Rs 120/-

MULTIMEDIA

ELECTIVE(III)

BCT

CHAPTER WISE NOTE

AND

CHAPTER WISE COMPLETE

OLD QUESTION SOLUTION

(Reference Prof. Dr. Subarna sir slide)

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(ACEM/072/BCT/559)

2072 BATCH

BEST OF LUCK FOR THE EXAM

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Unit 1. Introduction: Multimedia

Q. 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**.

ELEMENTS OF MULTIMEDIA

Text

Text is the foundation for word processing programs and is still the fundamental information used in many multimedia programs. In fact, many multimedia applications are based on the conversion of a book to a computerized form.

Static Graphics images:

When you imagine graphics images you believably think of "still" images-that is, images such as those in a photograph or drawing. There is no occurrence in these kinds of picture. Still graphics images are an all-important portion of multimedia because humans are modality adjusted.

Animation:

Animation mention to moving graphics images. The happening of somebody giving CPR makes it much easier to learn internal organ revitalization, rather than just screening a static picture.

Full-Motion Video:

Full-motion video, such as the images depicted in a television, can add even more than to a multimedia application. Although full-motion video may sound similar a perfect way to add a powerful message to a multimedia application, it is nowhere near the quality you would anticipate after watching television.

Audio Sound:

The combination of audio sound into a multimedia application can offer the user with information not likely finished any other technique of announcement. Some types of information can't be taken efficiently without using sound.

Multimedia Application:

- 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.

USES AND APPLICATIONS OF MULTIMEDIA:

- Multimedia in Education

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- Multimedia in Games
- Multimedia in Training
- Creative industries
  Creative industries use multimedia for a variety of purposes ranging from fine art, entertainment, to commercial art, to journalism, to media and software servi provided for any of the industries
- Science and Technology
- Language communication
- Medicine:
  In medicine, doctors can get trained by looking at a virtual surgery or they c simulate how the human body is affected by diseases spread by viruses and bacte and then develop techniques to prevent it.

FEATURES OF MULTIMEDIA:

Photo gallery:

Show your photos arranged in a nice-looking grid format.

Slideshows:

Combine your pictures with music and animate them in a slideshow.

Audio player:

Add music, podcasts, or other audio files to your website.

Video player:

Upload videos and display them in a professional player or embed videos directly from sharing websites such as http://www.youtube.com.

Embedded documents:

Embed already existing documents from script.com or other document sharing web directly into your website for easy viewing.

ADVANTAGES OF MULTIMEDIA

Creativity:

It brings more life to discussions.

Variety:

It caters all types of learners.

Cost-effective:

Multimedia mostly requires only a one-time purchase of devices and software, which c used unlimited times thereafter.

Evaluation:

It offers ideal learning assessment tools which are also entertaining for the students.

Realistic Approach:

It provides approaches which make learning more realistic.

Wide Variety of Support:

Multiple media formats are available for use, with different models being able to multimedia

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Trendy:

The current trend of culture leans toward technology, and a great number of resources are being made available for different media formats.

DISADVANTAGES OF MULTIMEDIA

Accessibility:

Multimedia definite quantity electricity to be operated, which may not be accessible in some rural areas or may not be systematically acquirable due to deficit and intermission.

Distracting:

Multimedia may take away the focusing from the lesson due to its attention-grabbing formats.

Costly:

Production of multimedia is more costly than others because it is made up of more than one medium. Production of multimedia requires an electronic device, which may be relatively expensive. Multimedia requires electricity to run, which adds to the cost of its use.

Time Consuming:

Creating multimedia requires more time.

Requires Mastery:

Multimedia requires consistent and long practice to master, which may take a lot of time and energy from the user.

Limited Support/Compatibility:

There is a wide variety of gadget models which arouses incompatibilities of media formats.

Fragile:

The device used for multimedia must be used with attention; vulnerability to moisture or other elements could cause costly, reparable damage which would require another purchase of a device.

Q. What is Hypertext and Hypermedia?

Hyper-Text:

- Hypertext is text which is not constrained to be linear.
- Hypertext refers to a word, phrase or chunk of text that can be linked to another document or text.
- Hypertext covers both textual hyperlinks and graphical ones.
- The term was coined by Ted Nelson in the 1960s and is one of the key concepts that makes the Internet work. Without hypertext, following a link on a topic to a related article on that topic – one of the primary means of navigating the Web – would be impossible.

Hypermedia

- Hypermedia is a term used for hypertext which is not constrained to be text: it can include graphics, video and sound, for example. Apparently, Ted Nelson was the first to use this term too.

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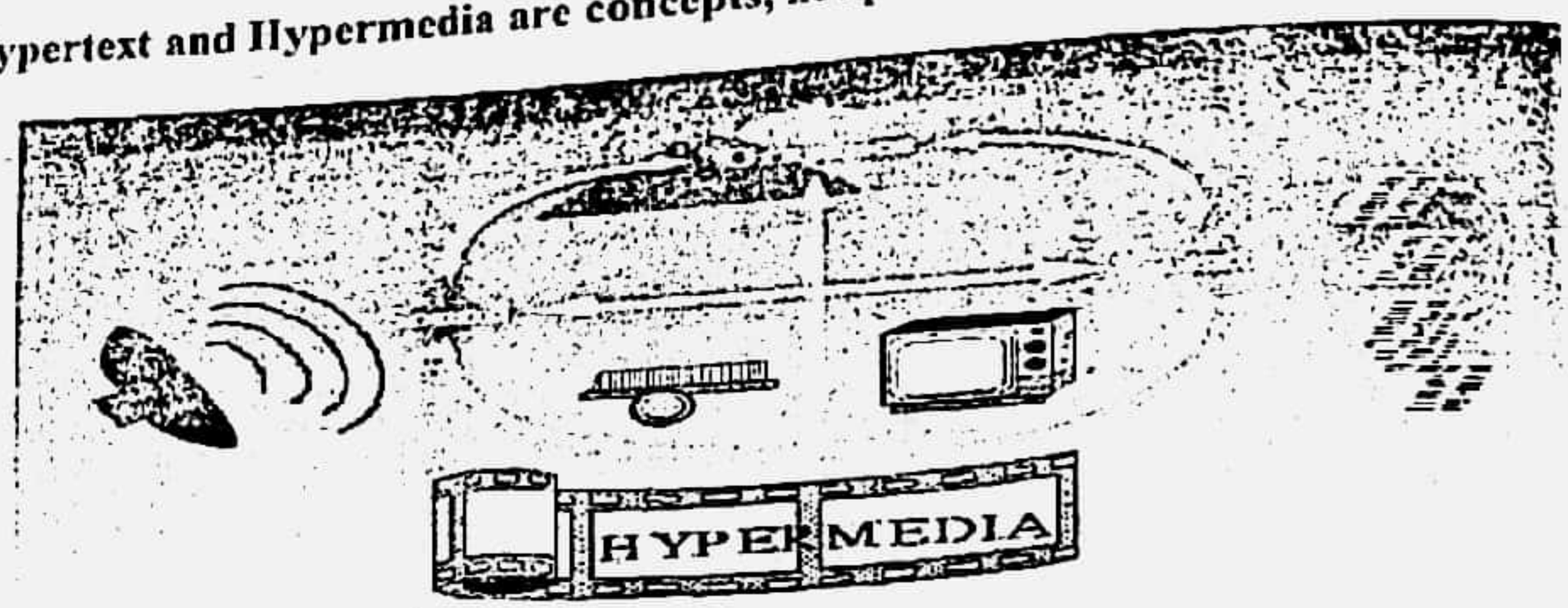
Hypertext and Hypermedia are concepts, not products.



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

Multimedia Systems

- A Multimedia System is a system capable of processing multimedia data and applications
- A Multimedia System is characterized by the processing, storage, generation, manipulation of Multimedia information.
- A computer system with the capabilities to capture, digitize, compress, store, decompress and present information is called multimedia system.
- The aim of multimedia system is to provide a creative and effective way of producing, storing and communicating 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

- Render different data at same time - continuously.
- Sequencing within the media
- Playing frames in correct order/time frame in video
- Synchronization — inter-media scheduling

Key Issues for Multimedia Systems

- 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

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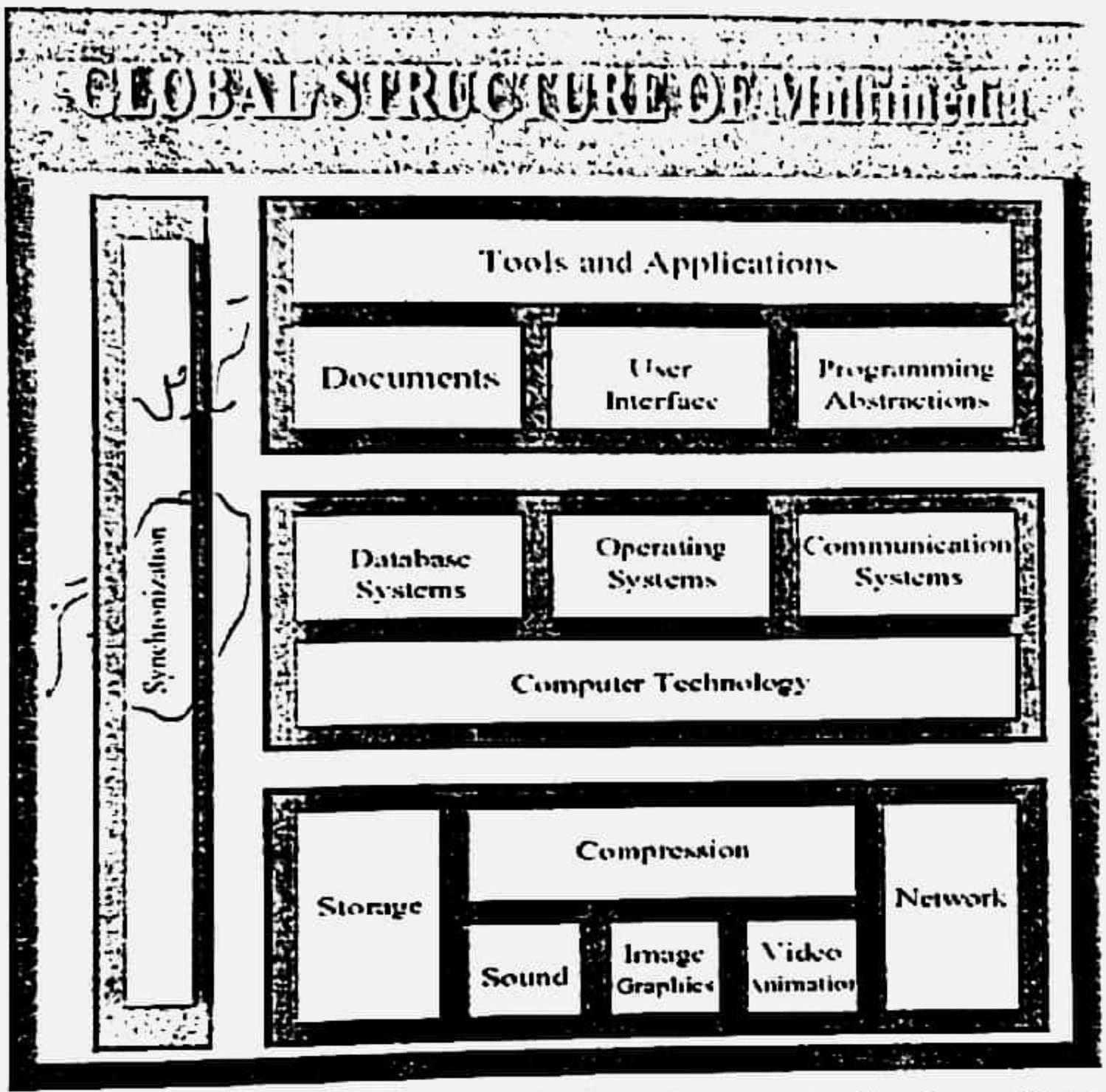
Global Structure



Application domain — provides functions to the user to develop and present multimedia projects. This includes Software tools, and multimedia projects development methodology.
System domain — including all supports for using the functions of the device domain, e.g. operating systems, communication systems (networking) and database systems.
Device domain — basic concepts and skill for processing various multimedia elements and for handling physical device.

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Unit 2. Sound and Audio System

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 1s 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 characterized by the following attributes:
Period, Frequency (Pitch), Amplitude (Loudness) Bandwidth (Dynamic)

1.1 Pitch and Frequency

- Period is the interval at which a periodic signal repeat regularly.
- Pitch is a perception of sound by human beings It measures how 'high' is the sound as itis perceived by a listener.
- Frequency measures a physical property of a wave. It is the reciprocal value of period f = 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
Hyper sound 1 GHz — 10 THz

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 $1 watt/m^2$, we may start feel the sound. The ear may be damaged. This is known as the threshold of feeling. If the intensity is 10 "watt $/m^2$, we may just be able to hear it. This is known as the threshold of hearing.

The relative intensity of two different sounds ismeasured using the deciBel (dB). It is defined byrelative intensity in dB = $10 \log I_2/I_1$
Very often, we will compare a sound with the threshold of hearing.

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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 soundcard 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 1n a computer, samples of the wave are taken.
- Each sample is represented by a number, the 'code'.
- This process is known as digitization.
- This method of digitizing sound is known as pulse code modulation (PCM). Refer to Unit 1 for more information on digitization.
- According to Nyquist sampling theorem, 1n order to capture all audible frequency components of a sound, i.e., up to 20h. Hz, we need to set the sampling to at least twice of this. This is why one of the most popular sampling rates for high quality sound is 4410 Hz.
- Another aspect we need to consider 1s 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 96d.

2.1 Quality versus File Size

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

S=Rx (b/8) *C* D

Where S= file size(bytes), R= Sampling Rates (samples per second), b = resolution, C = channels, D = Recording Duration

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

For example, if we record 10 seconds of stereo music at 44 1kHz, 16 bits, the size will be:

S = 44100 x (16/8) x 2x 10

= 1,764,000bytes

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= 1722.7Kbytes

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

2.2 Audio File Formats

- The most commonly used digital sound format in Windows systems is .wav fi
- Sound is stored in .wav as digital samples known as Pulse Code Modulation (P
- Each .wav file has a header containing information of the file.

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). Eg mp3 MPEG-1-layer

RealAudio file is a proprietary format.

2.3. Audio Hardware

Recording and Digitizing sound:

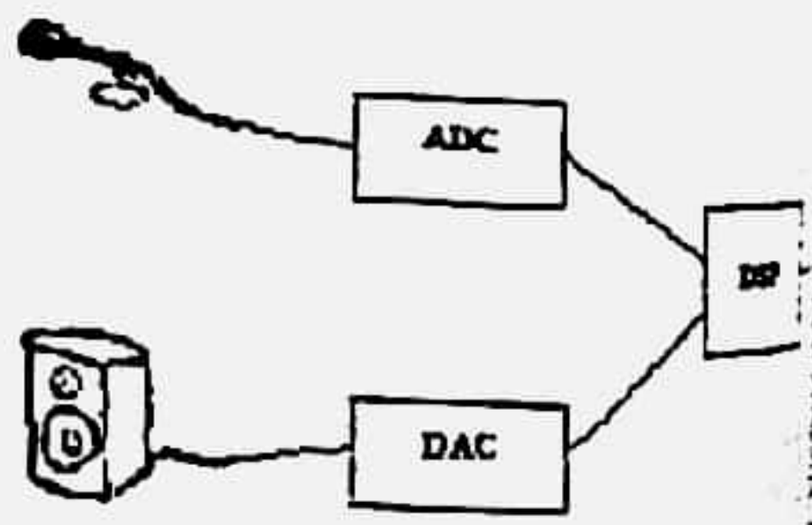
- An analog-to-digital converter (ADC) converts the analog sound signal into samples.
- A digital signal processor (DSP) processes the sample, e.g. filtering, mod compression, and so on.

Play back sound:

- A digital signal processor processes the sample, e.g. decompression, demod and so on
- A digital-to-analog converter (DAC) converts the digital samples into sound si
- All these hardware devices are integrated into a few chips on a sound card

Different sound card has different capability of processing digital sounds. When b sound card, you should look at:

- maximum sampling rate « stereo or mono
- duplex or simplex
- stereo or mono



2.4 Audio Software

Windows device driver — controls the hardware device.

Many popular sound cards are Plus and Play. Windows has drivers for them recognize them automatically. For cards that Windows does not have drivers, you ne 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 chan 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:

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Unit 3. Images and Graphics

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 quantized intensity value.

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 colourimages are often known as indexed colour images. The values are actually indexing to a table of many more different colors. For example, Color 3 is mapped to (200, 10, 10).

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

16-bitcan 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.

1.3. Resolution

- Resolution measures how much detail an image can have. There are several resolutions relating toimages.

Image resolution is the number of pixels in an image.

320 x 240 = 76800 pixels, 700 x 400 = 280000 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, 288 * 216 images displayed on a monitor with 96dpi will be 3" x 2*1/4",

Output resolution — refers to number of dots per mech (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 some of the most common ways:

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- 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 chang volume and speed, deleting part of the sound.

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

3 Computer Music — MIDI

- Sound waves, whether occurred natural or man-made, are often very complex, they consist of many frequencies. Digital sound is relatively straight forward to re complex sound. However, it is quite difficult to generate (or synthesize) com sound.
- There is a better way to generate high quality music. This is known as MID Musical Instrument Digital Interface.
- It is a communication standard developed in the early 1980s for electronic instrum and computers. It specifies the hardware connection between equipment's as well the format in which the data are transferred between the equipment's.
- Common MIDI devices include electronic music synthesizers, modules, and MI devices in common sound cards.
- General MIDI is a standard specified by MIDI Manufacturers Association. To be G compatible, a sound generating device must meet the General MIDI system level performance requirement.

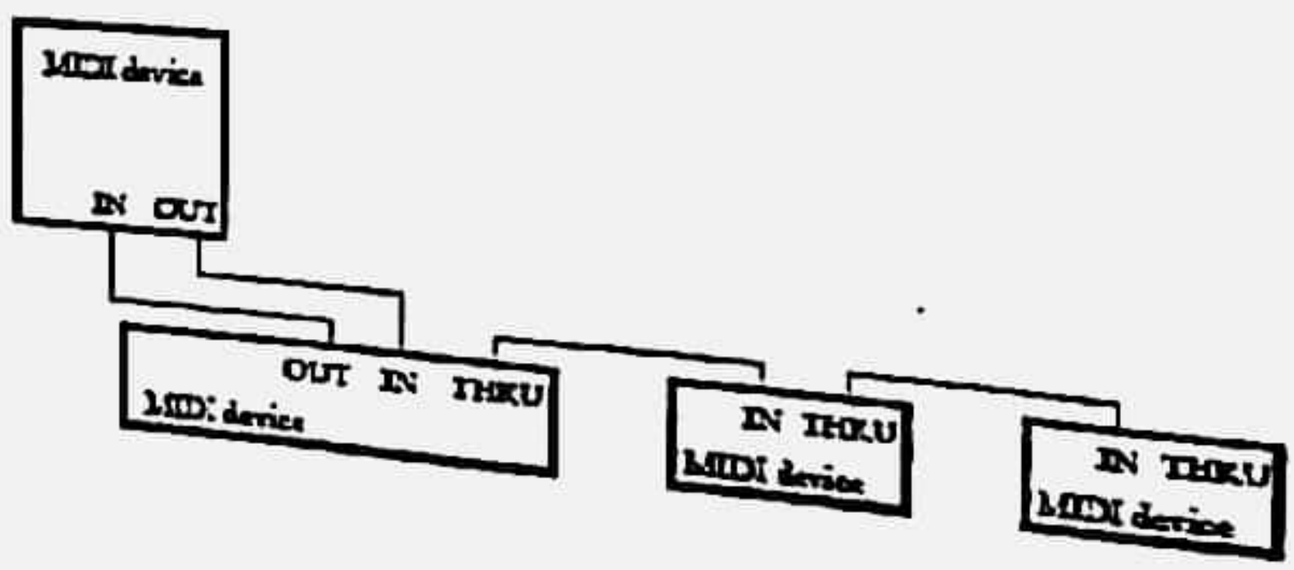
3.1 MIDI Hardware

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



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- 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 1s 24-bit. The commonly used resolution 1s 320) x 240, 640 x 480 and 800 x GOD.
- 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 graphics. 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.

