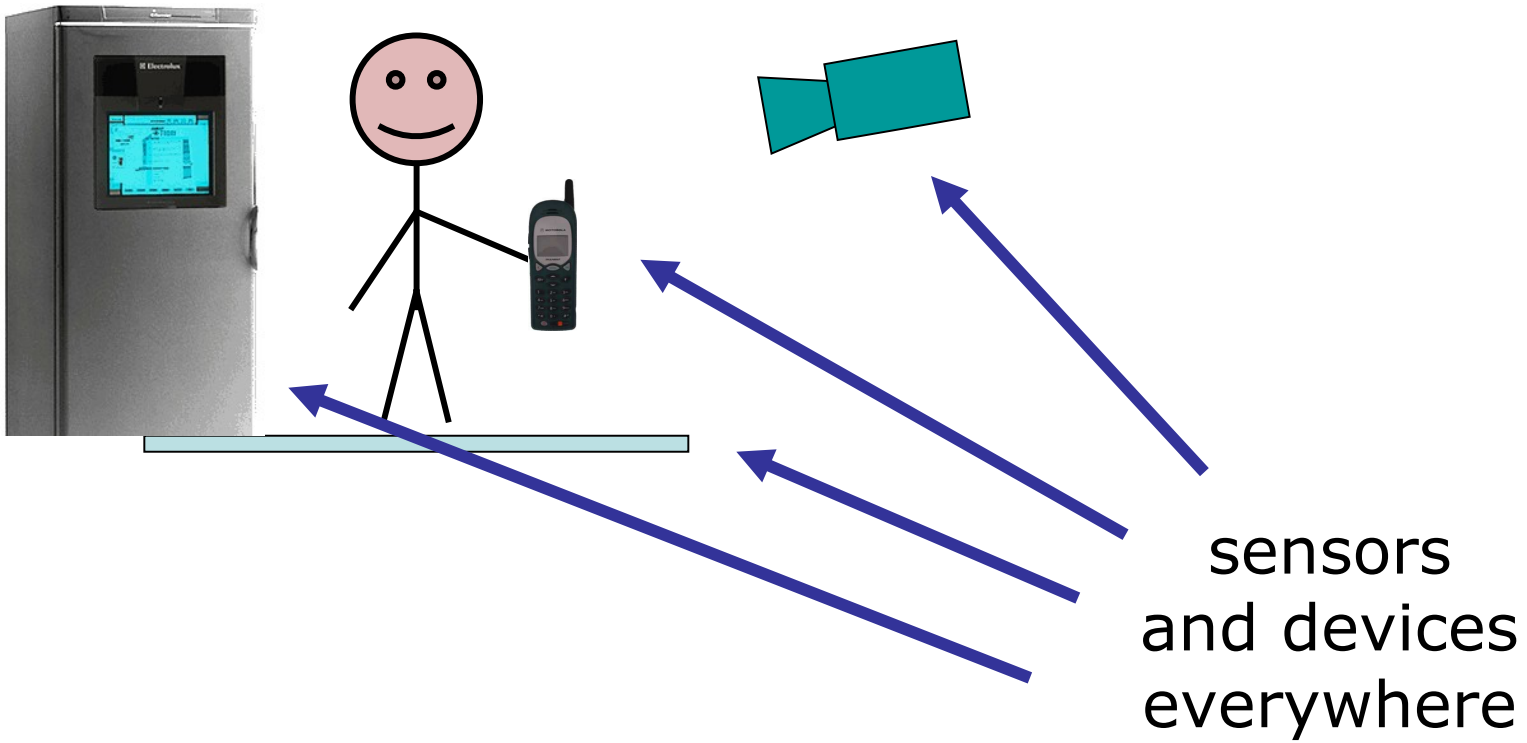
  … and if it is not right …

Now most computing is interactive

- rapid feedback
- the user in control (most of the time)
- doing rather than thinking …

Is faster always better?

Richer interaction



text entry devices

keyboards (QWERTY et al.)
chord keyboards, phone pads
handwriting, speech

Keyboards

- Most common text input device
- Allows rapid entry of text by experienced users

- Keypress closes connection, causing a character code to be sent
- Usually connected by cable, but can be wireless

layout – QWERTY

- Standardised layout
  but …
  - non-alphanumeric keys are placed differently
  - accented symbols needed for different scripts
  - minor differences between UK and USA keyboards

- QWERTY arrangement not optimal for typing
  - layout to prevent typewriters jamming!
- Alternative designs allow faster typing but large social base of QWERTY typists produces reluctance to change.

alternative keyboard layouts

Alphabetic

- keys arranged in alphabetic order
- not faster for trained typists
- not faster for beginners either!

