What is Multimedia?

Multimedia means that computer information can be represented through audio, video, and animation in addition to traditional media (i.e., text, graphics/drawings, images).

General Definition

A good general working definition for this module is:

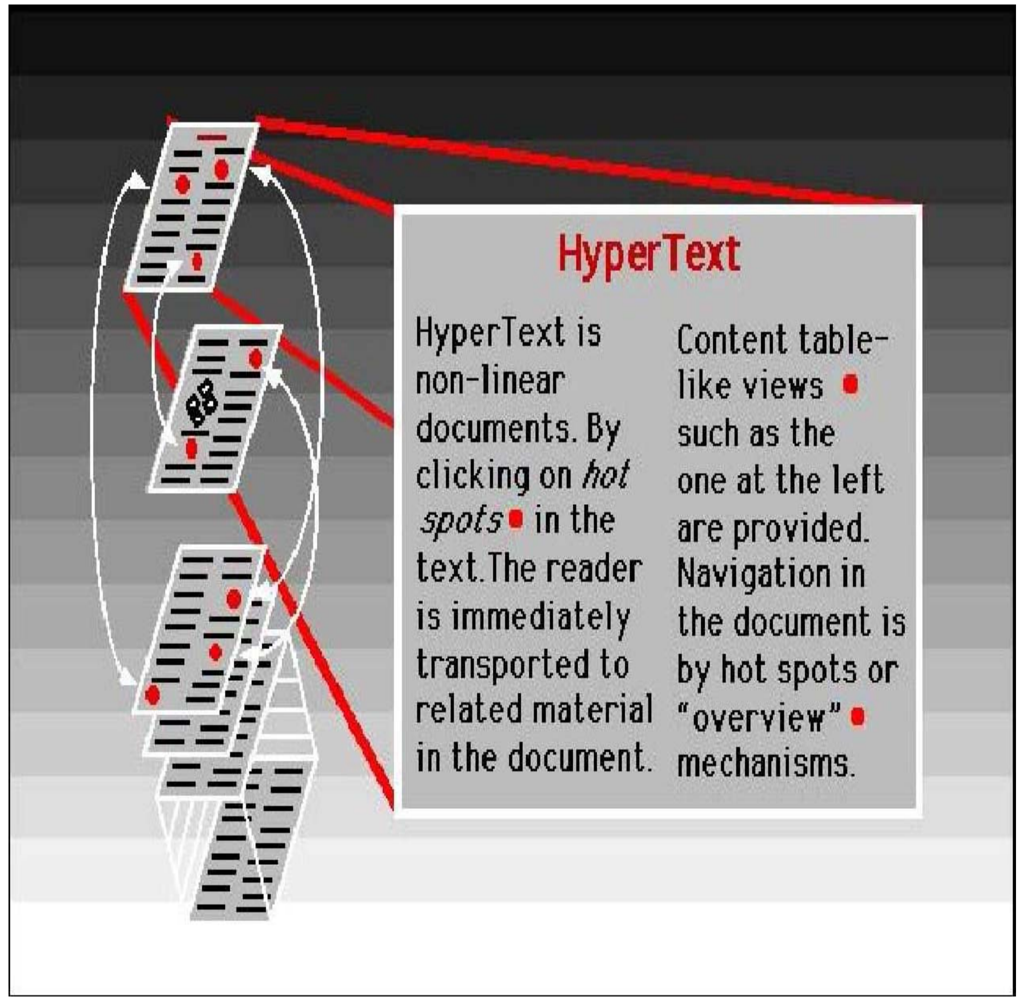
- **Multimedia** is the field concerned with the **computer controlled** integration of text, graphics, drawings, still and moving images (Video), animation, audio, and any other media where every type of information can be represented, stored, transmitted and processed **digitally**.

Multimedia Application Definition

- A **Multimedia Application** is an application which uses a collection of multiple media sources e.g. text, graphics, images, sound/audio, animation and/or video

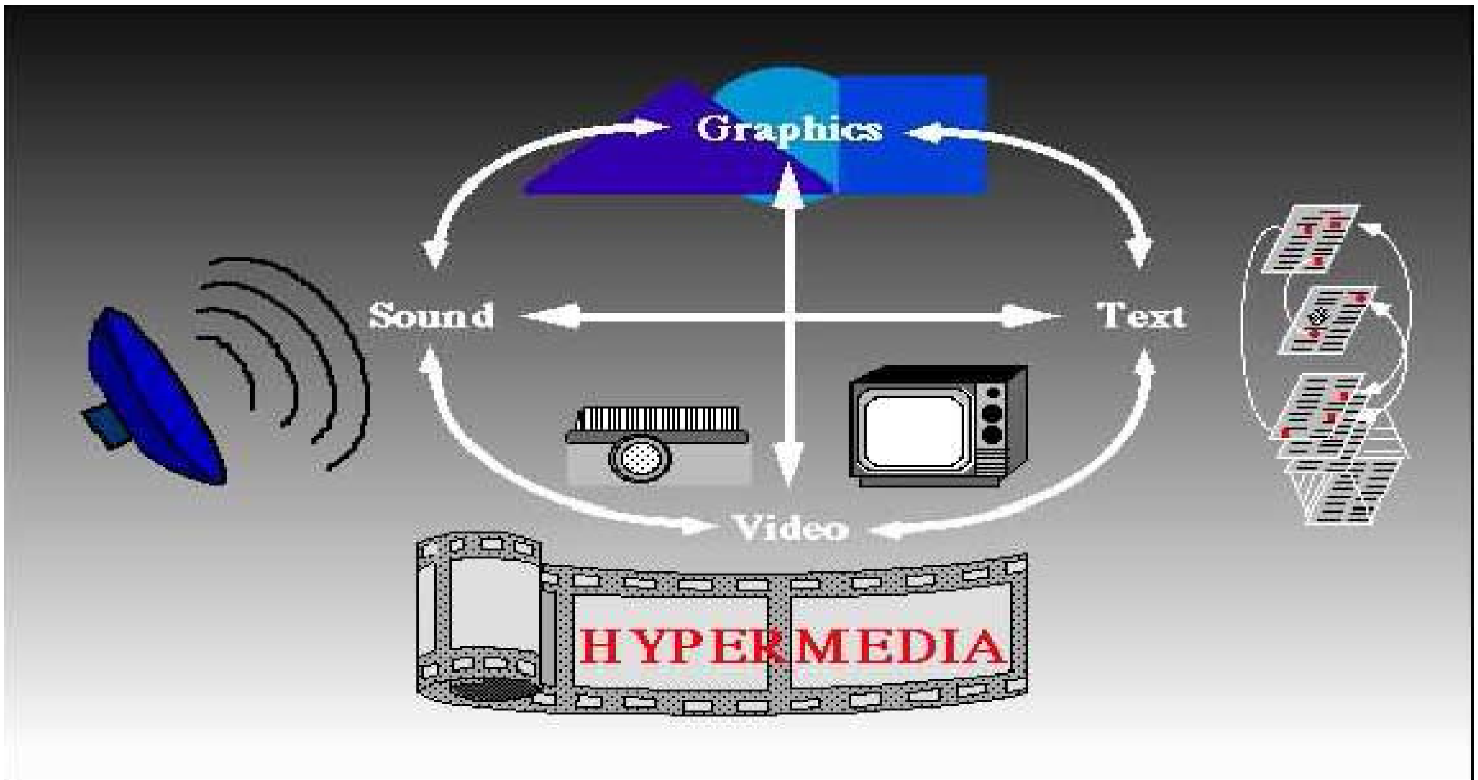
What is HyperText and HyperMedia?

- Hypertext is a text which contains links to other texts.
- The term was invented by Ted Nelson around 1965.



Hypermedia

- HyperMedia is not constrained to be text-based. It can include other media, e.g., graphics, images, and especially the continuous media – sound and video.



Example Hypermedia Applications?

- The World Wide Web (WWW) is the best example of a hypermedia application.
- Powerpoint
- Adobe Acrobat

Multimedia Systems

- A **Multimedia System** is a system capable of processing multimedia data and applications
- A **Multimedia System** is characterised by the processing, storage, generation, manipulation of Multimedia information.

Characteristics of a Multimedia System

A Multimedia system has four basic characteristics:

- Multimedia systems must be **computer controlled**.
- Multimedia systems are **integrated**.
- The information they handle must be represented **digitally**.
- The interface to the final presentation of media is usually **interactive**.

Challenges for Multimedia Systems

- Distributed Networks
- Temporal relationship between data

– Render different data at same time - continuously.

– Sequencing within the media

playing frames in correct order/time frame in video

– **Synchronisation** — inter-media scheduling

Key Issues for Multimedia Systems

The key issues multimedia systems need to deal with here are:

- How to represent and store temporal information.
- How to strictly maintain the temporal relationships on play back/retrieval
- What process are involved in the above.
- Data has to represented **digitally** — Analog–Digital Conversion, Sampling etc.
- Large Data Requirements — bandwidth, storage, compression

Components of a Multimedia System

Now let us consider the Components (Hardware and Software) required for a multimedia system:

- **Capture devices** — Video Camera, Video Recorder, Audio Microphone, Keyboards, mice, graphics tablets, 3D input devices, tactile sensors, VR devices. Digitising Hardware
- **Storage Devices** — Hard disks, CD-ROMs, DVD-ROM, etc
- **Communication Networks** — Local Networks, Intranets, Internet, Mulitmedia or other special high speed networks.
- **Computer Systems** — Multimedia Desktop machines, Workstations, MPEG/VIDEO/DSP Hardware
- **Display Devices** — CD-quality speakers, HDTV,SVGA, Hi-Resolution monitors, Colour printers etc.

Applications

Examples of Multimedia Applications include:

- World Wide Web
- Hypermedia courseware
- Video conferencing
- Video-on-demand
- Interactive TV
- Groupware
- Home shopping
- Games
- Virtual reality
- Digital video editing and production systems

Practical

Lab 1 and 2

Adobe Photoshop

- Welcome to Adobe Photoshop, the professional image-editing standard for photographers, professional designers, and graphics producers.
- Photoshop provide a consistent work environment with other Adobe applications including Adobe Illustrator, Adobe InDesign , Adobe GoLive, Adobe LiveMotion, Adobe After Effects, and Adobe Premiere.

Objectives:

- By doing this Lab student will be able to edit various format of Images and give the various effects in images.
- We can use various exciting tools of Adobe Photoshop to edit image, which includes

Lab 3 and 4

Macromedia FreeHand

- Macromedia FreeHand is a vector-based drawing application. With FreeHand, you can create vector graphics that can be scaled and printed at any resolution, without losing detail or clarity.
- We can use FreeHand to create print and web illustrations such as logos and advertising banners. We can also use FreeHand to turn our artwork into Macromedia Flash animations.
- The FreeHand user interface contains a workspace and Tools panel that are consistent with other Macromedia products such as Macromedia Dreamweaver, Fireworks, and Flash, to give us a true integrated print and web solution. In addition, now we can view and test our freeHand documents in a Macromedia Flash Player window without ever leaving the freeHand environment.

Objectives:

- By doing this Lab student will able to design a various type of logos using the different tools of Macromedia freehand.

Lab 5 and 6

Macromedia Flash

- Flash is an authoring tool that designers and developers use to create presentations, applications, and other content that enables user interaction. Flash projects can include simple animations, video content, complex presentations, applications, and everything in between. In general, individual pieces of content made with Flash are called *applications*, even though they might only be a basic animation. You can make media-rich Flash applications by including pictures, sound, video, and special effects.
- Flash is extremely well suited to creating content for delivery over the Internet because its files are very small. Flash achieves this through its extensive use of *vector graphics*. Vector graphics require significantly less memory and storage space than bitmap graphics because they are represented by mathematical formulas instead of large data sets. Bitmap graphics are larger because each individual pixel in the image requires a separate piece of data to represent it.

Objectives:

- By doing this Lab student will able to create different types of animation, use the action script to control the various objects.

Lab 7

Swish Max

- SWiSHmax is a new addition to the SWiSHzone family of Flash authoring tools. If you want to create stunning and powerful Flash animations without using Flash, then SWiSHmax is the tool for you.

Objectives:

- By doing this Lab student will able to create different types of animation and give different type of effect to an object.

Lab 8 and 9

Adobe Premiere

- Adobe Premiere, a revolutionary nonlinear video-editing application that delivers a breakthrough render-free experience. Its high-performance toolset takes video and audio production to a new level, giving a professional edge. Adobe Premiere Pro delivers the power and precision you need to tell a story better and faster than ever before.

Objectives:

- By doing this Lab student will able to edit and publish the movie in various formats.

Lab 10 and 11

Macromedia Director

- Macromedia Director MX is the most popular authoring tool of choice for legions of web and multimedia developers. With Director, you can create movies for websites, kiosks, and presentations as well as movies for education and entertainment. Movies can be as small and simple as an animated logo or as complex as an online chat room or game. Director movies can include a variety of media, such as sound, text, graphics, animation, and digital video. A Director movie can link to external media or be one of a series of movies that refer to one another actions.

Objective:

- This lab should be done after using all the tools of the multimedia. By doing this lab student will be able to integrate all the multimedia objects like audio, video , images etc and will able to create different interactive presentations.

Project

Multimedia related project

References books;

- Tay Vaughan, Multimedia, Making it work
- Ralf Steinmetz and Klara Nahrstedt , Multimedia: Computing, communication & applications
- John Villamil-casanova and Louis Molina , Multimedia production, Planning Delivery
- Lee Allis, Inside Macromedia Director
- John R. Nyquist and Robert Martin, Director 8 and Lingo Bible
- Gary Rosenzweig and John Thompson, using Macromedia Director 8

UNIT 2

Sound/Audio

Objectives

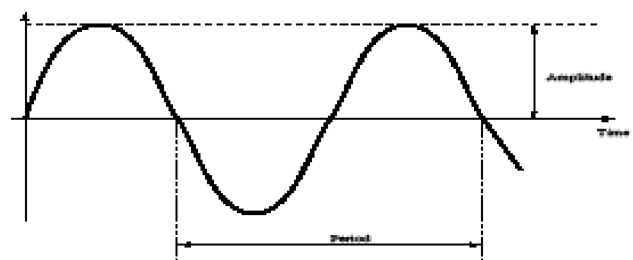
- To understand how computers process sound
- To understand how computers synthesize sound
- To understand the differences between two major kinds of audio, namely digitised sound and MIDI music

Contents

1 The Nature of Sound

Sound is a physical phenomenon produced by the vibration of matter and transmitted as waves. However, the perception of sound by human beings is a very complex process. It involves three systems:

- the *source* which emits sound;
- the *medium* through which the sound propagates;
- the *detector* which receives and interprets the sound.



Sounds we heard everyday are very complex. Every sound is comprised of waves of many different frequencies and shapes. But the simplest sound we can hear is a sine wave.

Sound waves can be characterised by the following attributes:

Period	Frequency	Amplitude	Bandwidth
	Pitch	Loudness	Dynamic

1.1 Pitch and Frequency

Period is the interval at which a periodic signal repeats regularly.
Pitch is a perception of sound by human beings It measures how 'high' is the sound as it is perceived by a listener.
Frequency measures a physical property of a wave. It is the reciprocal value of period $f = \frac{1}{P}$. The unit is Herts (Hz) or kiloHertz (kHz).

Musical instruments are tuned to produce a set of fixed pitches.

Infra-sound	0 – 20 Hz
Human hearing range	20 – 20 kHz
Ultrasound	20 kHz – 1 GHz
Hypersound	1 GHz – 10 THz

Note	Ratio	Frequencies
C	1:1	264
D	9:8	297
E	5:4	330
F	4:3	352
G	3:2	396
A	5:3	**440**
B	15:8	495
C	2:1	528

1.2 Loudness and Amplitude

The other important perceptual quality is *loudness* or *volume*.

Amplitude is the measure of sound levels. For a digital sound, amplitude is the sample value.

The reason that sounds have different loudness is that they carry different amount of power. The unit of power is watt. The intensity of sound is the amount of power transmitted through an area of $1m^2$ oriented perpendicular to the propagation direction of the sound.

If the intensity of a sound is $1watt/m^2$, we may start feel the sound. The ear may be damaged.

This is known as the *threshold of feeling*. If the intensity is $10^{-12}watt/m^2$, we may just be able to hear it. This is know as the *threshold of hearing*.

The relative intensity of two different sounds is measured using the unit *Bel* or more commonly *deciBel* (*dB*). It is defined by

$$\text{relative intensity in } dB = 10 \log \frac{I_2}{I_1}$$

Very often, we will compare a sound with the *threshold of hearing*.

Typical sound levels generated by various sources

160 dB	Jet engine
130 dB	Large orchestra at fortissimo
100 dB	Car on highway
70 dB	Voice conversation
50 dB	Quiet residential areas
30 dB	Very soft whisper
20 dB	Sound studio

Typical sound levels in music

Intensity $(watt/m^2)$	**Sound Level** dB	***Loudness***
1	120	*Threshold of feeling*
10^{-3}	90	*fff*
10^{-4}	80	*ff*
10^{-5}	70	*f*
10^{-6}	60	*mf*
10^{-7}	50	*p*
10^{-8}	40	*pp*
10^{-9}	30	*ppp*
10^{-12}	0	*Threshold of hearing*

1.3 Dynamic and Bandwidth

- *Dynamic range* means the change in sound levels.

  For example, a large orchestra can reach 130dB at its climax and drop to as low as 30dB at its softest, giving a range of 100dB.

- *Bandwidth* is the range of frequencies a device can produce or a human can hear.

FM radio	50Hz – 15kHz
AM radio	80Hz – 5kHz
CD player	20Hz – 20kHz
Sound Blaster 16 sound card	30Hz – 20kHz
Inexpensive microphone	80Hz – 12kHz
Telephone	300Hz – 3kHz
Children's ears	20Hz – 20kHz
Older ears	50Hz – 10kHz
Male voice	120Hz – 7kHz
Female voice	200Hz – 9kHz

2 Computer Representation of Sound

- Sound waves are continuous while computers are good at handling discrete numbers.
- In order to store a sound wave in a computer, samples of the wave are taken.
- Each sample is represented by a number, the ‘code’.
- This process is known as *digitisation*.
- This method of digitising sound is know as *pulse code modulation* (PCM).

  Refer to Unit 1 for more information on digitisation.
- According to Nyquist sampling theorem, in order to capture all audible frequency components of a sound, i.e., up to $20kHz$, we need to set the sampling to at least twice of this.

  This is why one of the most popular sampling rate for high quality sound is $4410Hz$.
- Another aspect we need to consider is the resolution, i.e., the number of bits used to represent a sample.

  Often, 16 bits are used for each sample in high quality sound. This gives the SNR of $96dB$.

2.1 Quality versus File Size

The size of a digital recording depends on the sampling rate, resolution and number of channels.

$$S = R \times (b/8) \times C \times D$$

Higher sampling rate, higher resolution gives higher quality but bigger file size.

S	file size	bytes
R	sampling rate	samples per second
b	resolution	bits
C	channels	1 - mono, 2 - stereo
D	recording duration	seconds

For example, if we record 10 seconds of stereo music at 44.1kHz, 16 bits, the size will be:

$$\begin{aligned} S &= 44100 \times (16/8) \times 2 \times 10 \\ &= 1,764,000\text{bytes} \\ &= 1722.7\text{Kbytes} \\ &= 1.68\text{Mbytes} \end{aligned}$$

Note: $\begin{aligned} 1\text{Kbytes} &= 1024\text{bytes} \\ 1\text{Mbytes} &= 1024\text{Kbytes} \end{aligned}$

High quality sound files are very big, however, the file size can be reduced by compression.