VRML stands for Virtual Reality Markup Language. It is for descripting a scene in a virtual world.

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

2.1 Vector versus Bitmap

Vector	Bitmap
A vector graphic contains mathematical description of objects	A bitmap contains an exact pixel-by-pixel value of an image
A vector graphic 1s resolution independent	A bitmap file is fixed in resolution
The file size of a vector graphic depends on the number of graphic elements it contains	The file size of a bitmap is completely determined by the image resolution and its depth.
Displaying a vector graphic usually involves a large amount of processing	A bitmap image is easier to render

3 Colour Systems

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

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

3.1 RGB Colour Model

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 a blue, are added to black to produce new colours.
You can imagine three light sources of the primary colours shine on a black surface, b varying the intensity of the lights, you will produce different colours.
R — Red
G — Green
B — Blue

3.2 CMY Colour Model

This model is based on the light absorbing quality of inks printed on paper. Combining thre primary colour pigments, Cyan, Magenta and Yellow, should absorb all light, thus resulting i black.
It is a subtractive model.
The value of each primary colour is assigned a percentage from the lightest (0%) to th darkest (100%).
Because all inks contain some impurities, three inks actually produce a muddy brown, a blac 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 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 proportion to the hue and is measured as a percentage from 0°%(gray) to 100% (fu saturated).
Brightness — is the relative lightness or
darkness of the colour. Itis measured as a percentage from 0%o(black) to 100%(whute).

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 th any chrominance information, so a more suitable coding distinguishes between luminance a

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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 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.

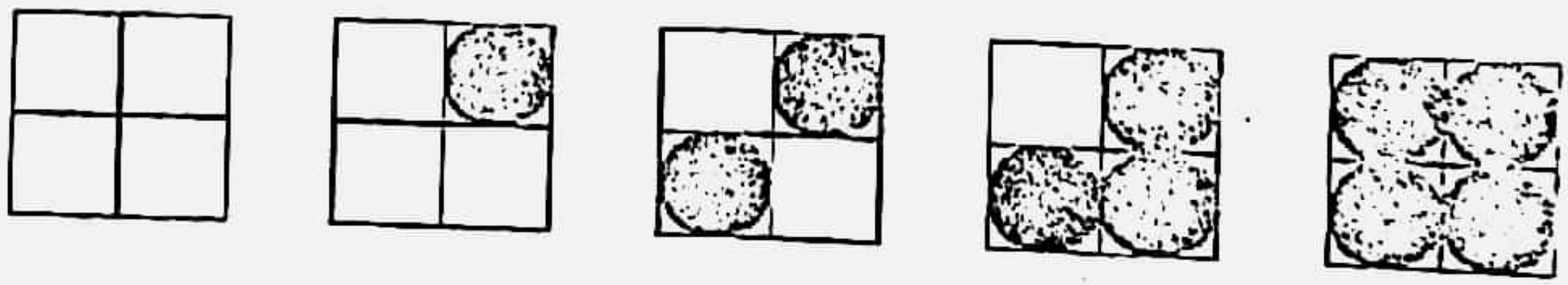
3.6 Colour Palette

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.
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 distinguishable. 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 contains information to identify and decode the data:

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

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Some formats are defined to work only in certain platform while other can be used for platforms. Some formats are specific for an application. Some formats are for images, other 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.

6 Digital Image Processing

This is a very large area contain 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 im the image. A sub-area 1s 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, eg scale, rotate,
- Special effects, eg texture, stylize, blur, sharpen.

Unit: 4 Video and Animation

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
- 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

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- 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
- 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

Videoresolution

- 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
- 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
- **Digitalizing 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 is40ms/625 = 64μs
- At a horizontal resolution of 425 pixel, the time for sampling each pixel is 64μs/425 = 0.15μsi.e., sampling rate is at least 7Mhz
- This requires very fast hardware
- Hardware required to capture video:

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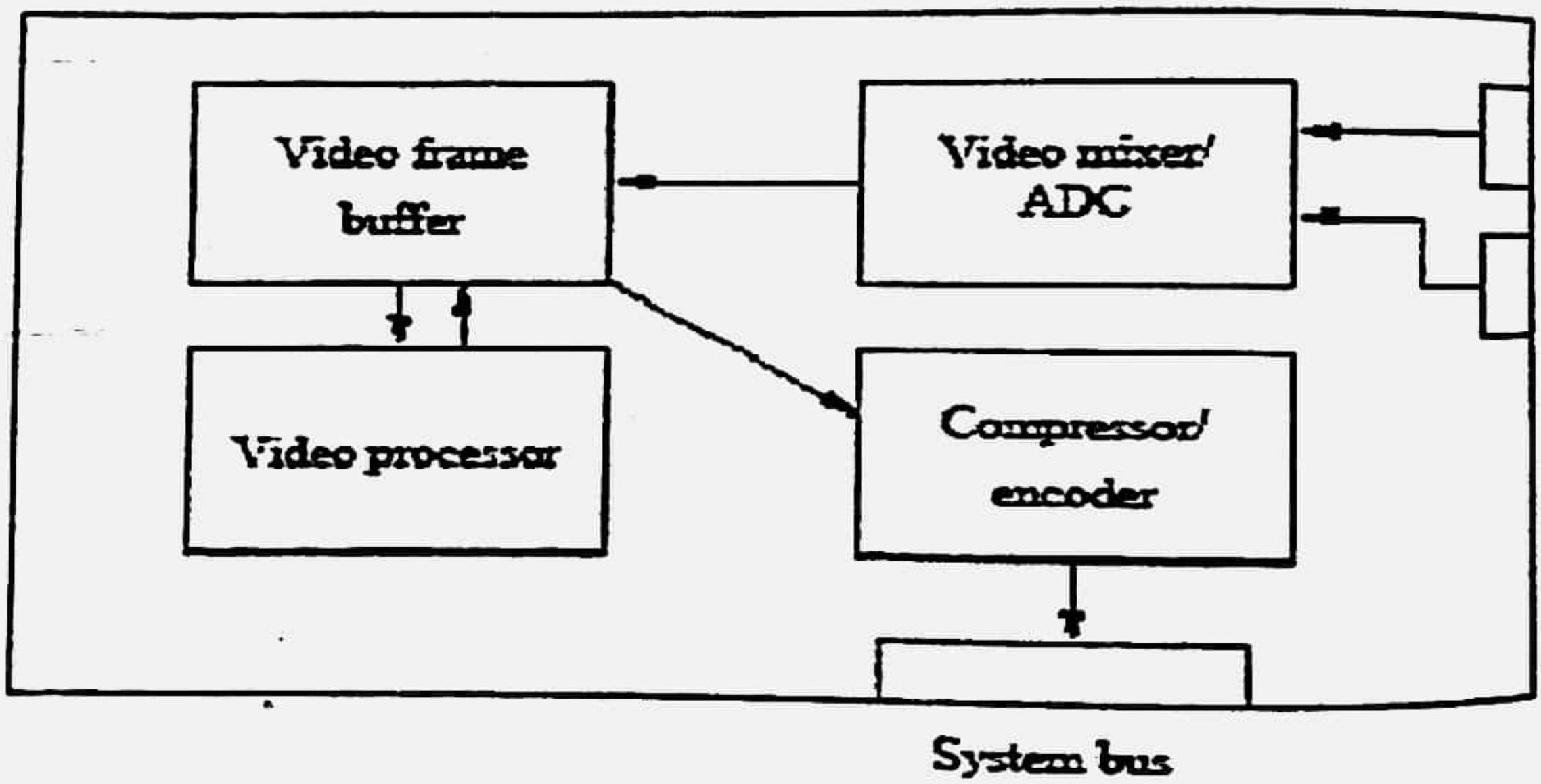
- Video sources: TV, VCR, Laserdisc player, Camcorder
- Video capture card
- Storage space: large hard disk

Video capturecards

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 Format

- AVI (Audio Video Interleaved) format was defined by Microsoft for its Video f Windows systems
- It supports video playback at up to 30 frames per second on a small window (typic size 300X200 with 8 or 16-bit colour)
- It is a software-only system
- It supports a number of compression algorithms

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- 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 are 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

UNIT 5: 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.

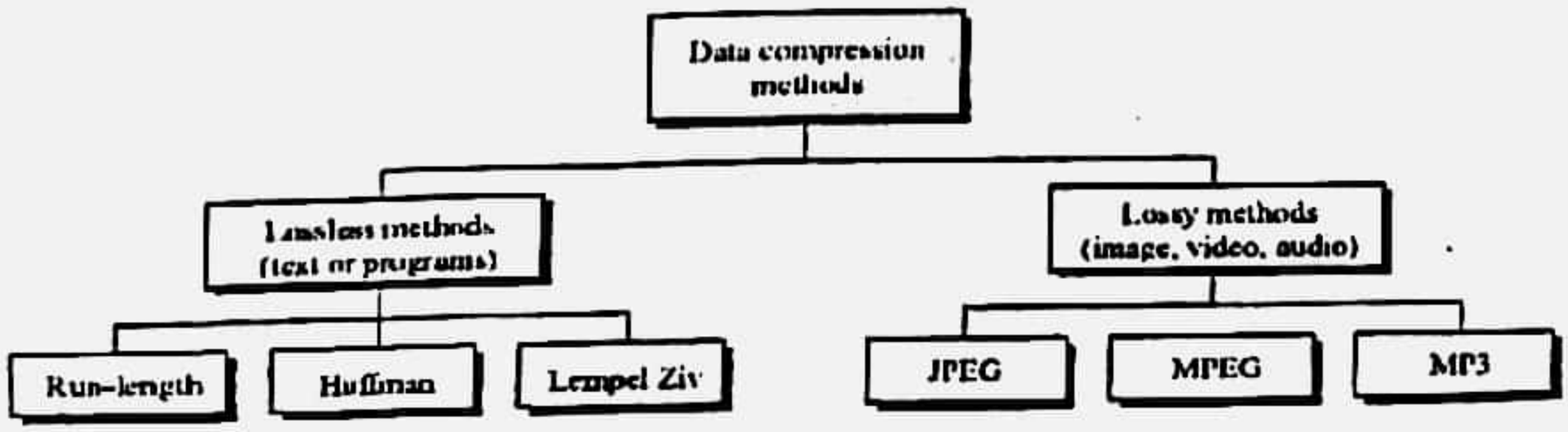

Figure1 Data compression methods

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Compression

How is compression possible?

- Redundancy in digital audio, image, and video data
- Properties of human perception

1) 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
2) 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 on 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

1) **Lossless compression**
   - lossless compression for legal and medical documents, computer programs
   - exploit only data redundancy

2) **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 : $I = \log2(1/p)$
- Symbols that occur rarely convey a large amount of information
- Average information per symbol is called entropy H

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

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- 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 repetitions is called the length of the run
- Run of any length is represented by three characters
  - eeeeeee7tnnnnnnnn
  - @e7t@n8

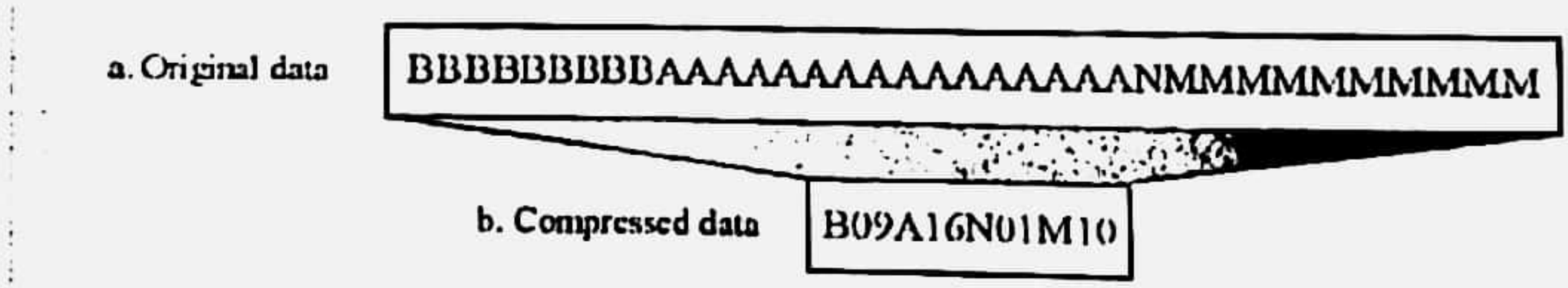

Figure 15.2: Run-length encoding example

Lempel.Zi.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

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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

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

384*288* 3 * 25 frames = 8294400 bytes

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

$$=216 \times 10^6 \text{bits/sec}$$
$$= 27 \times 10^6 \text{Bytes/sec}$$

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**.

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.

Categories of Compression Techniques

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

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.

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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.

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,

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.

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.

JPEG

- JPEG (stands for Joint Photographic Experts Group) is a joint ISO and CCITT (*ComitéConsultatif 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.

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.

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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.

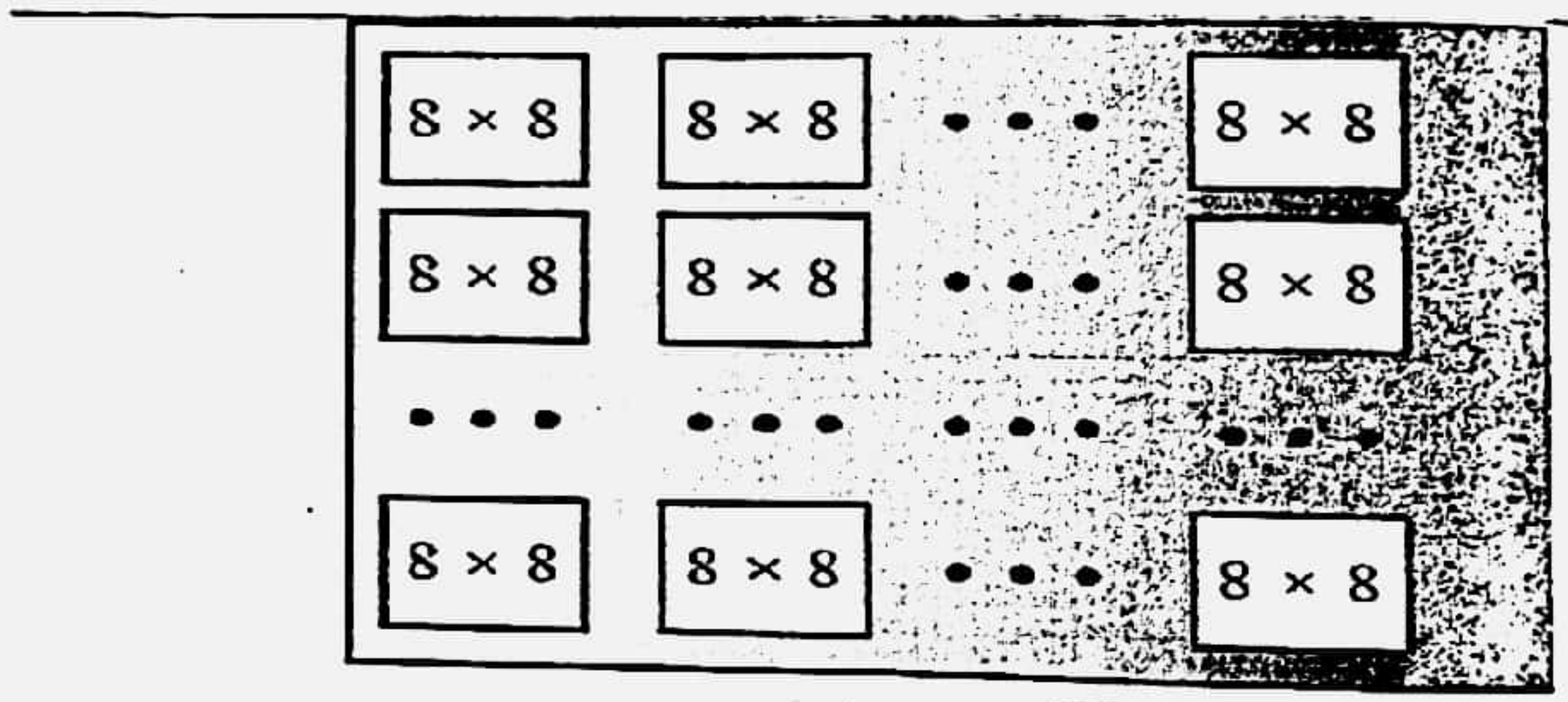

Figure 2: JPEG grayscale example, 640 × 480 pixels

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.

