chapter 2

The Computer

The Computer

- In order to understand how humans interact with computers, we need to have an understanding of both parties in the interaction.
- This chapter considers the computer and its associated input–output devices and investigates how the technology influences the nature of the interaction and style of the interface.
- What happens when we (as people) interact with each other?
  - We are either passing information to other people, or receiving information from them.
  - Often, the information we receive is in response to the information that we have recently imparted to them, and we may then respond to that.
  - Therefore, interaction is a process of information transfer.

The Computer

- Relating this to the electronic computer, the same principles hold:
  - Interaction is a process of information transfer, from the user to the computer and from the computer to the user.

- The details of computer processing should largely be irrelevant to the end-user, but
  - Interface designer needs to be aware of the limitations of storage capacity and computational power.
  - Software designers often have high-end machines on which to develop applications.

The Computer

- The following section of this chapter concentrates on the transference of information from the user to the computer and back.

- Moreover, they consider the computer itself, its processor and memory devices and the networks that link them together.

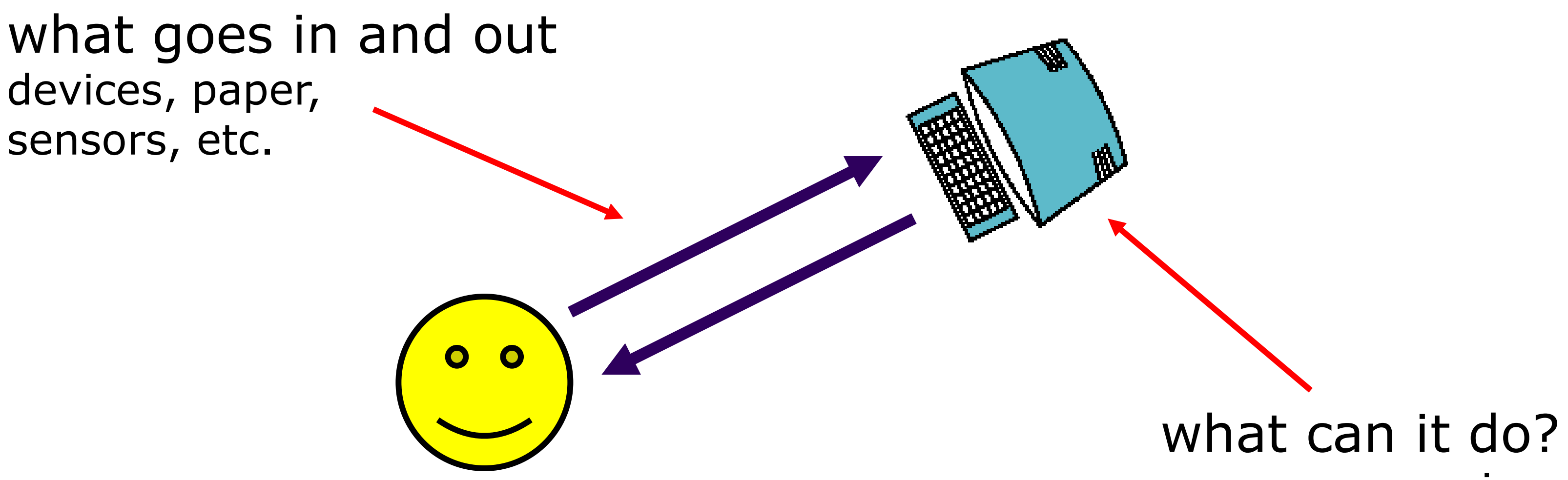
- The computer system comprises various elements (e.g., input devices, output devices, and etc.), each of which affects the user of the system.

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

Interacting with Computers

to understand human–*computer* interaction
… need to understand computers!

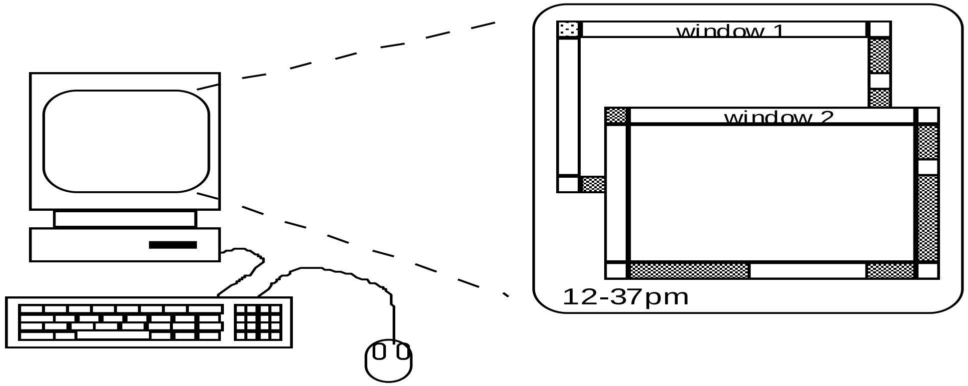


A 'typical' Computer System

?

- 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?
  - hands up, …
    … none, 1, 2 , 3, more!!

- computers in your pockets?

are you thinking …
… PC, laptop, PDA ??

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?

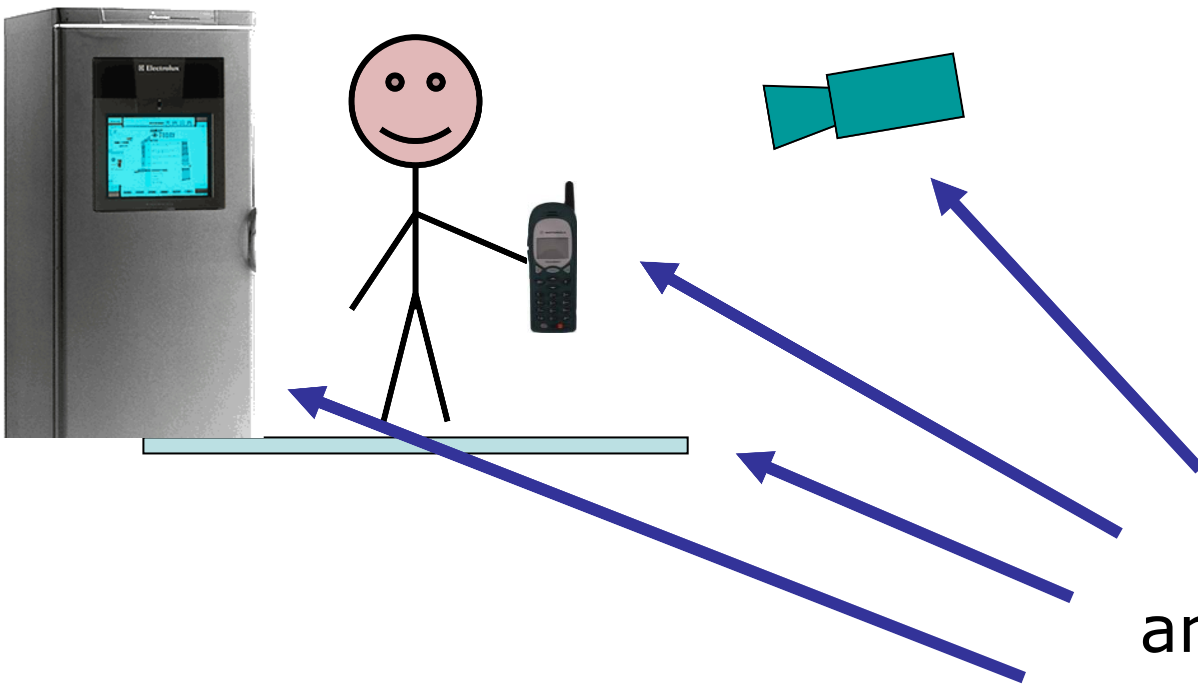
- Long ago in a galaxy far away … *batch* processing
  - punched card stacks or large data files prepared
  - long wait ….
  - line printer output

    … 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



sensors
and devices
everywhere

Text Entry Devices

keyboards (QWERTY et al.)

chord keyboards, phone pads

handwriting, speech

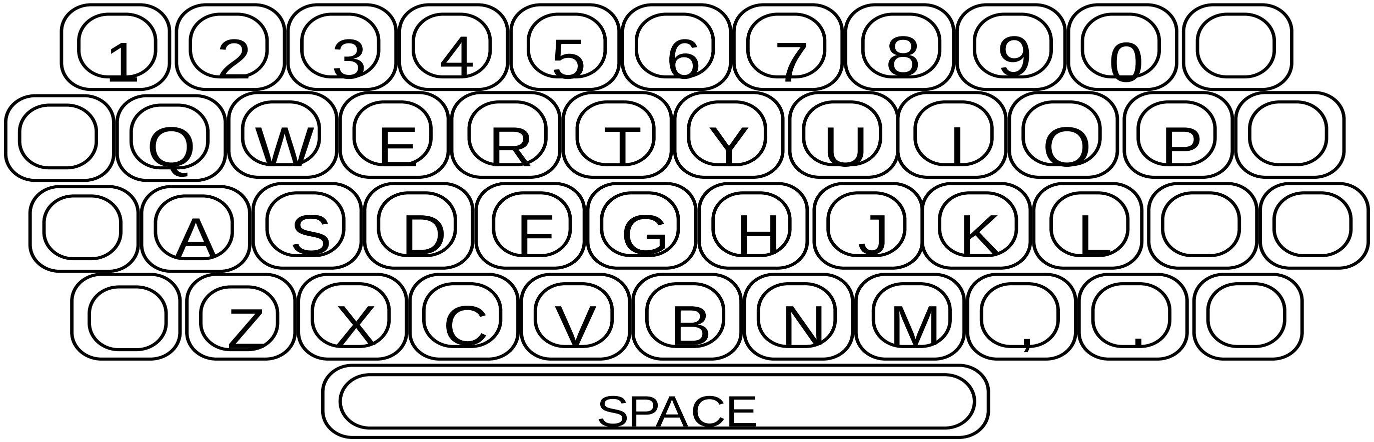
Keyboards

- The plain keyboard is the most obvious means of text entry (most common).
  - Allows rapid entry of text by experienced users
  - Usually connected by cable, but can be wireless
- There are several variations for the text entry such as:
  - Different keyboard layouts (chord keyboards, Qwerty Keyboards, Dvorak keyboards, etc)
  - Handwriting Recognition
  - Speech Recognition
- How keyboards work?