Dvorak

- common letters under dominant fingers
- biased towards right hand
- common combinations of letters alternate between hands
- 10-15% improvement in speed and reduction in fatigue
- But - large social base of QWERTY typists produce market pressures not to change

special keyboards

- for one handed use
  - e.g. the Maltron left-handed keyboard

Chord keyboards

only a few keys - four or 5

letters typed as combination of keypresses

compact size

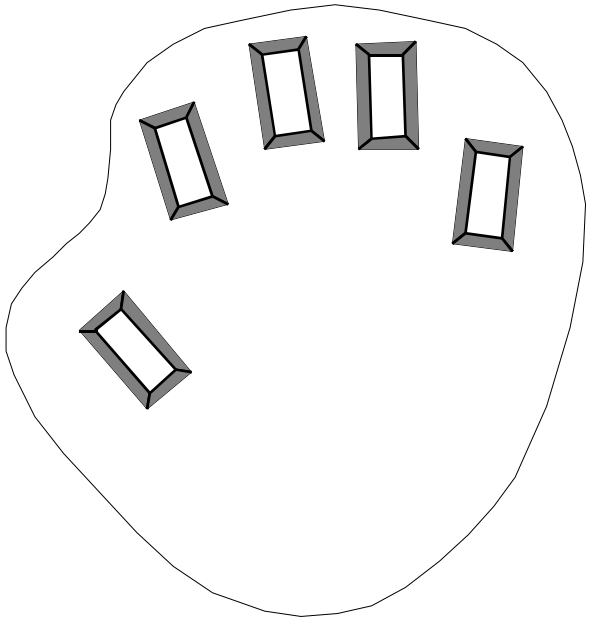
- ideal for portable applications

short learning time

- keypresses reflect letter shape

fast

- once you have trained



BUT - social resistance, plus fatigue after extended use

NEW – niche market for some wearables

phone pad and T9 entry

- use numeric keys with multiple presses

  2 – a b c 6 - m n o
  3 - d e f 7 - p q r s
  4 - g h i 8 - t u v
  5 - j k l 9 - w x y z

  hello = 4433555[pause]555666

  surprisingly fast!

- T9 predictive entry
  - type as if single key for each letter
  - use dictionary to 'guess' the right word
  - hello = 43556 …
  - but 36 -> menu 'em' or 'en'

Handwriting recognition

- Text can be input into the computer, using a pen and a digesting tablet
  - natural interaction
- Technical problems:
  - capturing all useful information - stroke path, pressure, etc. in a natural manner
  - segmenting joined up writing into individual letters
  - interpreting individual letters
  - coping with different styles of handwriting
- Used in PDAs, and tablet computers …
  … leave the keyboard on the desk!

Speech recognition

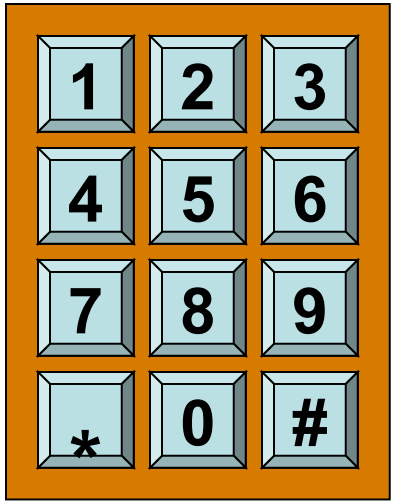
- Improving rapidly
- Most successful when:
  - single user – initial training and learns peculiarities
  - limited vocabulary systems
- Problems with
  - external noise interfering
  - imprecision of pronunciation
  - large vocabularies
  - different speakers

Numeric keypads

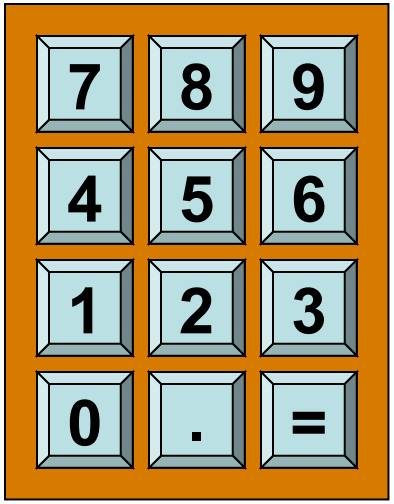
- for entering numbers quickly:
  - calculator, PC keyboard
- for telephones

not the same!!