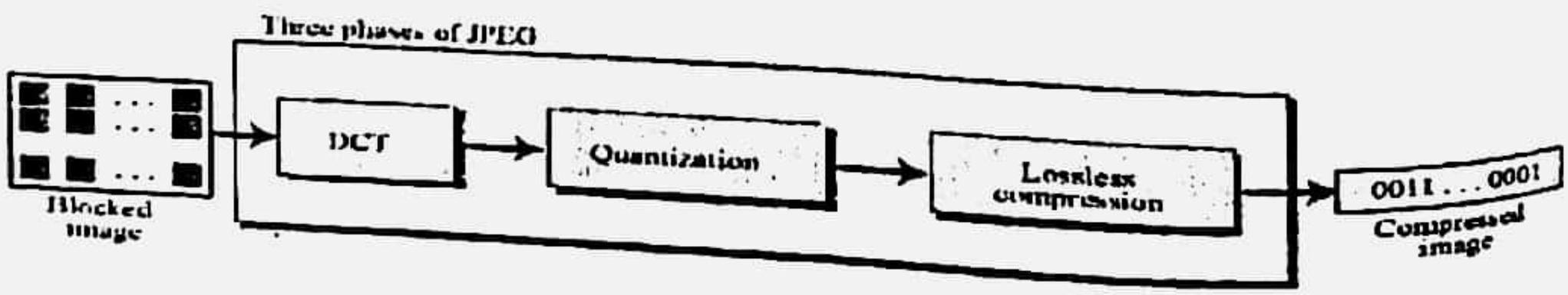

Figure 3 The JPEG compression process

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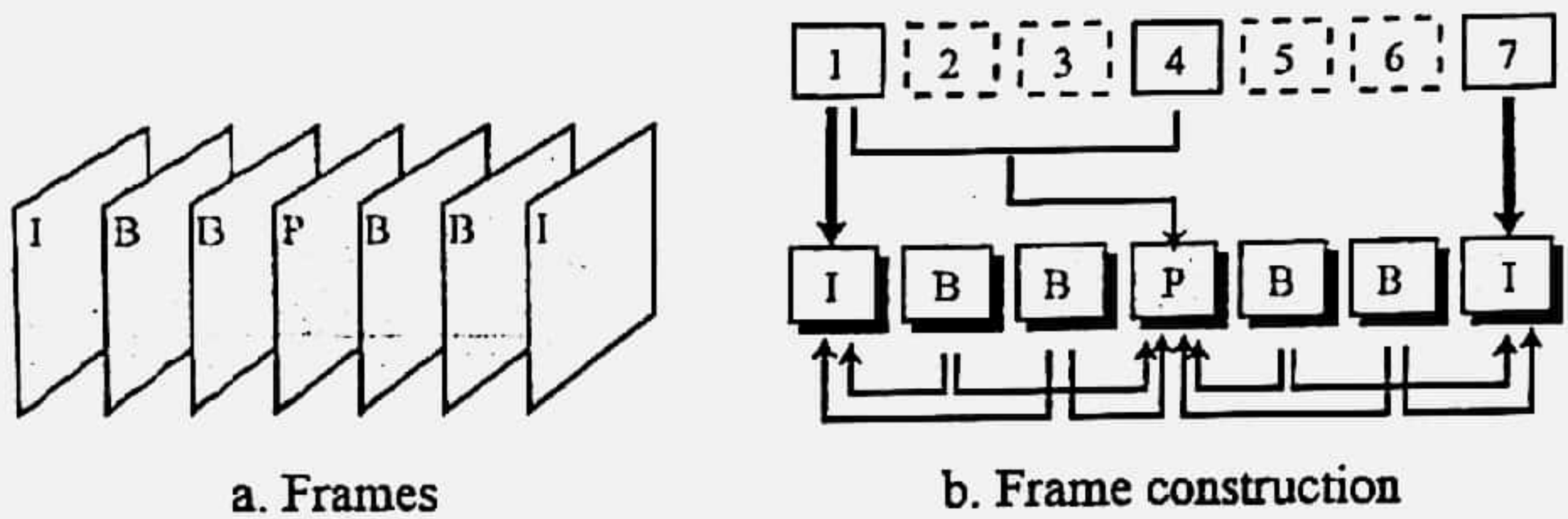
Video compression – MPEG encoding

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 spatailly compressing each frame and temporally compressing a set of frames.



a. Frames

b. Frame construction

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.

By changing appropriate parameters, the user can select

– the quality of the reproduced image

– compression processing time

– the size of the compressed image

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.

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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.

JPEG — Preparation

- A source image consists of at least one and at most 255 planes.
- Each plane Ci may have different number ofpixels 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 $2 \leq p \leq 12$.

The meaning of the value in these planes is not specified in the standard.

The image is divided into 8 X 8 blocks.

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.
- 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:
    - Preparation
    - 2) Processing
    - 3) Quantization
    - 4) Entropy Encoding
- 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
- for each component, a pixel is coded with eight bits

How MPEG encode the video stream?

In order to achieve higher compression ratio, MPEG uses the fact the image on consecutive frames differ relatively 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:

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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

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

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.

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

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:

Summary

Compression methods — lossless vs. lossy

Entropy coding — run-length encoding, Huffman encoding

Source coding — prediction (DPCM, DM), transformation (DCT)

hybrid coding — JPEG, MPEG

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Unit 6: 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

The user interfaces

- 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.

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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 recognize that people make mistakes.
- UI design principles underlie interface designs although not all principles are applicable to all designs.

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

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 behavior 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.

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User diversity	The interface should provide appropriate interaction facilities for different types of system user.

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 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

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

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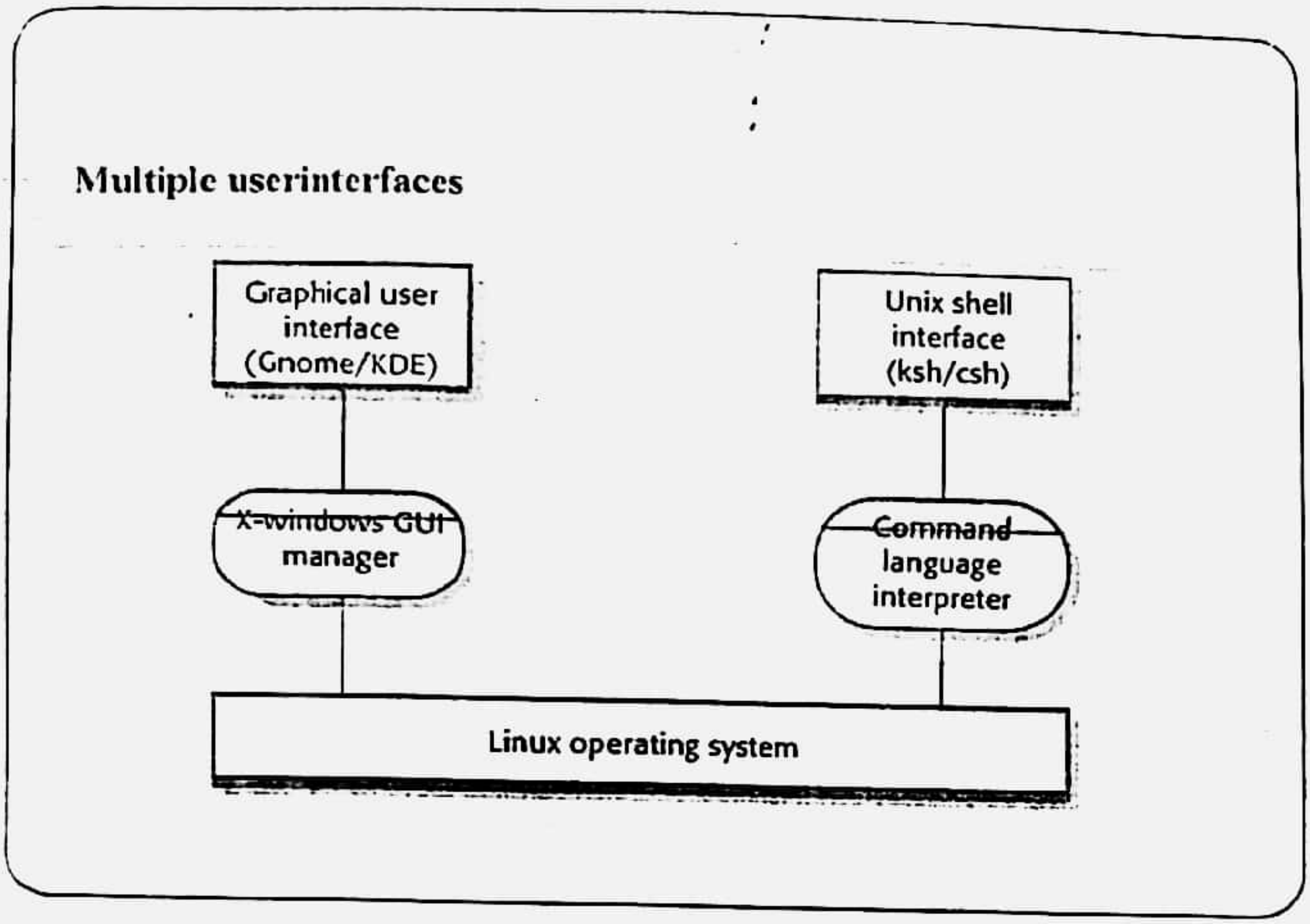
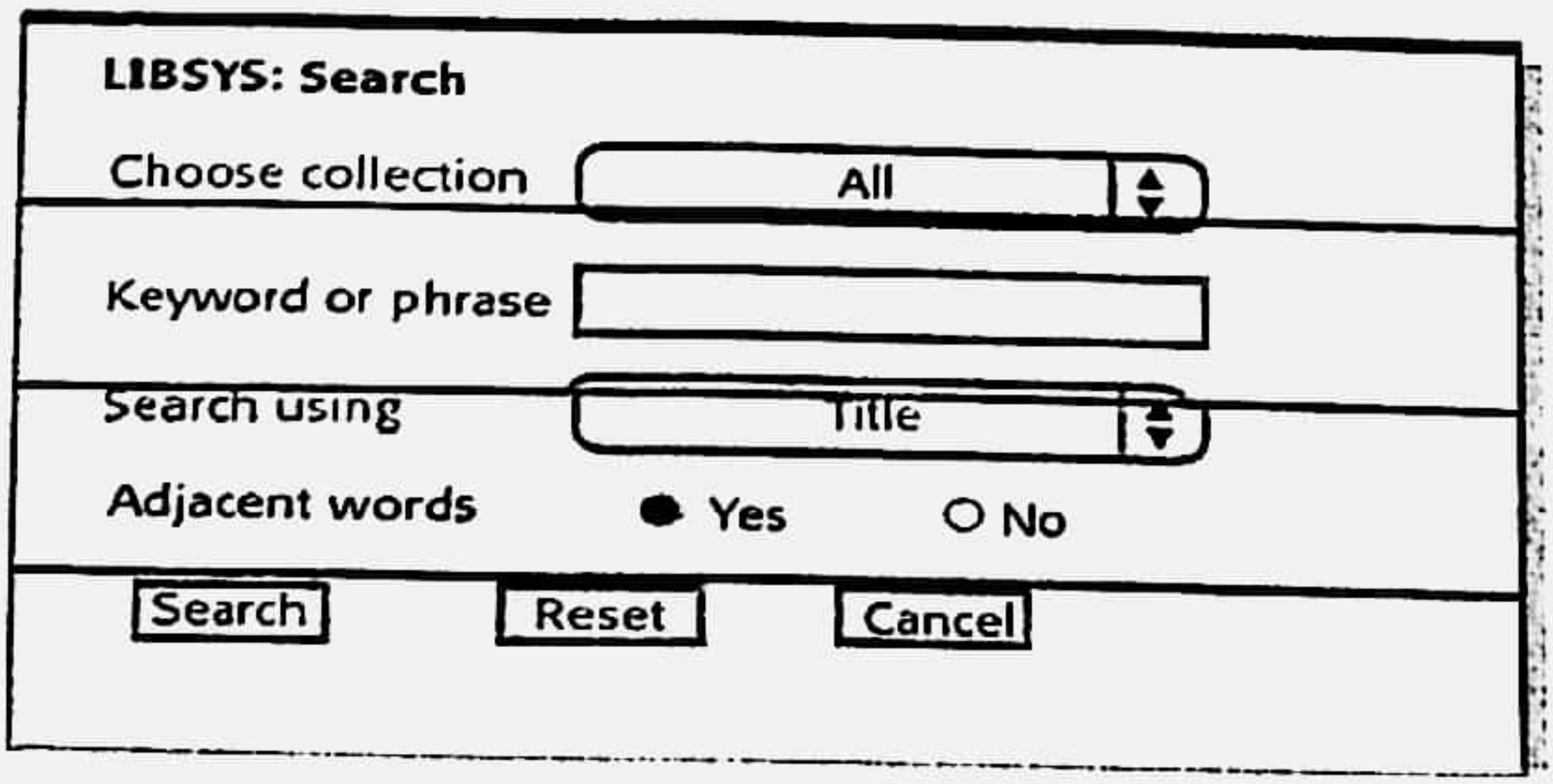
Multiple userinterfaces



Web-basedinterfaces

- 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 searchform



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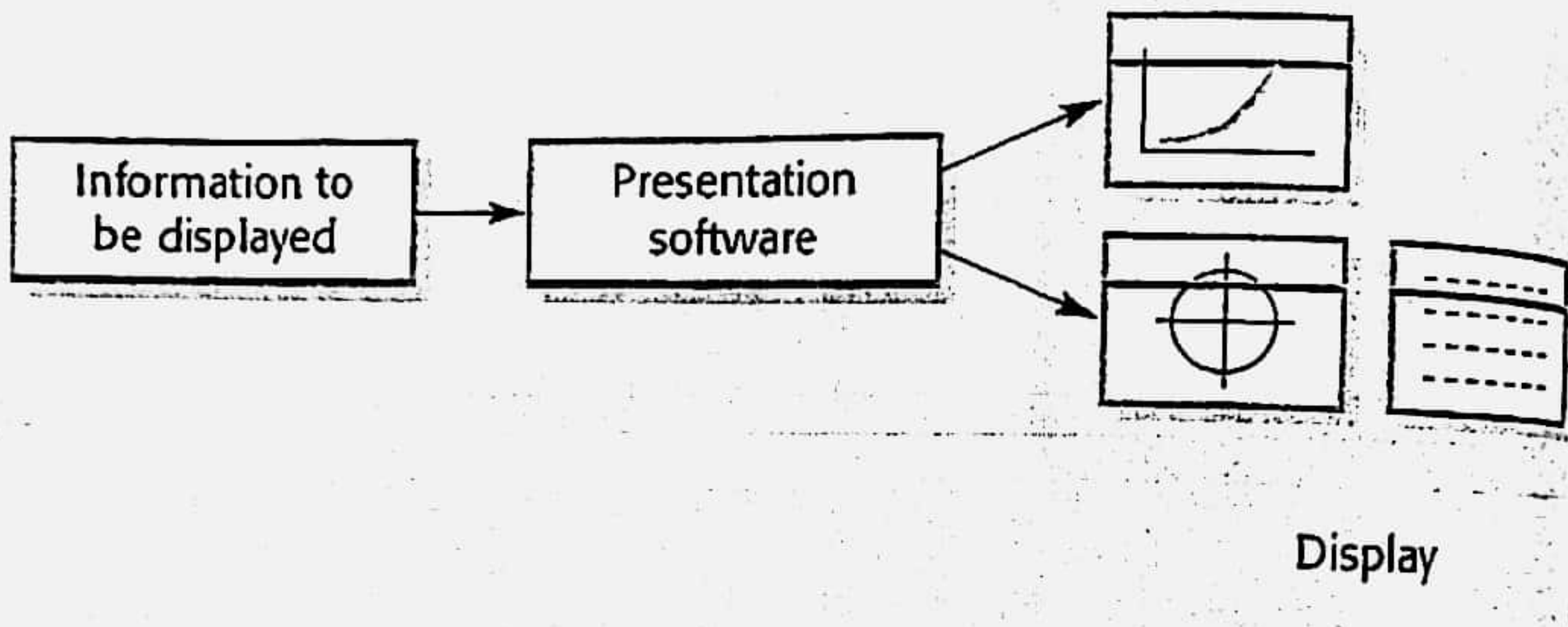
Information presentation

- 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 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?

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.

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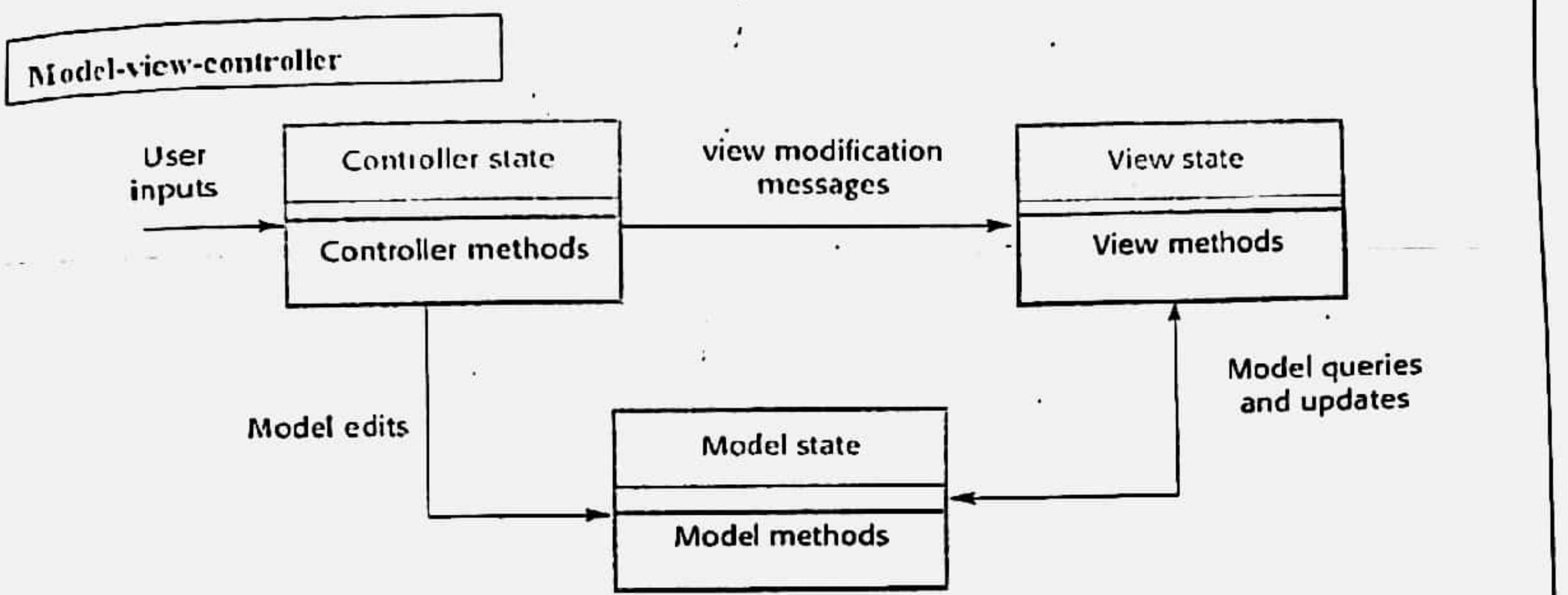