QWERTY Keyboards

- Proposed by Charles Sholes in 1868.
- The layout of the digits and letters on a QWERTY keyboard is fixed, but non-alphanumeric keys vary between keyboards.
  - For example, there is a difference between key assignments on British and American keyboards.
- The QWERTY arrangement of keys is 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.

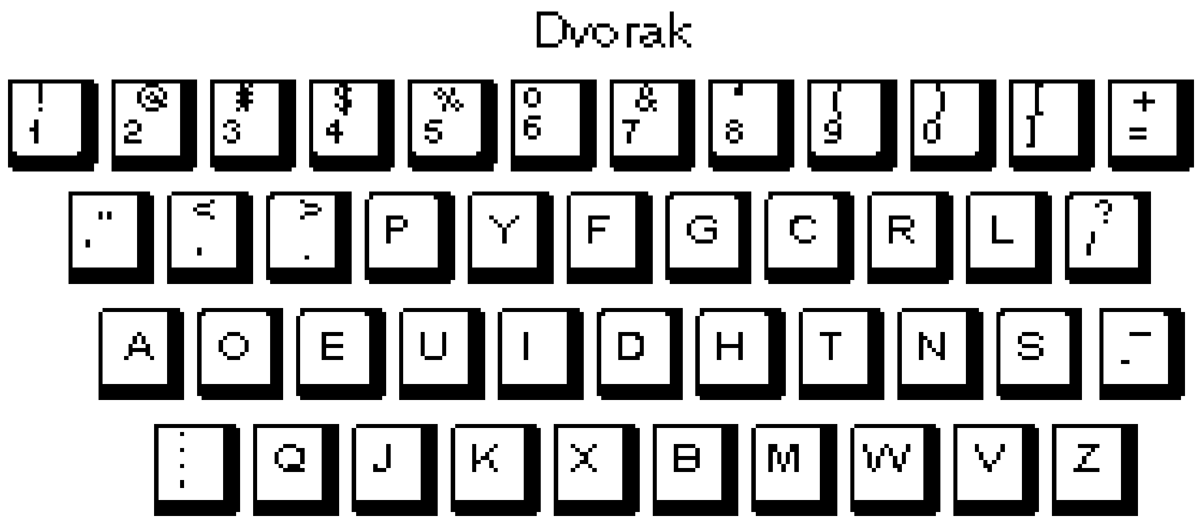
QWERTY Keyboards



Alternative Keyboard Layouts (DVORAK Keyboard)

- Designed in 1930's by August Dvorak.
- The DVORAK keyboard uses a similar layout of keys to the QWERTY system, but assigns the letters to different keys.
  - Keeping the most commonly used keys on the home or middle
  - Biased towards right hand
  - Common combinations of letters alternate between hands
  - 70% of keystrokes are made without the typist having to stretch far
  - 10-15% improvement in speed and reduction in fatigue
  - But - large social base of QWERTY typists produce market pressures not to change

Alternative Keyboard Layouts (DVORAK Keyboard)



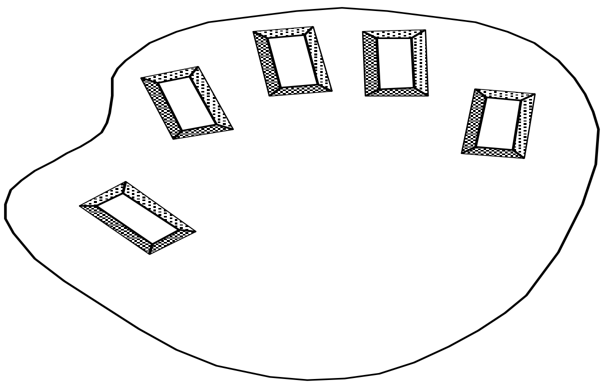
Alternative Keyboard Layouts (Alphabetic Keyboard)

Alphabetic

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

Chord keyboards

- Chord keyboard as a data entry input device was first seriously investigated in the mid-1950s by the Canadian Post Office.
- Chord keyboards are significantly different from normal alphanumeric keyboards.
- Only a few keys (four or five) are used.
- Letters are produced by pressing one or more of the keys at once.
- Ideal for portable applications



Chord keyboards

- Advantages:
  - Very Small (palm sized).
  - Can be used by one hand.
  - Learning time is hours.
  - Faster than conventional keyboards.
- Disadvantages:
  - Fatigue - hard to use for long time.
  - Social resistance

Phone Pad and Numeric Keypads

- Phone Pad:
- 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

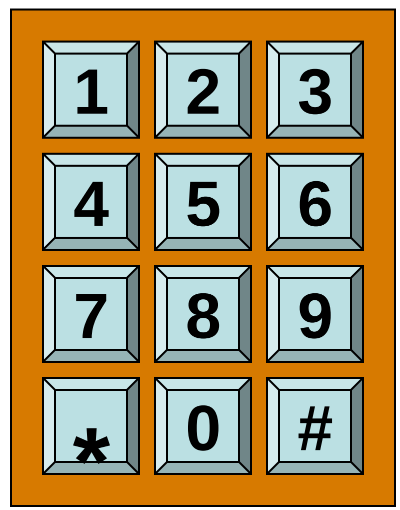
- hello = 4433555[pause]555666
  surprisingly fast!

Phone Pad and Numeric Keypads

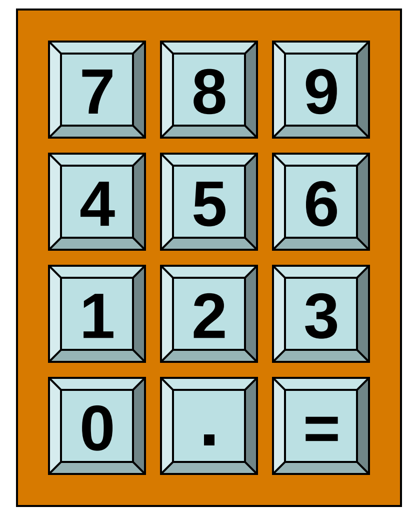
- Numeric Keypads:
- For entering numbers quickly
  - calculator, PC keyboard
- For telephones

Not the same!!

ATM like phone



telephone



calculator

Special Keyboards

- Designs to reduce fatigue for repetitive strain injury (RSI)
- For one handed use

  e.g. the Maltron left-handed keyboard

Handwriting Recognition

- Handwriting recognition is an attractive method of text entry
- Text can be input into the computer, using a pen and a digesting tablet
  - natural interaction

- Technical problems carried heavy limitations in two key areas:
  - Character extraction
    - individual characters are recognised by ease but difficult to interpret handwriting with no distinct separation between characters.
    - coping with different styles of handwriting.

Handwriting Recognition

- Feature extraction
  - Individual properties of symbols were hard-coded (aspect ratio, pixel distribution, number of strokes, distance from the image centre, and reflection). This requires development time.

- Used in PDAs, and tablet computers … … leave the keyboard on the desk!

Speech Recognition

- Speech recognition is a promising area of text entry.
- Improving rapidly
- Only used in very limited situations

- 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

Positioning, Pointing and Drawing

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

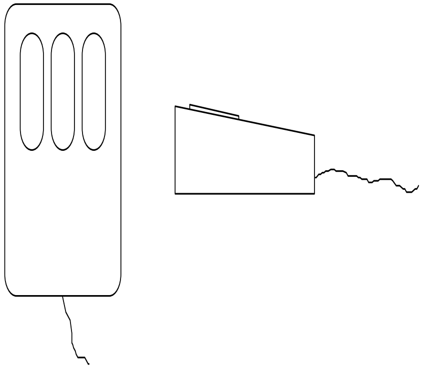
Pointing Devices

- Pointing devices allow the user to point, position and select items.
- Either directly or by manipulating a pointer on the screen.
- Many pointing devices can also be used for free-hand drawing.
- Although the skill of drawing with a mouse is very different from using a pencil.

The Mouse

- The mouse has become a major component of the majority of desktop computer systems sold today.
- 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.)



How does it work?