File size for some common sampling rates and resolutions

Sampling Rate	Resolution	Stereo /Mono	Size for for 1 Min.	Comments
44.1KHz	16-bit	Stereo	10.5MB	CD-quality recording
44.1KHz	16-bit	Mono	5.25MB	A good trade-off for high-quality recordings of mono sources such as voice-overs
44.1KHz	8-bit	Stereo	5.25MB	Achieves highest playback quality on low-end devices such as most of the sound cards
44.1KHz	8-bit	Mono	2.6MB	An appropriate trade-off for recording a mono source
22.05KHz	16-bit	Stereo	5.25MB	Darker sounding than CD-quality recording because of the lower sampling rate
22.05KHz	16-bit	Mono	2.5MB	Not a bad choice for speech, but better to trade some fidelity for a lot of disk space by dropping down to 8-bit
22.05KHz	8-bit	Stereo	2.6MB	A very popular choice for reasonable stereo recording where full bandwidth playback is not possible
22.05KHz	8-bit	Mono	1.3MB	A thinner sound than the choice just above, but very usable
11KHz	8-bit	Stereo	1.3MB	At this low a sampling rate, there are few advantages to using stereo
11KHz	8-bit	Mono	650K	In practice, probably as low as you can go and still get usable results
5.5KHz	8-bit	Stereo	650K	Stereo not effective
5.5KHz	8-bit	Mono	325K	About as good as a bad telephone connection

2.2 Audio File Formats

The most commonly used digital sound format in Windows systems is `.wav` files.

- Sound is stored in `.wav` as digital samples known as *Pulse Code Modulation*(PCM).
- Each `.wav` file has a header containing information of the file.
  - type of format, e.g., PCM or other modulations
  - size of the data
  - number of channels
  - samples per second
  - bytes per sample
- There is usually no compression in `.wav` files.

Other format may use different compression technique to reduce file size.

- `.vox` use *Adaptive Delta Pulse Code Modulation* (ADPCM).
- `.mp3` MPEG-1 layer 3 audio.
- RealAudio file is a proprietary format.

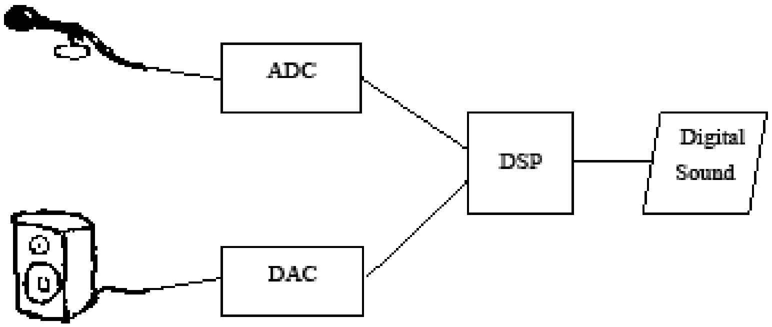
Some common audio files formats

Extension	MIME Type	Platform	Use
aif	Audio/x-aiff	Mac, SGI	Audio
aifc	Audio/x-aiff	Mac, SGI	Audio (compressed)
AIFF	Audio/x-aiff	Mac, SGI	Audio
aiff	Audio/x-aiff	Mac, SGI	Audio
au	Audio/basic	Sun, NeXT	ULAW audio data
mov	Video/QuickTime	Mac, Win	QuickTime video
mpe	Video/mpeg	All	MPEG video
mpeg	Video/mpeg	All	MPEG video
mpg	Video/mpeg	All	MPEG video
mp3	Audio/x-mpeg	All	MPEG audio
qt	Video/QuickTime	Mac, Win	QuickTime video
ra,ram	Audio/x-pn-realaudio	All	RealAudio Sound
snd	Audio/basic	Sun, NeXT	ULAW Audio Data
vox	Audio/	All	VoxWare Voice
wav	Audio/x-wav	Win	WAV Audio

2.3 Audio Hardware

- Recording and Digitising sound:
  - An *analog-to-digital converter*(ADC) converts the analog sound signal into digital samples.
  - A *digital signal processor*(DSP) processes the sample, e.g. filtering, modulation, compression, and so on.
- Play back sound:
  - A *digital signal processor* processes the sample, e.g. decompression, demodulation, and so on
  - An *digital-to-analog converter*(DAC) converts the digital samples into sound signal
- All these hardware devices are integrated into a few chips on a sound card

- Different sound card have different capability of processing digital sounds. When buying a sound card, you should look at:
  - maximum sampling rate
  - stereo or mono
  - duplex or simplex

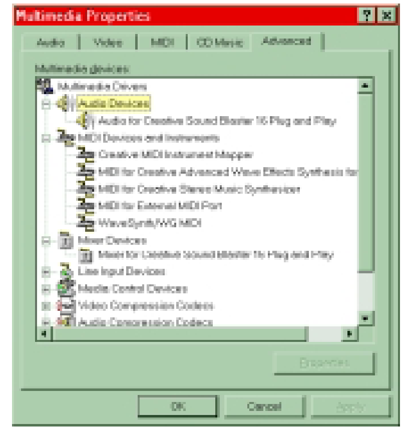


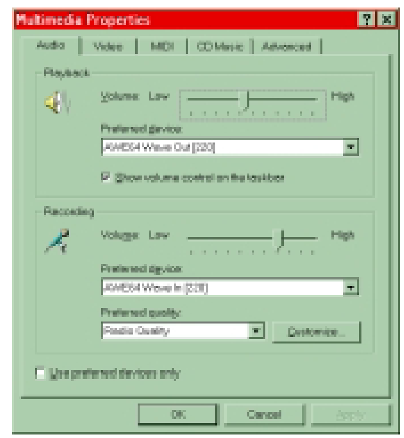
2.4 Audio Software

- Windows device driver — controls the hardware device.

  Many popular sound cards are Plus and Play. Windows has drivers for them and can recognise them automatically. For cards that Windows does not have drivers, you need to get the driver from the manufacturer and install it with the card.

- If you do not hear sound, you should check the settings, such as interrupt, DMA channels, and so on.





- Device manager — the user interface to the hardware for configuring the devices.
  - You can choose which audio device you want to use
  - You can set the audio volume

Mixer — its functions are:

- to combine sound from different sources
- to adjust the play back volume of sound sources
- to adjust the recording volume of sound sources

Recording — Windows has a simple Sound Recorder.

Editing — The Windows Sound Recorder has a limiting editing function, such as changing volume and speed, deleting part of the sound.

There are many freeware and shareware programs for sound recording, editing and processing.

3 Computer Music — MIDI

Sound waves, whether occurred natural or man-made, are often very complex, i.e., they consist of many frequencies. Digital sound is relatively straight forward to record complex sound. However, it is quite difficult to generate (or synthesize) complex sound.

There is a better way to generate high quality music. This is known as *MIDI* — Musical Instrument Digital Interface.

It is a communication standard developed in the early 1980s for electronic instruments and computers. It specifies the hardware connection between equipments as well as the format in which the data are transfered between the equipments.

Common MIDI devices include electronic music synthesisers, modules, and MIDI devices in common sound cards.

General MIDI is a standard specified by MIDI Manufacturers Association. To be GM compatible, a sound generating device must meet the General MIDI system level 1 performance requirement.

- minimum of 24 fully voices
- 16 channels, percussion on channel 10
- minimum 16 simultaneous and different timbre instruments
- minimum 128 preset instruments
- Support certain controllers

This sign indicated that the device is a general MIDI device.

GENERAL MIDI

3.1 MIDI Hardware

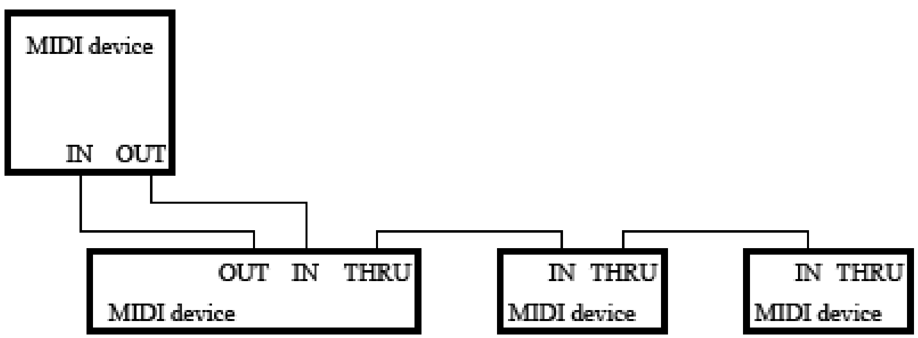
An electronic musical instrument or a computer which has MIDI interface should has one or more MIDI ports. The MIDI ports on musical instruments are usually labelled with:

IN — for receiving MIDI data;

OUT — for outputting MIDI data that are generated by the instrument;

THRU — for passing MIDI data to the next instrument.

MIDI devices can be daisy-chained together.



MIDI software

MIDI player for playing MIDI music. This includes:

- Windows media player can play MIDI files
- Player come with sound card — Creative Midi player
- Freeware and shareware players and plug-ins— Midigate, Yamaha Midplug, etc.

MIDI sequencer for recording, editing and playing MIDI

- Cakewalk Express, Home Studio, Professional
- Cubasis
- Encore
- Voyetra MIDI Orchestrator Plus

Configuration — Like audio devices, MIDI devices require a driver. Select and configure MIDI devices from the control panel.

4 Summary — MIDI versus digital audio

Digital Audio	MIDI
• Digital representation of physical sound waves	• Abstract representation of musical sounds and sound effects
• File size is large if without compression	• MIDI files are much more compact
• Quality is in proportion to file size	• File size is independent to the quality
• More software available	• Much better sound if the sound source is of high quality
• Play back quality less dependent on the sound sources	• Need some music theory
• Can record and play back any sound including speech	• Cannot generate speech

UNIT 3

Images and Graphics

Objectives

- To understand how computers process images and graphics
- To understand how computers work with colours
- To understand the differences between images and graphics

Contents

1 The Nature of Digital Images

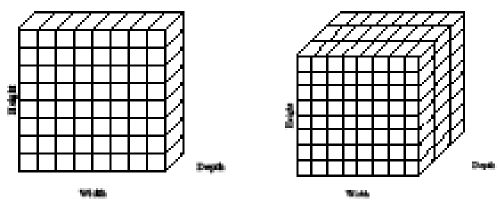
An *image* is a spatial representation of an object, a two-dimensional or three-dimensional scene or another image. Often the images reflect the *intensity* of lights.

Most photographs are called *continuous-tone* images because the method used to develop the photograph creates the illusion of perfect continuous tone throughout the image.

Images stored and processed by computers, displayed on computer screens, are called *digital images* although they often look like continuous-tone. This is because they are represented by a matrix of numeric values each represents a quantised intensity values.

1.1 Basic Concepts

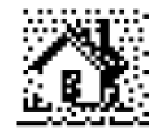
The smallest element on a digital image is known as a *pixel* — a picture element. A digital image consists of a (usually rectangular) matrix of pixels.



1.2 Depth

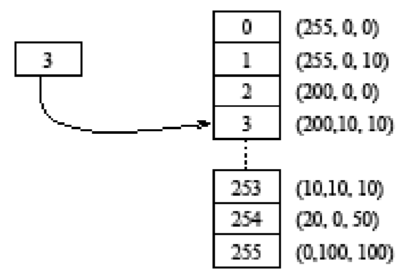
The *depth* of an image is the number of bits used to represent each pixel.

1-bit black-and-white image, also called *bitmap image*.



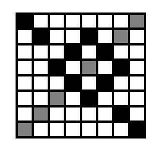
4-bit can represent 16 colours, used in low resolution screens(EGA/VGA)

8-bit can have 256 colours. The 256 colour images are often known as *indexed* colour images. The values are actually indexes to a table of many more different colours. For example, Colour 3 is mapped to (200, 10, 10).



8-bit grey 256 grey-levels. The image contains only brightness/intensity data without colour information.

255	0	0	0	0	0	0	128
0	255	0	0	255	0	128	0
0	0	0	255	0	255	0	0
0	0	255	0	128	0	255	0
0	0	0	255	0	255	0	0
0	0	128	0	255	0	0	0
0	128	0	0	0	0	255	0
128	0	0	0	0	0	0	255



16-bit can have 65536 colours, also known as hi-colour in Windows systems. The 16 bits are divided into 5 bits for RED, 6 bits for GREEN and 5 bits for BLUE.

24-bit $2^{24} = 16,777,216$ colours, true colour. Each byte is used to represent the intensity of a primary colour, RED, GREEN and BLUE. Each colour can have 256 different levels.

RED	GREEN	BLUE	Colour
255	0	0	Red
0	255	0	Green
0	0	255	Blue
255	255	0	Yellow
255	0	255	Magenta
0	255	255	Cyan
127	127	127	Light gray
255	255	255	White
0	0	0	Black

32-bit $2^{32} = 4,294,967,296$ (4G). Usually, 3 bytes are used to represent the three primary colours and the fourth byte is used as the *alpha channel*.

1.3 Resolution

Resolution measures how much detail an image can have. There are several resolutions relating to images.

Image resolution is the number of pixels in an image.

$$320 \times 240 = 76800 \textbf{ pixels}, \; 700 \times 400 = 280000 \textbf{ pixels}$$

Display (Monitor) resolution — refers to number of dots per inch (dpi) on a monitor.

Windows systems usually have 96dpi resolution. Some high resolution video adapters/monitors support 120dpi. For example, a 288×216 image displayed on a monitor with 96dpi will be $3'' \times 2\frac{1}{4}''$.

Output resolution — refers to number of dots per inch (dpi) on a (hard copy) output device.

Many printers have 300dpi or 600 dpi resolution. High-quality imagesetters can print at a range between 1200dpi and 2400dpi, or higher. The above image printed on a 300dpi printer will be 0.96×0.72 inch.

1.4 Acquiring Digital Images

There are many ways to create or get digital images. We list asome of the most common ways:

- Make an image from scratch with a paint program. A good program will allow you to choose the depth, resolution and size.
- Grab an image of a screen. The depth, resolution and size is determined by the screen.
- Capture an image from a digital camera or a camcorder. The depth, resolution and size is determined by the camera or the camcorder. The popular depth is 24-bit. The commonly used resolution is 320×240, 640×480 and 800×600.
- Scan a photograph or a print using a scanner. You can select from a range of different depths and resolution. The choice should be determined by the type of original and the final output form.
- Convert from existing digital media — e.g., photoCD. The attribute is determined by the original image.
- Synthesize an image from numerical data.

2 Vector Graphics

Instead of using pixels, objects can be represented by their attributes, such as size, colour, location, and so on. This type of graphics is known as *vector graphics*, or *vector drawing*. This is an abstract representation of a 2-dimensional or 3-dimensional scene.

A vector graphics file contains graphics primitives, for example, rectangles, circles, lines.

There are many languages for describing vector grphics. Three of them are very popular. They are:

PostScript was developed by Adobe as a page description language. The next page shows a graphic with its PostScript program source. (Example on next page.)

VRML stands for Virtual Reality Markup Language. It is for descripting a scene in a virtual world. An simple examle is shown on the right.

SVG stands for Scalable Vector Graphic. It is a language for describing two-dimensional graphics in XML. It allows three types of grahic objects: vector graphic shapes, images and text.

VRML sample

```
Cube {
  Width 30 Depth 30 Height 30}
Material {
  ambientColor 0.2 0.2 0.2
  diffuseColor 0.8 0.8 0.8
  specularColor 0 0 0
  emissiveColor 0 0 0
  shininess 0.2
  transparency 0
  }
```

2.1 Vector versus Bitmap

Bitmap

- A bitmap contains an exact pixel-by-pixel value of an image
- A bitmap file is fixed in resolution
- The file size of a bitmap is completely determined by the image resolution and its depth
- A bitmap image is easier to render

Vector graphic

- a vector graphic contains mathematical description of objects
- a vector graphic is resolution independent
- the file size of a vector graphic depends on the number of graphic elements it contains
- displaying a vector graphic usually involves a large amount of processing

3 Colour Systems

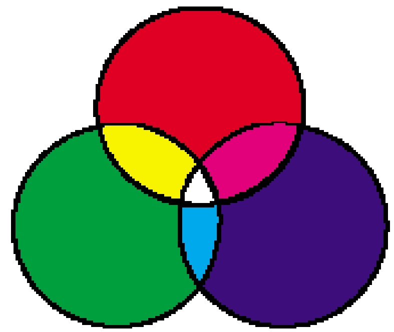
Colour is a vital component of multimedia. Colour management is both a subjective and a technical exercise, because:

- Colour is a physical property of light, but
- Colour perception is a human physiological activity.
- Choosing a right colour or colour combination involves many trials and aesthetic judgement.
- Colour is the frequency/wave-length of a light wave within the narrow band of the electromagnetic spectrum (380 – 760nm) to which the human eye responds.

Wavelength	Intensity	Spectral Purity
Hue	Brightness	Saturation

3.1 RGB Colour Model

R — Red
G — Green
B — Blue



This is probably the most popular colour model used in computer graphics.

It is an *additive* system in which varying amount of the three primary colours, red, green and blue, are added to black to produce new colours.

You can imagine three light sources of the primary colours shine on a black surface. By varying the intensity of the lights, you will produce different colours.

3.2 CMY Colour Model

This model is based on the light absorbing quality of inks printed on paper. Combining three primary colour pigments, Cyan, Magenta and Yellow, should absorb all light, thus resulting in black.

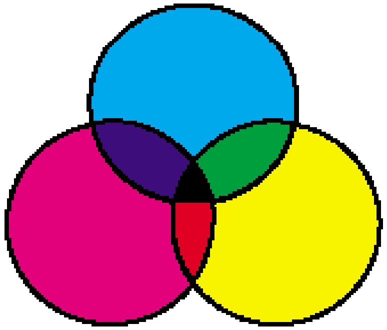
It is a *subtractive* model.

The value of each primary colour is assigned a percentage from the lightest (0%) to the darkest (100%).

Because all inks contain some impurities, three inks actually produce a muddy brown, a black colour is added in printing process, thus CMYK model.

Note: the primary colours in RGB and CMY models are complementary colours.

C — Cyan
M — Magenta
Y — Yellow



3.3 HSB Colour Model

This model is based on the human perception of colour.

The three fundamental characteristics of colours are:

Hue — is the wavelength of the light. Hue is often identified by the name of the colour. It is measured as a location on the standard colour wheel as a degree between 0° to 360°.

Saturation — is the strength or purity of the colour. It represents the amount of gray in proportion to the hue and is measured as a percentage from 0%(gray) to 100%(fully saturated).

Brightness — is the relative lightness or darkness of the colour. It is measured as a percentage from 0%(black) to 100%(white).

3.4 YUV Colour Model

This model is widely used in encoding colour for use in television and video.

The theory behind this model is that human perception is more sensitive to brightness than any chrominance information, so a more suitable coding distinguishes between luminance and chrominance. This also produces a system that is compatible with black-and-white TV systems.

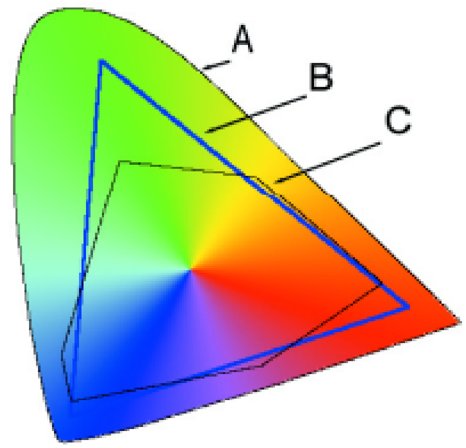
The Y-signal encodes the brightness information. Black-and-white television system will use this channel only.