Fig: Model-view-controller

Alternative information presentations

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

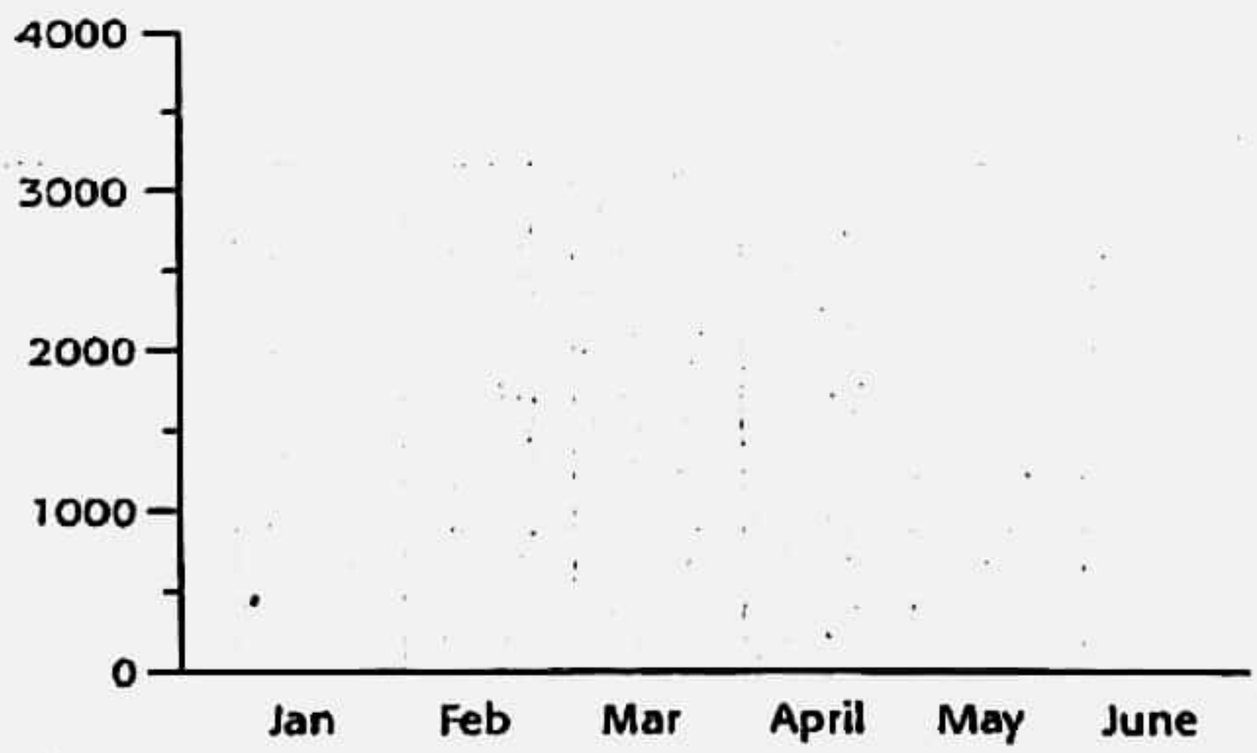

Fig: Alternative Information Presentation

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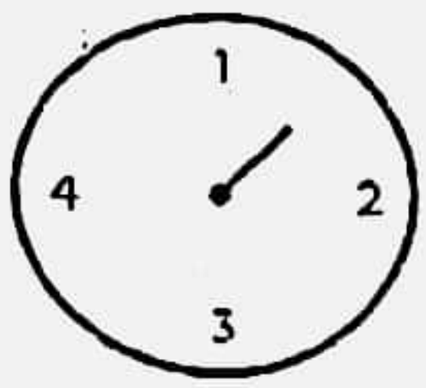
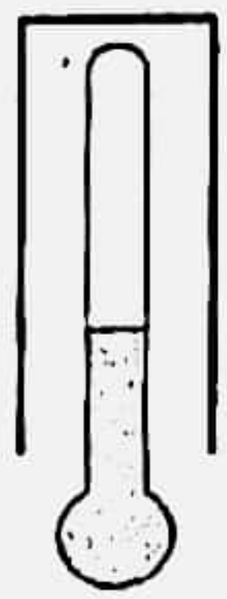
Presentation Methods

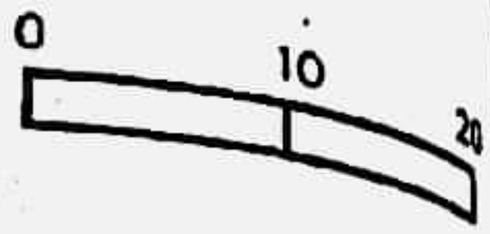


Dial with needle

Pie chart

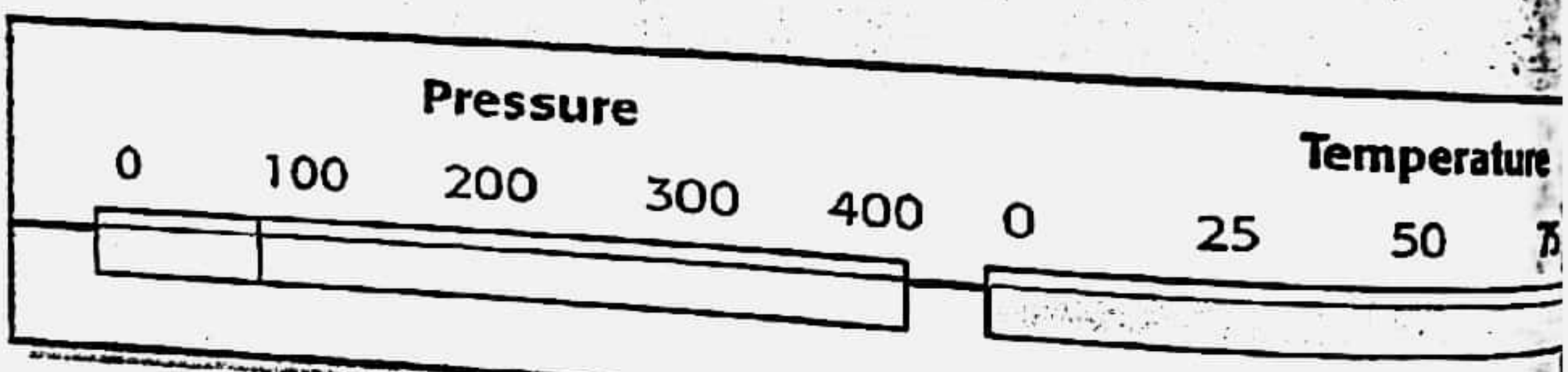


Thermometer



Horizontal bar

Displaying relative values



Data visualisation

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

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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 users become familiar with a s system, they become irritated by long, meaningful 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 user skills as well as their experience. Messages for the different classes of user may be ex pressed in different 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

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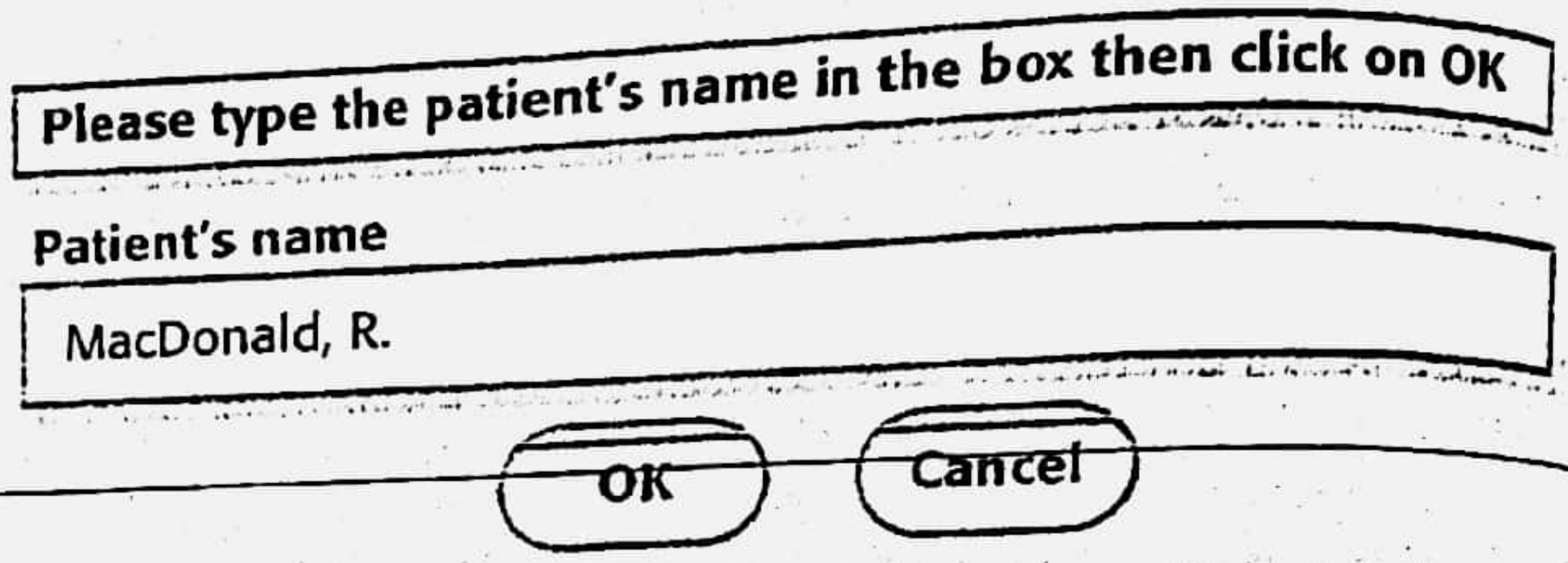
	America. A suitable message for one culture might be unacceptable in another.

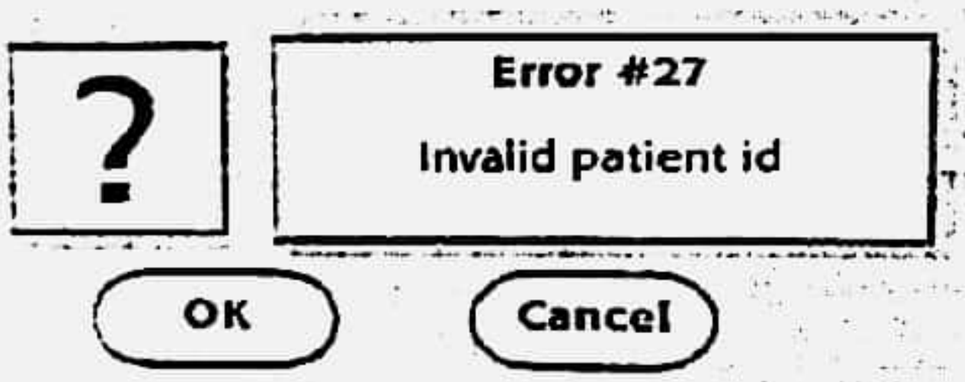
User error

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

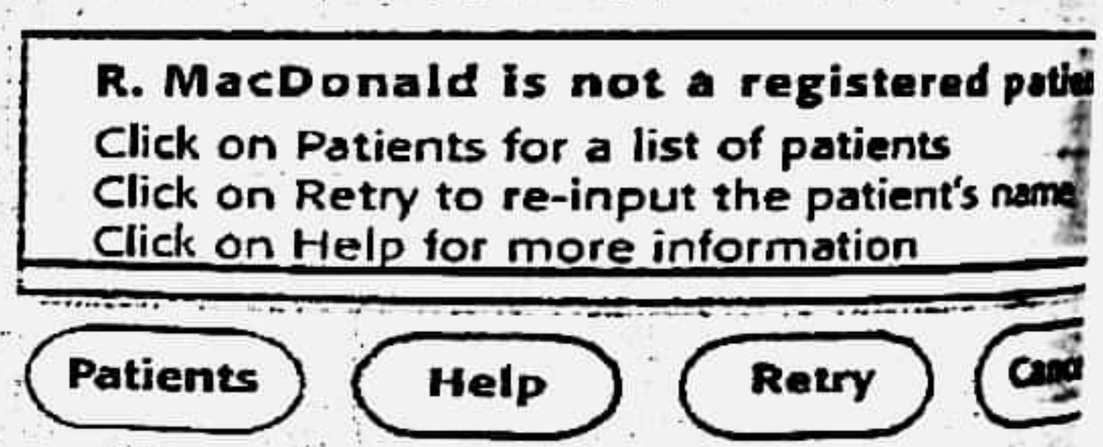


Good and Bad messages

System-oriented error message



User-oriented error message



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.

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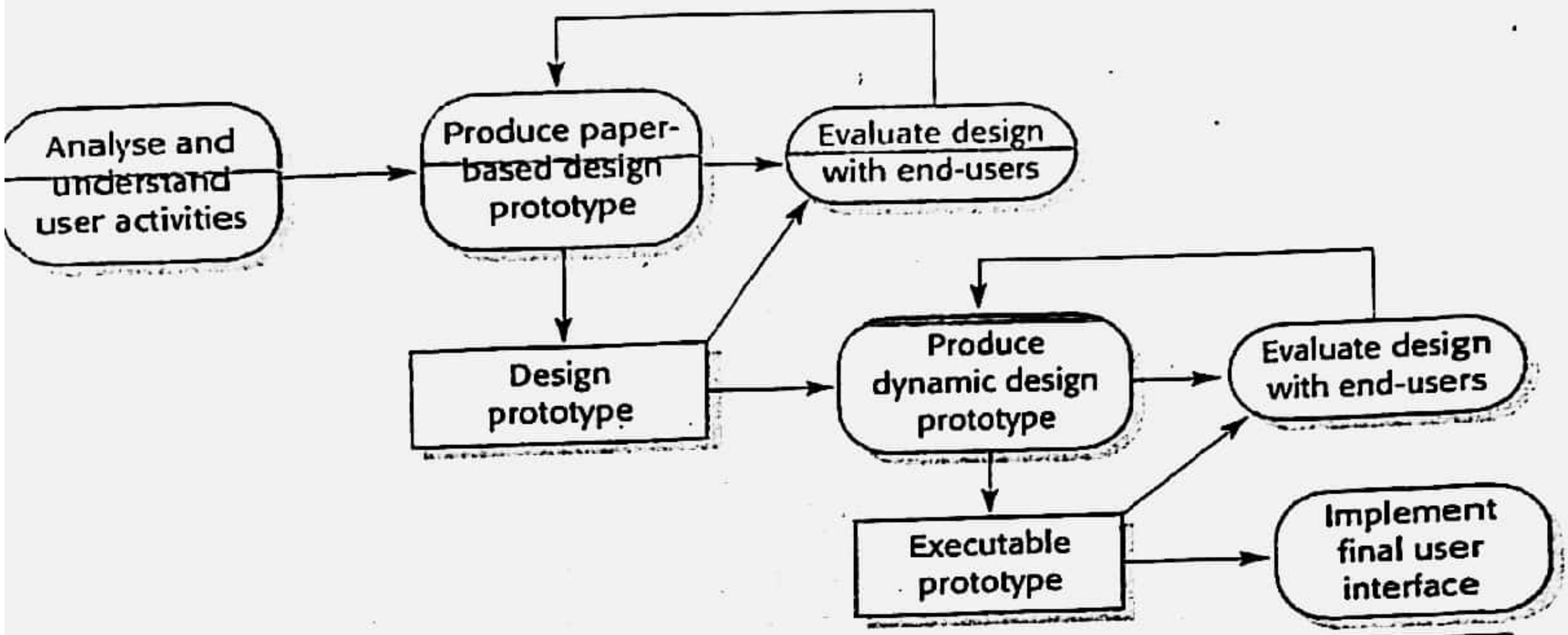

User analysis

- 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.

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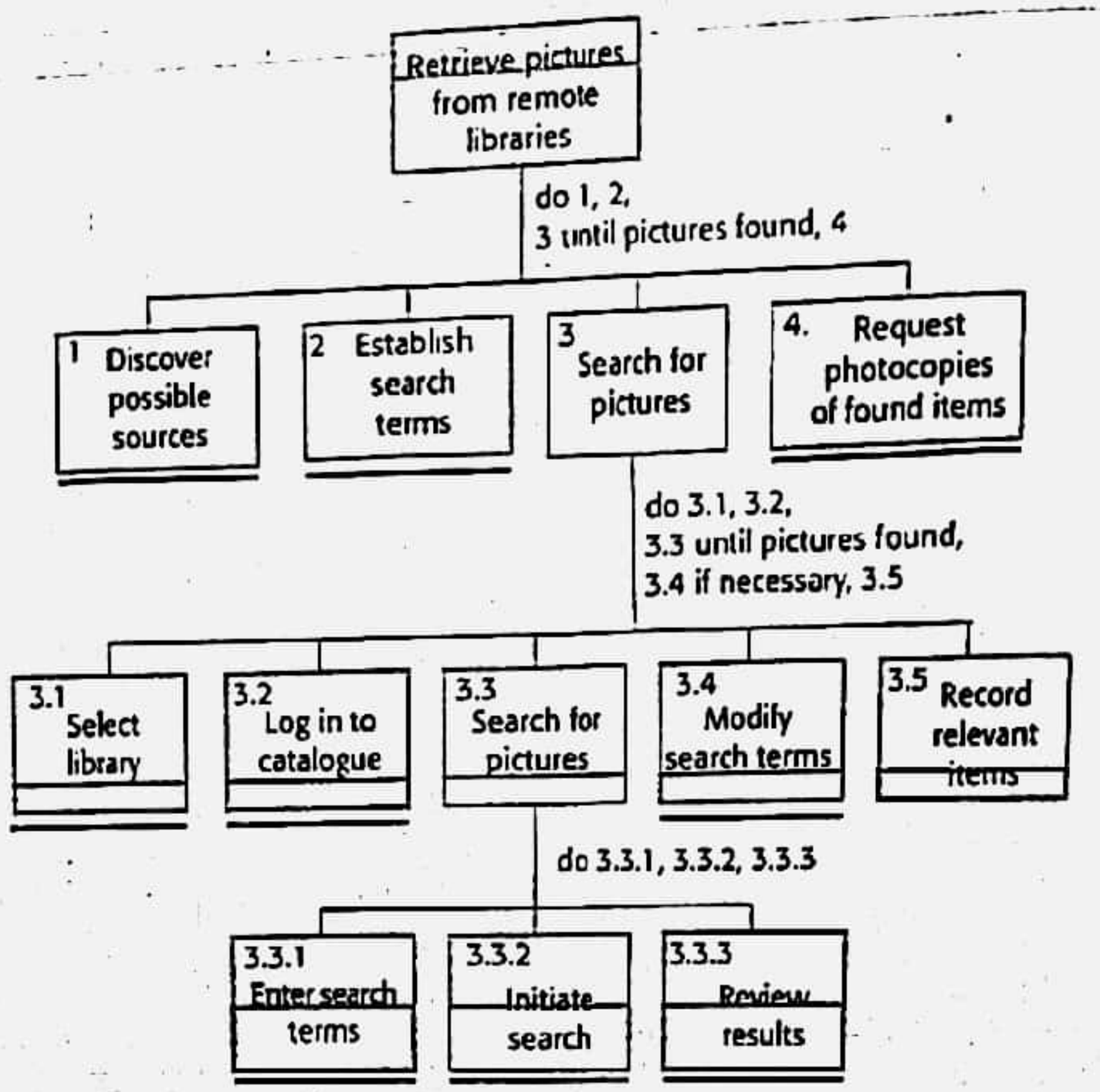
Hierarchical task analysis



Interviewing

- Design semi-structured interviews based on open-ended questions.
- Users can then provide information that they think is essential; not just information th 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 unsc way about their work.
- Valuable because many user tasks are intuitive and they find these very difficult to des and explain.
- Also helps understand the role of social and organizational influences on work.

Ethnographic records

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

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

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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 take a new user to become productive with the system?
Speed of operation	How well does the system response match the user's work practice?
Robustness	How tolerant is the system of user error? Recoverability
Recoverability	How good is the system at recovering from user errors?

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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, comma languages and natural language.
- Graphical displays should be used to present trends and approximate values. Digi displays when precision is required.
- Colour should be used sparingly and consistently.