- Two methods for detecting motion
  - Mechanical
    - ball on underside of mouse turns as mouse is moved
    - 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

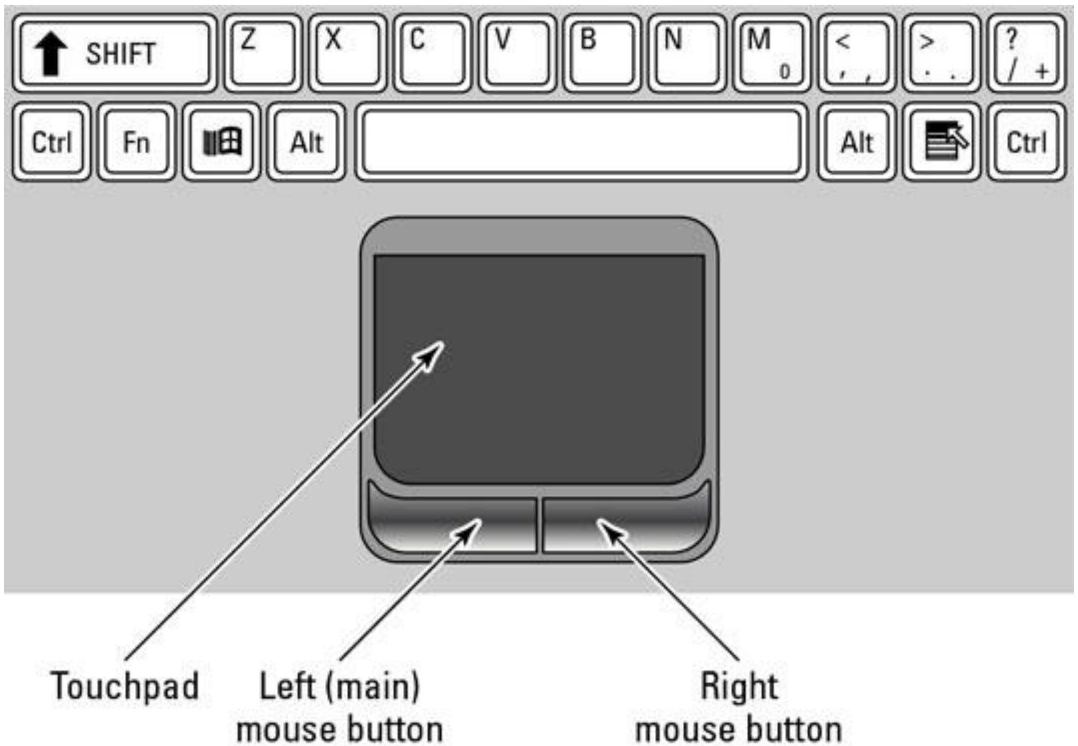
Even by Foot …

- 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
  - piano pedals

Touchpad

- The first touch pad was invented by George E. Gerpheide in 1988.
- Apple Computer was the first to license and use the touch pad in its Powerbook laptops in 1994.
- The touch pad has since become the leading cursor controlling device in laptops.
- Also called a glide pad, glide point, trackpad.
- touchpad is an input device on laptops and some keyboards.
- It can be used in place of an external mouse.
- A touch pad works by sensing the user's finger movement and downward pressure.

Touchpad


SHIFT
Z
X
C
V
B
N
M
Ctrl
Fn
Alt
Alt
Ctrl
Touchpad
Left (main)
mouse button
Right
mouse button

Touchpad

- The touch pad contains several layers of material:
  - The top layer is the pad that you touch
  - Separated electrodes in form a grid (horizontal and vertical rows)
  - Circuit board
- The layers with electrodes are charged with a constant alternating current (AC).
- As the finger approaches the electrode grid, the current is interrupted and the interruption is detected by the circuit board.
- The initial location where the finger touches the pad is registered.
- Subsequent finger movement will be related to that initial point.

Trackball

- Trackball is a pointing input device, used to enter motion data into computers or other electronic devices.
  - 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
- Trackballs were common on portable and notebook computers (such as the BlackBerry Tour) where there may be no desk space on which to run a mouse.
- Trackballs are common on CAD workstations for easy precision, before the advent of the touchpad.

Trackball


Left Click
Forward Button
Back Button
Low Voltage Indicator
Trackball
Wheel
Right Click
DPI Switch(+&-)
perixx

Joystick

- Joystick is an indirect input device, taking up very little space. Consisting of a small palm-sized box with a stick.
  - inexpensive
  - fairly robust
  - familiarity to users
- For this reason they are found in market for computer games.
- Also used for aircraft controls and 3D navigation.

Joystick

Joystick

Keyboard Nipple

- Keyboard nipple
  - For laptop computers.
  - Miniature joystick in the middle of the keyboard, between the G, H, and B keys.
  - Operated by pushing in the general direction the user wants the cursor to move.

Touch-Sensitive Screen

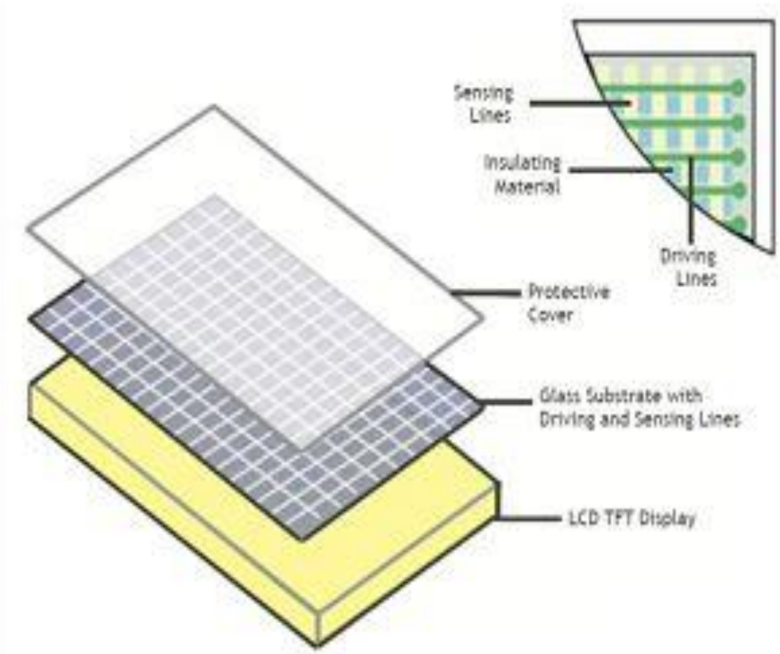
- A touch screen is a both input and output device . The screens are sensitive to pressure; a user interacts with the computer by touching pictures or words on the screen.
- Detect the presence of finger or stylus on the screen.

- There are three types of touch screen technology:
  - Resistive is coated with a thin metallic electrically conductive and resistive layer that causes a change in the electrical current which is registered as a touch event and sent to the controller for processing.
    - Affordable
    - Offer only 75% clarity
    - Can be damaged by sharp objects
    - Not affected by outside elements such as dust or water

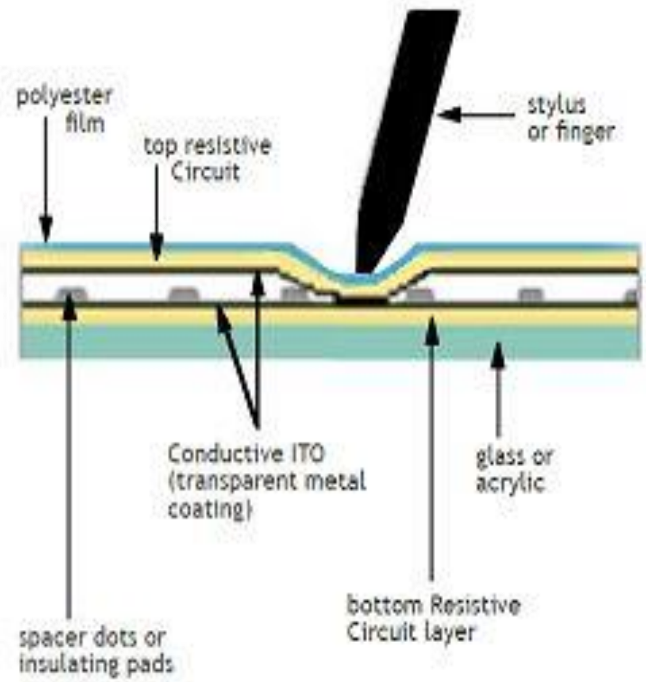
Touch-Sensitive Screen

- There are three types of touch screen technology:
  - Capacitive is touch screen and coated with a material that stores electrical charges.
  - When the panel is touched, a small amount of charge is drawn to the point of contact.
  - Circuits located at each corner of the panel measure the charge and send the information to the controller for processing.
    - Capacitive touch screen panels must be touched with a finger
      - unlike resistive and surface wave panels that can use fingers and stylus
    - not affected by outside elements
    - have high clarity

Touch-Sensitive Screen



Capacitve Touch Screen



Resistive Touch Screen

Touch-Sensitive Screen

- There are three types of touch screen technology:
  - Surface wave is technology uses ultrasonic waves that pass over the touch screen.
  - When the panel is touched, a portion of the wave is absorbed and registers this change then sends this information to the controller for processing.
    - Most advanced of the three types
    - But can be damaged by outside elements

Stylus and Light Pen

- Stylus
  - Small pen-like pointer to draw directly on screen
    - Like a tiny ink pen but uses pressure instead of ink
  - 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

Stylus and Light Pen

Stylus Pen

Light Pen

Digitizing Tablet

- Digitizing Tablet
  - An input device that enables you to enter drawings and sketches into a computer.
- A digitizing tablet consists of an electronic tablet and a cursor or pen.
  - used on special surface
  - very accurate
  - used for digitizing maps

Eye gaze

- also called eye tracking is a way of accessing your computer or communication aid using a mouse that you control with your eyes.

- 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!