The U and V channels encode the chromatic information. The resolution of the U and V channels is often less than the Y channel for the reason of reducing the size.

3.5 Gamut

The *gamut* of a colour system is the range of colours that can be displayed or printed. The spectrum of colours that can be viewed by human eye is wider than any method of reproducing colour.

Different colour models have different gamut. The CMYK model is smaller than RGB model. On the right is a Chromaticity Diagram which illustrates gumat of RGB and CMYK colour systems.

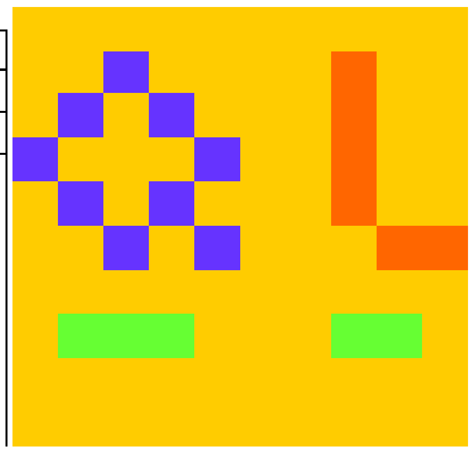


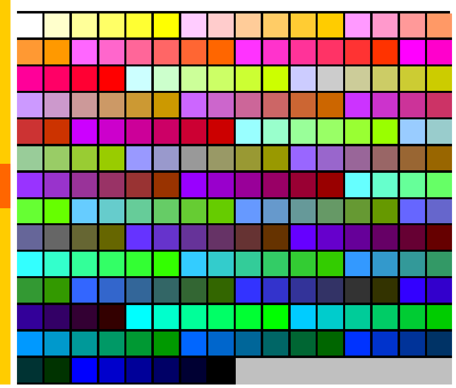
A Natural colour
B RGB gamut
C CMYK gamut

3.6 Colour Palette

A *colour palette* is an index table to available colours in an indexed colour system. When working in 8-bit mode, a system can display only 256 colours out of a total of 16 million colours. The system keeps a default palette of available colours.

11	11	11	11	11	11	11	11	11	11
11	11	132	11	11	11	11	16	11	11
11	132	11	132	11	11	11	16	11	11
132	11	11	11	132	11	11	16	11	11
11	132	11	132	11	11	11	16	11	11
11	11	132	11	132	11	11	11	16	16
11	11	11	11	11	11	11	11	11	11
11	112	112	112	11	11	11	112	112	11
11	11	11	11	11	11	11	11	11	11
11	11	11	11	11	11	11	11	11	11





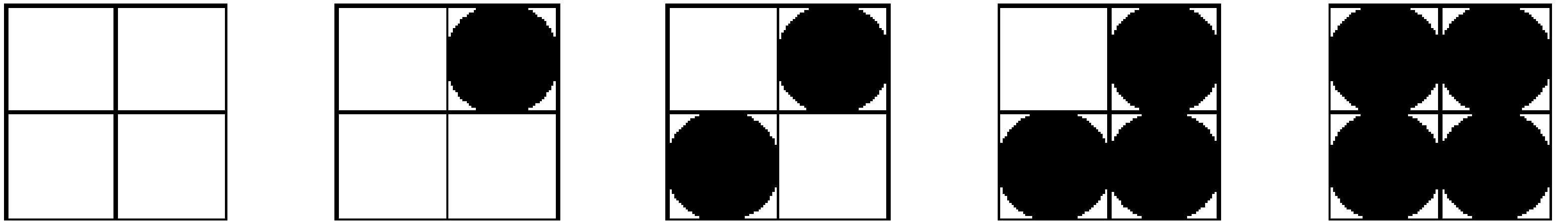
Palette flashing. Each program may have its own palette. It may replace the system palette with its own for the period it is active. This may cause an annoying flash of strange colours in your screen, known as *palette flashing*. This is a serious problem in multimedia applications.

4 Some Image Techniques

4.1 Dithering

Dithering is a technique to increase the number of colours to be perceived in an image. It is based on human eye's capability for *spatial integration*, that is, if you look at a number of closely placed small objects from a distance, they will look like merged together.

Dithering technique groups a number of pixels together, say 4, to form a cluster. When viewed from sufficient distance, the individual pixel will not be distiguishable. The cluster will look like a single block of a colour different from the individual pixel.



5 Image And Graphics File Formats

A digital image is stored in a file conforming to certain format. In addition to the pixel data, the file contaions information to identify and decode the data:

- The format
- The image size
- Depth
- Colour and palette
- Compression

Some formats are defined to work only in certain platform while other can be used for all platforms. Some formats are specific for an application. Some formats are for images, others are for vector graphics. Some formats allow compression, others contain only raw data.

Note: Formats using compression will make the file size smaller. Some compression algorithms will lose some image information.

Some popular file formats

Format	Type	Ext	Description
Adobe Photoshop	bitmap	psd	specific for the application
Apple Macintosh PICT	bitmap	pict	platform dependent format
AutoCAD DXF	vector	dxf	specific for the application
CompuServ GIF	bitmap	gif	cross platform, indexed colour, new standard allows animation, popular on WWW
Jpeg	bitmap	jpg	using lossy compression, file size is very small, popular on WWW
Portable Bitmap	bitmap	pbm, pgm, ppm	platform independent
PC Paintbrush	bitmap	pcx	specific for the application
Portable Network Graphic	bitmap	png	very new format, platform independent
PostScript	vector	ps, eps	page description language
TIFF	bitmap	tif	allows compression, and different depth, popular in many applications
Windows bitmap	bitmap	bmp	no compression, platform dependent
Windows Metafile	metafile	wmf	may contain bitmap and graphics elements

6 Digital Image Processing

This is a very large area containing the following sub-areas:

- *Image analysis* is concerned with techniques for extracting descriptions from images that are necessary for higher-level scene analysis methods.
- *Image recognition* is concerned with the techniques for recovering information about objects in the image. A sub-area is character recognition.
- *Image enhancement* is concerned with the technique to improve the image and to correct some defects, such as,
  - colour and tonal adjustment,
  - Transformations, e.g., scale, rotate,
  - Special effects, e.g., texture, stylize, blur, sharpen.

7 Image And Graphics Software

- Image editing and processing tools, such as
  - Windows Paint — simple
  - Adobe Photoshop
  - Macromedia Firework
  - MetaCreation Painter
  - Corel PhotoPaint
  - Paint Shop Pro — a low cost shareware
  - The GIMP — an open source program with excellent functions
- Vector graphics tools, such as
  - Adobe Illustrator
  - Macromedia Freehand
  - Corel Draw
- Format conversion tools — Many applications can open/import files in various formats and save/export to another format. Paint Shop Pro can understand files in a very large number of formats.

Video and Animation

Prof. S. Shakya

Motion

- Both video and animation give us a sense of motion
- They exploit some properties of human eye's ability of viewing pictures
- Motion video is the element of multimedia that can hold the interest of viewers in a presentation

Visual Representation

- **The visual effect of motion is due to a biological phenomenon known as *persistence of vision***
- **An object seen by the human eye remains mapped on the eye's retina for a brief time after viewing (approximately 25 ms)**
- **Another phenomenon contributing to the vision of motion is known as *phi phenomenon***
- **When two light sources are close by and they are illuminated in quick succession, what we see is not two lights but a single light moving between the two points**
- **Due to the above two phenomena of our vision system, a discrete sequence of individual pictures can be perceived as a continuous sequence**

Visual Representation

- ***Temporal aspect of Illumination*—To represent**
- **visual reality, two conditions must be met the rate of repetition of the images must be high enough to guarantee smooth motion from frame to frame**
- **the rate must be high enough so that the persistence of vision extends over the interval between flashes**
- **The frequency at which the flicking light source must be repeated before it appears continuous is known as the *fusion frequency***
- **This depends on the brightness of the light source**
- **The brighter the light source the higher the fusion frequency**

- **It is known that we perceive a continuous motion to happen at any frame rate faster than 15 frames per second**
- **PAL television system has a frame rate of 25 frames/s**

Visual Representation

- **Another problem known as *flicker* occurs due to a periodic fluctuation of brightness perception**
- **A technique known as *interleaving* improves the view by**

  -dividing a frame into two fields, each contains the alternative scan lines, and

  - displaying the field in twice of the frames rate

Video resolution

- The smallest detail that can be reproduced in the image is a pixel
- Practically, some of the scene inevitably fall between scanning lines, so that two lines are required for such picture elements
- Only about 70% of the vertical detail is presented by
  the scanning lines
- *Aspect ratio* is the ratio of the picture width to height.
- It is 4:3 for conventional TV
- The picture width, horizontal resolution and the total detail content of the image can be calculated

Video resolution

- **Conventional video systems have relative low resolution**

- compare to computer screens: typical resolution of

- 640 x 480**, even up to** 1024 X 768
- **One consequence of this low resolution is that video played on computer screen are usually in a small window**
- **On the other hand, even with this low resolution, the amount of data in video is huge**

Consider PAL TV at 25 frames per second, if we sample at

352 x 288 with 16 bits per pixel, the raw video size is

352 x288 x16 x 25 = 40.55Mbit/s = 5Mbytes/s

-Compare this with a typical Ethernet bandwidth of 10Mbit/s

-or a double speed CD-ROM drive of 300Kbyte/s

- **Therefore, we need to compress the video data**

Digitalising Video

- **We need to *capture* or *digitize* video for playing back on computers or integrating into multimedia applications**
- **We need to take a lot of samples**
- **At 25 frames per second, each frame requires** 1/25 = 40ms
- **There 625 scan lines in each frame, giving each scan line is** 40ms/625 = 64µs
- **At a horizontal resolution of 425 pixel, the time for sampling each pixel is** 64µs/425 = 0.15µs **, i.e., sampling rate is at least 7Mhz**
- **This requires very fast hardware**
- **Hardware required to capture video:**
  - **Video sources: TV, VCR, LaserDisc player, Camcorder**
  - **Video capture card**
  - **Storage space: large hard disk**

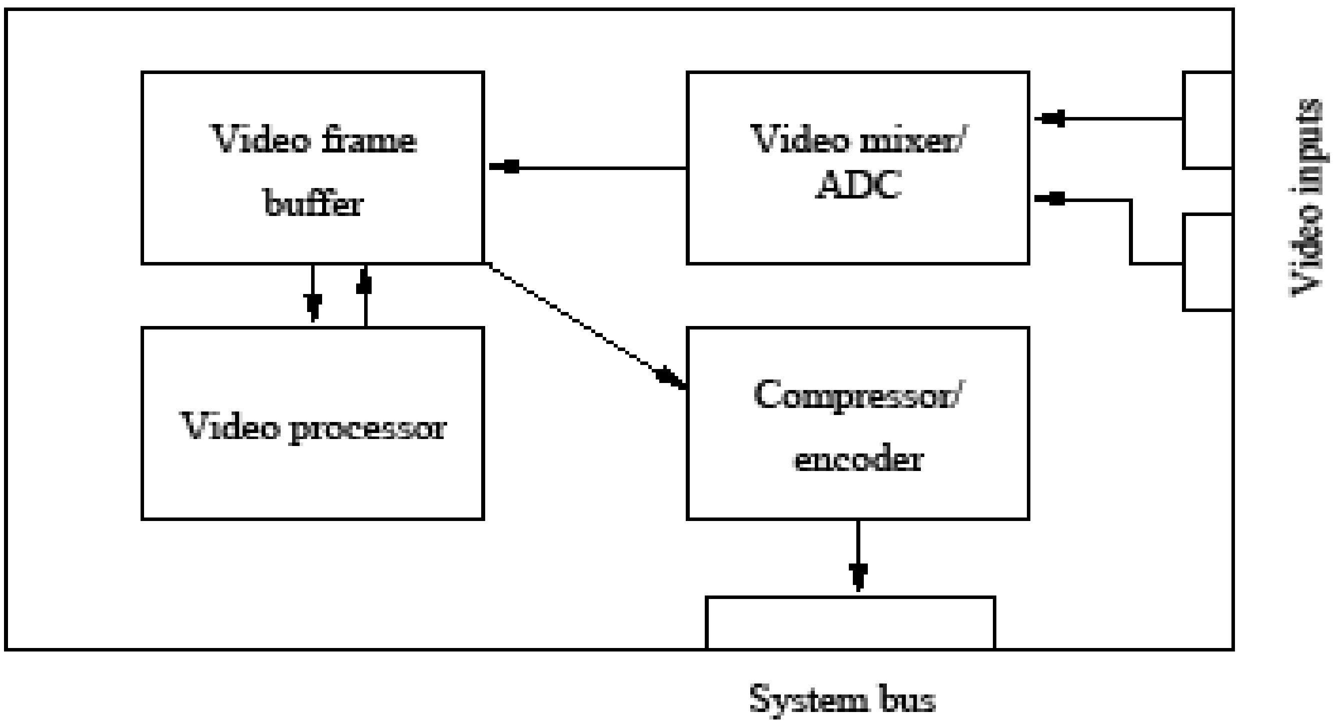
Video capture cards

- There are many different video capture cards on the market

The common features in these cards are:

- Can accept composite video or S-VHS in NTSC or PAL; high-end capture cards can accept digital video (DV)
- Video input mixer and ADC— to select/combine video sources, to convert analog video signal to digital samples
- Video frame buffer— temporary storage for video frame
- Video processor— to filter or enhance the video frame, e.g., reduce noise, adjust brightness, contrast and colour
- Compressor/encoder— to compress and encode the digital video into a required format
- Interface to the system PCI bus

Video capture cards



Video formats

- **AVI (Audio Video Interleaved) format was defined by Microsoft for its Video for Windows systems**
- **It supports video playback at up to 30 frames per second on a small window (typical size** 300X200 **with 8 or 16 bit colour)**
- **It is a software-only system**
- **It supports a number of compression algorithms**
- **QuickTime was originally developed by Apple for storing audio and video in Macintosh systems**
- **It supports video playback at up to 30 frames per second on a small window (typical size** 300X200 **with 8 or 16 bit colour)**
- **It is a software-only system**
- **It supports a number of compression algorithms**

Animation

- To *animate* something is, literally, to bring it to life
- An animation covers all changes that have a visual effect
- Visual effect can be of two major kinds:
- *motion dynamic*— time varying positions
- *update dynamic*— time varying shape, colour, texture, or even lighting, camera position, etc.
- The visual effects is the result of exploiting the properties of human vision system as described above (in the section about video)
- A computer animation is an animation performed by a computer using graphical tools to provide visual effects

Input process

- The first step in producing computer animation is *input process*
- *Key frames* have to be created and input into the computer
- *Key frames* are the frames in which the objects being animated are at extreme or characteristic positions
- They can be drawn using traditional artistic tools, such as pen and brush, and then digitised
- *The digital images may need to be cleaned up*
- They can also be created using drawing or painting tools directly
- In *composition stage*, the foreground and background figures are combined to generate the individual frames

Inbetween process

- **The animation of movement from one position to another needs a composition of frames with intermediate positions in between the key frames**
- **The process of *inbetweening* is performed in computer animation through *interpolation***
- ***The system is given the starting and ending positions***
- ***It calculates the positions in between***

Inbetween process

- **The easiest interpolation is *linear* interpolation**
- ***It has many limitations: the object does no move smoothly, look unreal***
- ***Spline* interpolation can make object move more smoothly**
- **Inbetweening also involves interpolating the shapes of objects**
- **Some animation involves changing the colour of objects**
- ***This is usually done using colour look-up table (CLUT)***
- ***By cycling through the colours in the CLUT, the objects' colours will change***
- ***Morphing* is a popular effect in which one image transforms into another**

Controlling animation

- **Full explicit control —the animator provides a description of everything that occurs in the animation**
- ***either by specifying simple changes, such as scaling, transformation***
- ***or by providing key frames***
- **Procedural control —using a program to calculate the position, angle, etc. of the objects**
- ***In physical systems, the position of one object may influence the motion of another***
- **Constraint-based systems —movement of objects that are in contact with each other is constraint by physical laws**
- ***An animation can be specified by these constraints***
- **Tracking live action —**
- **People or animals act out the parts of the characters in the animation**
- **The animator trace out the characters**

Controlling animation

- ***Kinematics*** **refers to the position and velocity of points**
- ***The ball is at the origin at time t = 0. It moves with a constant acceleration in the direction (1,1,5) thereafter.***
- **The final result of an animation is the sum of all the steps. If it does not fit, the animator has to try again. This is known as *forward kinematics*.**
- ***Inverse kinematics (IK)*** **is concerned with moving a skeleton from one pose to another.**
- ***The animator specifies the required position of the end effecter, the IK algorithm will calculate the joint position, angle, etc.***
- ***Dynamics*** **takes into account the physical laws that govern the masses and forces acting on the objects**
- ***The ball is at the origin at time t = 0 second. It has a mass of 200 grams. The force of gravity acts on it.***

Displaying animation

- **The rules governing the showing of video apply to animation as well**
- **The frame rate should be at least 10, preferably 15 to 20, to give a reasonably smooth effect**
- **There are basically three common ways to display animation**
- **Generate a digital video clip**
- *Many Animation tools will export an animation in common digital video format, e.g., QuickTime*
- **Create a package including runtime system of the animation tool**
- *For example, Director can create a projector including all casts. The projector can then be distributed and play the animation.*
- **Show the animation in the animation tool**

Animation tools

- **Macromedia Director and Flash**
- *It is one of the most popular interactive animation tool for generating interactive multimedia applications*
- **MetaCreations Poser**
- ***It understands human motion and inverse kinematics, e.g., move an arm the shoulders will follow.***
- **Discreet 3D Studio Max**
- *Very popular for creating 3D animations*
- **Animation language—VRML (Virtual Reality Modeling Language)**

Video formats

MPEG (Motion Picture Expect Group) is a working group under ISO

- There are several versions of mpeg standard.
- The most commonly used now is mpeg-1
- It requires hardware support for encoding and decoding (on slow systems)
- The maximum data rate is 1.5Megabit/sec
- The next generation mpeg-2 is now getting popular
- Mpeg-2 improves mpeg-1 by increasing the maximum data rate to 15Mbit/sec
- It can interleave audio and video

DATA COMPRESSION

Why Compress?

- To reduce the volume of data to be transmitted (text, fax, images)
- To reduce the bandwidth required for transmission and to reduce storage requirements (speech, audio, video)

Data compression implies sending or storing a smaller number of bits. Although many methods are used for this purpose, in general these methods can be divided into two broad categories: lossless and lossy methods.