Key points

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

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Unit 7: Abstraction for Programming

- 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

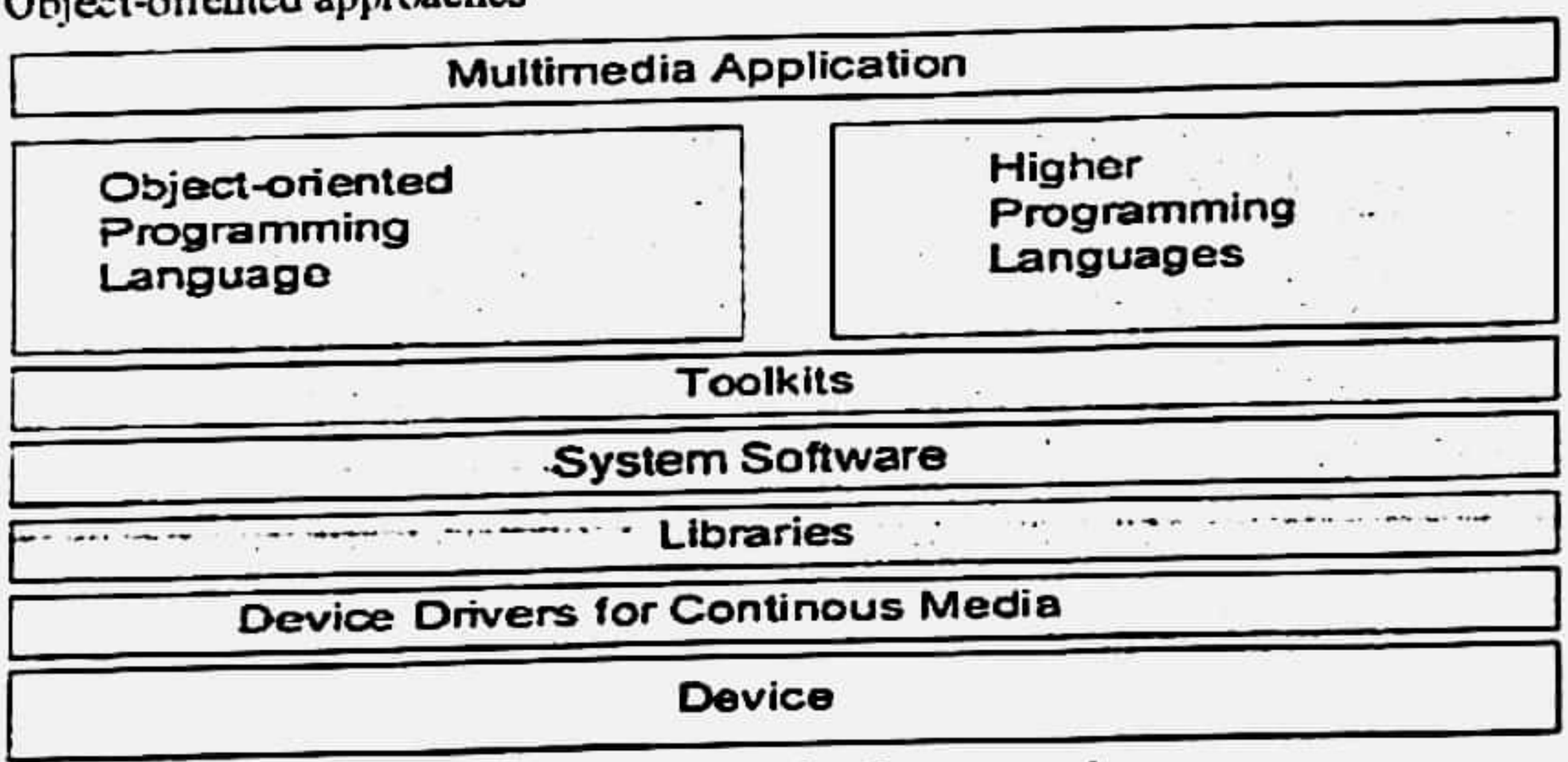

Figure: Abstraction for Programming

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

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Libraries Open GL

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 (rat of read access during a normal presentation)
  - Presentation rate is changed for VCR (Video Cassette Recorder) functions lik 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 sourc and a sink
  - Prior to the flow the stream is established equivalent to the setup of a connection in a networked environment

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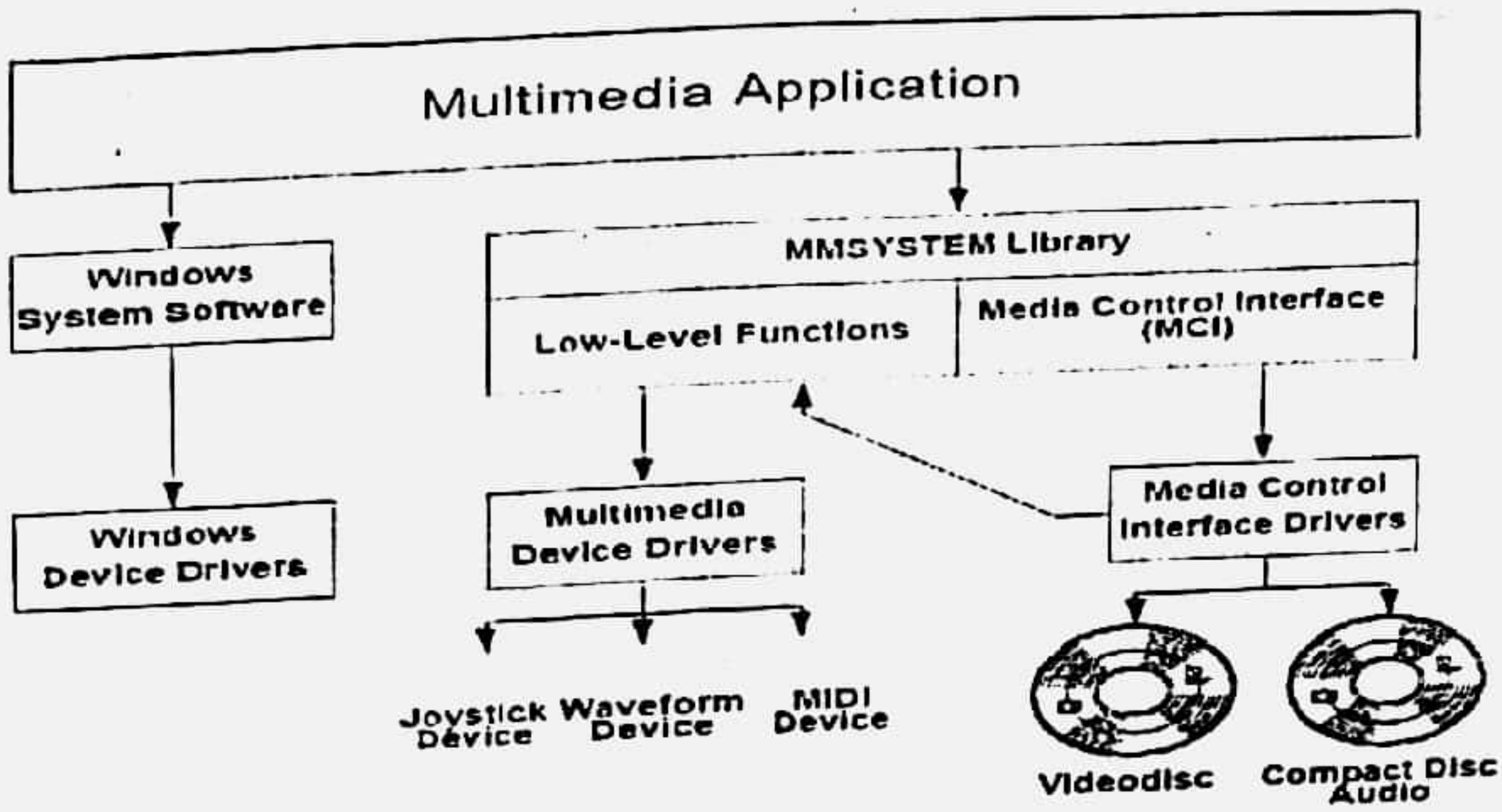
System Software: Windows Media Control Interface (MCI):



- MMSYSTEM library for extensibility and device independence

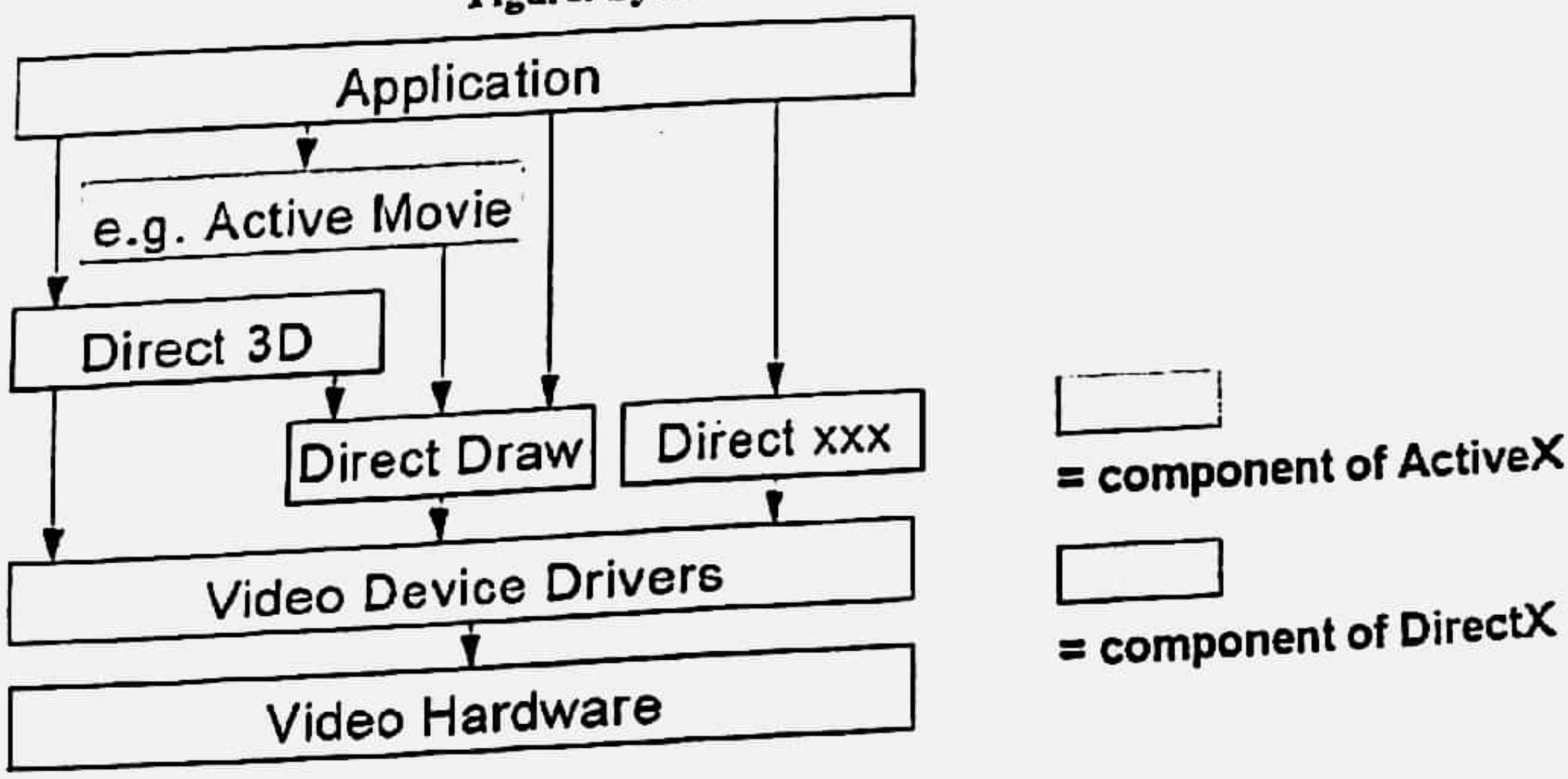
System Software - DirectX

- 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

Figure: System Software - DirectX



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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 user's 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 Language:

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:

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)
..
```

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

```
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);
};
```

Figure: Devices as classes

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Processing units as classes:

Three main objects:

- Source objects
- Destination objects
- Combined source-destination objects allow 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

Media as classes:

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