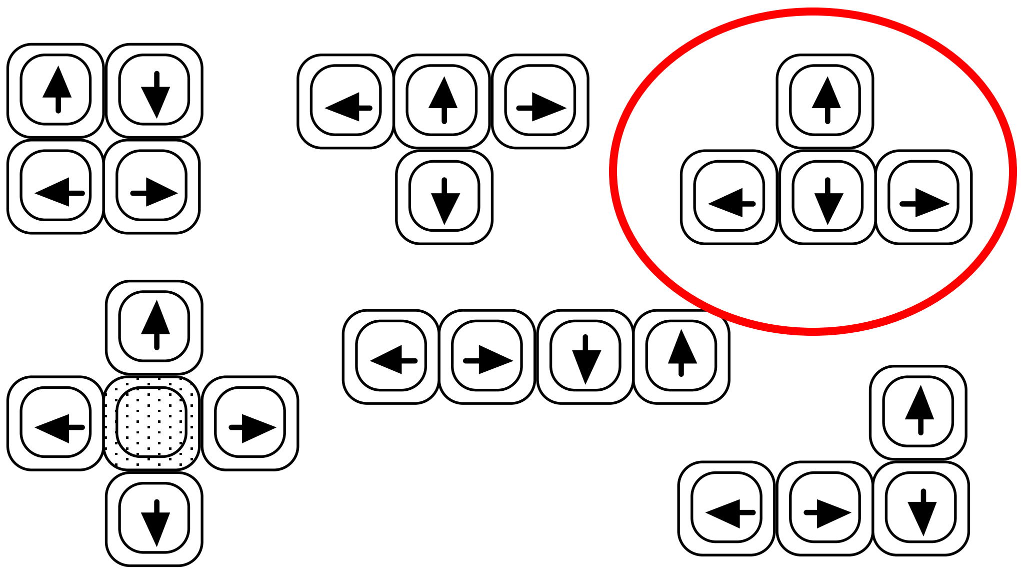
Eye gaze

Eye gaze

Cursor Keys

- The cursor keys or arrow keys are keyboard keys that move the pointer (cursor) on screen.
  - Four keys (up, down, left, right) on keyboard.
  - Provided for interactive navigation on a computer system.
  - Historically there have been many different arrangements.
  - No standard layout has been the inverse-T layout, most common.
  - Useful for not much more than basic motion for text-editing tasks.

Cursor Keys



Discrete Positioning Controls

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

display devices

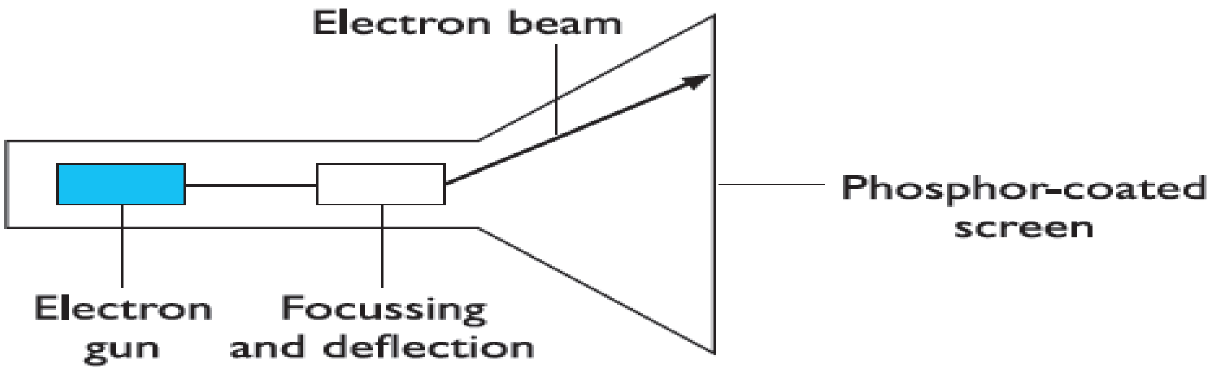
bitmap screens (CRT & LCD)

large & situated displays

digital paper

CRT

- CRT (Cathode Ray Tube) is the computer screen that works in a similar way to a standard television screen
  - similar way to a standard television screen.
  - stream of electrons is emitted from an electron gun.
  - focused and directed by magnetic fields.
  - the beam hits the phosphor-coated screen.
  - phosphor is excited by the electrons and glows.



CRT

- The electron beam is scanned from left to right, then flicked back to rescan the next line, from top to bottom.
- This is repeated, at about 30 Hz (that is, 30 times a second) per frame.
- Although higher scan rates are sometimes used to reduce the flicker on the screen.

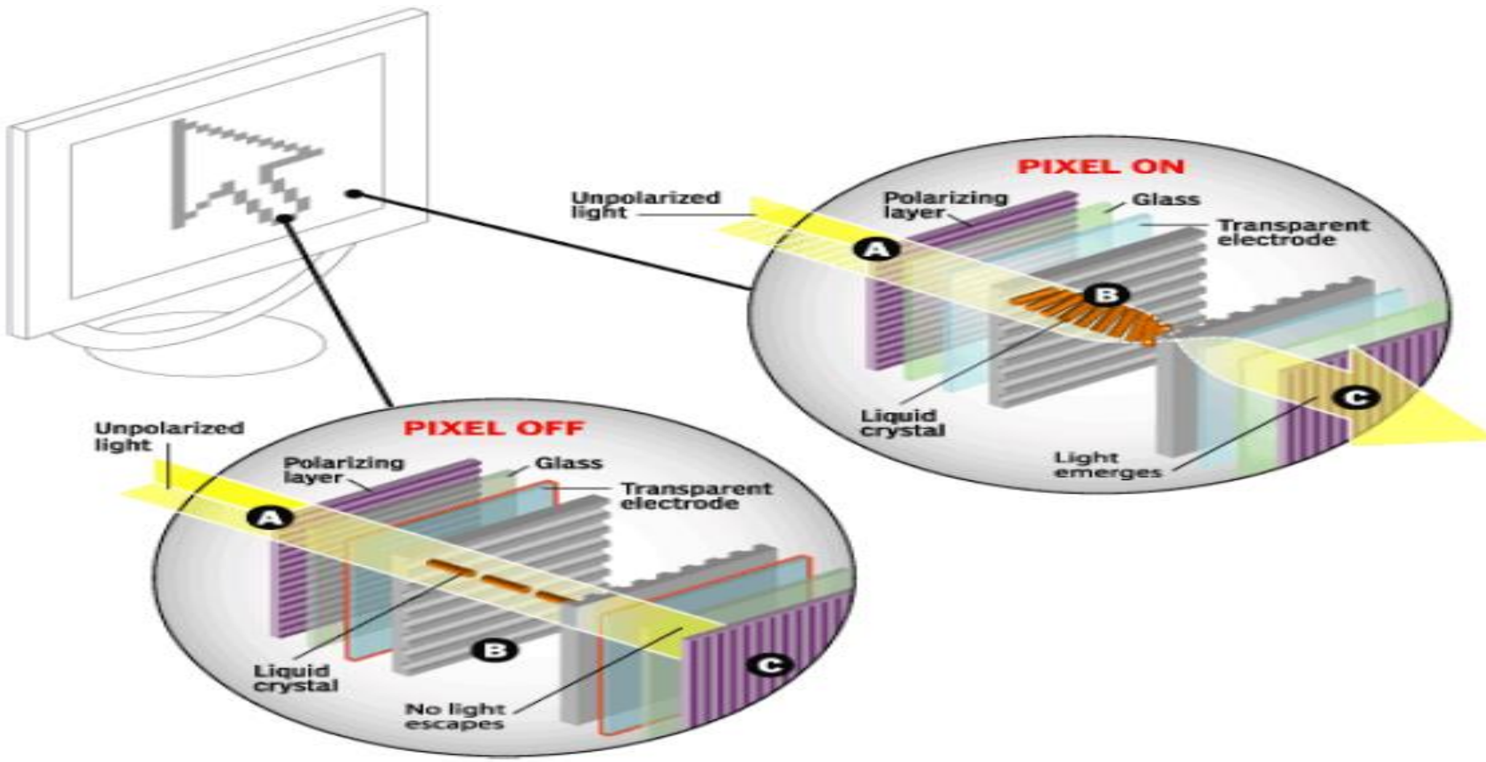
LCD

- LCD (Liquid Crystal Display) is a flat-panel display that uses the light modulating properties of liquid crystals.
- Liquid crystals do not emit light directly.
- LCD consists primarily of two plates of glass with a thin layer of liquid crystal solution sandwiched between them.
  - The top plate is transparent and polarized.
  - The bottom plate is reflective.
- The type of liquid crystals used in LCD panels have very specific properties that enable them to serve as effective that open and close to block or let light through in response to an electric current.
- The liquid crystals is controlled on current by a voltage applied between the glass plates via transparent electrodes that form a grid.

LCD

- As the electric current passes through these liquid crystals, they untwist to varying degrees, depending on the voltage applied.
- This untwisting effect will change the polarization of the light passing through the LCD panel.
- More or less light is able to pass through the polarized filter on the face of the LCD.
- Intersecting grid points represent picture elements (pixels).
- In a color LCD panel, each pixel is made up of three liquid crystal cells.
- Each of those three cells contains a red, green, or blue filter.
- Light passing through the filtered cells creates the colors seen on the LCD.