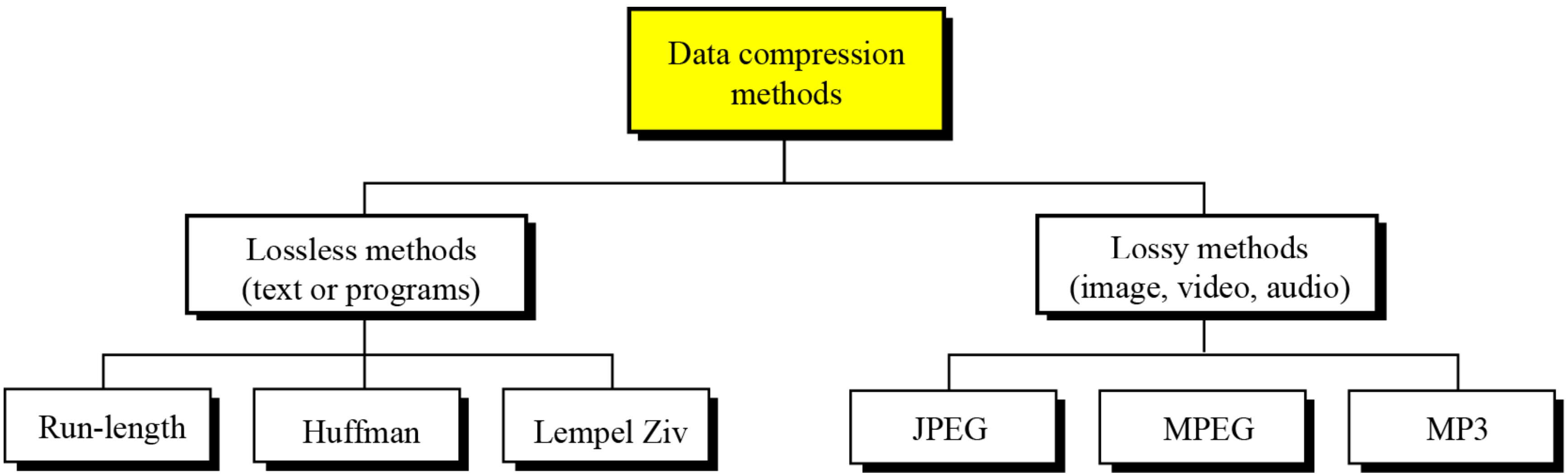


Figure1 Data compression methods

Compression

- How is compression possible?
  - Redundancy in digital audio, image, and video data
  - Properties of human perception
- Digital audio is a series of sample values; image is a rectangular array of pixel values; video is a sequence of images played out at a certain rate
- Neighboring sample values are correlated

Redundancy

- Adjacent audio samples are similar (predictive encoding); samples corresponding to silence (silence removal)
- In digital image, neighboring samples on a scanning line are normally similar (spatial redundancy)
- In digital video, in addition to spatial redundancy, neighboring images in a video sequence may be similar (temporal redundancy)

Human Perception Factors

- Compressed version of digital audio, image, video need not represent the original information exactly
- Perception sensitivities are different for different signal patterns
- Human eye is less sensitive to the higher spatial frequency components than the lower frequencies (transform coding)

Classification

- Lossless compression
  - lossless compression for legal and medical documents, computer programs
  - exploit only data redundancy
- Lossy compression
  - digital audio, image, video where some errors or loss can be tolerated
  - exploit both data redundancy and human perception properties
- Constant bit rate versus variable bit rate coding

Entropy

- Amount of information *I* in a symbol of occurring probability *p* : $I = \log_2(1/p)$
- Symbols that occur rarely convey a large amount of information
- Average information per symbol is called entropy H

$$H = \ p_i x \log_2(1/p_i) \text{ bits per codeword}$$

- Average number of bits per codeword = $N_i p_i$ where N_i is the number of bits for the symbol generated by the encoding algorithm

Huffman Coding

- Assigns fewer bits to symbols that appear more often and more bits to the symbols that appear less often
- Efficient when occurrence probabilities vary widely
- Huffman codebook from the set of symbols and their occurring probabilities
- Two properties:
  - generate compact codes
  - prefix property

Run-length Coding

- Repeated occurrence of the same character is called a run
- Number of repetition is called the length of the run
- Run of any length is represented by three characters
  - eeeeeee7tnnnnnnnn
  - @e7t@n8

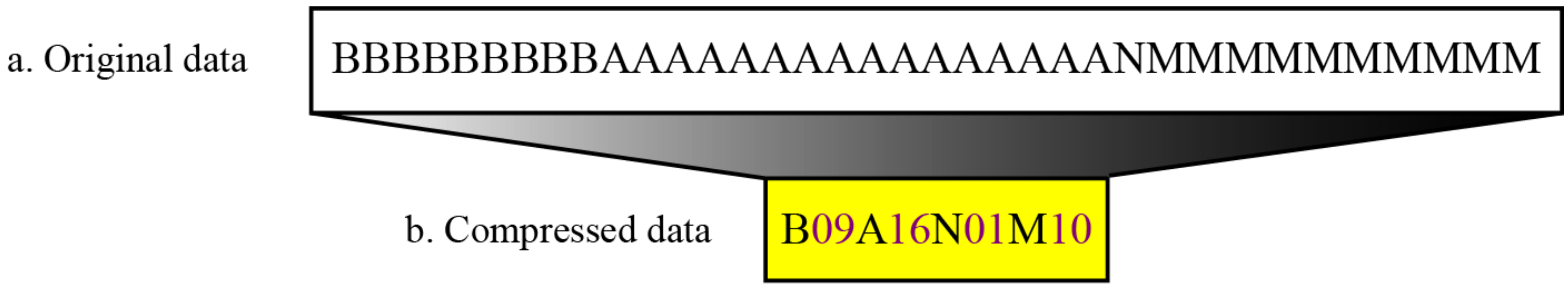


Figure 15.2 Run-length encoding example

Lempel-Ziv-Welch (LZW) Coding

- Works by building a dictionary of phrases from the input stream
- A token or an index is used to identify each distinct phrase
- Number of entries in the dictionary determines the number of bits required for the index -- a dictionary with 25,000 words requires 15 bits to encode the index

Arithmetic Coding

- String of characters with occurrence probabilities make up a message
- A complete message may be fragmented into multiple smaller strings
- A codeword corresponding to each string is found separately

Data Compression

Coding Requirements

- Let us consider the general requirements imposed on most multimedia systems:
- Storage — multimedia elements require much more storage space than simple text. For example, a full screen true colour image is 640 x 480 X 3 = 921600 bytes

Data Compression

- **The size of one second of uncompressed CD quality stereo audio is 44.1kHz X 2 X 2 = 176400 bytes**
- **The size of one second of uncompressed PAL video is**

384X288X 3 X 25 frames = 8294400 bytes

Data Compression

- **Throughput** — continuous media require very large throughput. For example, an uncompressed CD quality stereo audio stream needs 176400 bytes/sec. A raw digitized PAL TV signal needs(13.5MHz + 6.75MHz + 6.75MHz) X 8bits

$= 216 \times 10^6$ bits/sec

$= 27 \times 10^6$ Bytes/sec

Data Compression

- **Interaction** — to support fast interaction, the end-to-end delay should be small. A ‘face-to-face’ application, such as video conferencing, requires the delay to be less than 50ms. Furthermore, multimedia elements have to be accessed randomly.
- **Conclusion**:
- Multimedia elements are **very large**.
- We need to reduce the data size using **compression**.

Data Compression

Kinds of coding methods

- **Lossless — the compression process does not reduce the amount of information.**

- The original can be reconstructed exactly

- **Lossy — the compression process reduces the amount of information.**

-**Only an approximation of the original can be reconstructed.**

Data Compression

Categories of Compression Techniques

- **Entropy coding is lossless**
- **Source coding and hybrid coding are lossy.**

Data Compression

Coding techniques

- **Vector Quantization — a data stream is divided into blocks of n bytes (where n > 1). A predefined table contains a set of patterns is used to code the data blocks.**
- **LZW —a general compression algorithm capable of working on almost any type of data. It builds a data dictionary of data occurring in an uncompressed data stream. Patterns of data are identified and are matched to entries in the dictionary. When a match is found the code of the entry is output.**

Data Compression

- **Since the code is shorter than the data pattern, compression is achieved. The popular zip application used this method to compress files.**
- **Differential coding — (also know as prediction or relative coding) The most known coding of this kind is DPCM (Differential Pulse Code Modulation). This method encodes the difference between the consecutive samples instead of the sample values. For example,**

Data Compression

- PCM 215 218 210 212 208 . . .
- DPCM 215 3 -8 2 -4 . . .
- DM (Delta Modulation) is a modification of DPCM. The difference is coded with a single bit.

Data Compression

Huffman coding

- The principle of Huffman coding is to assign shorter code for symbol that has higher probability of occurring in the data stream.
- The length of the Huffman code is optimal.

A Huffman code tree is created using the following procedures

- Two characters with the lowest probabilities are combined to form a binary tree.
- The two entries in the probability table is replaced by a new entry whose value is the sum of the probabilities of the two characters.
- Repeat the two steps above
- Assign 0 to be left branches and 1 to the right branches of the binary tree.
- The Huffman code of each character can be read from the tree starting from the root.

Data Compression

JPEG

- **JPEG (stands for Joint Photographic Experts Group) is a joint ISO and CCITT (*Comité Consultatif International Téléphonique et Télégraphique*), working group for developing standards for compressing still images**
- **The JPEG image compression standard became an international standard in 1992**
- **JPEG can be applied to colour or grayscale images**

LOSSY COMPRESSION METHODS

Our eyes and ears cannot distinguish subtle changes. In such cases, we can use a lossy data compression method. These methods are cheaper—they take less time and space when it comes to sending millions of bits per second for images and video. Several methods have been developed using lossy compression techniques. JPEG (Joint Photographic Experts Group) encoding is used to compress pictures and graphics, MPEG (Moving Picture Experts Group) encoding is used to compress video, and MP3 (MPEG audio layer 3) for audio compression.

Image compression – JPEG encoding

an image can be represented by a two-dimensional array (table) of picture elements (pixels).
A grayscale picture of 307,200 pixels is represented by 2,457,600 bits, and a color picture is represented by 7,372,800 bits.

In JPEG, a grayscale picture is divided into blocks of 8×8 pixel blocks to decrease the number of calculations because, as we will see shortly, the number of mathematical operations for each picture is the square of the number of units.

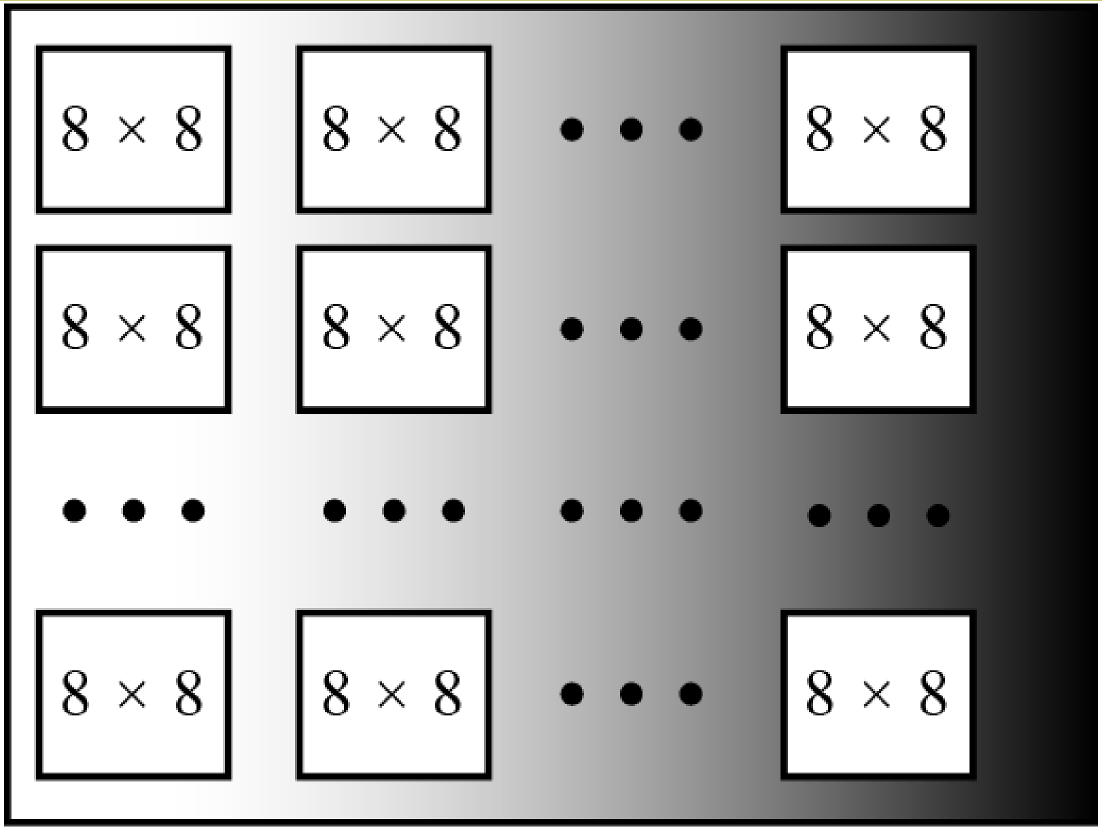


Figure 2 JPEG grayscale example, 640 × 480 pixels

The whole idea of JPEG is to change the picture into a linear (vector) set of numbers that reveals the redundancies. The redundancies (lack of changes) can then be removed using one of the lossless compression methods we studied previously. A simplified version of the process is shown in Figure 3.

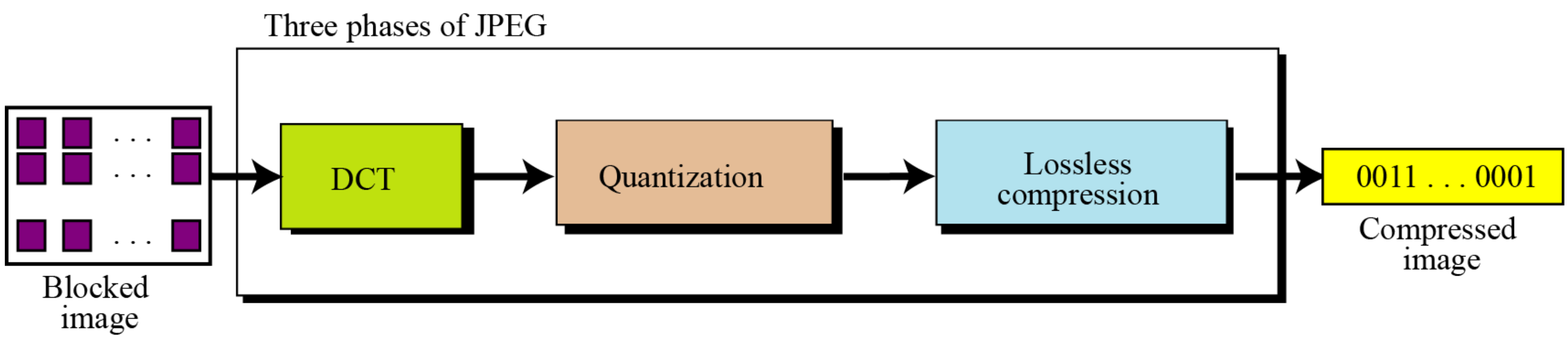


Figure 3 The JPEG compression process

Video compression – MPEG encoding

The Moving Picture Experts Group (MPEG) method is used to compress video. In principle, a motion picture is a rapid sequence of a set of frames in which each frame is a picture. In other words, a frame is a spatial combination of pixels, and a video is a temporal combination of frames that are sent one after another. Compressing video, then, means spatially compressing each frame and temporally compressing a set of frames.

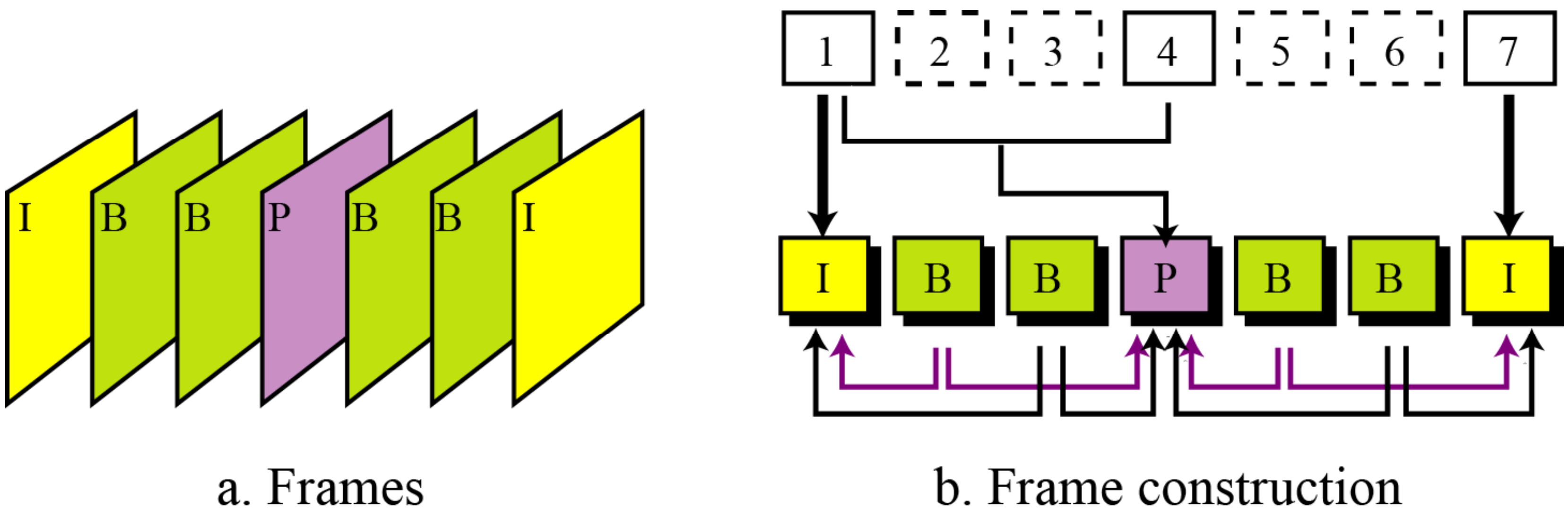


Figure 4 MPEG frames

Audio compression

Audio compression can be used for speech or music. For speech we need to compress a 64 kHz digitized signal, while for music we need to compress a 1.411 MHz signal. Two categories of techniques are used for audio compression: predictive encoding and perceptual encoding.

Data Compression

- By changing appropriate parameters, the user can select

– the quality of the reproduced image
– compression processing time
– the size of the compressed image

Data Compression

- The JPEG standard have three levels of definition as follows:
- Baseline system — must reasonably decompress colour images, maintain a high compression ratio, and handle from 4bits/pixel to 16bits/pixel.
- Extended system — covers the various encoding aspects such as variable length encoding, progressive encoding, and hierarchical mode of encoding.

Data Compression

- Special lossless function— ensures that at the resolution at which the image is compressed, decompression results in no loss of any detail the was in the original image.

Data Compression

- **JPEG — Preparation**
- **A source image consists of at least one and at most 255 planes.**
- **Each plane Ci may have different number of pixels in the horizontal (Xi) and vertical (Yi) dimension.**
- **The resolution of the individual plane may be different.**
- **Each pixel is represented by a number of bits p where $2 \leq p \leq 12$.**

Data Compression

- **The meaning of the value in these planes is not specified in the standard.**
- **The image is divided into 8 X 8 blocks.**

Data Compression

MPEG

- **MPEG (stands for Moving Picture Experts Group) is also a joint ISO and CCITT working group for developing standards for compressing still images**
- **The MPEG video compression standard became an international standard in 1993**
- **MPEG uses technology defined in other standards, such as JPEG and H.261**

Data Compression

- It defines a basic data rate of 1.2Mbits/sec
- It is suitable for symmetric as well asymmetric compression It follows the reference scheme that consists of four stages of processing:

1. Preparation
2. Processing
3. Quantization
4. Entropy Encoding

Data Compression

- In the preparation stage, unlike JPEG, MPEG defines the format of the images
- Each image consists of three components — YUV
- The luminance component has twice as many samples in the horizontal and vertical axes as the other two components (known as colour sub-sampling
- The resolution of the luminance component should not exceed 768 pixels

Data Compression

- for each component, a pixel is coded with eight bits

Data Compression

How MPEG encode the video stream

- **In order to achieve higher compression ratio, MPEG uses the fact the image on consecutive frames differ relative small. It uses a temporal prediction technique to encode the frame so that the storage requirement is greatly reduced.**
- **Common MPEG data stream consists of four kinds of frames:**

Data Compression

- **I-frame (Intra-frame) — it is a self contained frame, and it is coded without reference to any other frames.**
- **P-frame (Predictive-coded frame) — It is coded using the predictive technique with reference to the previous I-frame and/or previous P-frame.**
- **B-frame (Bi-directionally predictive coded frame) — It requires information of the previous and following I- and P-frames for encoding and decoding.**

Data Compression

- D-frame (DC-coded frame) Only the lowest frequency component of image is encoded. It is used in fast forward or fast rewind.