```
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
  ...
```

Figure: Object-Oriented Approaches-Media as Class

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RAJAN SHRESTHA (BCT/072/559)

Q-1. Explain global structure of multimedia.

OR

Multimedia system in terms of application domain, system domain and device domain

Ans:-

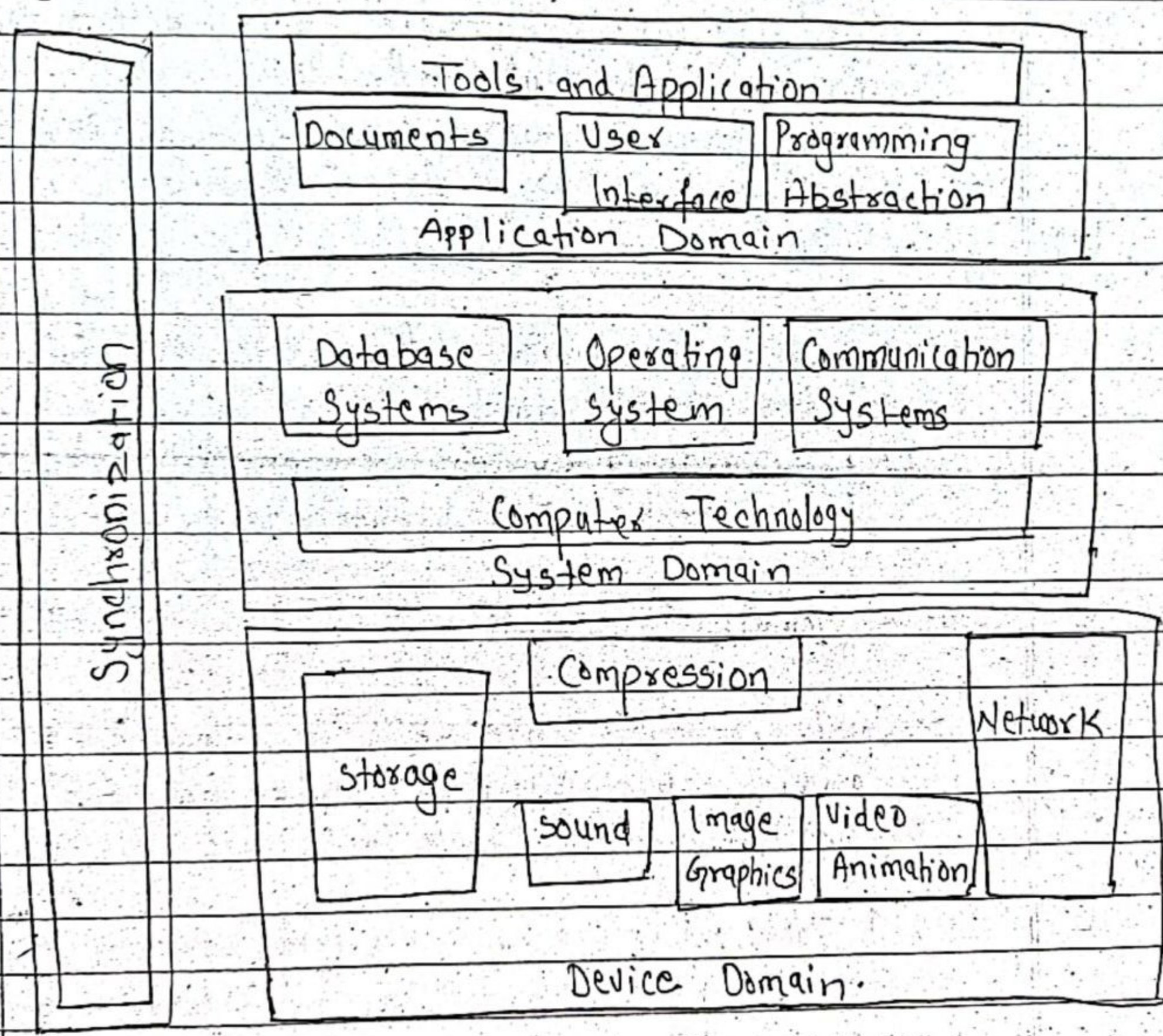

Fig: Multimedia Global Structure

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(1) Application Domain:

→ provides functions to the user to develop and present multimedia projects.
This includes software tools, and multimed projects development methodology.
→ services of system domain, document handling
→ presented to user through user interface

(2) System Domain

→ including all supports for using the function of the device domain
e.g: operating systems, communication system (networking) and database systems

(3) Device Domain

→ basic concepts and skill for processing various multimedia elements and for handling physical device (storage device).

- Operating system serves as an interface between comp hardware / system software and all other software compon
- Database system allows a structured access to data or a management of large database
- Communication system is responsible for data transmissi according to the timing and reliability requirement of m multimedia application.

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Q. What is the different stages in multimedia application development? Explain with example.

→ An application is a collection of programs that satisfies certain specific requirements (resolves certain problems).

A multimedia application development is usually composed of the following phases:

(1) Design phase
(2) Gather requirement
  (i) User, hardware and software requirement
  (ii) Perform analysis.
  (iii) Develop the design in its various iterations
    (a) High-level design
    (b) Detailed design
(3) Code and test application
(4) Perform user tests.
(5) Perform system tests
(6) Go into production - hand off to operation
(7) Ensure that all documentation is in place.
(8) Maintenance phase - on going day-to-day changes and enhancements to application.

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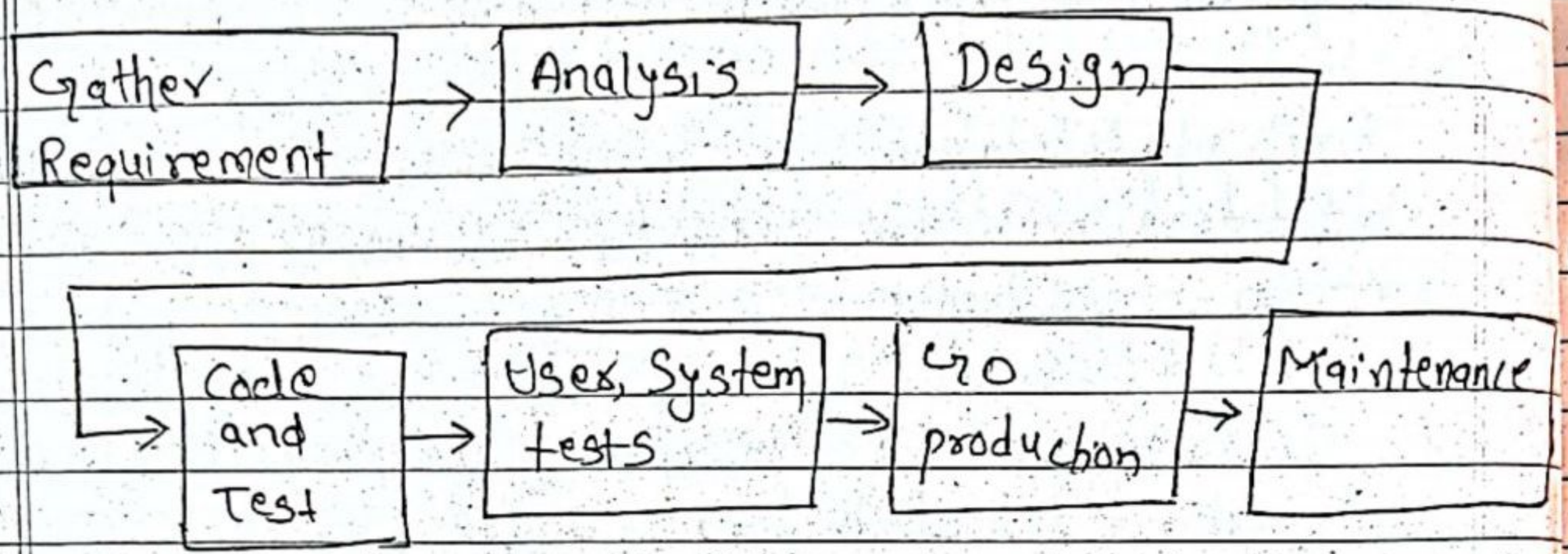
Fig 1: Application development Life cycle



Summary:

Multimedia systems development cycle

(i) Planning and costling
(ii) Designing
(iii) Developing and producing
(iv) Testing and debugging
(v) Delivering

(i) Planning and costling:

→ To capture the ideas and requirements of you or your clients
→ To identify the potential audience and users of the application
→ To findout the benefit that will gain from developing the application

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→ To evaluate the feasibility and costs of the entire project, including all tasks of production, testing and delivery

(ii) 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

(iii) Developing and producing:

→ Producing is the phase when your multimedia project is actually rendered.

→ The tasks to be performed in this phase are:

(a) Acquiring all media elements

(b) Composing the elements according to the story board

→ This is the phase when your artistic talent and your technical knowledge are in high demand

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(iv) 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

(v) Delivering:

→ You should plan how to deliver the product very early in the development process.
→ Now a days, CD-ROM and Internet are the two most popular means of delivering multimedia applications.

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Q: What are the properties of a multimedia system? Explain.

A multimedia system is characterized by computer control, integration production, manipulation, presentation storage and communication of independent information which is encoded at least through a continuous (time dependent) and a discrete (time independent) medium.

Properties of multimedia system (CID)

(1) Combination of media

According to the definition of multimedia system, a multimedia system must be composed with the help of different mediums and devices and all together when works or comes in function then it forms the multimedia system.

(2) Independence:

In the multimedia system different media should be independent from each other whereas there should be inherently tight connection between different media to work together also.

(3) Computer supported integration (computer control)

The different independent media are combined in arbitrary forms to work together as a

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system with the support of computers. Computer supported integration also called control through the computer in media system.

Communication System:

Communication capable multimedia system must be approached. Multimedia information not only be created, proceed and stored but also be distributed above the single computer boundary which makes the multimedia application much popular and useful in distributed environment.

Integrated:

Multimedia systems must be (are) integrated. At least one discrete and one continuous media combined for information presentation and sharing.

Interactive:

The interface to the final presentation of media is usually interactive. User is able to navigate, interact, create & communicate

Digitalize:

The information they handle must be represented digitally. consists of various form of media i.e. text, graphics, audio, video and animations; created, stored, processed and transmitted digitally.

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Differentiate between MIDI and digital audio.

MIDI	Digital Audio
1. Stands for Musical Instrument Digital Interface	1. Digitalized Audio.
2. A MIDI file is a file that records music and controls the notes of each instrument, what note of the scale is, etc.	2. Digital audio files are the files that records or reproduce sound. It is like a tape recorder
3. Defn: A MIDI file is a software for representing musical information in a digital format	3. A digital audio refers to the reproduction & transmission of sound stored in a digital format
4. Format Type: Compressed	4. Compressed
5. Advantages: → Files are tiny often less than 10K → Download from a webpage in no time → Fit easily on a floppy disk → The files are any time ideal.	5. Advantages: → They produce the exact sound files → It reproduce better than CD quality
6. Contain: Donot contain a recording of sound.	6. Contain recording of sound.

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	MIDI	Digital Audio
7.	Disadvantage: → They sound little different from the original sounds.	7. Disadvantages: → They take upto 10MB or more per minute. → It could take several min to download. → When combined with video file can cause problem.
8.	Storage: No actual sound stored in MIDI file	8. Actual sound stored in digital audio file

Q. Explain about audio hardware and audio software.

Ans:- Audio hardware is an important component of a complete multimedia system. Audio hardwares are the devices that helps in recording, digitalizing etc.

(A) Recording and Digitizing 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.

(B) Play back sound:

A DSP processes the sample i.e decompression

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demodulation as well.

→ A DAC converts the digital samples into sound samples/signals.

→ All these hardware devices are integrated into a few chips on a sound card with varying processing capability.

Audio software:

These are the sound drivers or audio drivers which controls hardware devices.

Windows device driver - controls hardware device. Many popular sound card are plug and play.

→ Windows has drivers for them and can recognize them automatically.

→ For cards the Windows does not have drivers, you need to get the driver from the manufacturer and install it with the card.

Device-manager: the user interface to the hardware for configuring the devices.

Some audio software are mixers, recorder, editor, etc.

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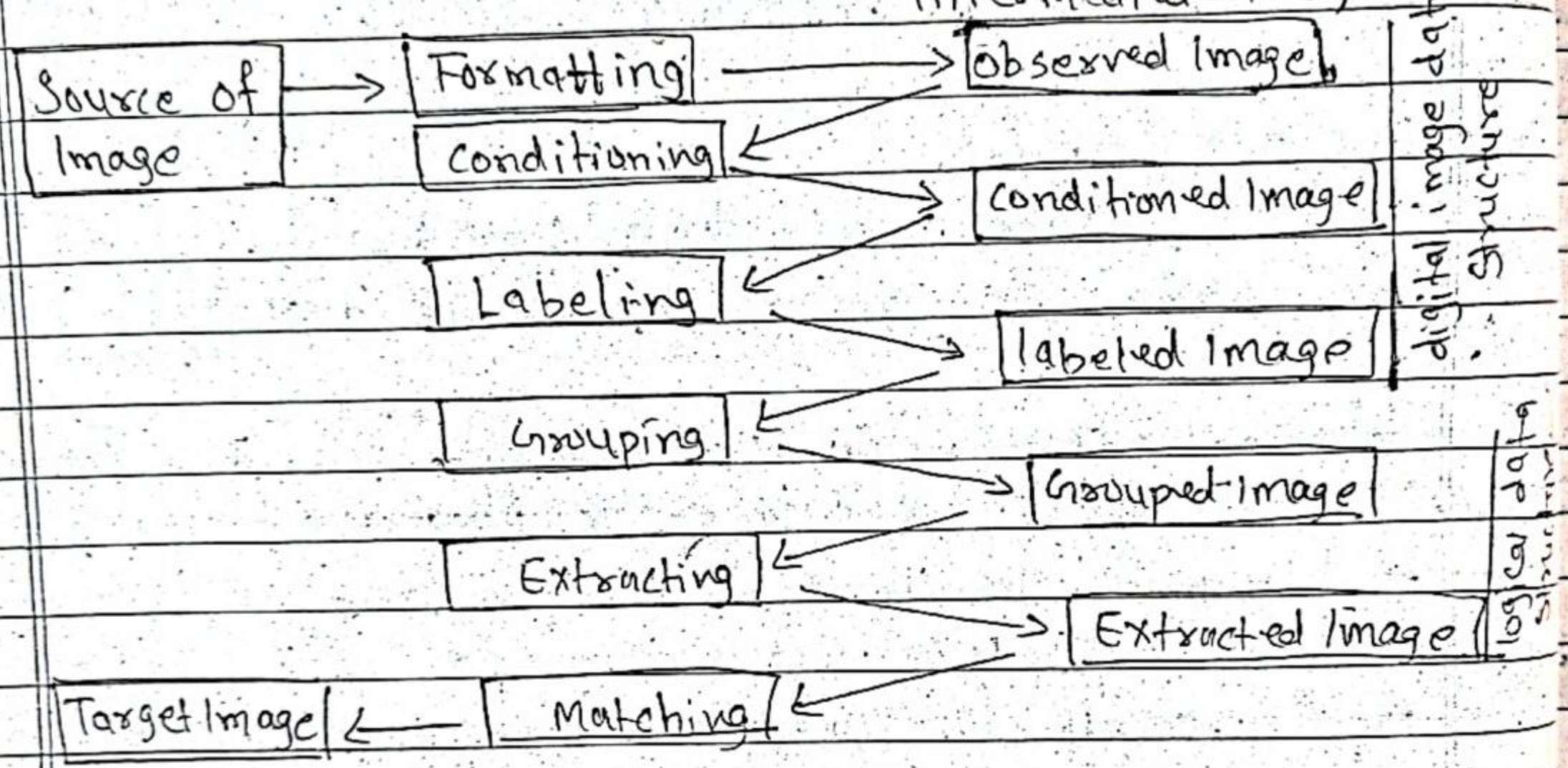
Explain the Image recognition steps in detail.

An image recognition pay attentions to each of the following steps: image formatting, conditioning, labeling, grouping, extraction and matching. (FCLGEM)



① Formatting

- capturing an image from a camera and bringing it into digital form.
- Digital representation of an image in the form of pixels.

② Conditioning

- Conditioning suppresses, or normalizes, the uninteresting variations in the image, effectively highlighting the interesting parts of image

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- applied uniformly and in context-independent

(3) Labeling

- Informative patterns in an image have structure
- Patterns are usually composed of adjacent pixels which share some property such that it can be inferred that they are part of same structure (e.g edge).
- Edge detection techniques focus on identifying continuous adjacent pixels which differ greatly in intensity or color, because these are likely to mark boundaries, between objects, or an object and the background, and hence form edge.
- After the edge detection process is complete, many edges will have been identified. Thesholding filters out insignificant edges. The remaining edges are labeled.

(4) Grouping:

- Grouping can turn edges into lines by determining that different edge belong to same spatial event.
- A grouping operation, where edges are grouped into lines, is called line-fitting
- After grouping, digital image structure is stored in a logical data structure.

(5) Extracting:

- Grouping only records the spatial event(s) to which pixels belong. Feature extraction involves generating

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a list of properties for each set of pixels in a spatial event.

- These may include a set's centroid, area, etc.
- If it is a region, then the number of holes might be useful.
- In case of an arc, the average curvature of arc might be useful to know.
- Feature extraction can also describe the topographic relationships between different groups.

(6) Matching:

- Finally, once the pixels in the image have been grouped into objects and the relationship between the different objects has been determined, the final step is to recognize the objects in the im
- Once an object or set of object parts has been recogn measurements (distance between two part, angle between two lines or area) can be made.
- Matching involves comparing each object in the image with previously stored models and determining best match templete matching.

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

S → file size; R → sampling rate; b → Resolution; C → channels (1 = mono, 2 = stereo); D → recording duration.