LCD


PIXEL ON
Unpolarized light
Polarizing layer
Glass
Transparent electrode
A
B
Liquid crystal
C
Light emerges
PIXEL OFF
Unpolarized light
Polarizing layer
Glass
Transparent electrode
A
Liquid crystal
B
C
No light escapes

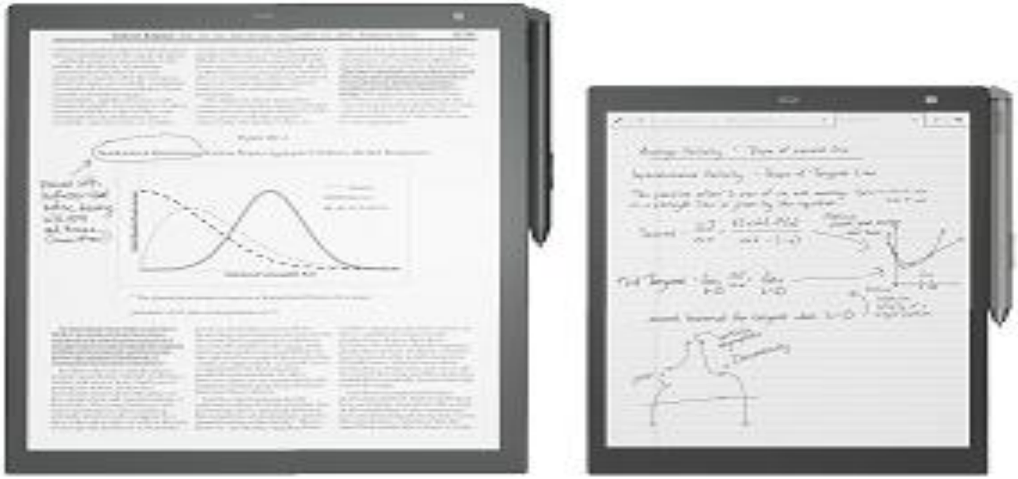
Advantages of LCD

- Advantages of LCD Displays:
  - Easier to manufacture.
  - Have higher resolution because several million pixels can be etched onto one chip.
  - Can be much smaller.
- Other Display Technologies
  - LED (Light-Emitting Diode)
  - Gas Plasma
  - DLP (Digital Light Processing)
- See the following figures

LCD

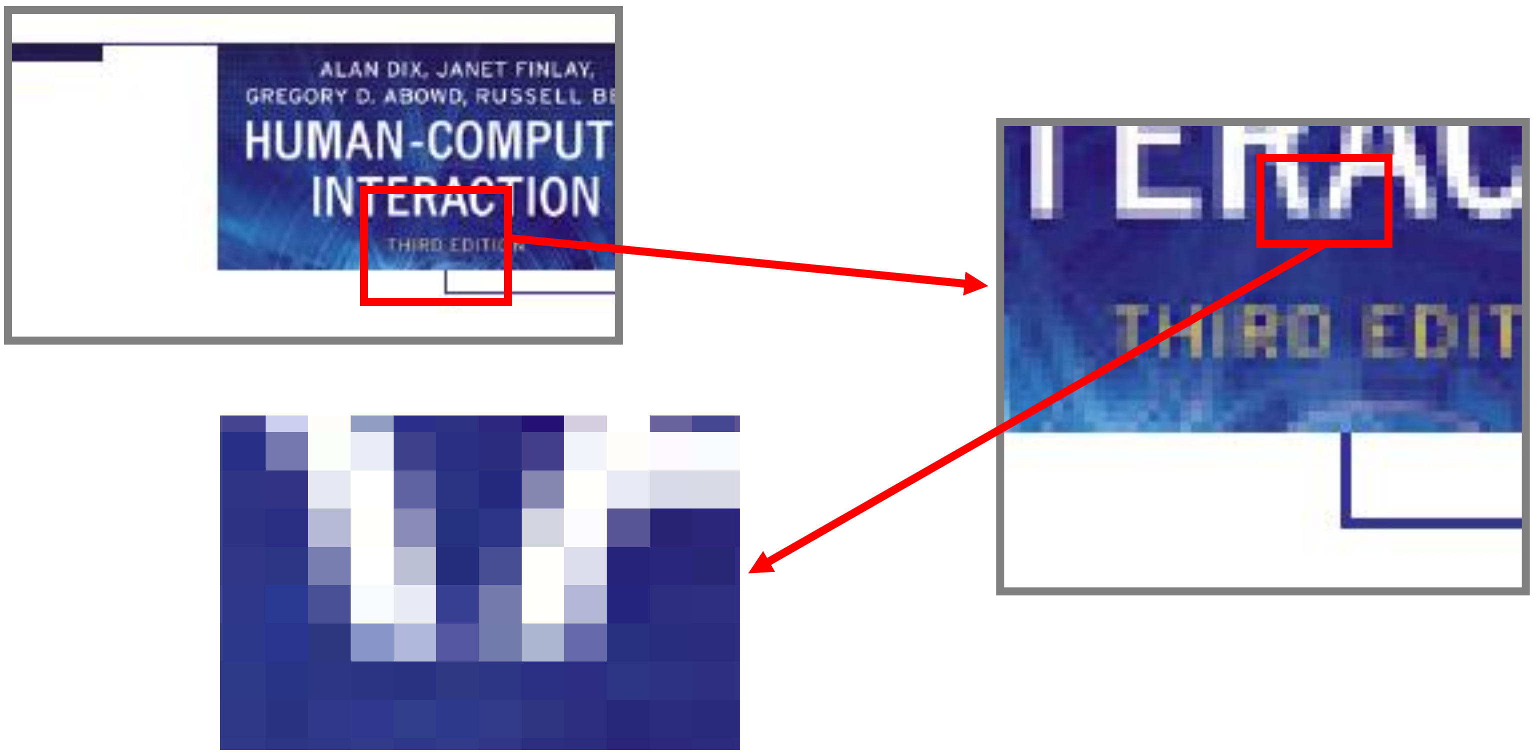
Digital Paper

- Digital paper is a new form of 'display' that is still in its infancy is the various forms of digital paper.
- Digital papers are thin flexible materials that can be written to electronically, just like a computer screen.
- but which keep their contents even when removed from any electrical supply.



Bitmap Displays

- screen is vast number of coloured dots



Bitmap Displays - Resolution and Color

- Virtually all computer displays are based on some sort of bitmap.
- Display is made of vast numbers of colored dots or pixels in a rectangular grid.
- These pixels may be limited to:
  - Black and white
    - for example, the small display on many TV remote controls
  - Grayscale
  - Full color
- In monochrome screens, the intensity at each pixel is held by the computer's video card.
- More bits per pixel give rise to more color or intensity possibilities.
  - For example, 8 bits/pixel give rise to 2^8 = 256 possible colors at any one time.

Bitmap Displays - Resolution and Color

- Resolution is used in a confused way for screens. There are two numbers to consider:
  - The total number of pixels
    - in standard computer displays this is always in a 4:3 ratio
    - perhaps 1024 pixels across by 768 down, or 1600 × 1200
  - The density of pixels
    - measured in pixels per inch

- Monitors, LCDs screen or other display devices will quote their maximum resolution, but the computer may actually give it less than this.

Virtual Reality and 3D Interaction

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

Virtual Reality

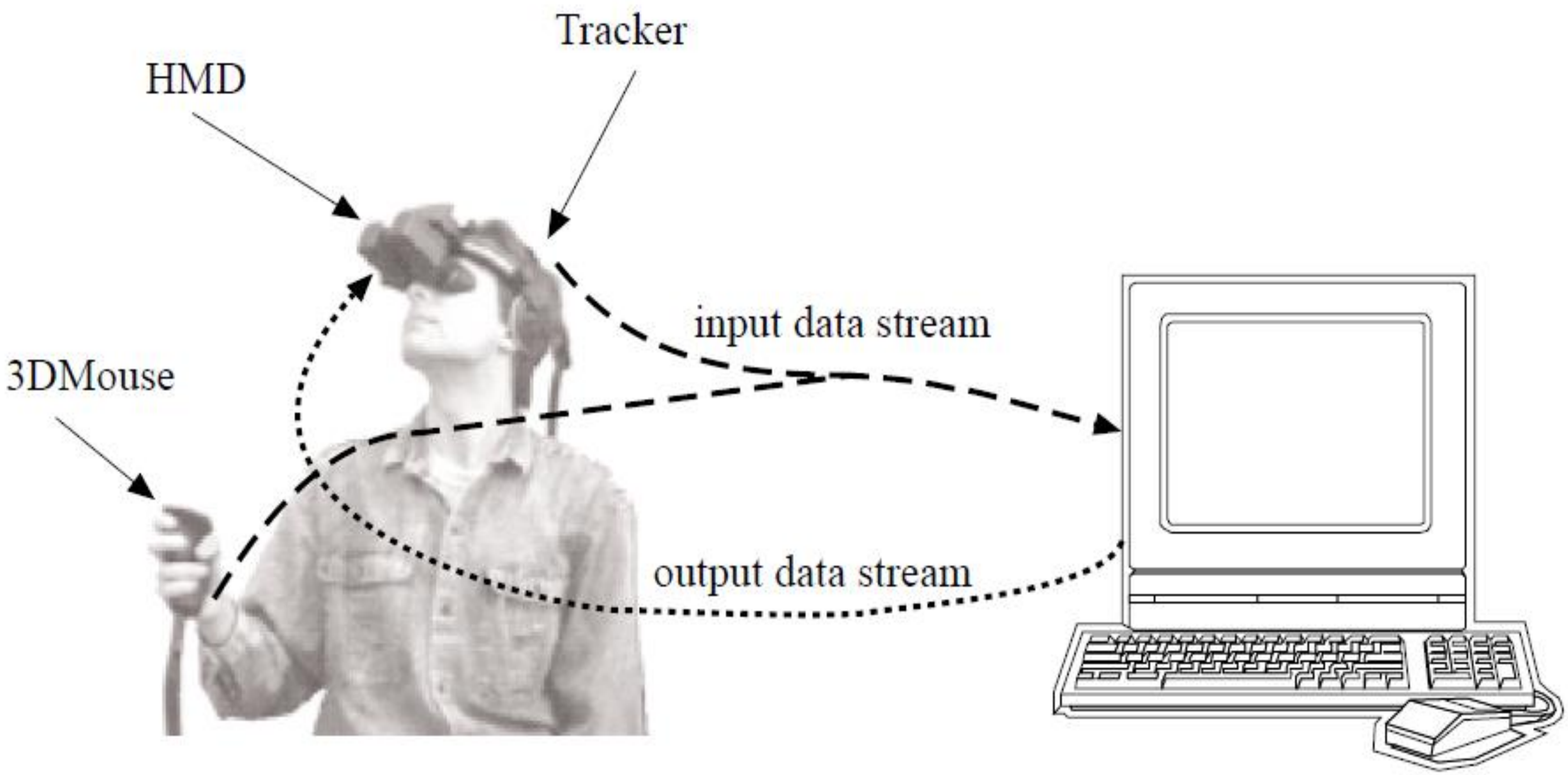
- Virtual Reality is an artificial environment that is created with software and presented to the user in such a way that the user suspends belief and accepts it as a real environment.