ATM like phone



telephone



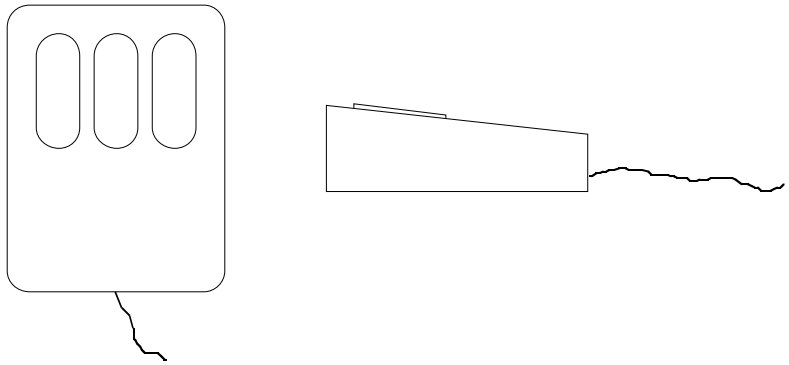
calculator

positioning, pointing and drawing

mouse, touchpad
trackballs, joysticks etc.
touch screens, tablets
eyegaze, cursors

the Mouse

- Handheld pointing device
  - very common
  - easy to use

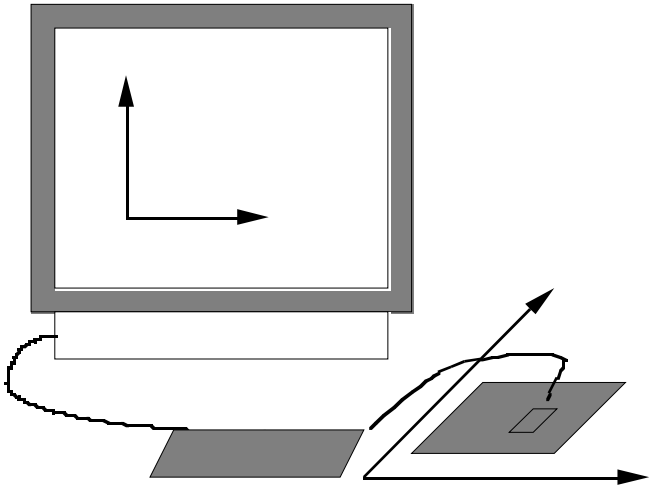


- Two characteristics
  - planar movement
  - buttons

    (usually from 1 to 3 buttons on top, used for making a selection, indicating an option, or to initiate drawing etc.)

the mouse (ctd)

Mouse located on desktop
- requires physical space
- no arm fatigue



Relative movement only is detectable.

Movement of mouse moves screen cursor

Screen cursor oriented in (x, y) plane,
mouse movement in (x, z) plane …

… an *indirect* manipulation device.
- device itself doesn't obscure screen, is accurate and fast.
- hand-eye coordination problems for novice users

How does it work?

Two methods for detecting motion

- Mechanical
  - Ball on underside of mouse turns as mouse is moved
  - Rotates orthogonal potentiometers
  - Can be used on almost any flat surface
- Optical
  - light emitting diode on underside of mouse
  - may use special grid-like pad or just on desk
  - less susceptible to dust and dirt
  - detects fluctuating alterations in reflected light intensity to calculate relative motion in (x, z) plane

Even by foot …

- some experiments with the *footmouse*
  - controlling mouse movement with feet …
  - not very common :-)

- but foot controls are common elsewhere:
  - car pedals
  - sewing machine speed control
  - organ and piano pedals

Touchpad

- small touch sensitive tablets
- 'stroke' to move mouse pointer
- used mainly in laptop computers

- good 'acceleration' settings important
  - fast stroke
    - lots of pixels per inch moved
    - initial movement to the target
  - slow stroke
    - less pixels per inch
    - for accurate positioning

Trackball and thumbwheels

Trackball

- ball is rotated inside static housing
  - like an upsdie down mouse!
- relative motion moves cursor
- indirect device, fairly accurate
- separate buttons for picking
- very fast for gaming
- used in some portable and notebook computers.