Q. Suppose if we record the 5 seconds of stereo music at 44.1 KHz with 32 bits. Calculate the file size? (2066 Magh Q.No.6)

Given,

Sampling frequency (R) = 44.1 kHz
= 44100 Hz

Resolution (b) = 32 bits

Recording duration (D) = 5 seconds

Channel (C) = stereo type so 2
= 2

Now we know,

$$S(\text{File size}) = R \times \frac{b}{8} \times C \times D$$

$$= 44100 \times \frac{32}{8} \times 2 \times 5$$

$$= 1764000 \text{ bytes}$$

$$= \frac{1764000}{1024} \text{ K byte}$$

$$= 1722.65 \text{ Kbyte}$$

$$= \frac{1722.65}{1024} \text{ M byte}$$

$$= 1.682 \text{ M byte}$$

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Q- Calculate the file size if we record the 10 second of stereo music a 44.1 kHz with 16 bits. (2069 Bhadra Q-No.3)

Given,

Sampling rate (R) = 44.1 kHz
= 44100 Hz

Duration recording time (D) = 10 second

channel (C) = 2 for stereo-music

Resolution (b) = 16 bit

file size (S) = ?

We know

$$S = R \times \frac{b}{8} \times C \times D$$

8 bit = 1 byte

$$= 44100\ Hz \times \frac{16}{8}\ byte \times 2 \times 10\ second$$

$$= \frac{44100}{sec} \times \frac{16}{8}\ byte \times 2 \times 10\ sec \quad \left[\because f = \frac{1}{T}\right]$$

$$= 1764000\ byte$$

$$= \frac{1764000}{1024 \times 1024}\ mbyte$$

$$= 1.682\ mbyte$$

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Q. A bitmap image has resolution 640x480 pixels. Each pixel is 32 bit deep. What is the size of the bitmap in bytes? (2068 Chaitra Q.No.5)

Soln

Given,

Resolution (b) = 640x480 pixel
Resolution bit (R) = 32 bit
Bitmap size (S) = ?

We know

S = Resolution x Resolution bit
= 640x480 x 32 bit
= $640 \times 480 \times \frac{32}{8}$ byte
= 1228800 byte
= $\frac{1228800}{1024}$ Kbyte
= 1200 K byte
= $\frac{1200}{1024}$ M byte
= 1.17 M byte

[(1 byte = 8 bit)
$\frac{1}{8}$ byte = 1 bit
$\frac{1}{8} \times 32$ = 32 bit]

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Q. The table on the left below represents an indexed image. The table on the right is colour index table. What is the colour of the following pixels: (2072 Ashwin Q.No.3)

(0,2), (1,1), (1,3) (2,1) (2,2), (3,0)

	0	1	2	3
0	2	3	(i) 0	3
1	7	(ii) 2	1	5
2	5	6	4	4
3	2	7	5	0

Fig: Indexed image

	R	G	B	
0	0	255	0	→ Green
1	255	0	0	→ Red
2	0	0	255	→ Blue
3	0	0	0	→ Black
4	255	255	0	→ Yellow
5	127	127	127	→ Light & G
6	255	0	255	→ Magnet
7	255	255	255	→ White

Fig: Colour index table

Soln:

	Pixel	Indexed image	Colour (From colour index table)
i	(0,2)	0	Green
ii	(1,1)	2	Blue
iii)	(1,3)	5	Light & Gray
iv)	(2,1)	6	magnetum
v)	(2,2)	4	Yellow
vi)	(3,0)	2	Blue

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A certain source emits symbols {A, B, C, D, E} with corresponding probabilities

- P(A) = 0.06
- P(B) = 0.48
- P(C) = 0.02
- P(D) = 0.28
- P(E) = 0.24

Create a Huffman code tree and also derive the Huffman code for each symbol. (2074 Bhadra Q-NO-5)

Sol^n

(1) P(CA) = 0.02 + 0.06 = 0.08

P(C) = 0.02 P(A) = 0.06

(2) P(CAD) = 0.28

P(CA) = 0.08 P(D) = 0.28

(3) P(ECAD) = 0.52

P(E) = 0.24 P(CAD) = 0.28

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(4) $P(BE(AD) = 1$

$P(B) = 0.48$ $P(E(AD) = 0.52$

Now, constructing Huffman Tree:

$P(ABCDE) = 1$

0 1

$P(B) = 0.48$ $P(E(AD) = 0.52$

0 1

$P(E) = 0.24$ $P(C(AD) = 0.28$

0 1

$P(C(A) = 0.08$ $P(D) = 0.20$

0 1

$P(C) = 0.02$ $P(A) = 0.06$

Final Answer

From Huffman tree,

Symbol	Huffman code
A	1101
B	0
C	1100
D	111
E	10

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Q. Calculate file size in byte for 30 seconds recording at 44.1 kHz, 8 bits resolution stereo sound.

Given

Sampling rate (R) = 44.1 kHz
= 44100 Hz

Duration (Recording Time) (D) = 30 seconds

Channel (C) = 2 for stereo

Resolution bit (b) = 8 bits

file size (S) = ?

We know,

$$S = R \times \frac{b}{8} \times C \times D$$

$$= 44100 \times \frac{8}{8} \times 2 \times 30$$

$$= 2646000 \text{ byte}$$

$$= \frac{2646000}{1024 \times 1024} \text{ Mbyte}$$

$$= 2.523 \text{ Mbyte}.$$

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Explain the computer representation of sound and MIDI software.

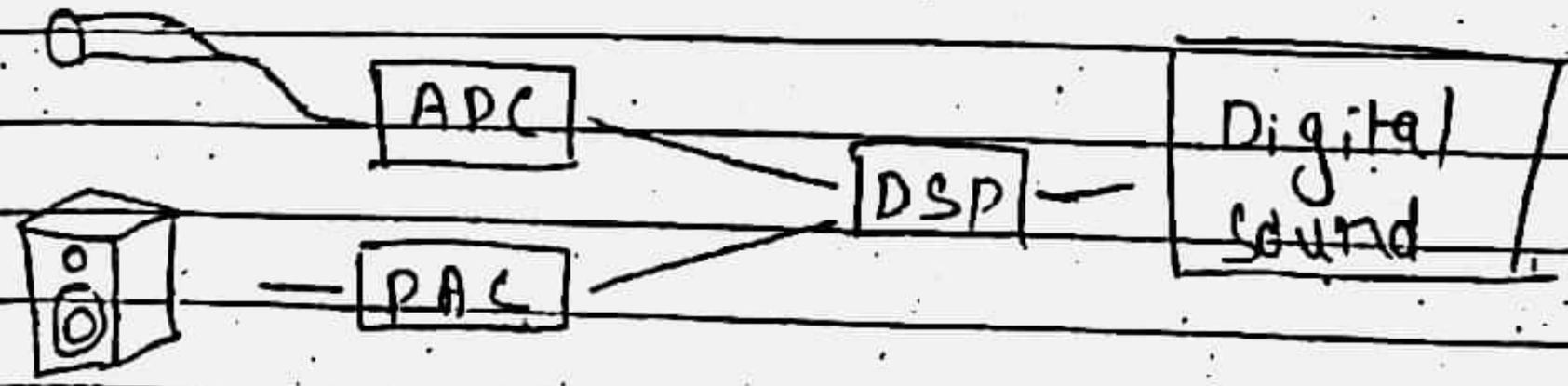
Ans:- Sound is a physical phenomenon caused by vibration of material. In multimedia we are concerned with sounds in the audiosonic range.

Audio representation on computers

A computer measures the amplitude of the waveform at regular time intervals it then generates a series of sampling values. The mechanism that converts an audio signal into digital sample is the analog-to-digital converter (ADC). A digital-to-analog converter (DAC) is used to achieve the opposite conversion.

Audio Sampling:

1. Determine number of samples per second
2. At each time interval determine the amplitude
3. Stored the sample rate and the individual amplitudes



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MIDI (Musical Instrument Digital Interface)

The MIDI is a small piece that plugs directly into the computer's serial port and allows the transmission of music signals.

Note that: MIDI doesnot produce sound, only produce the parameters that are needed to be sent to the device that translates those numbers into sound

Data format has instrument specification, notion of beginning and end of note, frequency and sound volume. This data grouped into MIDI messages that specify a music event.

A message contains 1 or 2 or 3 bytes
1. First byte is status byte used to transmit message to a specific channel.
2. Remaining bytes are data bytes

The number of data bytes is dependent on status byte.

MIDI standard specifies 16 channels and identifies 128 instruments. For example, 0 is for piano, 40 for violin, 73 for flute, etc

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Q- Explain in detail the process of speech recognition & gen

Speech Recognition: (CIP LAST)

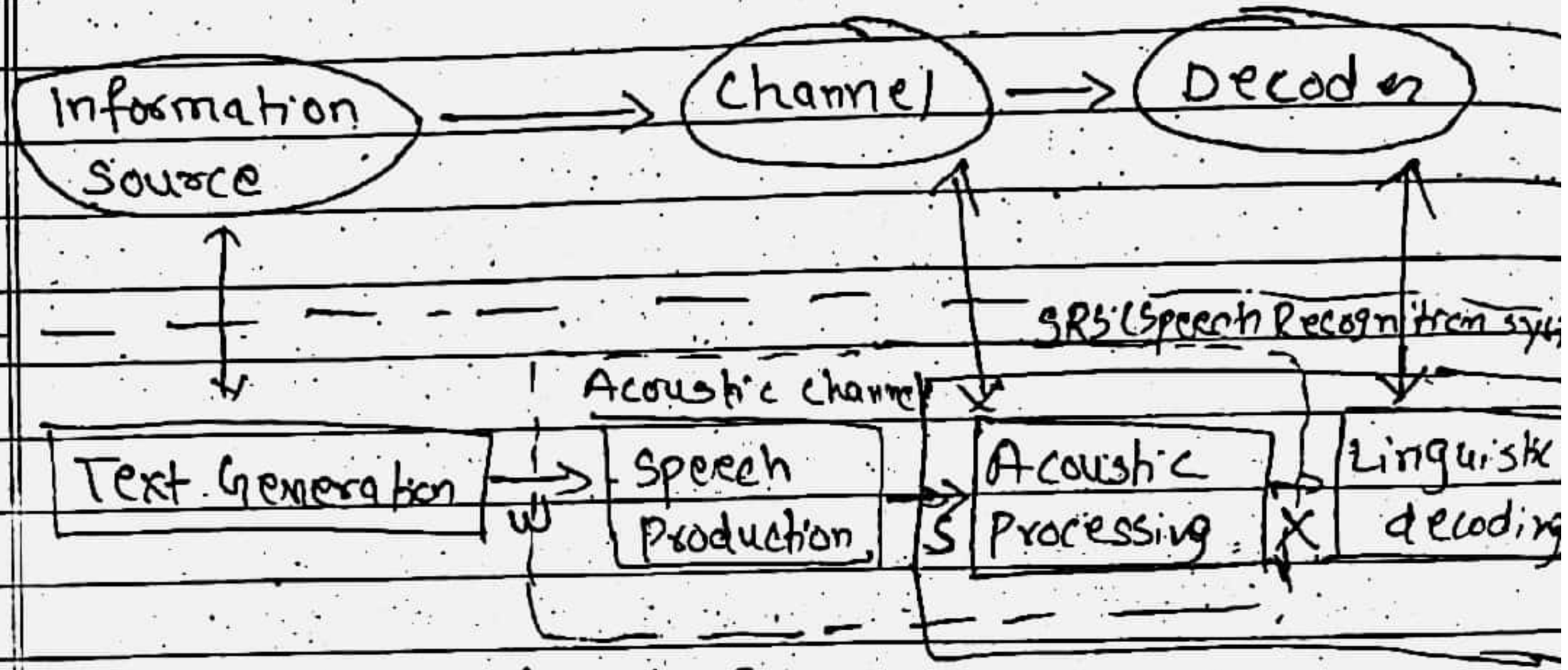

Fig: Speech Recognition process.

Speech Recognition is the ability to translate a dictation or spoken word to text.

→ It is also known as Speech-to-Text and Voice Recognition.

→ It is achieved by following certain steps and the software responsible for it is known as 'Speech Recognition System'.

→ SR system are usually implemented in the form of dictation software and intelligent assistants in personal computers, smartphones, web browsers and many other devices

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Signal Analyzer / Speech Analyzer :-

Analyzes the speech signal and removes the background noise thus focusing only on the speaker's speech.

Acoustic model :

Identifies phonemes from the speech sample using a probability based mathematical model. In figure $W \rightarrow X$, represent acoustic model. i.e $P(X|W)$.

Language model : $\rightarrow$ i.e $P(W)$

Identifies words and thus sentences uttered by the speaker from the phonemes by making use of a dictionary file and grammar file.

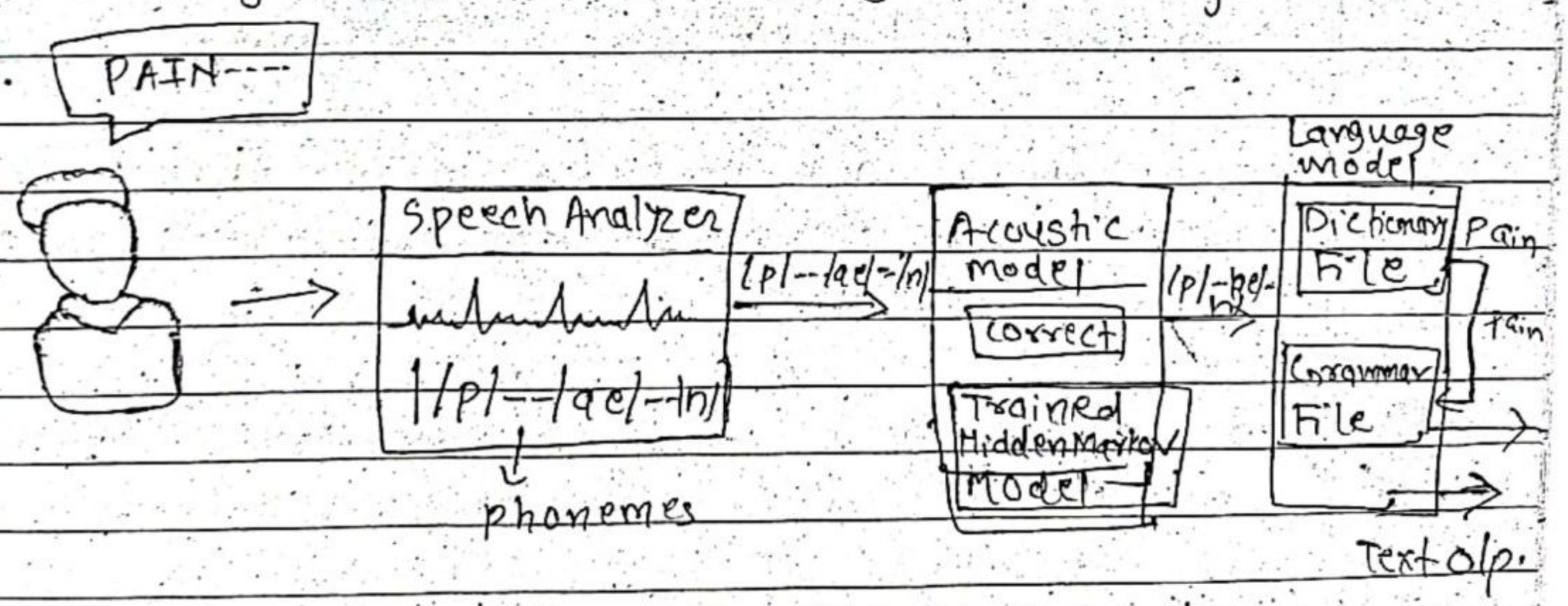

Fig: Process of speech Recognition

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Chapter 3: Images and Graphics

Q- What are bitmap images? Explain the advantages and disadvantages of bitmap over vector images

Ans: Bitmap (or Raster) images are stored as a series of tiny dots called pixels. Each pixel is actually a very small square that is assigned a colour, and then arranged in a pattern to form the image.

→ When you zoom in on a bitmap image you can see the individual pixels that makeup that image.

→ Bitmap graphics can be edited by erasing or changing the color of individual pixels using a program such as Adobe Photoshop.

Advantages of bitmap over vector images

1. Bitmap formats are best for images that need to have a wide range of color graduation, such as most photographs.

2. Bitmap file can be easily created from existing pixel data stored in an array in memory.

3. Pixel values may be modified individually or as large groups by altering a palette if present

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4. Allows you to create any image, regardless of its complexity. In contrast, vector graphics cannot accurately convey the effect of the transition from one colour to another without a loss in file's size
5. Bitmap image are easier to render.

Disadvantages of bit-map over vector images

1. In vector image, any particular element of the image could be scaled out without quality loss.
2. The parameters of objects are stored and can be quickly changed which means moving, scaling, rotation, etc doesnot degrade the picture quality in vector.
3. Vector images are independent of the actual size of the depicted image
4. Bitmap can take up a lot of room. Compression can reduce the size of file.
5. Bitmaps when they are enlarged too much, they look un-natural and blocky.

Q. Explain different colour model.

RGB Colour Model.

→ RGB colour model is an additive colour model.

→ In this case red, green and blue light are added together in various combinations to reproduce a wide spectrum of colors.

→ The RGB colour model comprises of 24-bits

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per pixel with 8 bits assigned to red, 8 bits to green and 8-bit to blue.

→ The amount of values available with 8 bits is 256 (2^8) ranging from 0-255.

→ The primary purpose of RGB colour model is for the display of images in electronic systems, such as on television screens and computer monitors and it's also used in digital photography.

→ In order to create a colour with RGB, three coloured light beams (one red, one green, and one blue) must be superimposed.

→ With no intensity, each of the three colour is perceived as black, while full intensity produces white.

2. CMYK - colour Model

→ CMYK colour model (four-color process) is a subtractive color model.

→ Primarily used in printing, CMYK works by partially or completely masking colours on a white background.

→ The printed ink reduces the light that would otherwise be reflected. That's why this model is called subtractive because inks 'subtract' brightness from a white background

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from four colors: cyan, magenta, yellow and black.
→ It is frequently suggested that the 'K' in CMYK comes from the last letter in 'black' and was chosen because 'B' already refers to blue.
→ Actually, 'K' in CMYK stands for 'Key' since in four-colour printing cyan, magenta, and yellow printing plates are carefully keyed or aligned with the key of black key plate.
→ Black is used because the combination of the three primary colors (CMY) doesn't produce a fully saturated black.
→ CMYK is able to produce the entire spectrum of visible colors due to the process of half-toning.
→ In this process, each color is assigned a saturation level and miniscule dots of each of the three colours are printed in tiny pattern. This enables the human eye to perceive a specific color made from the combination.

3 HSB colour model.
→ The HSB (Hue, Saturation, Brightness) colour model defines a colour space in terms of three constituent components:
(i) Hue: the color type (such as red, blue or yellow)