Data Compression

MPEG-2

- **MPEG-2 is a newer video encoding standard which builds on MPEG-1**
- **It supports higher video quality and higher data rate (up to 80 Mbits/sec)**
- **It supports several resolutions**:

pixels/line	line/frame	frames/sec
352	288	30
720	576	30
1920	1152	60

Data Compression

Summary

- **Compression methods — lossless vs. lossy**
- **Entropy coding — run-length encoding, Huffman encoding**
- **Source coding — prediction (DPCM, DM), transformation (DCT)**
- **hybrid coding — JPEG, MPEG**

User interface design

Objectives

- To suggest some general design principles for user interface design
- To explain different interaction styles and their use
- To explain when to use graphical and textual information presentation
- To explain the principal activities in the user interface design process
- To introduce usability attributes and approaches to system evaluation

Topics covered

- Design issues
- The user interface design process
- User analysis
- User interface prototyping
- Interface evaluation

The user interface

- User interfaces should be designed to match the skills, experience and expectations of its anticipated users.
- System users often judge a system by its interface rather than its functionality.
- A poorly designed interface can cause a user to make catastrophic errors.
- Poor user interface design is the reason why so many software systems are never used.

Human factors in interface design

- Limited short-term memory
  - People can instantaneously remember about 7 items of information. If you present more than this, they are more liable to make mistakes.
- People make mistakes
  - When people make mistakes and systems go wrong, inappropriate alarms and messages can increase stress and hence the likelihood of more mistakes.
- People are different
  - People have a wide range of physical capabilities. Designers should not just design for their own capabilities.
- People have different interaction preferences
  - Some like pictures, some like text.

UI design principles

- UI design must take account of the needs, experience and capabilities of the system users.
- Designers should be aware of people's physical and mental limitations (e.g. limited short-term memory) and should recognise that people make mistakes.
- UI design principles underlie interface designs although not all principles are applicable to all designs.

User interface design principles

Principle	Description
User familiarity	The interface should use terms and concepts which are drawn from the experience of the people who will make most use of the system.
Consistency	The interface should be consistent in that, wherever possible, comparable operations should be activated in the same way.
Minimal surprise	Users should never be surprised by the behaviour of a system.
Recoverability	The interface should include mechanisms to allow users to recover from errors.
User guidance	The interface should provide meaningful feedback when errors occur and provide context-sensitive user help facilities.
User diversity	The interface should provide appropriate interaction facilities for different types of system user.

Design principles

- User familiarity
  - The interface should be based on user-oriented terms and concepts rather than computer concepts. For example, an office system should use concepts such as letters, documents, folders etc. rather than directories, file identifiers, etc.
- Consistency
  - The system should display an appropriate level of consistency. Commands and menus should have the same format, command punctuation should be similar, etc.
- Minimal surprise
  - If a command operates in a known way, the user should be able to predict the operation of comparable commands

Design principles

- Recoverability
  - The system should provide some resilience to user errors and allow the user to recover from errors. This might include an undo facility, confirmation of destructive actions, 'soft' deletes, etc.
- User guidance
  - Some user guidance such as help systems, on-line manuals, etc. should be supplied
- User diversity
  - Interaction facilities for different types of user should be supported. For example, some users have seeing difficulties and so larger text should be available

Design issues in UIs

- Two problems must be addressed in interactive systems design
  - How should information from the user be provided to the computer system?
  - How should information from the computer system be presented to the user?
- User interaction and information presentation may be integrated through a coherent framework such as a user interface metaphor.

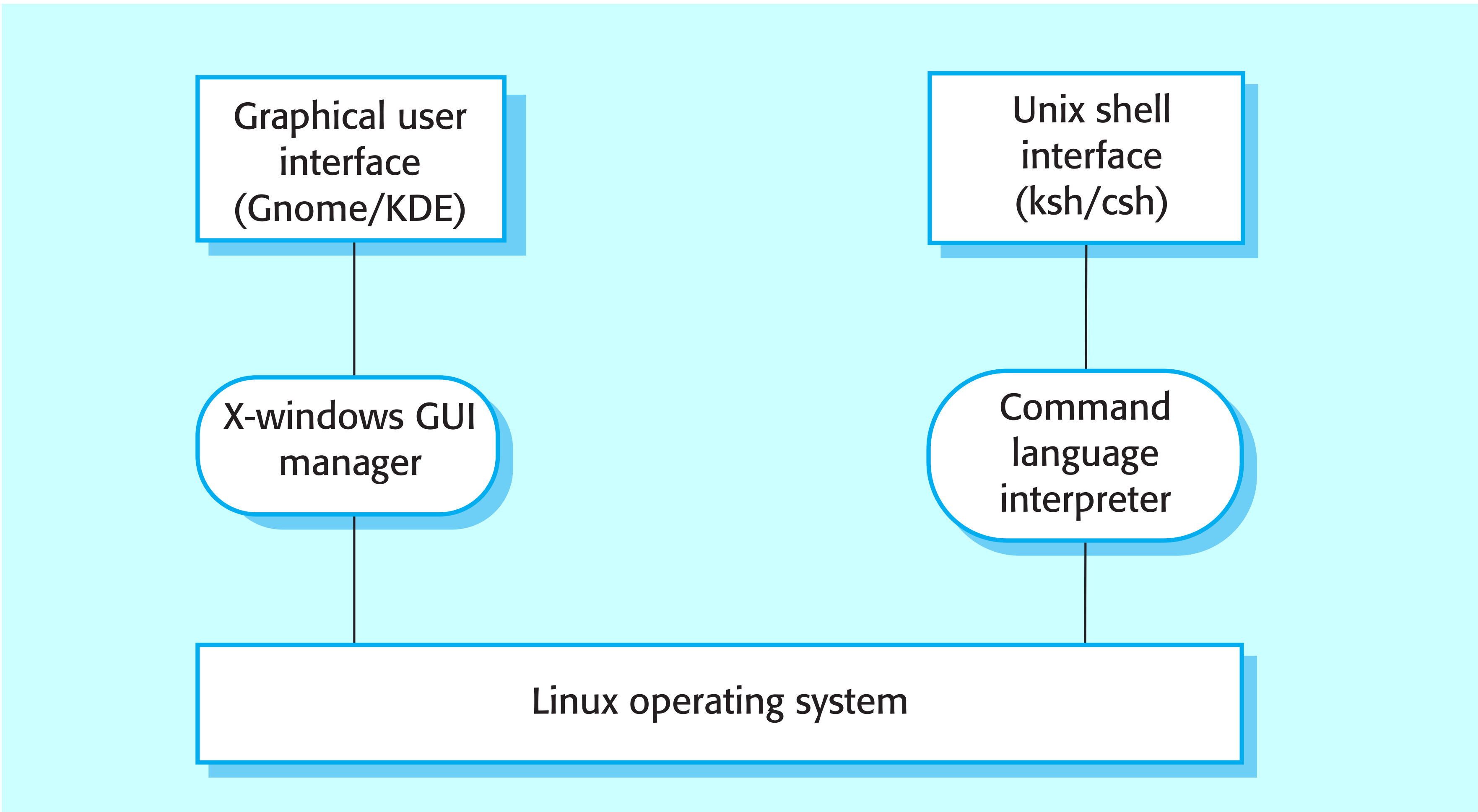
Interaction styles

- Direct manipulation
- Menu selection
- Form fill-in
- Command language
- Natural language

Interaction styles

Interaction style	Main advantages	Main disadvantages	Application examples
Direct manipulation	Fast and intuitive interaction Easy to learn	May be hard to implement. Only suitable where there is a visual metaphor for tasks and objects.	Video games CAD systems
Menu selection	Avoids user error Little typing required	Slow for experienced users. Can become complex if many menu options.	Most general-purpose systems
Form fill-in	Simple data entry Easy to learn Checkable	Takes up a lot of screen space. Causes problems where user options do not match the form fields.	Stock control, Personal loan processing
Command language	Powerful and flexible	Hard to learn. Poor error management.	Operating systems, Command and control systems
Natural language	Accessible to casual users Easily extended	Requires more typing. Natural language understanding systems are unreliable.	Information retrieval systems

Multiple user interfaces



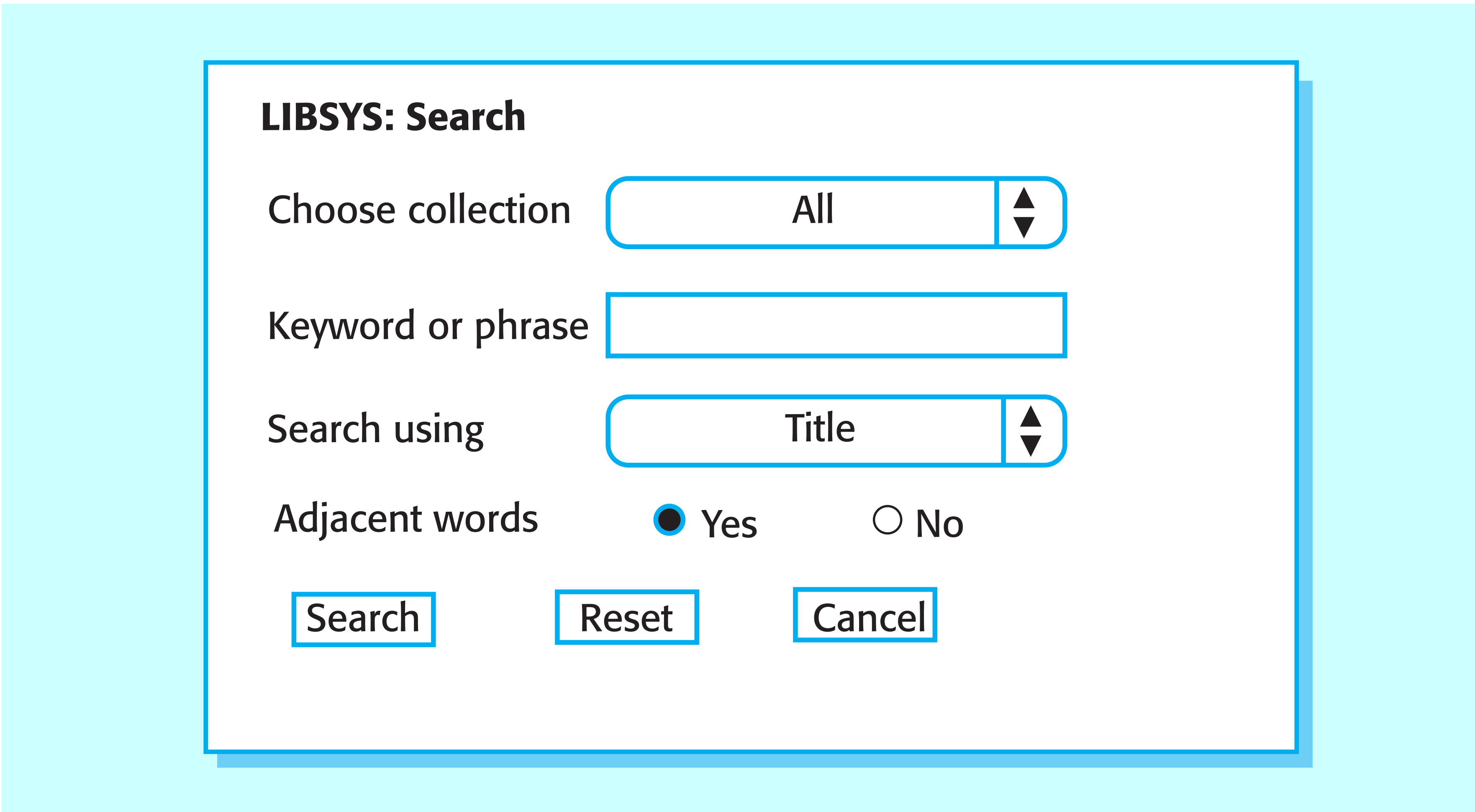
LIBSYS interaction

- Document search
  - Users need to be able to use the search facilities to find the documents that they need.
- Document request
  - Users request that a document be delivered to their machine or to a server for printing.

Web-based interfaces

- Many web-based systems have interfaces based on web forms.
- Form field can be menus, free text input, radio buttons, etc.
- In the LIBSYS example, users make a choice of where to search from a menu and type the search phrase into a free text field.

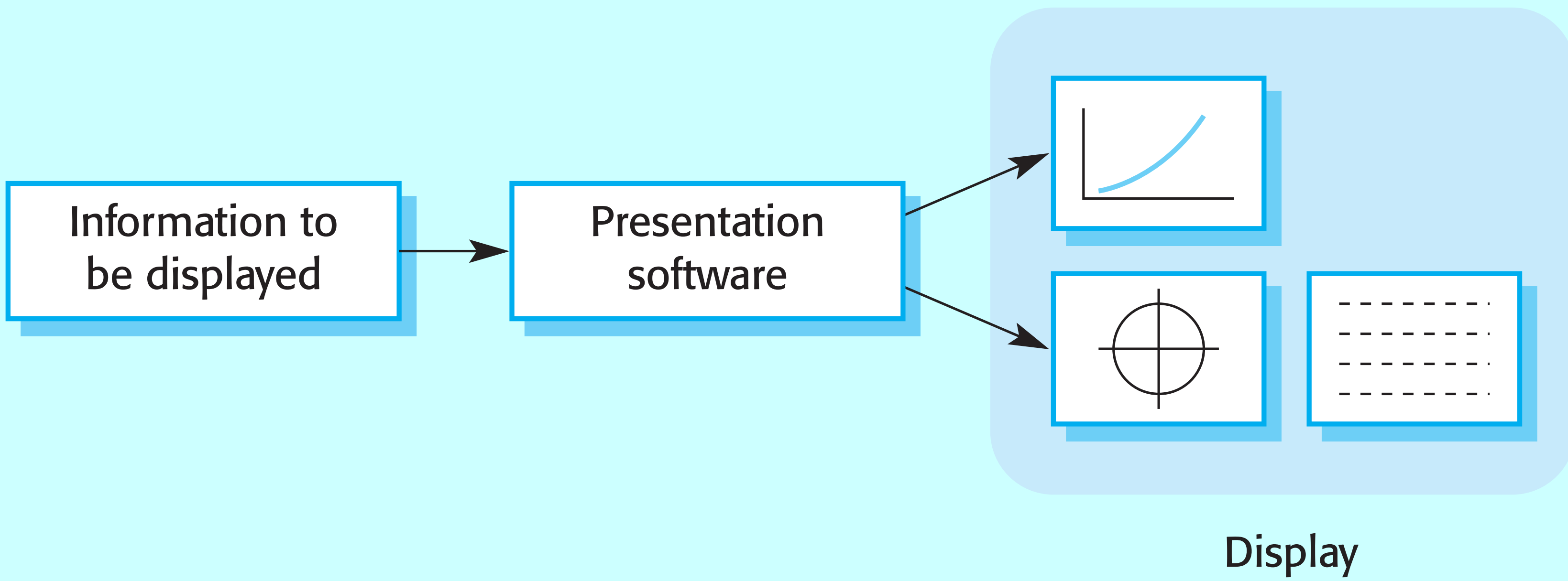
LIBSYS search form



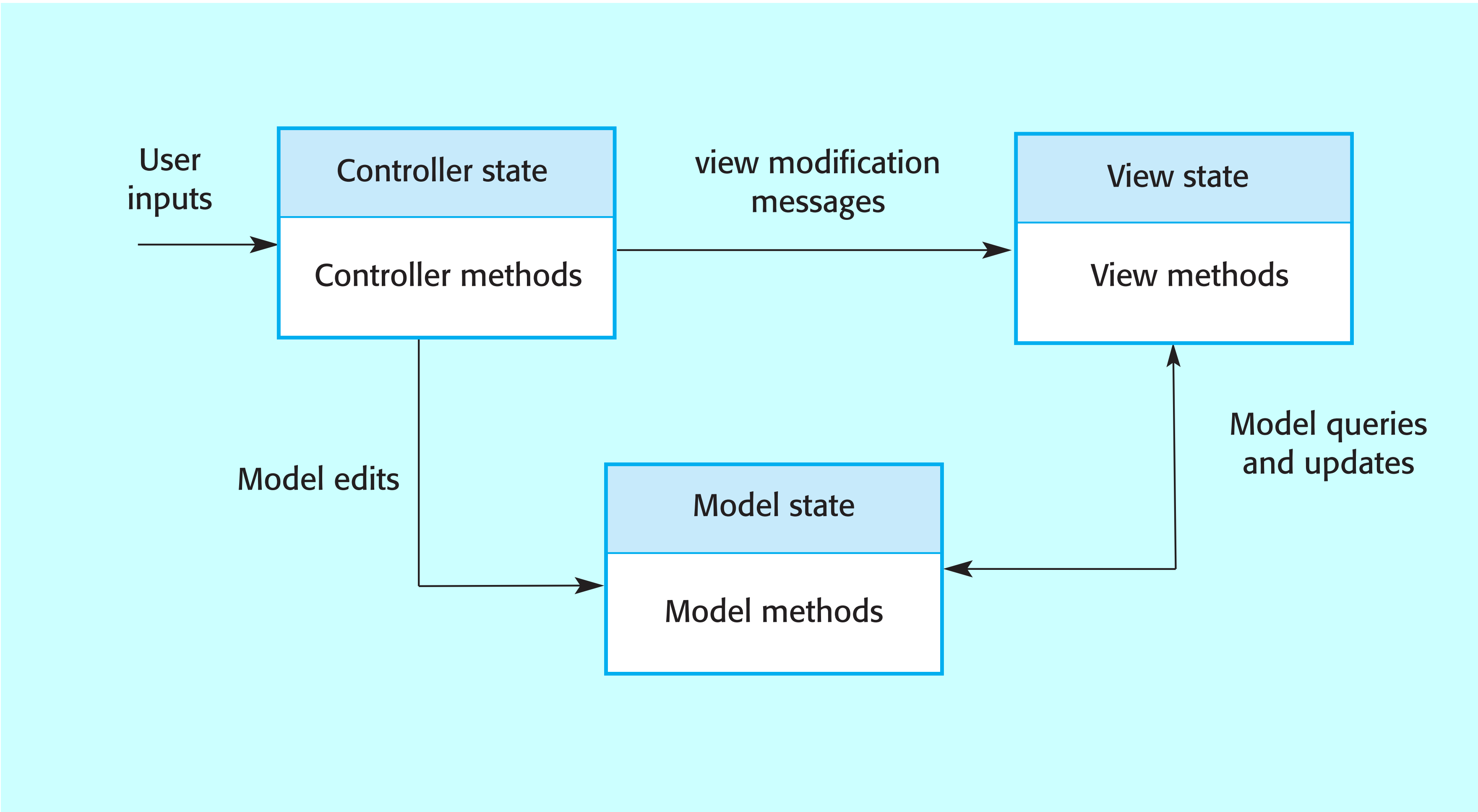
Information presentation

- Information presentation is concerned with presenting system information to system users.
- The information may be presented directly (e.g. text in a word processor) or may be transformed in some way for presentation (e.g. in some graphical form).
- The Model-View-Controller approach is a way of supporting multiple presentations of data.