Thumbwheels …

- for accurate CAD – two dials for X-Y cursor position
- for fast scrolling – single dial on mouse

Joystick and keyboard nipple

Joystick

- indirect
  pressure of stick = velocity of movement
- buttons for selection
  on top or on front like a trigger
- often used for computer games
  aircraft controls and 3D navigation

Keyboard nipple

- for laptop computers
- miniature joystick in the middle of the keyboard

Touch-sensitive screen

- Detect the presence of finger or stylus on the screen.
  - works by interrupting matrix of light beams, capacitance changes or ultrasonic reflections
  - *direct* pointing device
- Advantages:
  - fast, and requires no specialised pointer
  - good for menu selection
  - suitable for use in hostile environment: clean and safe from damage.
- Disadvantages:
  - finger can mark screen
  - imprecise (finger is a fairly blunt instrument!)
    - difficult to select small regions or perform accurate drawing
  - lifting arm can be tiring

Stylus and light pen

Stylus
- small pen-like pointer to draw directly on screen
- may use touch sensitive surface or magnetic detection
- used in PDA, tablets PCs and drawing tables

Light Pen
- now rarely used
- uses light from screen to detect location

BOTH …
- very direct and obvious to use
- but can obscure screen

Digitizing tablet

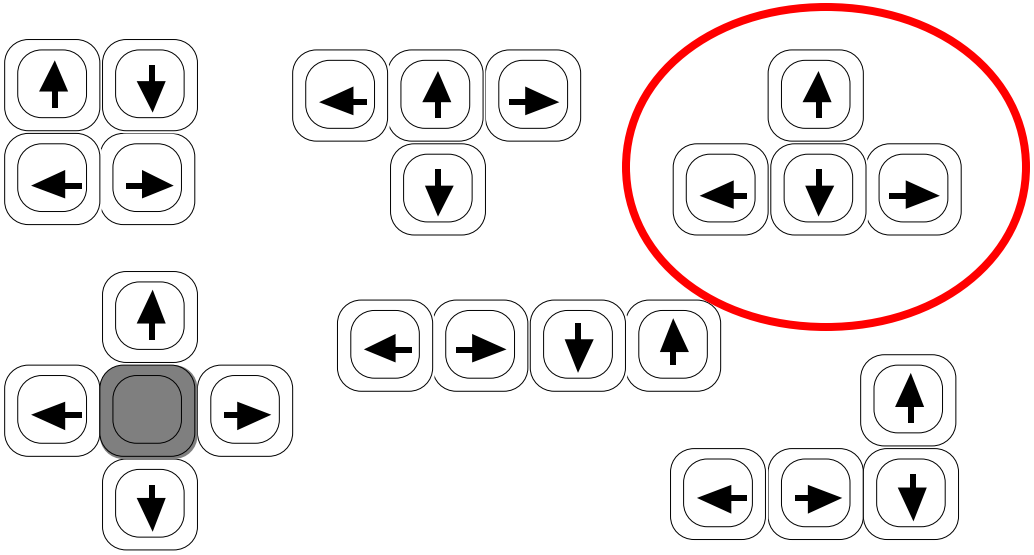
- Mouse like-device with cross hairs
- used on special surface
  - rather like stylus
- very accurate
  - used for digitizing maps

Eyegaze

- control interface by eye gaze direction
  - e.g. look at a menu item to select it
- uses laser beam reflected off retina
  - … a very low power laser!
- mainly used for evaluation (ch x)
- potential for hands-free control
- high accuracy requires headset
- cheaper and lower accuracy devices available
  sit under the screen like a small webcam

Cursor keys

- Four keys (up, down, left, right) on keyboard.
- Very, very cheap, but slow.
- Useful for not much more than basic motion for text-editing tasks.
- No standardised layout, but inverted “T”, most common



Discrete positioning controls

- in phones, TV controls etc.
  - cursor pads or mini-joysticks
  - discrete left-right, up-down
  - mainly for menu selection