- The components necessary for building and experiencing VR are divided into two main components:
  - hardware components
  - software components

Virtual Reality

- The hardware components are divided into five sub-components:
  - sensory displays
  - tracking system and input devices
  - computer workstation
  - process acceleration cards
- The software components are divided into four sub-components:
  - 3D modeling software
  - 2D graphics software
  - digital sound editing software
  - VR simulation software
- See the following figure which depicts the basic components of VR

Virtual Reality



VR Hardware Components Sensory Displays

- Sensory displays are used to display the simulated virtual worlds to the user.
- The most common sensory displays are:
  - computer visual display unit
  - HMD
  - headphones for 3D audio
- HMD (Head Mounted Displays) place a screen in front of each of the viewer's eyes at all times.
- Head movement is recognized by the computer, and a new perspective of the scene is generated.
- In most cases, a set of optical lens and mirrors are used to enlarge the view to fill the field of view and to direct the scene to the eyes.

VR Hardware Components
Sensory Displays

- HMD (Head Mounted Displays), See the following figure

VR Hardware Components Tracking System

- Tracking system is tracks the position and orientation of a user in the virtual environment.
- This system is divided into:
  - mechanical trackers
  - electromagnetic trackers
  - ultrasonic trackers
  - infrared trackers

VR Hardware Components Input Devices

- Input Devices are used to interact with the virtual environment and objects within the virtual environment.
- Examples are:
  - joystick (wand)
  - instrumented glove
  - keyboard
  - voice recognition
  - Etc
- 3D Mouse is in general a joystick-like device that can be moved in space by hand.
  - It is equipped with a tracker sensor to determine its position/orientation.
  - a few buttons that may trigger some actions.

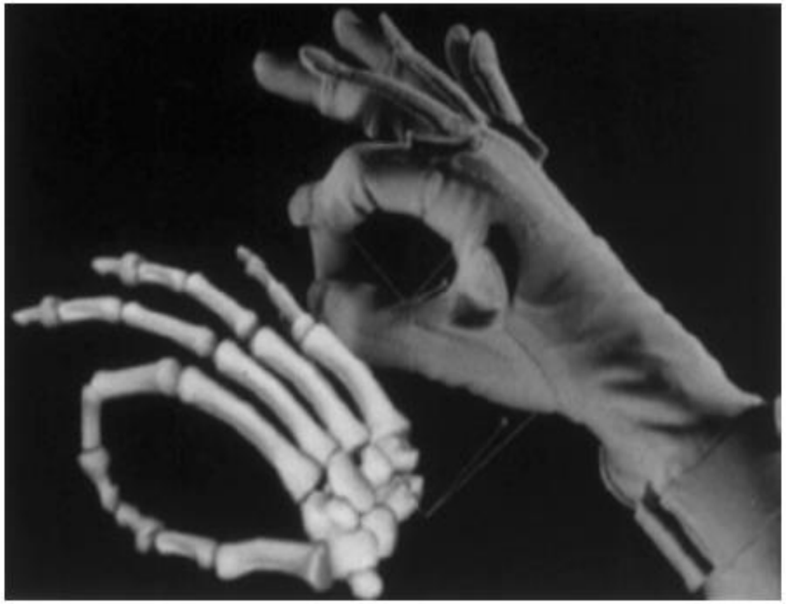
VR Hardware Components Input Devices

- Gloves are 3D input devices that can detect the joint angles of fingers.
  - allows the user richer interaction than the 3D mouse.
  - hand gestures may be recognized and translated into proper actions.

- The measurement of finger flexion is done with the help by:
  - fiber-optic sensors (e.g., VPL DataGlove),
  - foil-strain technology (e.g., Virtex CyberGlove)
  - resistive sensors

VR Hardware Components
Input Devices

VPL DataGlove



Virtex CyberGlove

3D Space

- VR can be applied for:
  - The simulation of a real environment for training and education.
  - The development of an imagined environment for a game or interactive story.
- VR systems present a 3D virtual world.
- Users need to navigate through these spaces and manipulate the virtual objects they find there.
- The following are some ways for the navigation:
  - Cockpit and virtual controls
  - 3D mouse
  - Dataglove
  - Whole-body tracking

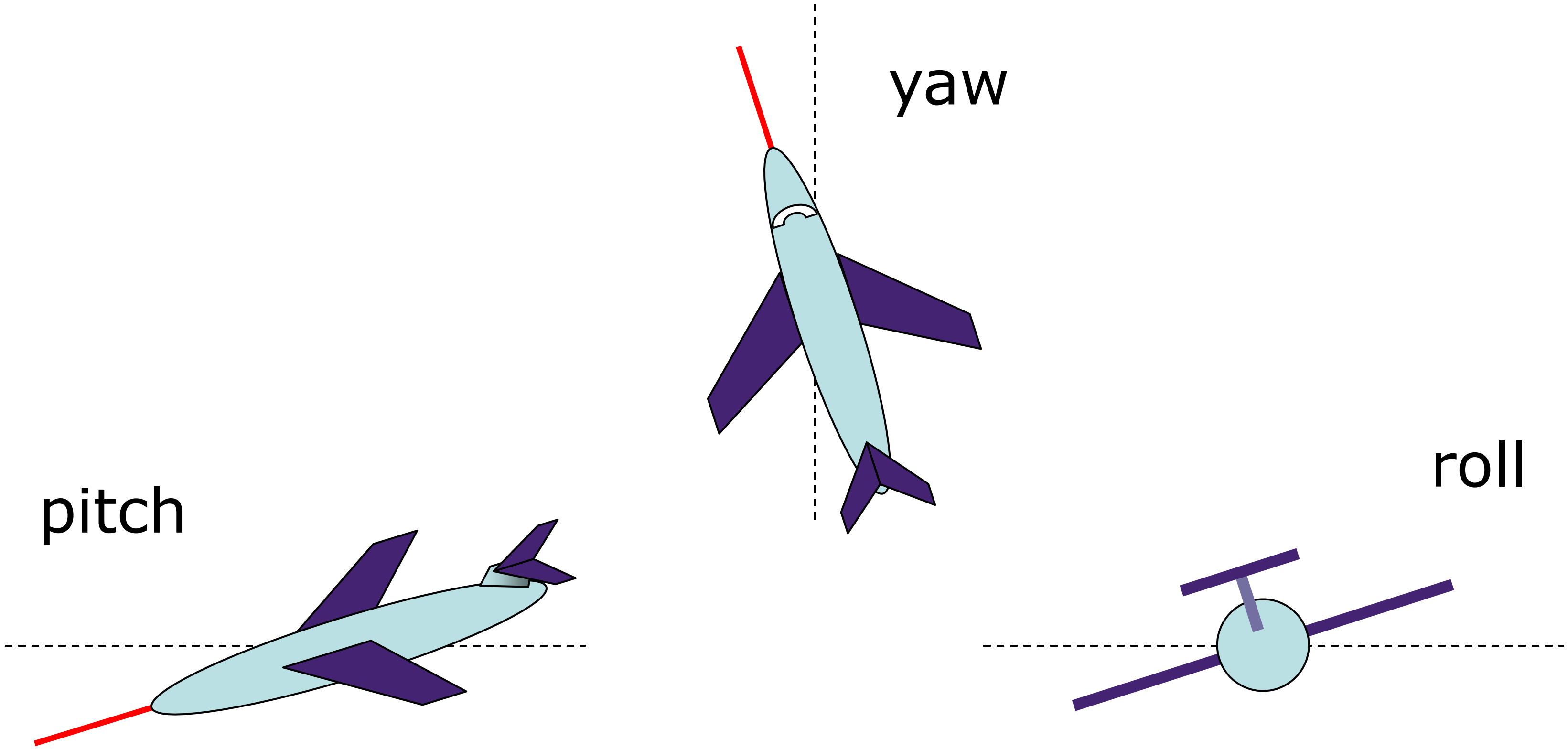
3D Space

- Many arcade games and also more serious applications use controls modeled on an aircraft cockpit to 'fly' through virtual space.
- In many PC games and desktop virtual reality, the controls are themselves virtual.
- May be a simulated form of the cockpit controls or more prosaic up/down left/right buttons.
- The user manipulates these virtual controls using an ordinary mouse (or other 2D device).
- Rather than just moving the mouse on a tabletop, you can pick the 3D up, move it in three dimensions, rotate the mouse and tip it forward and backward.

3D Space

- The 3D mouse has up/down angle (called pitch), left/right orientation (called yaw), and the amount it is twisted about its own axis (called roll).
- See the following figure.

Pitch, Yaw and Roll



Physical Controls, Sensors etc.

special displays and gauges
sound, touch, feel, smell
physical controls
environmental and bio-sensing

Physical Controls

- There are applications (such as such as interactive TV, in-car navigation systems, or personal entertainment) that may have special displays.
  - use sound, touch and smell as well as visual displays.
  - have dedicated controls and may sense the environment or your own bio-signs.