Information presentation



Model-view-controller



Information presentation

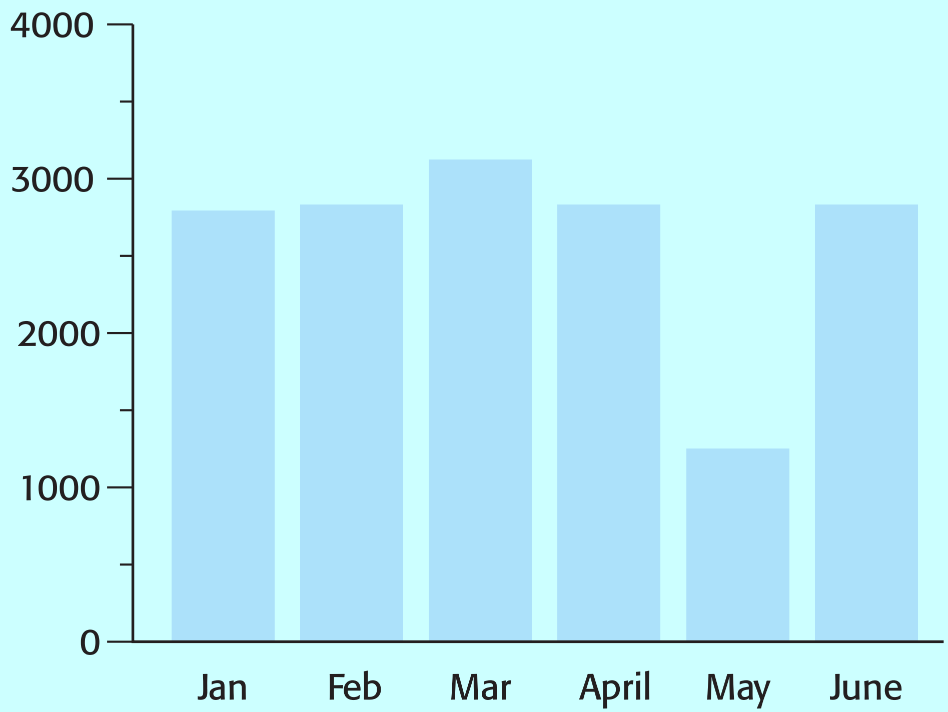
- Static information
  - Initialised at the beginning of a session. It does not change during the session.
  - May be either numeric or textual.
- Dynamic information
  - Changes during a session and the changes must be communicated to the system user.
  - May be either numeric or textual.

Information display factors

- Is the user interested in precise information or data relationships?
- How quickly do information values change? Must the change be indicated immediately?
- Must the user take some action in response to a change?
- Is there a direct manipulation interface?
- Is the information textual or numeric? Are relative values important?

Alternative information presentations

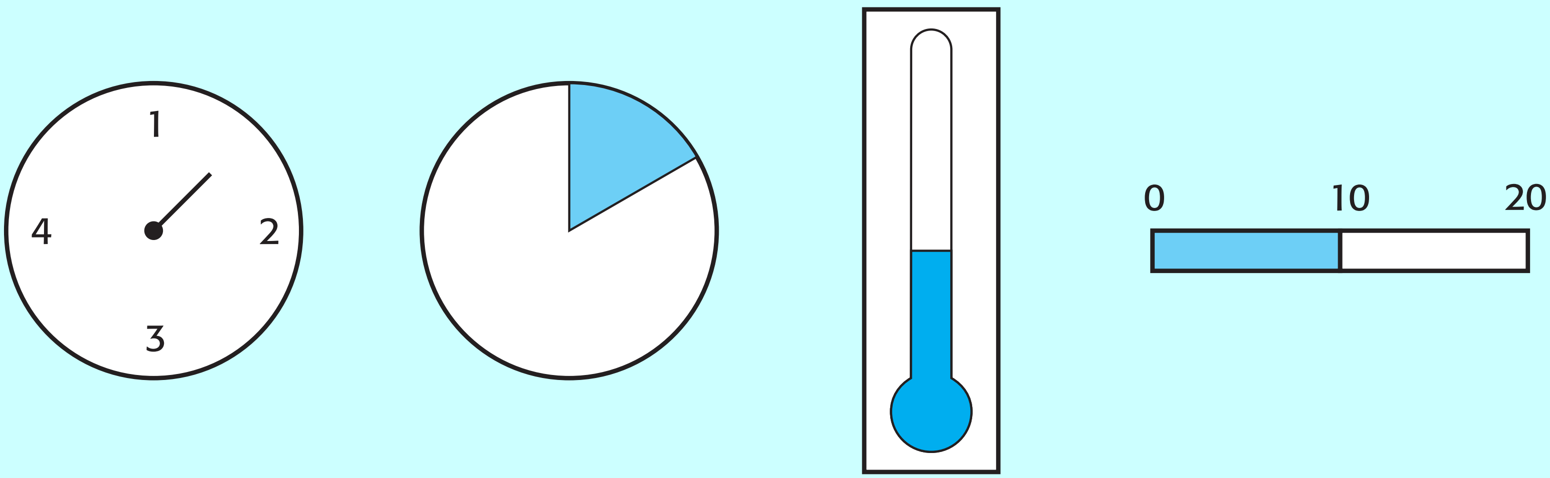
Jan	Feb	Mar	April	May	June
2842	2851	3164	2789	1273	2835



Analogue or digital presentation?

- Digital presentation
  - Compact - takes up little screen space;
  - Precise values can be communicated.
- Analogue presentation
  - Easier to get an 'at a glance' impression of a value;
  - Possible to show relative values;
  - Easier to see exceptional data values.

Presentation methods



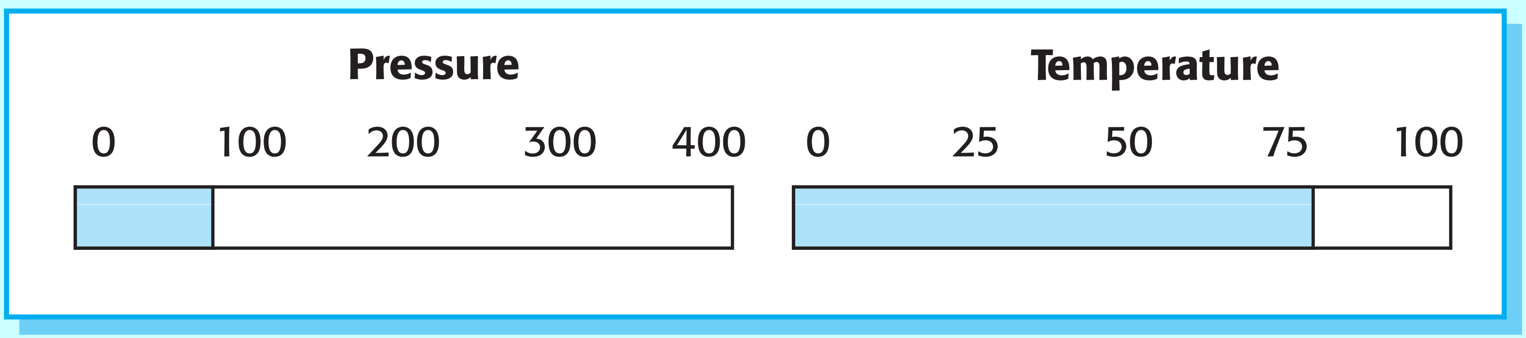
Dial with needle

Pie chart

Thermometer

Horizontal bar

Displaying relative values



Data visualisation

- Concerned with techniques for displaying large amounts of information.
- Visualisation can reveal relationships between entities and trends in the data.
- Possible data visualisations are:
  - Weather information collected from a number of sources;
  - The state of a telephone network as a linked set of nodes;
  - Chemical plant visualised by showing pressures and temperatures in a linked set of tanks and pipes;
  - A model of a molecule displayed in 3 dimensions;
  - Web pages displayed as a hyperbolic tree.

Colour displays

- Colour adds an extra dimension to an interface and can help the user understand complex information structures.
- Colour can be used to highlight exceptional events.
- Common mistakes in the use of colour in interface design include:
    - The use of colour to communicate meaning;
    - The over-use of colour in the display.

Colour use guidelines

- Limit the number of colours used and be conservative in their use.
- Use colour change to show a change in system status.
- Use colour coding to support the task that users are trying to perform.
- Use colour coding in a thoughtful and consistent way.
- Be careful about colour pairings.

Error messages

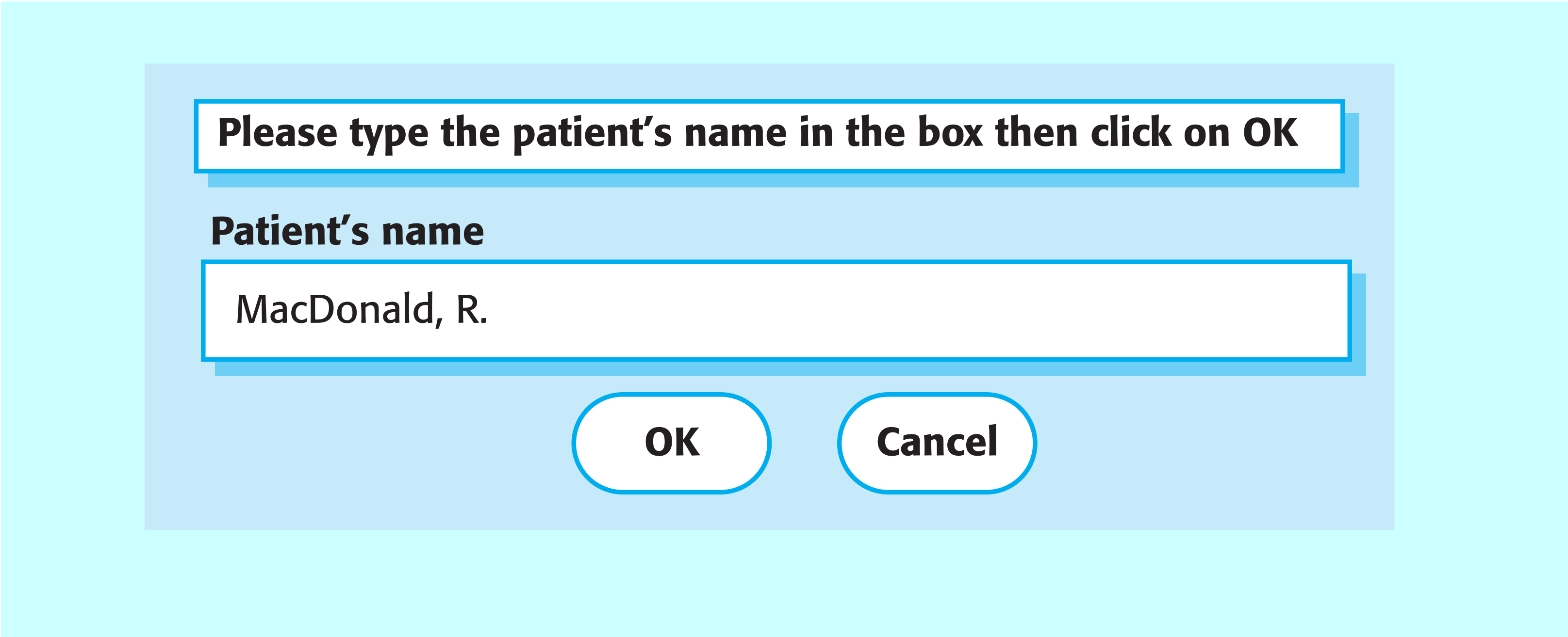
- Error message design is critically important. Poor error messages can mean that a user rejects rather than accepts a system.
- Messages should be polite, concise, consistent and constructive.
- The background and experience of users should be the determining factor in message design.

Design factors in message wording

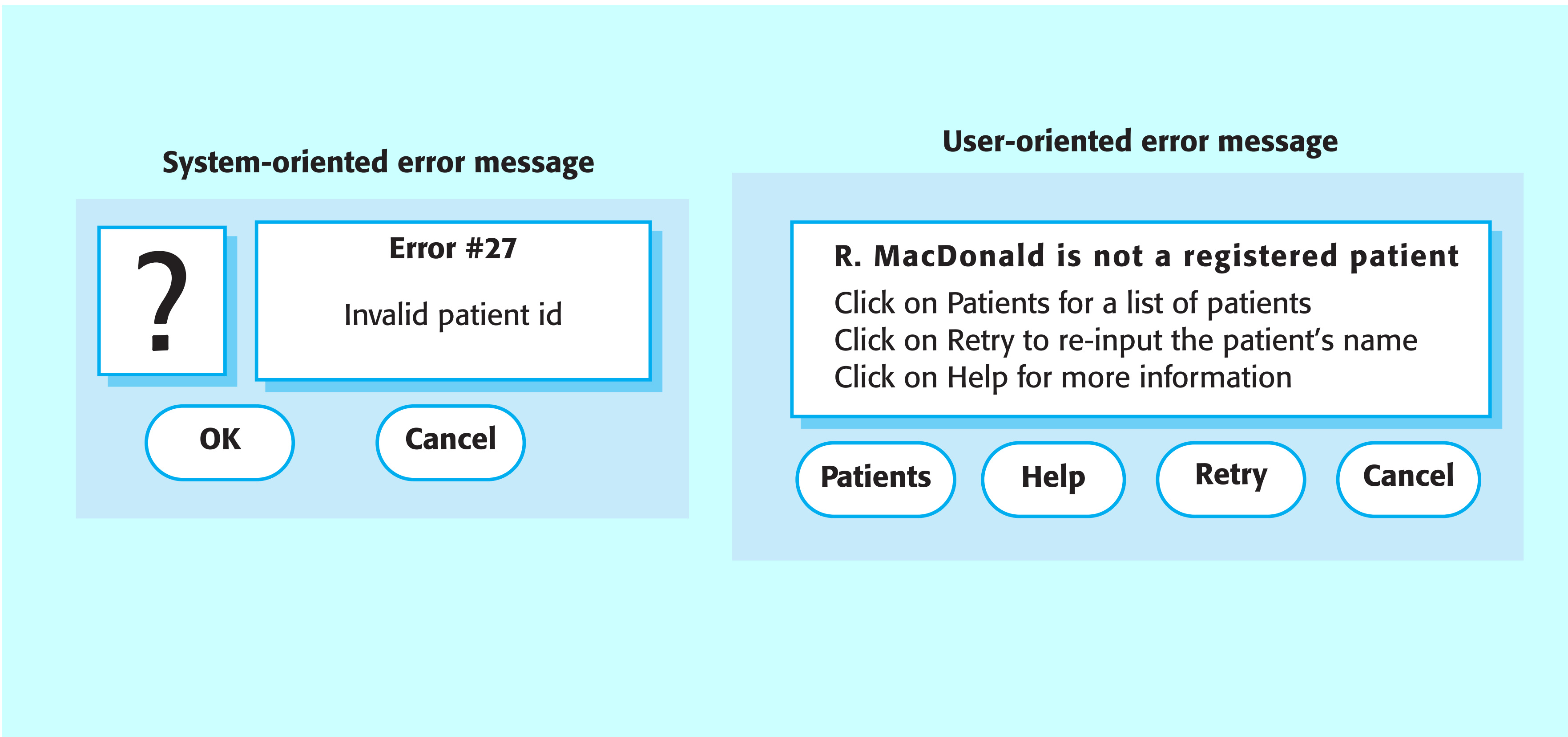
Factor	Description
Context	Wherever possible, the messages generated by the system should reflect the current user context. As far as is possible, the system should be aware of what the user is doing and should generate messages that are relevant to their current activity.
Experience	As u sers become familiar with a s ystem they become irritated by long, ÔmeaningfulÕ messages. However, beginners find it difficult to understand short terse statements of a problem. You should provide both types of message and allow the user to control message conciseness.
Skill level	Messages should be tailored to the userÕsskills as well as t heir experience. Messages for the different classes of user may be ex pressed in d ifferent ways depending on the terminology that is familiar to the reader.
Style	Messages should be positive rather than negative. They should use the active rather than the passive mode of address. They should never be insulting or try to be funny.
Culture	Wherever possible, the designer of messages should be familiar with the culture of the country where the system is sold. There are distinct cultural differences between Europe, Asia and America. A su itable message for one culture might be unacceptable in another.

User error

- Assume that a nurse misspells the name of a patient whose records he is trying to retrieve.



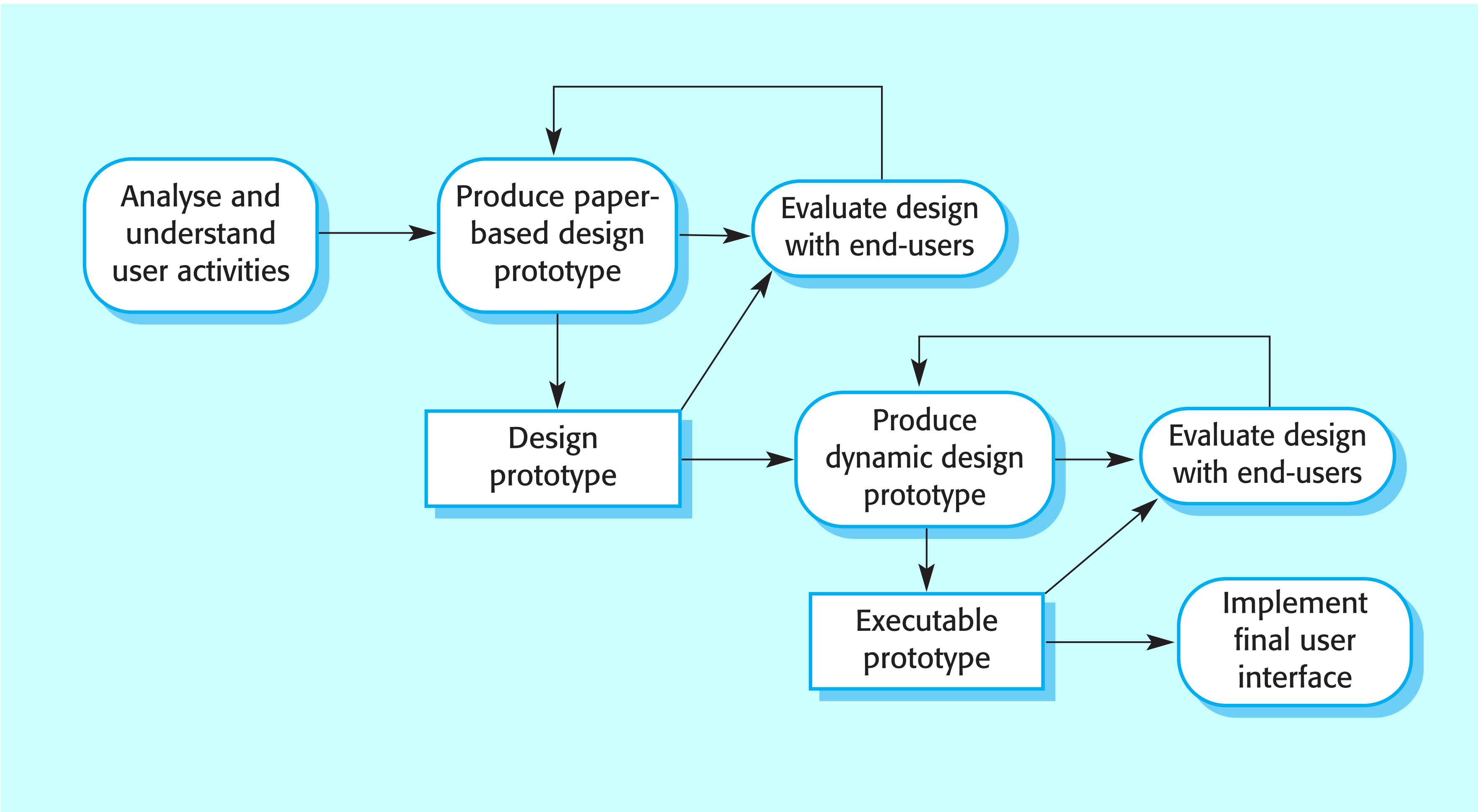
Good and bad message design



The UI design process

- UI design is an iterative process involving close liaisons between users and designers.
- The 3 core activities in this process are:
  - User analysis. Understand what the users will do with the system;
  - System prototyping. Develop a series of prototypes for experiment;
  - Interface evaluation. Experiment with these prototypes with users.