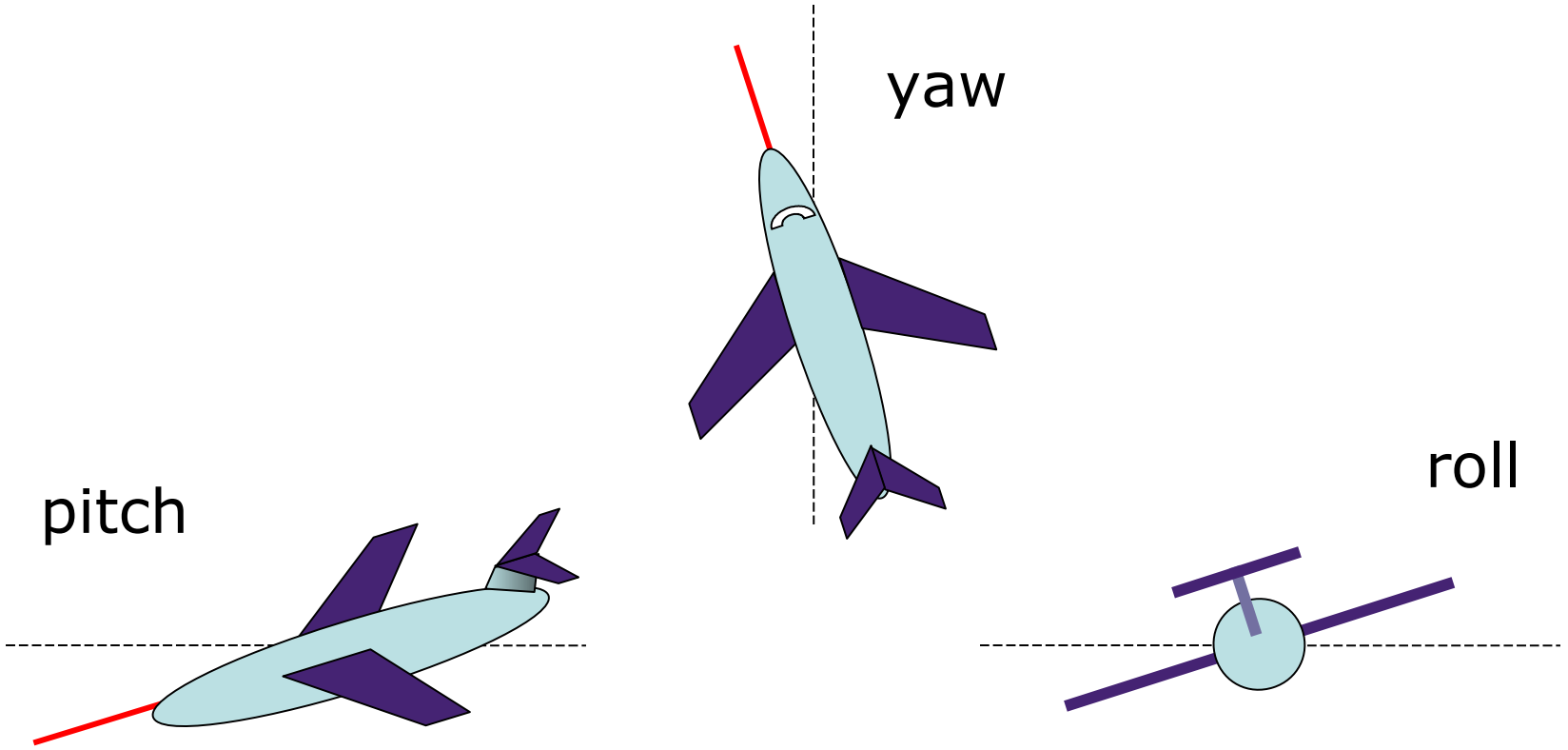
virtual reality and 3D interaction

positioning in 3D space
moving and grasping
seeing 3D (helmets and caves)

positioning in 3D space

- cockpit and virtual controls
  - steering wheels, knobs and dials … just like real!
- the 3D mouse
  - six-degrees of movement: x, y, z + roll, pitch, yaw
- data glove
  - fibre optics used to detect finger position
- VR helmets
  - detect head motion and possibly eye gaze
- whole body tracking
  - accelerometers strapped to limbs or reflective dots and video processing