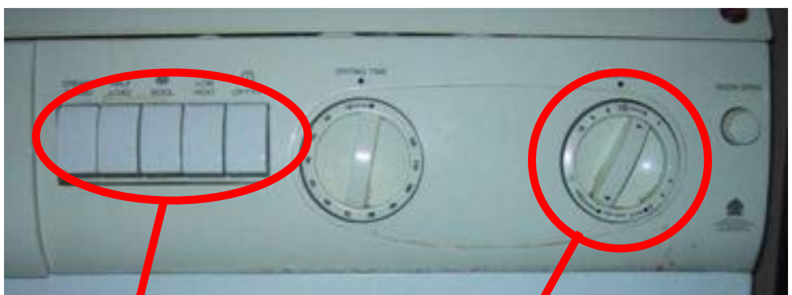
- The traditional computer system (which involves a mouse keyboard and screen) is not relevant or possible for these applications.

Physical Controls

- Desktop computer system has to serve many functions and so has generic keys and controls that can be used for a variety of purposes.
- In contrast, many dedicated physical control panels have been designed for particular devices.
- example:
  - Microwave controls
  - washing machine player
  - personal MiniDisc player

Physical Controls

- specialist controls needed …
  - industrial controls, consumer products, etc.



large buttons

clear dials

easy-clean smooth buttons

multi-function control

tiny buttons

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

Sounds

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

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

BMW iDrive

- for controlling menus
- feel small ‘bumps’ for each item
- makes it easier to select options by feel
- uses haptic technology from Immersion Corp.

Sensors

- In a public washroom there are often no controls for the wash basins, you simply put your hands underneath and (hope that) the water flows..
- The washbasin is controlled by a small infrared sensor that is triggered when your hands are in the basin.

- There are many different sensors available to measure:
  - temperature
  - movement (ultrasound, infrared, etc.)
  - location (GPS, global positioning, in mobile devices)
  - weight (pressure sensors)

Sensors

- Sensors can also be used to capture physiological signs (our own bodies) such as:
  - iris scanners
  - body temperature
  - heart rate
  - galvanic skin response
  - blink rate

Sensors -Design Focus

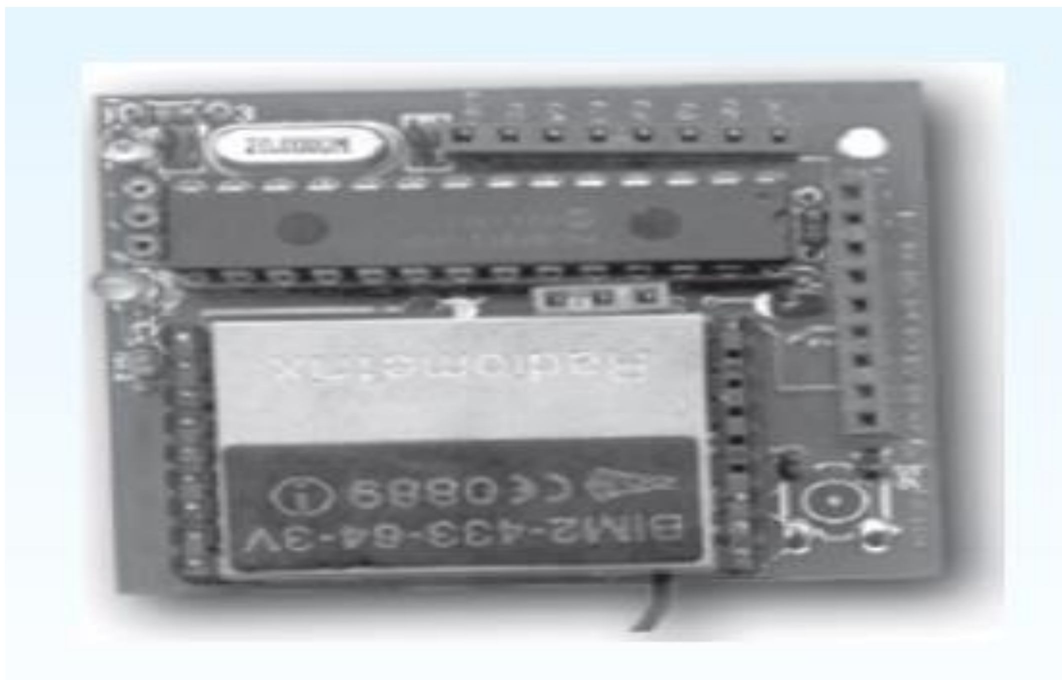
- Building systems with physical sensors is no easy task, such as:
  - You need a soldering iron
  - plenty of experience in electronics
  - even more patience
- Although some issues are unique to each sensor or project, many of the basic building blocks are similar.
- In microprocessors, the basic building blocks:
  - connecting simple microprocessors to memory
  - connecting simple microprocessors to networks
  - connecting various standard sensors (temperature, tilt)

Sensors -Design Focus

- Smart-Its is a project which made that job (i.e., Building systems with physical sensors) easier by creating a collection of components and an architecture for adding new sensors.
- There are a number of basic Smart-It boards, for example
  - Microprocessor with wireless connectivity
  - Sensor board including temperature and light
  - Power controller
- A variety of modules are plugged onto Smart-It boards. See the following figures

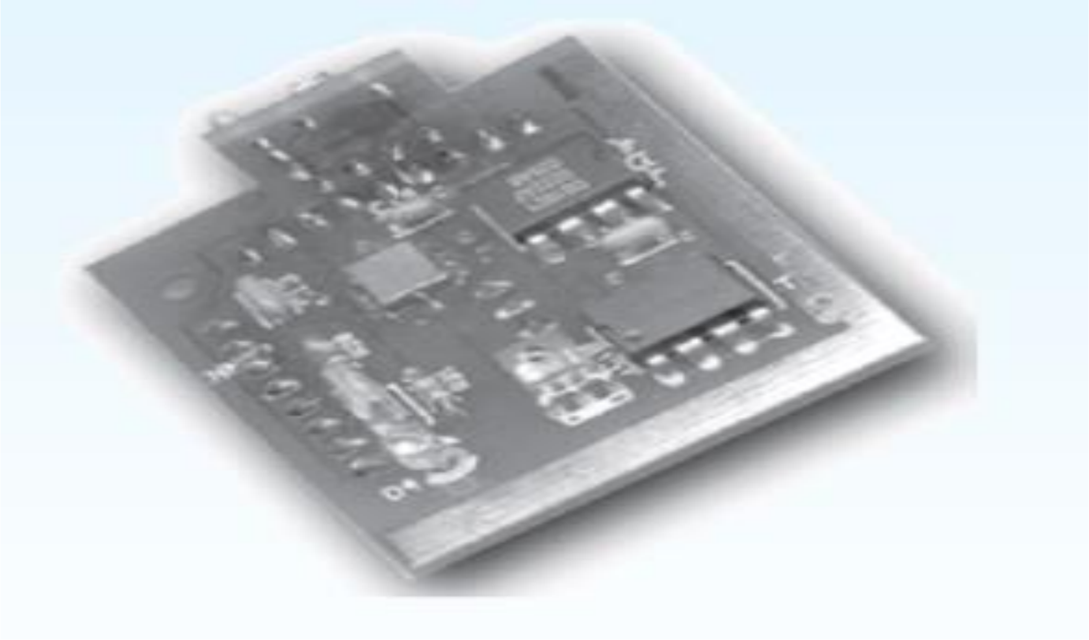
Sensors -Design Focus

- The following figure depicts a Smart-It board for a microprocessor with wireless connectivity



Sensors -Design Focus

- The following figure depicts a Smart-It board for a sensor board including temperature and light



Sensors -Design Focus

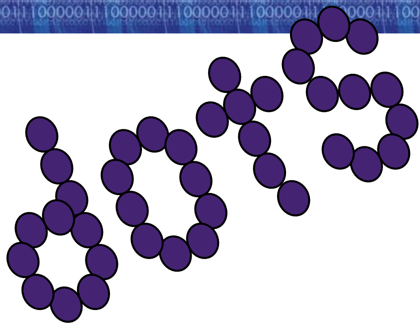
- The following figure depicts a Smart-It board for a power controller

Paper: Printing and Scanning

print technology
fonts, page description, WYSIWYG
scanning, OCR

Printing and Scanning

- Printing and Scanning is a technology to get information to and from paper.



Printing

- Popular printing technologies, like screens, build the image on the paper as a series of dots.
- Printing is image made from small dots.
- Allows any character set or graphic to be printed.
- This resolution is measured in dots per inch (dpi).

- Critical features:
  - resolution
    - size and spacing of the dots
    - measured in dots per inch (dpi)
  - speed
    - usually measured in pages per minute
  - cost!!

Types of dot-based Printers

- dot-matrix printers
  - use inked ribbon (like a typewriter)
  - line of pins that can strike the ribbon, dotting the paper
  - typical resolution 80-120 dpi
- ink-jet and bubble-jet printers
  - tiny blobs of ink sent from print head to paper
  - typically 300 dpi or better
- laser printer
  - like photocopier
  - dots of electrostatic charge deposited on drum
  - picks up toner rolled onto paper which is then fixed with heat
  - typically 600 dpi or better.