The design process



User analysis

- If you don't understand what the users want to do with a system, you have no realistic prospect of designing an effective interface.
- User analyses have to be described in terms that users and other designers can understand.
- Scenarios where you describe typical episodes of use, are one way of describing these analyses.

User interaction scenario

Jane is a student of Religious Studies and is working on an essay on Indian architecture and how it has been influenced by religious practices. To help her understand this, she would like to access some pictures of details on notable buildings but can't find anything in her local library.

She approaches the subject librarian to discuss her needs and he suggests some search terms that might be used. He also suggests some libraries in New Delhi and London that might have this material so they log on to the library catalogues and do some searching using these terms. They find some source material and place a request for photocopies of the pictures with architectural detail to be posted directly to Jane.

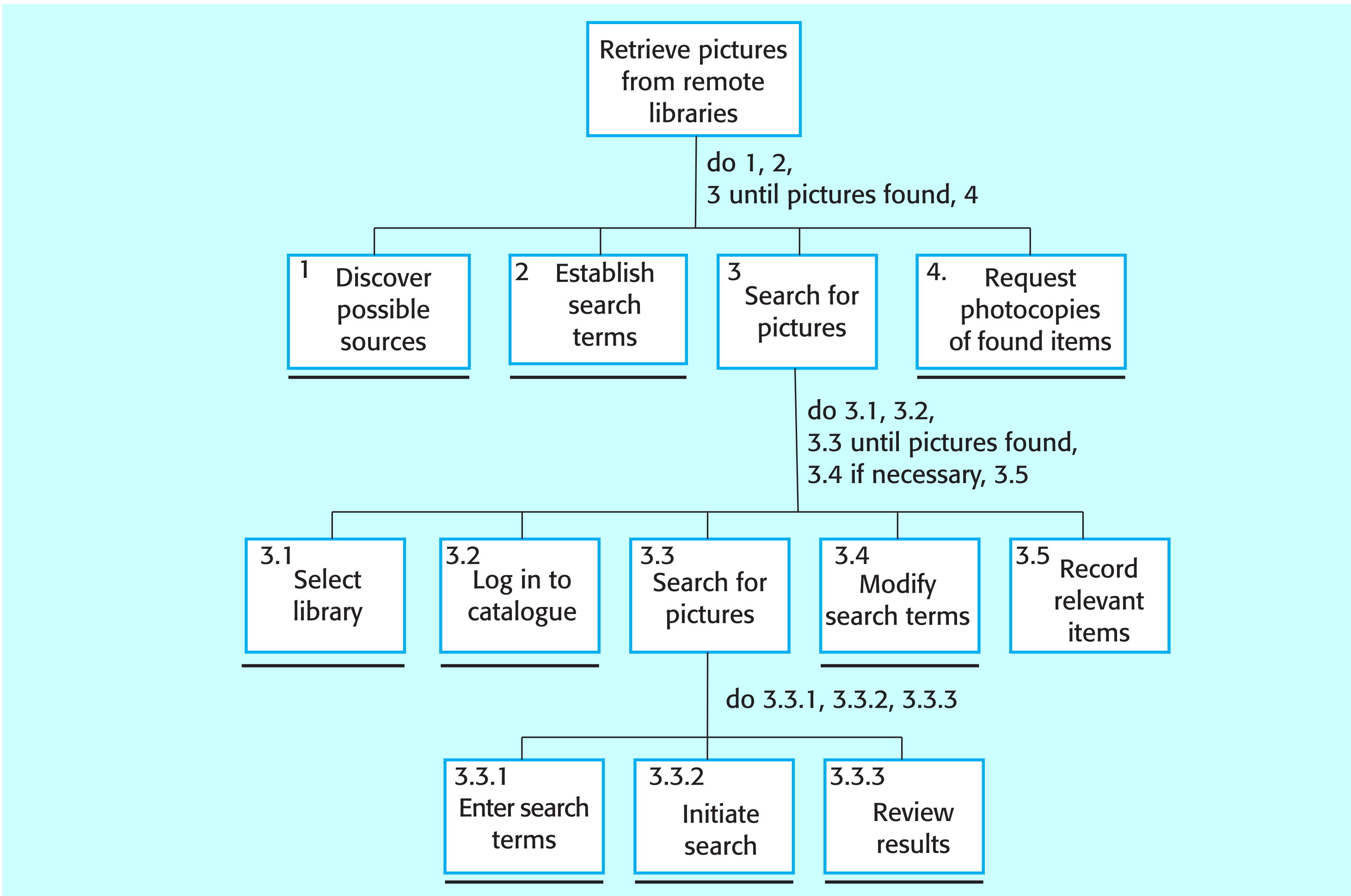
Requirements from the scenario

- Users may not be aware of appropriate search terms so need a way of helping them choose terms.
- Users have to be able to select collections to search.
- Users need to be able to carry out searches and request copies of relevant material.

Analysis techniques

- Task analysis
  - Models the steps involved in completing a task.
- Interviewing and questionnaires
  - Asks the users about the work they do.
- Ethnography
  - Observes the user at work.

Hierarchical task analysis



Interviewing

- Design semi-structured interviews based on open-ended questions.
- Users can then provide information that they think is essential; not just information that you have thought of collecting.
- Group interviews or focus groups allow users to discuss with each other what they do.

Ethnography

- Involves an external observer watching users at work and questioning them in an unscripted way about their work.
- Valuable because many user tasks are intuitive and they find these very difficult to describe and explain.
- Also helps understand the role of social and organisational influences on work.

Ethnographic records

Air traffic control involves a number of control ‘suites’ where the suites controlling adjacent sectors of airspace are physically located next to each other. Flights in a sector are represented by paper strips that are fitted into wooden racks in an order that reflects their position in the sector. If there are not enough slots in the rack (i.e. when the airspace is very busy), controllers spread the strips out on the desk in front of the rack.

When we were observing controllers, we noticed that controllers regularly glanced at the strip racks in the adjacent sector. We pointed this out to them and asked them why they did this. They replied that, if the adjacent controller has strips on their desk, then this meant that they would have a lot of flights entering their sector. They therefore tried to increase the speed of aircraft in the sector to ‘clear space’ for the incoming aircraft.

Insights from ethnography

- Controllers had to see all flights in a sector. Therefore, scrolling displays where flights disappeared off the top or bottom of the display should be avoided.
- The interface had to have some way of telling controllers how many flights were in adjacent sectors so that they could plan their workload.

User interface prototyping

- The aim of prototyping is to allow users to gain direct experience with the interface.
- Without such direct experience, it is impossible to judge the usability of an interface.
- Prototyping may be a two-stage process:
  - Early in the process, paper prototypes may be used;
  - The design is then refined and increasingly sophisticated automated prototypes are then developed.

Paper prototyping

- Work through scenarios using sketches of the interface.
- Use a storyboard to present a series of interactions with the system.
- Paper prototyping is an effective way of getting user reactions to a design proposal.

Prototyping techniques

- Script-driven prototyping
  - Develop a set of scripts and screens using a tool such as Macromedia Director. When the user interacts with these, the screen changes to the next display.
- Visual programming
  - Use a language designed for rapid development such as Visual Basic. See Chapter 17.
- Internet-based prototyping
  - Use a web browser and associated scripts.

User interface evaluation

- Some evaluation of a user interface design should be carried out to assess its suitability.
- Full scale evaluation is very expensive and impractical for most systems.
- Ideally, an interface should be evaluated against a usability specification. However, it is rare for such specifications to be produced.

Usability attributes

Attribute	Description
Learnability	How long does it ta ke a new user to become productive with the system?
Speed of operation	How well does the system response match the userÕswork practice?
Robustness	How tolerant is the system of user error?
Recoverability	How good is the system at recovering from user errors?
Adaptability	How closely is the system tied to a single model of work?

Simple evaluation techniques

- Questionnaires for user feedback.
- Video recording of system use and subsequent tape evaluation.
- Instrumentation of code to collect information about facility use and user errors.
- The provision of code in the software to collect on-line user feedback.

Key points

- User interface design principles should help guide the design of user interfaces.
- Interaction styles include direct manipulation, menu systems form fill-in, command languages and natural language.
- Graphical displays should be used to present trends and approximate values. Digital displays when precision is required.
- Colour should be used sparingly and consistently.

Key points

- The user interface design process involves user analysis, system prototyping and prototype evaluation.
- The aim of user analysis is to sensitise designers to the ways in which users actually work.
- UI prototyping should be a staged process with early paper prototypes used as a basis for automated prototypes of the interface.
- The goals of UI evaluation are to obtain feedback on how to improve the interface design and to assess if the interface meets its usability requirements.

User Interfaces

- Multimedia user interfaces are computer interfaces that communicate with users using multiple media, sometimes using multiple modes such as written text together with spoken language.
- GUI-using the mouse as the main input device-have greatly simplified human-machine interaction.

User Interfaces

- General design issues
- The main emphasis in the design of multimedia user interfaces is multimedia presentation. There are several issues which must be considered:

1. To determine the appropriate information content to be communicated
2. To represent the essential characteristics of the information.
3. To represent the communicative intent.
4. To chose the proper media for information presentation.
5. To coordinate different media and assembling techniques within a presentation.
6. To provide interactive exploration of information presented.

Abstractions for Programming

By

Prof. S. Shakya

Overview

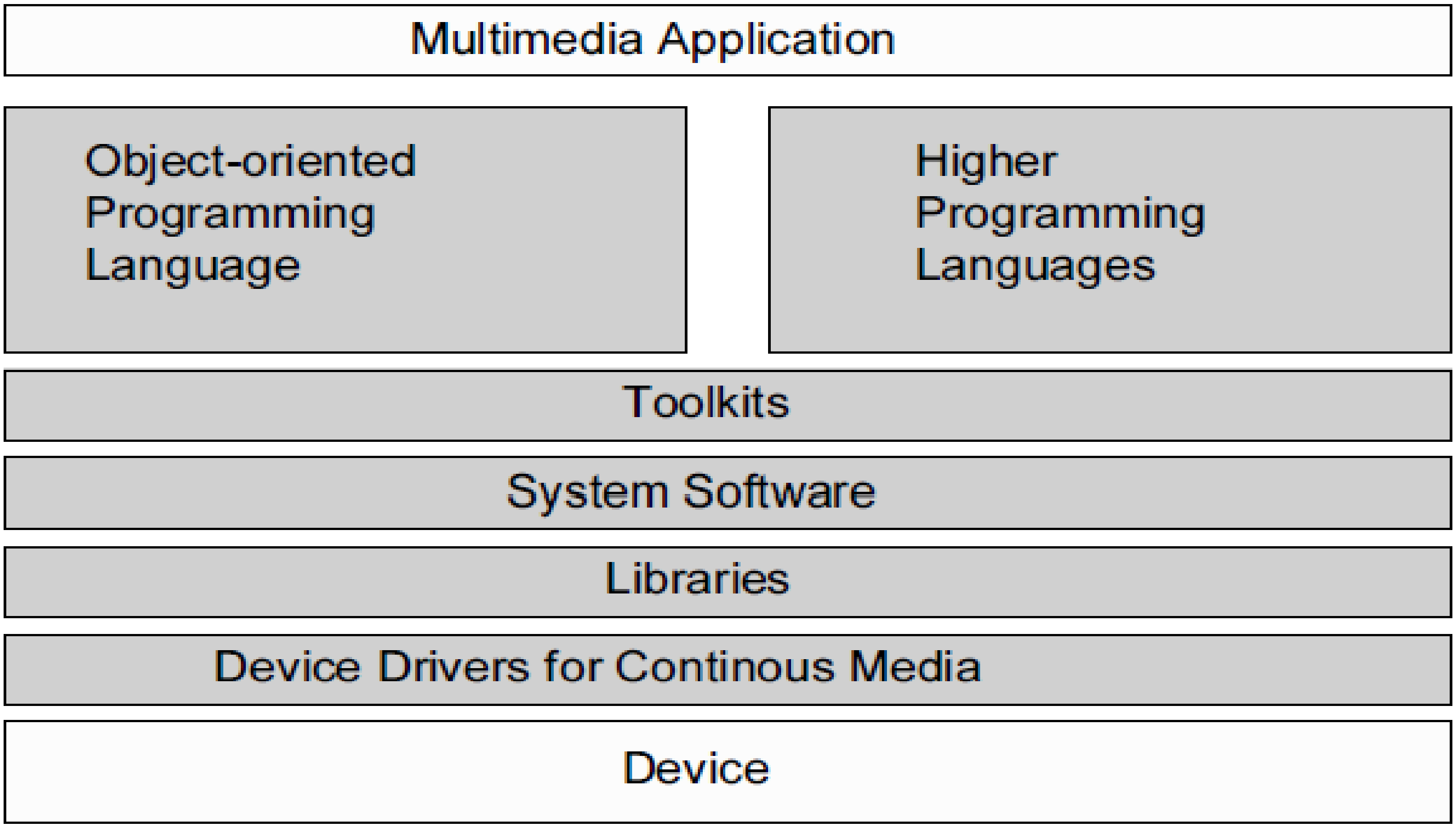
The state of the art of programming

- Most of the current commercially available multimedia applications are implemented in procedure-oriented programming languages
- Application code is still highly dependent on hardware
- Change of multimedia devices still often requires re-implementation
- Common operating system extensions try to attack these problems
- Different programming possibilities for accessing and representing multimedia data

Overview of different abstraction levels

- Libraries
- System software
- Toolkits
- Higher Programming languages
- Object-oriented approaches

Abstraction for Programming



Abstraction Levels of the Programming of Multimedia Systems

Abstractions from Multimedia Hardware

Strong hardware dependency may cause problems with:

- Portability
- Reusability
- Coding efficiency

Abstraction Levels

- Common operating system extensions try to solve this problem
- Different programming possibilities for accessing and representing multimedia data

Libraries

Processing of continuous media based on functions embedded in libraries

- Libraries differ in their degree of abstraction

Libraries - OpenGL

2D and 3D graphics API developed by Silicon Graphics

- Basic idea: “write applications once, deploy across many platforms”:
  - ✓ PCs
  - ✓ Workstations
  - ✓ Super Computers
- Benefits:
  - ✓ Stable
  - ✓ Reliable and Portable
  - ✓ Evolving
  - ✓ Scalable (Features like Zoom, Rectangle handling ...)
  - ✓ Well documented and easy to use
- Integrated with:
  - ✓ Windows 95/NT/2000/XP
  - ✓ UNIX X Window System

System Software

- ❑ Device access becomes part of the operating system:
- ❑ Data as *time capsules (file extensions)*
- Each Logical Data Unit (LDU) carries in its time capsule its data type, actual
- value and valid life span
- Useful concept for video, where each frame has a valid life span of 40ms (rate
- of read access during a normal presentation)
- Presentation rate is changed for VCR (Video Cassette Recorder) functions like
- fast forward, slow forward or fast rewind by

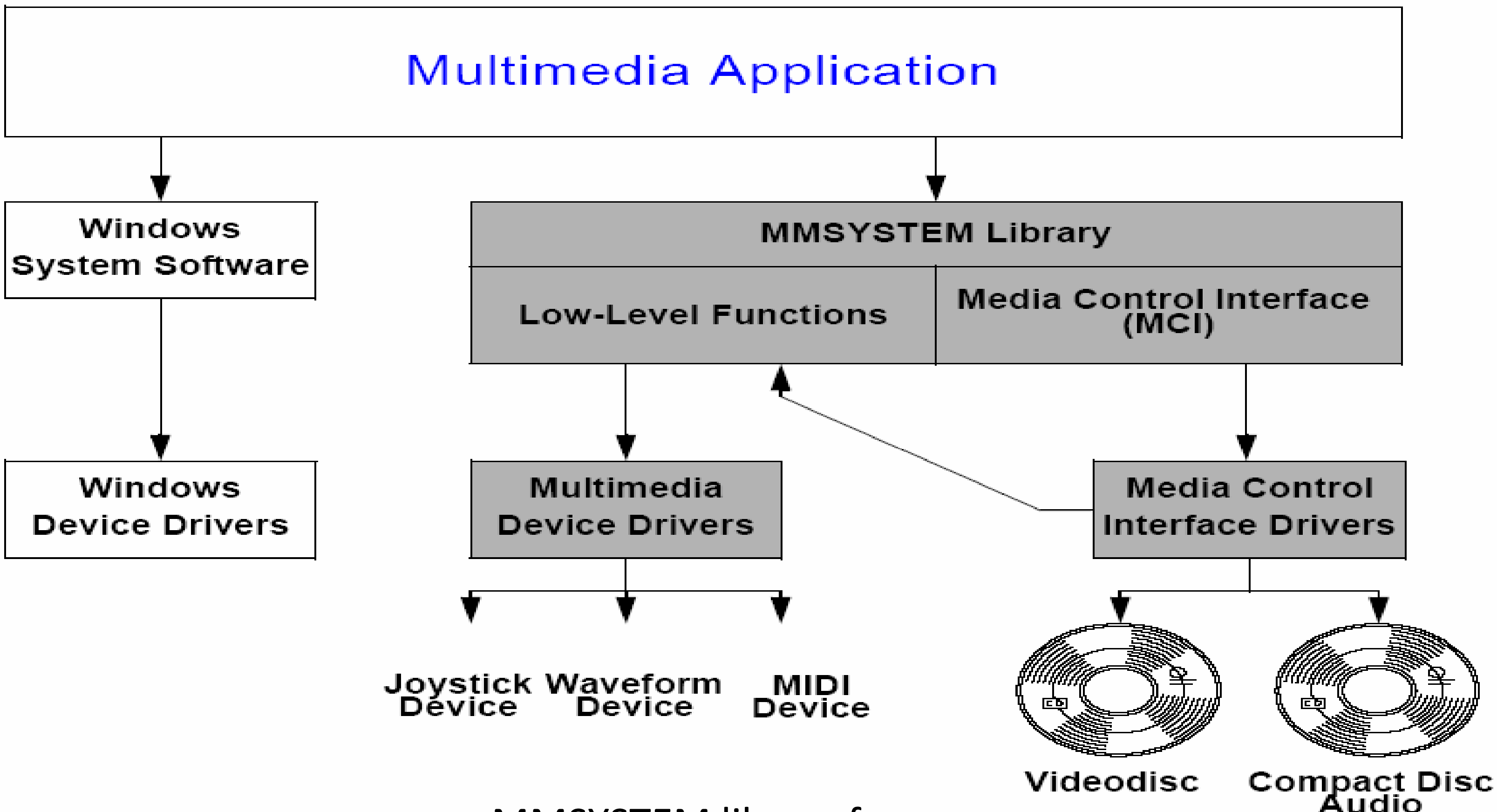
  - Changing the presentation life span of a LDU