pitch, yaw and roll



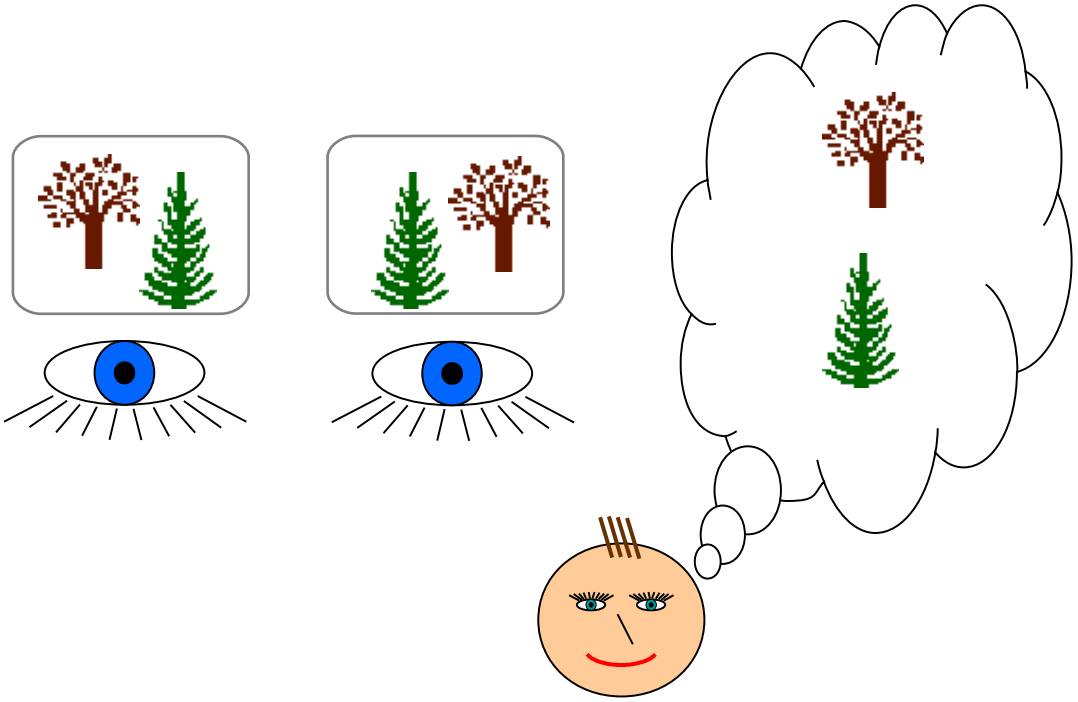
3D displays

- desktop VR
  - ordinary screen, mouse or keyboard control
  - perspective and motion give 3D effect
- seeing in 3D
  - use stereoscopic vision
  - VR helmets
  - screen plus shuttered specs, etc.