Printing in The Workplace

- shop tills
  - dot matrix
  - same print head used for several paper rolls
  - may also print cheques
- thermal printers
  - special heat-sensitive paper
  - paper heated by pins makes a dot
  - poor quality, but simple & low maintenance
  - used in some fax machines

Fonts

- Font is the particular style of text
  - Courier font
  - Helvetica font
  - Palatino font
  - Times Roman font
  - _§´∝≡↵ℜ⊗↵~ (special symbol)
- Size of a font measured in points (1 pt about 1/72”) (vaguely) related to its height
  - This is ten point Helvetica
  - This is twelve point
  - This is fourteen point
  - This is eighteen point
  - this is twenty-four point

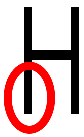
Fonts

- Pitch
  - fixed-pitch – every character has the same width

    e.g. Courier
  - variable-pitched – some characters wider

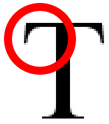
    e.g. Times Roman – compare the 'i' and the "m"
- Serif or Sans-serif
  - sans-serif – square-ended strokes

    e.g. Helvetica



  - serif – with splayed ends (such as)

    e.g. Times Roman or Palatino



Readability of Text

- lowercase
  - easy to read shape of words
- UPPERCASE
  - better for individual letters and non-words
    e.g. flight numbers: BA793 vs. ba793
- serif fonts
  - helps your eye on long lines of printed text
  - but sans serif often better on screen

Page Description Languages

- Pages very complex
  - different fonts, bitmaps, lines, digitised photos, etc.
- Can convert it all into a bitmap and send to the printer
  … but often huge !
- Alternatively Use a page description language
  - sends a *description* of the page can be sent,
  - instructions for curves, lines, text in different styles, etc.
  - like a programming language for printing!
- PostScript is the most common

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

- Scanners work by shining a beam of light at the page and then recording the intensity and color of the reflection.
  - Take paper and convert it into a bitmap
- Shines light at paper and note intensity of reflection.
  - colour or greyscale
- Monochrome scanners are typically only found in multi-function devices.
- color scanners usually have monochrome modes for black and white or grayscale copying.
- Typical resolutions from 600–2400 dpi.

Scanners

- 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

Scanners

- Used in
  - document storage and retrieval systems
    - where paper documents are scanned and stored on computer rather than filing cabinet.
  - desktop publishing for incorporating photographs
  - special scanners for slides and photographic negatives
- Cost
  - The costs of maintaining paper records are enormous.
    - Storing a bitmap image is neither most useful (in terms of access methods and space efficient)
    - scanning may be combined with OCR (Optical Character Recognition).

Optical character recognition

- OCR is the process whereby the computer can 'read' the characters on the page.
- 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

Memory

short term and long term
speed, capacity, compression
formats, access

Memory

- The different levels of computer memory are more commonly called primary and secondary storage.
- By analogy with the human memory, computer memory can be grouped into:
  - short-term (STM)
  - long-term memories (LTM)
- but the analogy is rather weak – the capacity of the computer's STM is a lot more than seven items.

- The details of computer memory are not in themselves of direct interest to the user interface designer. However, the limitations in capacity and access methods are important constraints on the sort of interface that can be designed.

Short-term Memory - RAM

- Most currently active information is held inshort-term memory (RAM).
- Different forms of RAM differ as to their precise access times, power consumption and characteristics.
  - on silicon chips
  - 100 nano-second access time
  - data transferred at around 100 Mbytes/sec
  - Most RAM is volatile (lose information if power turned off)
- Most RAM is volatile. However, many computers have small amount of non-volatile RAM, which retains its contents, perhaps with the aid of a small battery.
- Typical desktop computers:
  - 64 to 256 Mbytes RAM

Long-term Memory - Disks

- LTM consists of disks, possibly with small tapes for backup.
- There are two main kinds of technology used in disks:
  - magnetic disks
  - optical disks
- The most common storage media, floppy disks and hard (or fixed) disks, are coated with magnetic material, on which the information is stored.

Long-term Memory - Disks Magnetic Disks

- Magnetic disks, there are two access times:
  - The time taken to find the right track on the disk
  - The time to read the track.

- example:
  - Floppy disks store around 1.4 Mbytes
  - Hard disks typically 40 Gbytes to 100s of Gbytes
    - access time ~10ms
    - transfer rate 100kbytes/s

Long-term Memory - Disks
Optical Disks

- Optical disks use laser light to read and (sometimes) write the information on the disk.
- More robust that magnetic media
- CD-ROM is the most common optical disk.
  - Recordable CDs
    - form of WORM device (Write-Once Read-Many)
    - more flexible
    - can be written, but only once at any location
  - Rewritable CDs
    - rewrite time is typically much slower than the read time
- Many CD-ROM reader/writers can also read DVD format
  - developed for storing movies and also for AV applications, or very large files

Blurring Boundaries

- PDAs
  - often use RAM for their main memory
- Flash-Memory
  - used in PDAs, cameras etc.
  - silicon based but persistent
  - plug-in USB devices for data transfer

Speed and Capacity

- what do the numbers mean?
- some sizes (all uncompressed) ...
  - this book, text only ~ 320,000 words, 2Mb
  - the Bible ~ 4.5 Mbytes
  - scanned page ~ 128 Mbytes
    - (11x8 inches, 1200 dpi, 8bit greyscale)
  - digital photo ~ 10 Mbytes
    - (2–4 mega pixels, 24 bit colour)
  - video ~ 10 Mbytes *per second*
    - (512x512, 12 bit colour, 25 frames per sec)

Virtual Memory

- Problem:
  - running lots of programs + each program large
  - not enough RAM
- Solution - Virtual memory :
  - store some programs temporarily on disk
  - makes RAM appear bigger
- But … swopping
  - program on disk needs to run again
  - copied from disk to RAM
  - s l o w s   t h i n g s   d o w n

Compression

- Compression is reduce amount of storage required

- Lossless
  - recover exact text or image – e.g. GIF, ZIP
  - look for commonalities:
    - text: AAAAAAAAAABBBBBCCCCCCCC 10A5B8C
    - video: compare successive frames and store change
- Lossy
  - recover something like original – e.g. JPEG, MP3
  - exploit perception
    - JPEG: lose rapid changes and some colour
    - MP3: reduce accuracy of drowned out notes

Storage Formats - Text

- ASCII
  - 7-bit binary code for to each letter and character
- UTF-8
  - 8-bit encoding of 16 bit character set
- RTF (rich text format)
  - text plus formatting and layout information
- SGML (standardized generalised markup language)
  - documents regarded as structured objects
- XML (extended markup language)
  - simpler version of SGML for web applications

Storage Formats - Media

- Images
  - many storage formats :
    - (PostScript, GIFF, JPEG, TIFF, PICT, etc.)
  - plus different compression techniques
    - (to reduce their storage requirements)

- Audio/Video
  - again lots of formats :
    - (QuickTime, MPEG, WAV, etc.)
  - compression even more important
  - also ‘streaming’ formats for network delivery

Methods of Access

- large information store
  - long time to search => use index
  - what you index -> what you can access
- simple index needs exact match
- forgiving systems:
  - Xerox “do what I mean” (DWIM)
  - SOUNDEX – McCloud ~ MacCleod
- access without structure …
  - free text indexing (all the words in a document)
  - needs lots of space!!

Processing and Networks

finite speed (but also Moore's law)

limits of interaction

networked computing

Finite Processing Speed

- Processing speeds are fast (Computers that run interactive programs will process in the order of 100 million instructions per second).

- Speed of processing can seriously affect the user interface.
- These effects must be taken into account when designing an interactive system.
- Designers tend to assume fast processors, and make interfaces more and more complicated.

- There are two sorts of faults due to processing speed:
  - when it is too slow.
  - when it is too fast!.

Finite Processing Speed

- problems if system is too slow
  - cursor overshooting because system has buffered keypresses
  - icon wars
    - user clicks on icon, nothing happens, clicks on another, then system responds and windows fly everywhere
- In order to avoid faults of the this kind, the system buffers the user input; that is, it remembers key presses and mouse buttons and movement.

- problems if system is too fast
  - help screens may scroll through text much too rapidly to be read

Finite Processing Speed

- It is important to try to match the processing speeds of a computer with that of a human for the design of the Human-Computer Interface.

- There are several factors that can limit the speed of an interactive system:
  - Computation bound.
  - Storage channel bound.
  - Graphics bound.
  - Network capacity.

Moore's Law

- Computers get faster and faster!
- 1965 …
  - Gordon Moore, co-founder of Intel, noticed a pattern
  - Processor speed doubles every 18 months
  - PC … 1987: 1.5 Mhz, 2002: 1.5 GHz
- Similar pattern for memory
  - But doubles every 12 months!!
  - Hard disk … 1991: 20Mbyte : 2002: 30 Gbyte
- Baby born today
  - Record all sound and vision
  - By 70 all life's memories stored in a grain of dust!

/e3/online/moores-law/

The Myth of the Infinitely Fast Machine

- Implicit assumption … no delays
  an infinitely fast machine
- What is good design for real machines?
- Good example … the telephone :
  - type keys too fast
  - hear tones as numbers sent down the line
  - actually an accident of implementation
  - emulate in design

Networked Computing

- Networks allow access to …
  - large memory and processing
  - other people (groupware, email)
  - shared resources – esp. the web
- Issues
  - network delays – slow feedback
  - conflicts - many people update data
  - unpredictability

The Internet

- history …
  - 1969: DARPANET US DoD, 4 sites
  - 1971: 23; 1984: 1000; 1989: 10000
- common language (protocols):
  - TCP – Transmission Control protocol
    - lower level, packets (like letters) between machines
  - IP – Internet Protocol
    - reliable channel (like phone call) between programs on machines
  - Email_ HTTP
    - all build on top of these

Questions

?