  -Skipping of LDUs or repetition of LDUs
- ❑ Data as *streams*

  - a stream denotes the continuous flow of audio and video data between a source and a sink

  - Prior to the flow the stream is established equivalent to the setup of a connection in a networked environment

System Software: Windows *Media Control Interface (MCI):*

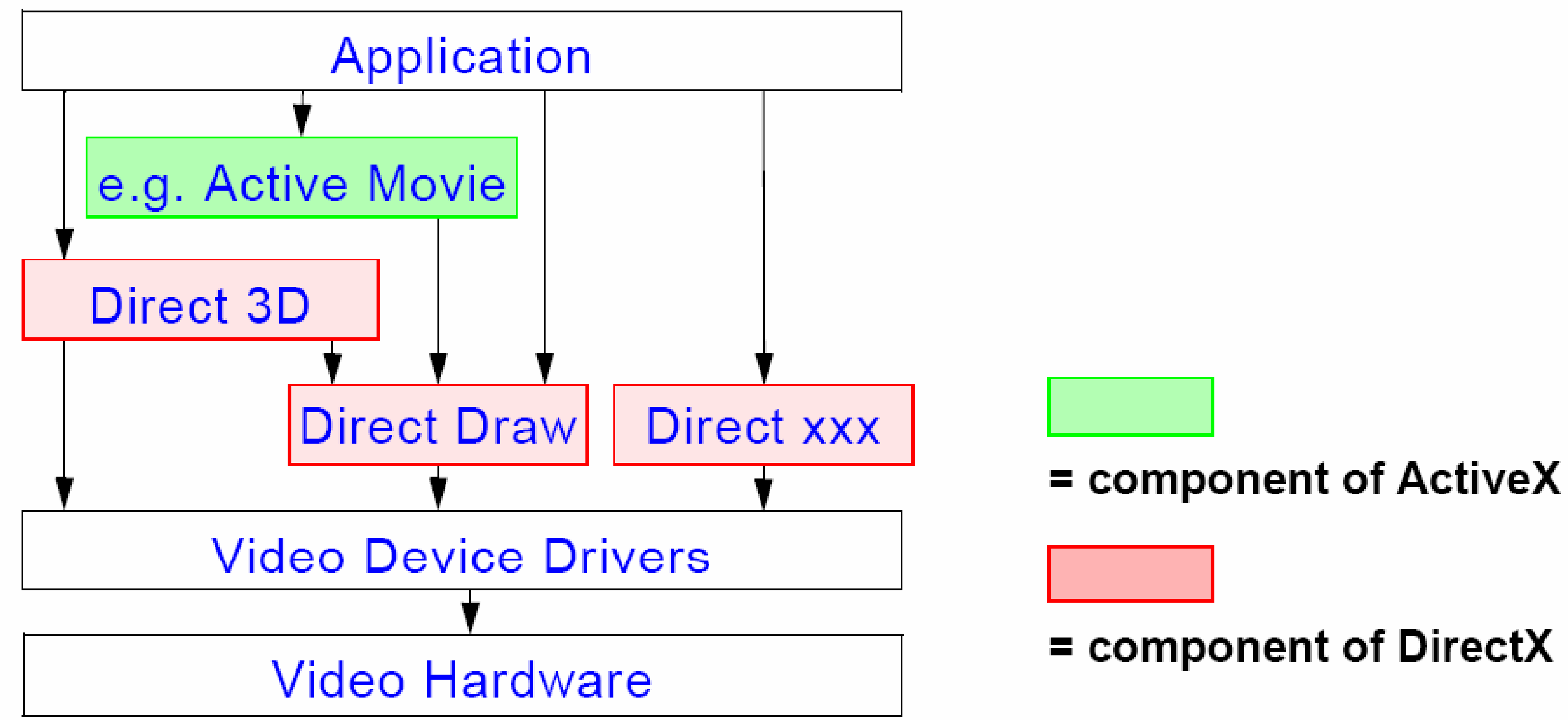


MMSYSTEM library for extensibility and device independence

System Software - DirectX

- Low-level APIs and libraries for high-performance applications
- Especially games - formerly known as the "Game SDK"
- Direct access to hardware services
- E.g. audio & video cards, hardware accelerators
- “DirectX” = “direct access”
- Strong relationship/interaction with ActiveX/DCOM

System Software - DirectX



System Software - DirectX

Components:

- DirectDraw - 2 dimensional graphics capabilities
- Direct3D - extensively functional 3D graphics programming API
- DirectSound - (3D) sound, mixing and playback of multiple streams
- DirectPlay - for network multiplayer game development
- DirectInput - input from various peripherals, e.g. joysticks, data gloves

Implementation Strategy:

- Hardware Abstraction Layer (HAL)
- Hardware Emulation Layer (HEL)
- Media Layer (for aggregated “high level” functionality)

✓ Animations
✓ Media streaming
✓ Synchronization

Toolkits

Simpler approach than the system software interface from the users point of view are toolkits:

- Abstract from the actual physical layer
- Allow a uniform interface for communication with all different devices of continuous media
- Introduce the client-server paradigm
- Can be embedded into programming languages or object-oriented environments

Higher Programming Languages

Media as data types:

- Definition of appropriate data types (e.g. for video and audio)
- Smallest unit can be a LDU
- Example of merging a text and a motion picture:

Higher Programming Languages

Media as files:

- instead of considering continuous media as data types they can be considered as files:

```
file_h1 = open(MICROPHONE_1,...)
file_h2 = open(MICROPHONE_2,...)
file_h3 = open(SPEAKER, ...)
...
read(file_h1)
read(file_h2)
mix(file_h3, file_h1, file_h2)
activate(file_h1, file_h2, file_h3)
...
deactivate(file_h1, file_h2, file_h3)
...
rc1 = close(file_h1)
rc2 = close(file_h2)
rc3 = close(file_h3)
```

Programming Language Requirements

- The high-level language should support parallel processing, because the processing of continuous data is
- controlled by the language through pure asynchronous instructions
- an integral part of a program through the identification of media

Different processes must be able to communicate through an inter-process communication mechanism, which must be able to:

- Understand a priori and/or implicitly specified time requirements (QoS parameters or extracted from the data type)
- Transmit the continuous data according to the requirements
- Initiate the processing of the received continuous process on time

Object-Oriented Approaches

Basic ideas of object-oriented programming is data encapsulation in connection with class and object definitions

- ✓ Abstract Type Definition (definition of data types through abstract interfaces)
- ✓ Class (implementation of a abstract data type)
- ✓ Object (instance of a class)

Other important properties of object-oriented systems are:

- ✓ Inheritance
- ✓ Polymorphism

Object-Oriented Approaches

- Devices as classes: devices are assigned to objects which represent their behavior and interface

Devices as classes

```
class media_device {
 char *name;
 public:
  void on(), off();
};
```

```
class media_in_device:
       public media_device {
private:
  DATA data;
public:
  refDATA get_data();
};
```

```
class media_out_device:
       public media_device {
public:
  void put_data(refDATA dat);
};
```

Object-Oriented Approaches

Processing units as classes:

- Three main objects:
  - ✓ Source objects
  - ✓ Destination objects
  - ✓ Combined source-destination objects allows the creation of data flow paths through connection of objects

- Multimedia object
  - ✓ Basic Multimedia Classes (BMCs) / Basic Multimedia Objects (BMOs)
  - ✓ Compound Multimedia Classes (CMCs) / Compound Multimedia Objects (CMO), which are compound of BMCs / BMOs and other CMCs/CMOs
  - ✓ BMOs and CMOs can be distributed over different computer nodes

Object-Oriented Approaches

Media as classes:

- Media Class Hierarchies define hierarchical relations for different media
- Different class hierarchies are better suited for different applications

Object-Oriented Approaches-Media as Class

```
Medium
 Acoustic_Medium
  Music
   Opus
    Score
     Audio_Block
      Sample_Value
  Speech
     ...
  ...
 Opitcal_Medium
  Video
   Video_Scene
```

```
Video
 Video_Scene
   Image
     Image_Segment
       Pixel
     Line
       Pixel
     Column
       Pixel
Animation
  ...
Text
  ...
```

Multimedia Applications Development

Multimedia Application Classes

- Game systems —they were the leaders in using multimedia technology because:
- The market is very large
- The demands on quality, although intense, are not crucial to the success
- Multimedia repositories —they are mostly play-back only systems

Multimedia Applications Development

- End users do not usually add information components
- The input and output components of the workflow are completely independent of each other
- They are similar to game systems except the size of the database is usually much larger and the indexing of the data components is required

Multimedia Applications Development

Interactive TV, video-on-demand

- **These systems are usually developed from cable TV technology**
- **The term *set-top box* is the common short name for the next generation of digital information processing system providing a connection between the digital network and the TV and other home appliances, such as telephone, fax, and so on**

Multimedia Applications Development

- In addition to providing the the basic cable TV converter function, the set-top boxes will have a wide range of functions that will allow them to provide a full interactive multimedia interface to services provided by cable companies and other service vendors
- The standardisation of the interface between the set-top box and the outside network and the interface between the set-top box and the home appliance is a critical issue

Multimedia Applications Development

Video/phone conferencing and hypermedia mail

- **The ability of seeing the picture of the other person in a video conference is a major improvement over just hearing the voice**
- **In addition to the ability of seeing the picture, there are many more functions, for example, interactive whiteboard, sharing of paper based diagram, sharing of output from a computer, etc**

Multimedia Applications Development

- **Video messages may be kept for a longer period than voice message, thus they require much more storage space**

Multimedia Applications Development

Shared workspaces and executive environments

- **A shared workspace allows a user to run applications and to display the output on screens on remote locations**
- **A shared executive environment allows different users on remote locations to execute the same application on their own workstation with the same set of data**

Multimedia Applications Development

Business process workflow Applications

- These applications depend on the business process for which a multimedia solution is being designed
- Traditional relational databases need to be extended in order to handle multimedia elements
- Object-oriented databases are much more natural medium for multimedia objects

Multimedia Applications Development

Types of Multimedia Systems

Home/Entertainment systems

- **Mostly interactive but not live**
- **The interaction is completely pre-programmed**
- **These systems may include a PC and a set-top box plus a TV**
- **They provide a connection to a cable service or to some service available on the Internet**

Multimedia Applications Development

Business systems

Dedicated systems

- **the creation, storage and manipulation of multimedia object is performed completely within the system**

Departmental systems

- **use a LAN to provide shared object storage management and shared processing**
- **support a specific business process or some well defined combination of business processes shared by most or all users in** the department

Enterprise-wide systems

- **Consist of a large number of LANs and WANs that are interconnected and allow sharing a number of departmental level or enterprise-level storage management and processing resources**
- **Support a combination of dedicated local applications and departmental applications as well as interdepartmental applications**

Components of Multimedia Systems

Multimedia input systems

- ***Scanning node*— captures still image and document image**
- ***User workstation*— may be used as voice and video input node**
- ***Video capture node*— this is required because video capture requires special hardware and software**
- ***Professional studio*— for high quality, professional multimedia objects**

Multimedia Applications Development

Multimedia output systems

- ***User workstation*— serve as the output node for text, graphics, image, audio or video**
- ***Teleconferencing studio*— a professional studio may contain multiple monitors, sound systems and channel switching controls**
- ***Print server* – for text, graphics and image hard-copy output**
- ***Fax server*— for data coming through the telephone channel**
- ***Gateway nodes*— for communication with other systems**

Multimedia Applications Development

Multimedia storage systems

- **Require a large amount of on-line storage as well as near-line and off-line storage. Also require the ability of duplicating some multimedia objects.**
- ***Database server*— supports the normal database requirement of a multimedia application**

Multimedia Applications Development

- ***Image server*— provides a storage and indexing of document images and graphics**
- ***Voice mail server*—primarily for voice messages**
- ***Audio server*—manages all digitized voice and audio objects, is capable of handling isochronous playback of these objects**

Multimedia Applications Development

- ***Video server*— must be capable of maintaining constant playback speed, and handling of a very large amount of data**
- ***Duplication station*— provides specialized high-speed duplication for different media, such as recordable CDs, optical disks, and so on**

Multimedia Applications Development

Multimedia systems development cycle

- **Planning and costing**
- **Designing**
- **Developing and producing**
- **Testing and debugging**
- **Delivering**

Multimedia Applications Development

Planning and costing

The main concerns in this phase are

- **to capture the ideas and requirements of you or your clients**
- **to identify the potential audience and users of the application**
- **to find out the benefit that will gain from developing the application**
- **to evaluate the feasibility and costs of the entire project, including all tasks of production, testing and delivery**

Multimedia Applications Development

- **Often, a ‘back-of-the-envelop’ or ‘paper napkin’ approach is used at this stage**
- The essentials are to capture the ideas and to quickly evaluate the feasibility of these ideas
- The most important considerations are

Multimedia Applications Development

hardware— the most common limiting factor for both development time and final users

- very poor sound output device or even no sound device
- limited amount of storage
- very narrow network bandwidth

software

- the cost of development software is fairly high
- the cost of software required in delivering to the end users may add up to a large sum

Multimedia Applications Development

contents— using existing material or producing from scratch

- existing material may not match your requirement
- they are copyrighted, permission may not be granted
- producing new material is expensive and time-consuming

skill— require very broad skill

- computer skill
- artistic skill
- application domain skill
- It is helpful to develop a pilot project or prototype before starting a full-scale development

Multimedia Applications Development

Designing

Design is a creative activity

- **It requires the knowledge and skill with computer**
- **It requires the talent in graphics arts, video and music**
- **It also requires the knowledge of the subject area of the application**

Multimedia Applications Development

Storyboarding —graphical outlines

- *Storyboards* describes the project in exact detail using words and sketches for each screen images, sound, and navigational choice
- Storyboarding can be very detail—sketching out every screen, right down to specific colour and shade, text contents, attributes, etc.
- It may just a schematic guide

Multimedia Applications Development

Storyboards can be drawn

- using traditional media, such paper and pencil
- using a computer tool

Multimedia Applications Development

Design —Architecture

- Architecture is the arrangement of the multimedia information
- A well-organized document will help the user find information more efficiently
- The architecture design should start early

Types of architecture

- Linear
- Hierarchy
- Nonlinear
- Composite

Multimedia Applications Development

Design —User interface

The main emphasis in the design of multimedia user interface is multimedia presentation

- ***Contents selection* is the key to convey the information to the user**
- **content can be influenced by constraints imposed by**
- the size and complexity of the presentation
- the quality of information
- the limitation of the display hardware
- the need for presentation completeness and coherence

Multimedia Applications Development

- **Media must be chosen to be “adequate”**

  For example, to present a course on how to play tennis, graphics and video are more suitable than text only.

- **Coordination —composition of different media**

Multimedia Applications Development

- **User interface techniques**

A sample application in remote surveillance

- A camera is connected to a computer which serves as a camera server. The server controls the camera through a standard serial interface. The control command is initiated from a client which is located remotely. The video data is digitized, compressed and sent to the client to be displayed there.

Multimedia Applications Development

- **Keyboard —fixed control commands are assigned to keys**
- **Buttons in a system with Graphical User Interface (GUI)**
- By clicking a button marked left, the camera is panned to the left.
- **Scroll bars—may be attached to the side of the video window**
- **Special device —joystick may be a more natural way of controlling the camera**
- **Direct manipulation of the video window — clicking a point in the video window, the camera is panned and/or tilted to centre at the point**

Multimedia Applications Development

User-friendliness

- **User-friendliness is the primary goal of multimedia interface**
- **What this user-friendliness means and how this property is achieved and how this is measured are not always clear**
- **Easy to learn instructions —the users do not need a long period of time before they can use the system**
- **Easy to remember instructions— for both sporadic and everyday users**

Multimedia Applications Development

Effective instructions —the user interface should enable effective use of the application

- **logically connected functions should be presented together and in a similar way**
- **graphical symbols are more effective than textual input and output**
- **different media should be able to be exchanged and shared among different applications**
- **Promptly feedback after a user initiates an action is necessary**
- **A configuration of a user interface should be usable by both professional and sporadic users**

Multimedia Applications Development

Developing and producing

- **Production is the phase when your multimedia project is actually rendered**
- **By now your project plan (and storyboard) has be filled with all details**
- **The tasks to be performed in this phase are:**
- Acquiring all media elements
- Composing the elements according to the storyboard
- **This is the phase when your artistic talent and your technical knowledge are in high demand**
- **You need to set up a method of tracking your media elements**
- **You need to set up a method of tracking the progress of your work**
- **You need a way (or an expert) to solve technical problem quickly**

Multimedia Applications Development

Rights and permissions

- **If you acquire content from somewhere, it is very important to know who has the right of the work**
- **The copyright law lists the following nine types of works that are protected:**
- **literary works, dramatic works, musical works, artistic works**
- **sound recordings, cinematograph films, television broadcast, sound broadcasts, published editions of works**

Multimedia Applications Development

You should license the rights to use copyrighted material before you use it in a multimedia project

- you may be able to negotiate outright ownership of copyrighted material
- you may be able to license the rights to use that material

Multimedia Applications Development

You need to consider what rights do you require

- How will the material be used and distributed
- Is the license for a fixed period
- Is the license exclusive or non-exclusive
- Where will your product be distributed
- Does the content owner have the authority to assign right to you
- Will the copyright owner receive renumeration for the license

Multimedia Applications Development

Testing and debugging

- **Like all other software, testing and debugging is an important and time-consuming phase**
- ***Alpha testing* is typically an internal activity**
- The product is tested by in-house team
- ***Beta testing* involves a wider range of testers**
- They should be representative of real users
- They should not include persons who have been involved in the production of the project

Multimedia Applications Development

- **A multimedia application may be used :**
- by many different users, many of them know very little about computers, and
- on a variety of different platforms and configurations, many different hardware and software
- **Therefore, it is important to test the product in a wide range of configurations**

Multimedia Applications Development

Delivering

- **You should plan how to deliver the product very early in the development process**
- **Nowadays, CD-ROM and Internet are the two most popular means of delivering multimedia applications**
- **According to the means of delivery and the target**
- **audience, you need to plan how the application is to be installed and used**

Multimedia Applications Development

- You need to include all necessary elements in the distribution
- all media elements— movie clips, sound clips, external casts
- runtime libraries— Director runtime
- drivers— DirectX
- helper programs— QuickTime viewer, Acrobat reader
- installation program, compression and decompression programs

Multimedia Applications Development

Summary

Multimedia application classes

- **Game systems**
- **Multimedia repositories**
- **Interactive TV**
- **Video/phone conferencing and hypermedia mail**
- **Shared workspace and execution environment**
- **Business process workflow applications**

Multimedia Applications Development

Types of multimedia systems

- Home/entertainment systems
- Business systems

Components of multimedia systems

- Multimedia input systems
- Multimedia output systems
- Multimedia storage systems

Multimedia application development life cycle

- Planning and costing
- Designing
- Developing and producing
- Testing and debugging
- Delivering