also see extra slides on 3D vision

VR headsets

- small TV screen for each eye
- slightly different angles
- 3D effect

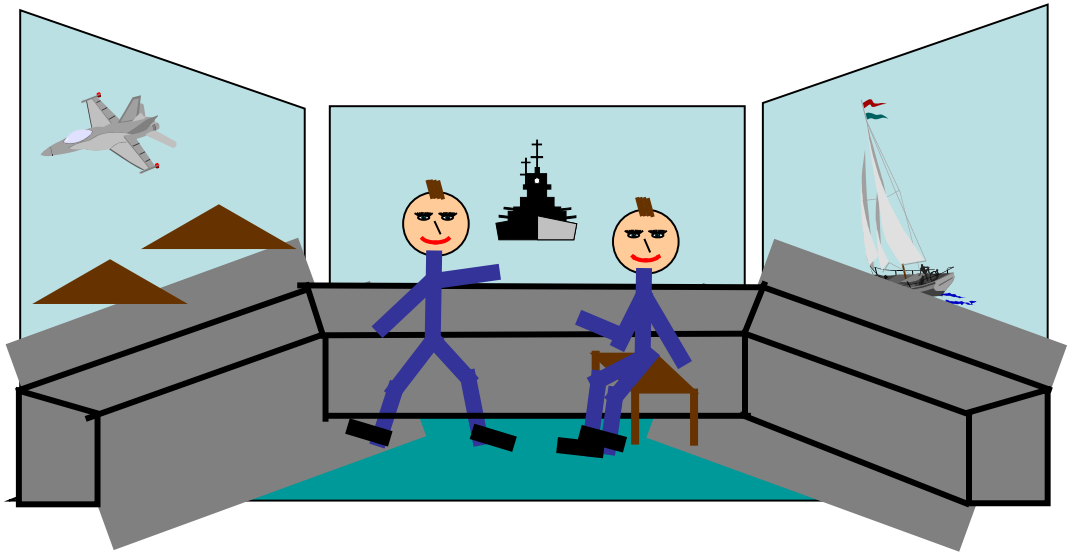


VR motion sickness

- time delay
  - move head … lag … display moves
  - *conflict:* head movement vs. eyes
- depth perception
  - headset gives different stereo distance
  - but all focused in same plane
  - *conflict:* eye angle vs. focus
- conflicting cues => sickness
  - helps motivate improvements in technology

simulators and VR caves

- scenes projected on walls
- realistic environment
- hydraulic rams!
- real controls
- other people



physical controls, sensors etc.

special displays and gauges

sound, touch, feel, smell

physical controls

environmental and bio-sensing

dedicated displays

- analogue representations:
  - dials, gauges, lights, etc.
- digital displays:
  - small LCD screens, LED lights, etc.
- head-up displays
  - found in aircraft cockpits
  - show most important controls
    … depending on context

Sounds

- beeps, bongs, clonks, whistles and whirrs
- used for error indications
- confirmation of actions e.g. keyclick

also see chapter 10

Touch, feel, smell

- touch and feeling important
  - in games … vibration, force feedback
  - in simulation … feel of surgical instruments
  - called *haptic* devices

- texture, smell, taste
  - current technology very limited

Environment and bio-sensing

- sensors all around us
  - car courtesy light – small switch on door
  - ultrasound detectors – security, washbasins
  - RFID security tags in shops
  - temperature, weight, location
- … and even our own bodies …
  - iris scanners, body temperature, heart rate, galvanic skin response, blink rate

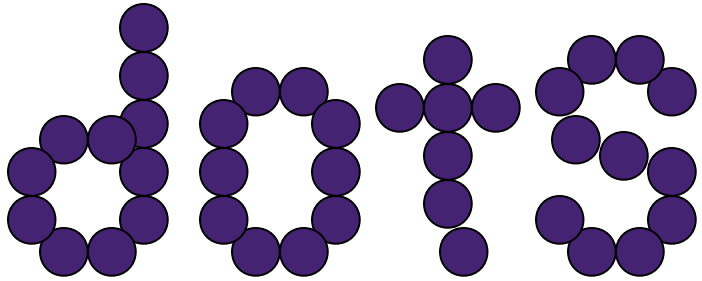
paper: printing and scanning

print technology

fonts, page description, WYSIWYG

scanning, OCR

Printing



- image made from small dots
  - allows any character set or graphic to be printed,
- critical features:
  - resolution
    - size and spacing of the dots
    - measured in dots per inch (dpi)
  - speed
    - usually measured in pages per minute
  - cost!!

Screen and page

- WYSIWYG
  - what you see is what you get
  - aim of word processing, etc.
- but …
  - screen: 72 dpi, landscape image
  - print: 600+ dpi, portrait
- can try to make them similar
  but never quite the same
- so … need different designs, graphics etc, for screen and print

Scanners

- Take paper and convert it into a bitmap
- Two sorts of scanner
  - flat-bed: paper placed on a glass plate, whole page converted into bitmap
  - hand-held: scanner passed over paper, digitising strip typically 3-4” wide
- Shines light at paper and note intensity of reflection
  - colour or greyscale
- Typical resolutions from 600–2400 dpi

Scanners (ctd)

Used in

- desktop publishing for incorporating photographs and other images
- document storage and retrieval systems, doing away with paper storage

+ special scanners for slides and photographic negatives

Optical character recognition

- OCR converts bitmap back into text
- different fonts
  - create problems for simple "template matching" algorithms
  - more complex systems segment text, decompose it into lines and arcs, and decipher characters that way
- page format
  - columns, pictures, headers and footers

Paper-based interaction

- paper usually regarded as *output* only
- can be *input* too – OCR, scanning, etc.
- Xerox PaperWorks
  - glyphs – small patterns of /\\//\\\
    - used to identify forms etc.
    - used with scanner and fax to control applications
- more recently
  - papers micro printed - like wattermarks
    - identify *which* sheet and *where* you are
  - special 'pen' can read locations
    - know where they are writing