→ ranges from 0 to 360° in most applications.

(Each value corresponds to one color: 0 is red, 45 is a shade of orange and 55 is a shade of yellow).

(ii) Saturation: intensity of the color.
→ ranges from 0 to 100 % (0 means no color that is a shade of grey between black and white; 100 means intense color).
→ also sometimes called as "purity".

(iii) Brightness (or value): the brightness of colour.
→ ranges from 0 to 100% (0 is always black; depending on the saturation, 100 may be white or a more or less saturated color).

4. YUV color model:

→ The YUV model defines a colour space in terms of one luma and two chrominance component.
→ YUV model is used in PAL, NTSC composite colour video standards.
→ YUV models human perception of colour more closely than the standard RGB model used in computer graphics hardware.
→ The YUV color model stands for
(i) Y, the luma component, or brightness
→ ranges from 0 to 100% in most applications.

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(ii) U and V are the chrominance components (blue-luminance and red-luminance difference components)
→ expressed as factors depending on the YUV version you want to use.

Q. Differences between bitmap and vector.

	Bitmap	Vector
1.	A type of graphics that represent a rectangular grid of pixels, viewable via a monitor, paper or another display medium.	A type of graphics defined in terms of 2D points that are connected by lines, curves to form polygon and other shapes.
2.	Uses pixels	Uses basic geometric shapes
3.	.jpg, .gif, .png are some type	.ps, .eps, .suf and .svg are type
4.	Resolution dependent, so they are not resizable without reducing picture quality.	Resolution independent so they are resizable without reducing picture quality
5.	File size is more	File size is less
6.	Possible to edit image to some extent.	Possible to edit images without reducing quality.
7.	Suitable for photographs.	Suitable for logos, clipart, icons

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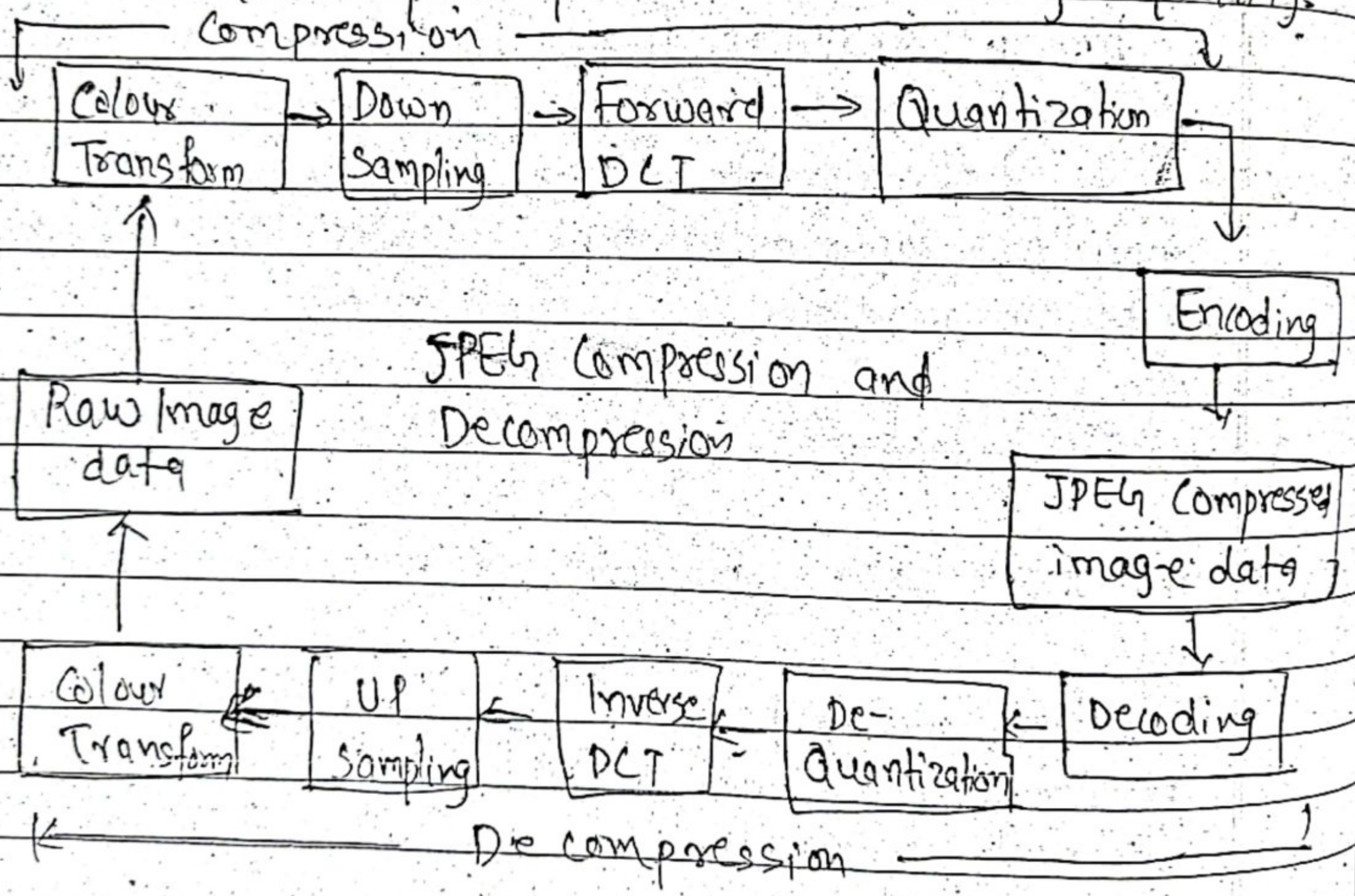
Q. Explain the steps of JPEG compression process in detail.

Ans:

JPEG is commonly used method of lossy compression for digital images. The degree of compression can be adjusted, allowing a selectable trade off between storage size and image quality.

- JPEG typically achieves 10:1 compression with little perceptible loss in image quality.



Steps:

① Splitting:

The input image is divided into smaller blocks having 8 * 8 dimensions, summing upto

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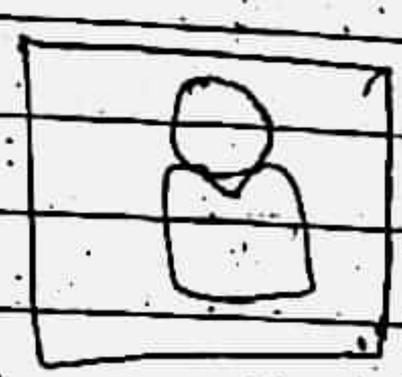
64 units in total. Each of these units of any image (PS) called a pixel, which is the smallest unit of any image.



Original Image

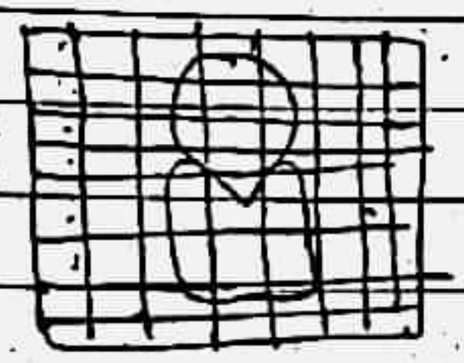


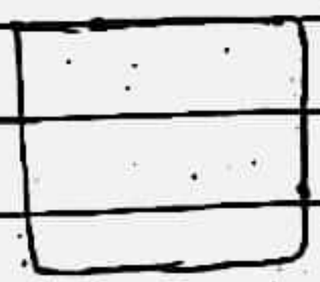
Image splitting

(2) RGB to Ycb Cr Conversion

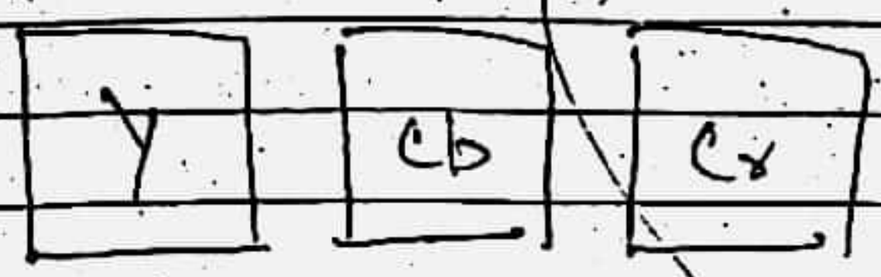
JPEG make use of [Y, Cb, Cr] model instead of [R, G, B] model

Y → brightness
Cb → Colour blueness
Cr → Colour redness

(a) Colour Transform



8x8 pixel
1 pixel = 3 components



M(1) with sampling factor (1,1,1)

(b) Down Sampling:

Y is taken for every pixel and Cb, Cr are taken for a block of 2*2 pixels.

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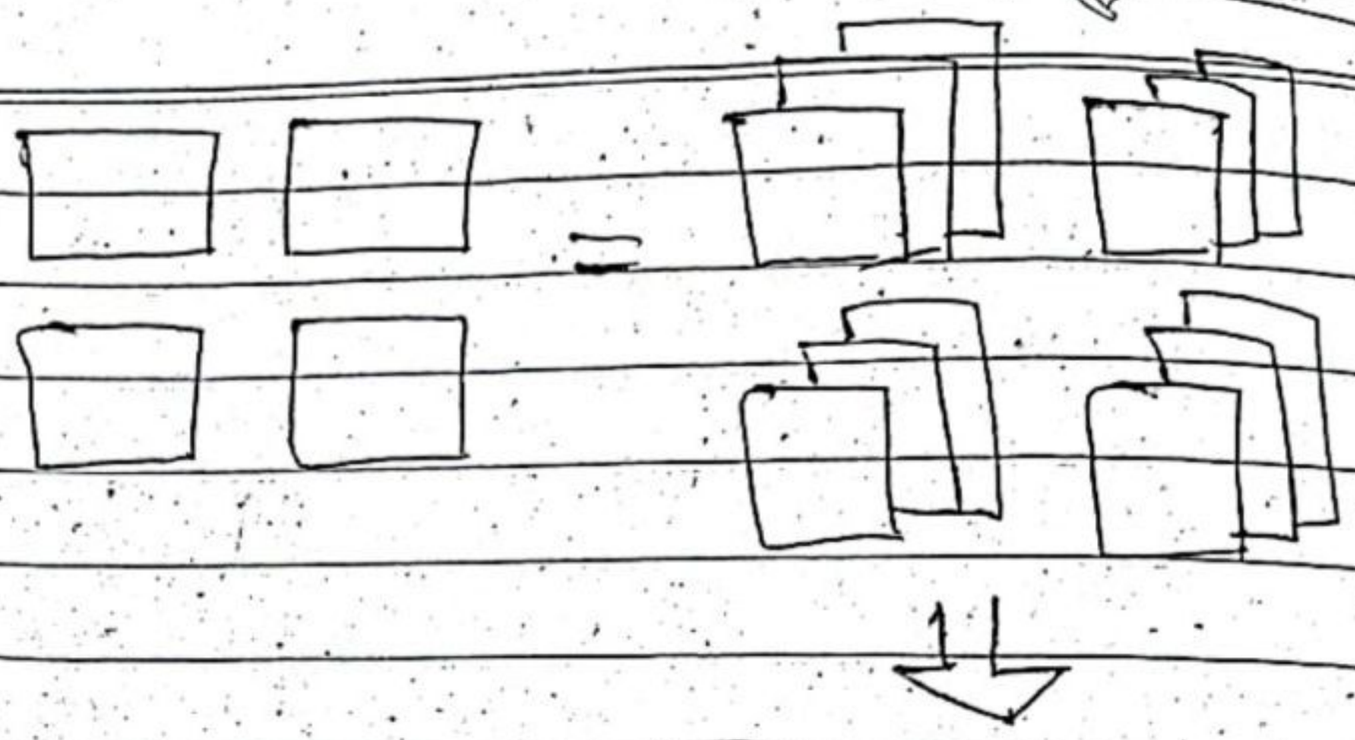
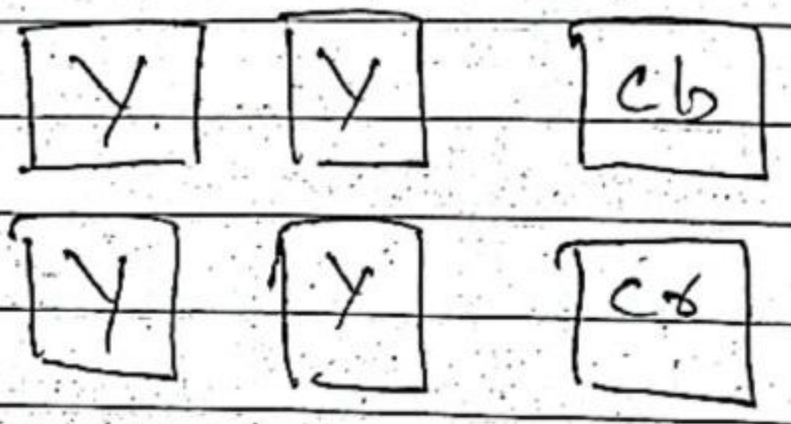
4-blocks
16x16 pixel



MCU with sampling factor (2,1,1)



* MCU ⇒ Minimum Coded Unit

③ Forward DCT:

The DCT uses the cosine function, therefore not interacting with complex numbers at all.
- DCT converts the information contained in a block (8x8) of pixels from spatial domain to the frequency Domain.

④ Quantization:

The next step is quantization process which is the main source of lossy compression.

→ The values in the quantization table are chosen to ~~preserve~~ preserve low frequency

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information and discard high frequency detail as human are less critical to the loss of information in this area.

Formula:

$$\hat{F}(u,v) = \text{round}\left(\frac{F(u,v)}{Q(u,v)}\right)$$

where $F(u,v)$ = represent DCT coefficient
$Q(u,v)$ = represents a quantization matrix.

Encoding:

This is the final steps in JPEG compressed image and this method uses Huffman coding and it reduces a large amount of memory without losing any detail of the image.
→ Most of the times it saves 70% of memory.

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Differentiate between Animation and Video

	Animation	Video
1.	Animation is an art concerned with drawing sketches of an object and showing them in a sequence so as to make them look like a moving and living thing.	Video is a recording of still or moving objects.
2.	Animation is a video which is created by an artist who makes lots of sketches which are shown with help of a camera at high rate.	Videos are made with video camera.
3.	Animation is an imagination, skill, art.	Video means reality recorded by camera.
4.	Making animation is more difficult than creating a video	It is easier somehow.
5.	Animation is a production technique to make moving images from individually drawn frames.	Video is a medium referred to analog-video-tape technology extended to digital video capture technology.

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Differentiate between Lossy and lossless compression

Basis	Lossy compression	Lossless compression
Basic	Lossy compression is the family of data encoding method that utilizes imprecise estimates to represent content.	lossless compression is a group of data compression algorithm that permits original data to be accurately rebuilt from compressed data.
Algorithm	Transform coding, DCT, DWT, fractal compression, RSSMS	RLE (Run-length Encoding) RLW, LZW, Huffman encoding, ~~Shannon~~ Shannon-Fano coding
Used in	Images, audio and video	Text or program, image, sound
Application	JPEG, GIF, MP3, MP4, etc	RAW, BMP, PNG, WAV, etc.
Data-holding capacity of channel	It has more data holding capacity of channel.	Less compared to lossy method
Data qlty	Data quality is compromised	No compromise in data qlty
Size	Reduce size of data	doesnot reduce size of data
Restore	doesnot restore original form	Restore original form

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Explain data compression methods with example.

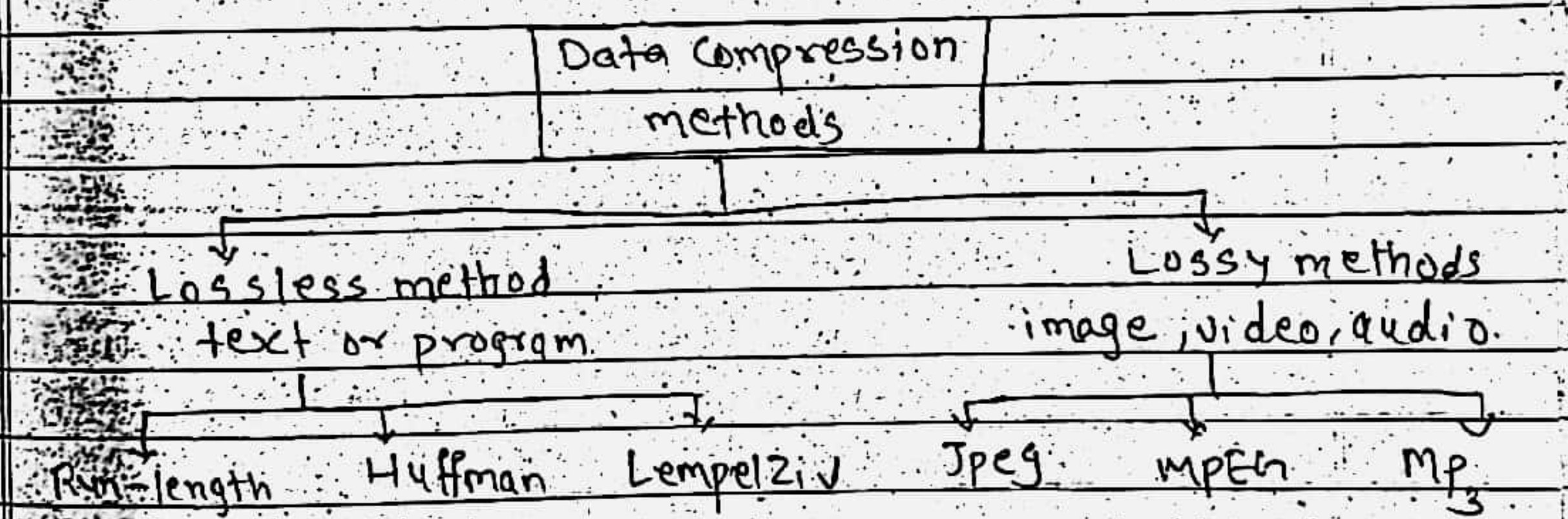
Data compression implies sending or storing a smaller number of bits.

The act of representation of information in a compact form is called data compression

Data Compression Techniques/methods are of two types:

① Lossless compression

② Lossy compression



① Lossless method:

- As per its name No data loss.
- Reconstruct the original message exactly from the compressed message.
- Generally used for text files, spreadsheet files, important documents.
- Some examples are RLE, Huffman coding

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(i) RLE- Run Length Encoding

- Simple compression technique
- Replace all consecutive numbers or alphabets by first the number of times an alphabet was used followed by the alphabet itself

Example:

Original data: aaaabbbccddddd

Compressed data: 4a3b2c5d

(ii) Huffman Coding

- Uses certain method for selecting representation for each symbol which gets certain code which is called as huffman code.
- Infact, assigns fewer bits to symbols that occur more often and more bit to symbols occur less in data
- It follows certain algorithm which is described below

① Make a base node for each code symbol.

② Count their occurences.

E.g:

If we have a sentence like following "the essential feature"

By counting we can find 12 different symbols:

	A	E	F	H	I	L	N	R	S	T	U	space
occurence →	2	5	1	1	1	1	1	1	2	3	1	2

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Represent E=5 with small bit followed by T, S, A, space and remaining ones.

iii) Lempel Zi Welch (LZW) Coding.

- LZW (LZ77) compression works by finding sequence of data that are repeated.
- It introduces a term called "sliding window", which means at any point of time, there is re-occurence of same word or character.

Example:

Let Distance (D): how far back into the window the sequence start.

(L) Length: the number of characters for which the sequence is identical.

e.g. 1 2 3 4 5 = D

blah blah blah blah blah

1 3 4 5 = L

Here you see that, data is repeated after another b, and hence our first compression would be like

→ blah b[D=5, L=5]

(B) Lossy Compression

→ Unlike Lossless, this method reduces data by eliminating specific information.

- It can achieve very high compression ratios through data removal.

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- Comparatively, These methods are less time taking, cheaper as well as it can reduce more space.

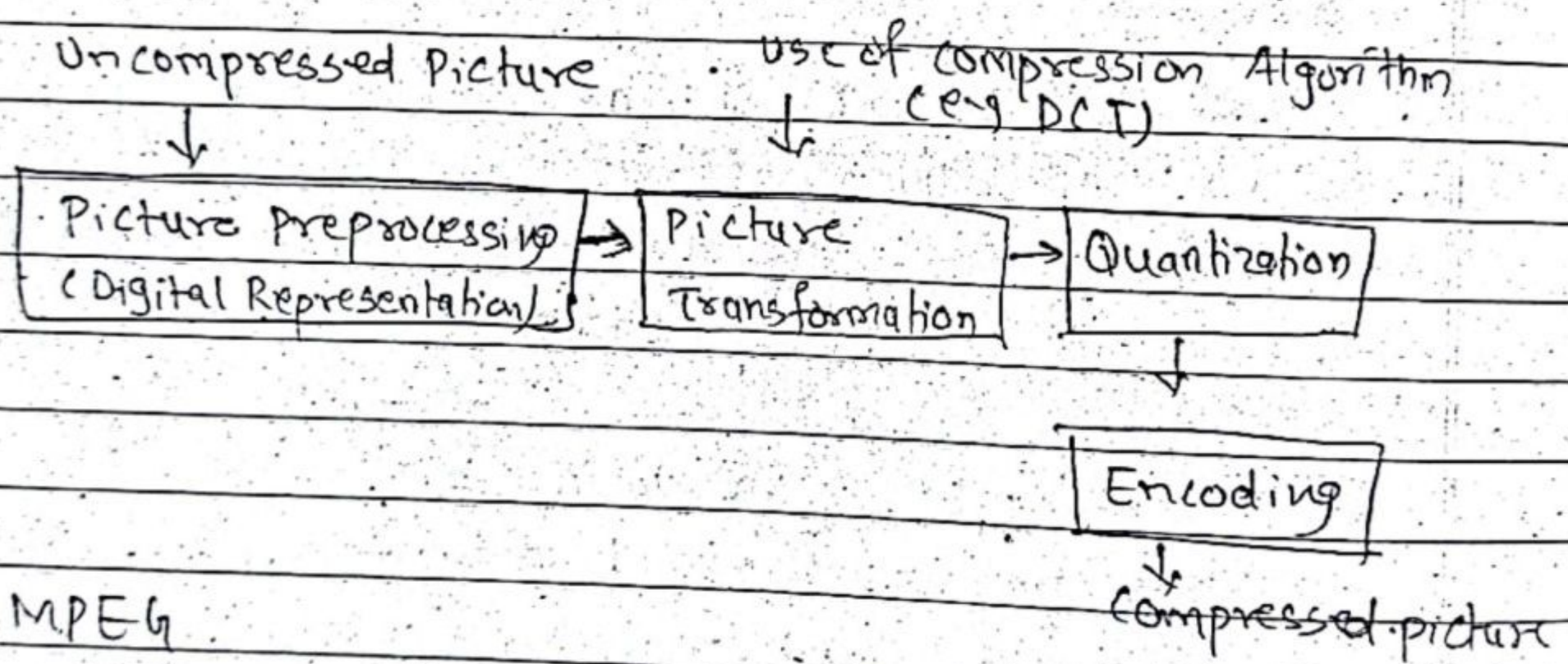
Methods based on lossy compression

JPEG - Used for pictures and graphics

MPEG - used for video compression.

Audio compression

(i) JPEG Compression:



(ii) MPEG

- Ultimately it uses JPEG compression technique only. Each frame of it are spatially compressed by JPEG.
- To know this compression, three frames are necessary to understand.
  1. I-Frame (intra coded)
  2. B-frame (Forward prediction)
  3. P-frame (Interframe coded)

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(iii) Audio compression:

- As name suggest, it is used for speech or music compression.

Using Application:

(1) Zip
(2) CSO
(3) RAR

For MULTIMEDIA:

(1) GIF
(2) JPEG
(3) MP3
MPEG and soon.

Q. Differentiate between JPEG and MPEG.

	JPEG	MPEG
1.	JPEG stands for Joint Photographic Expert Group.	MPEG stands for Moving Picture Expert Group
2.	JPEG is mainly used for image compression.	MPEG is used for audio and video compression.
3.	JPEG typically achieves 10:1 compression with little perceptible loss in image quality	Compression ratio in MPEG is 30:1 for general video
4.	JPEG normally stands for an Digital Image Format.	MPEG is a video and audio codec
5.	Extension: .jpg, .jpeg	extension: .mpe, .mpeg, .mp4

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Q. What are the steps to create the Huffman code tree? Explain with example how Huffman code reduce the file size?

Ans: Steps:

(1) Two characters with the lowest probabilities are combined to form a binary tree.
(2) The two entries in the probability table is replaced by a new entry whose value is the sum of the probabilities of the two character.
(3) Repeat the step (1) and (2).
(4) Assign 0 to left branch and 1 to the right branches of binary tree.
(5) The Huffman code of each character can be read from the tree starting from root.

Example:
Let we encode message 'mississippi' using Huffman coding.
Solⁿ:-
Following is the frequency table of characters in 'mississippi' in non-decreasing (ascending) order'

Character	frequency
m	1
p	2
s	4
i	4

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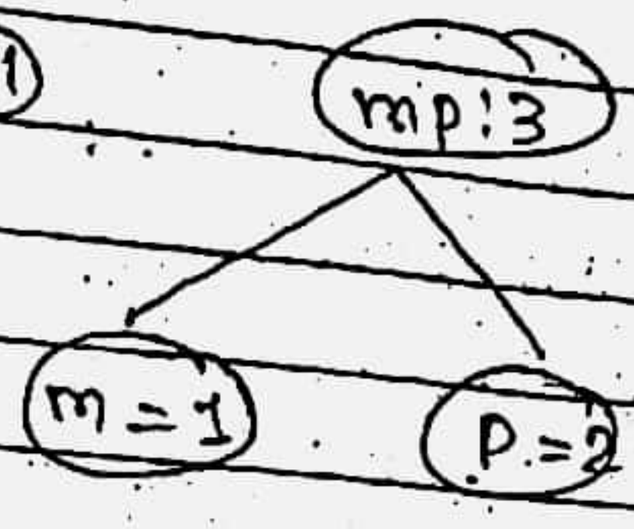
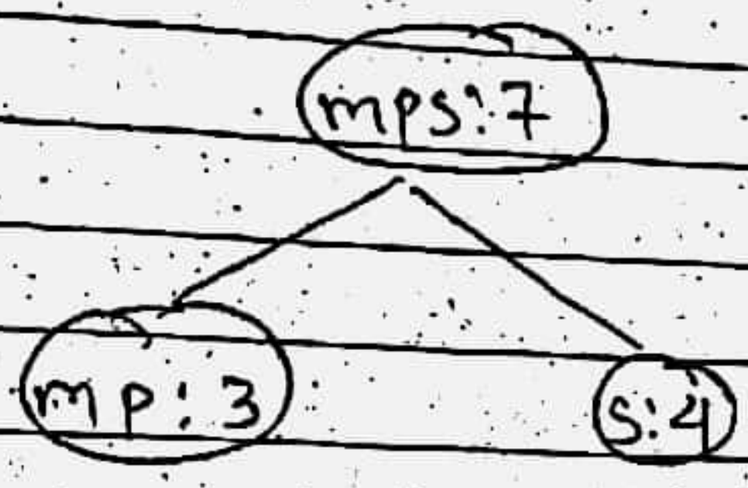
Now,

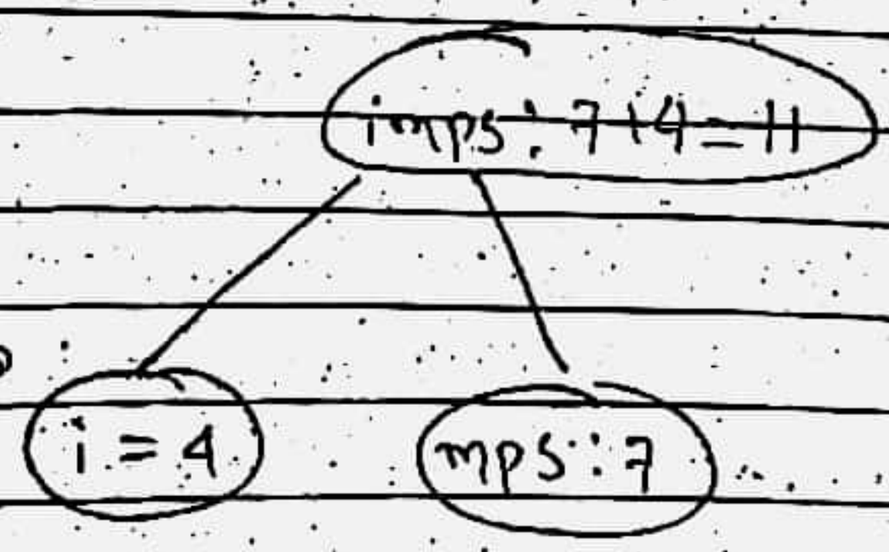
(1)



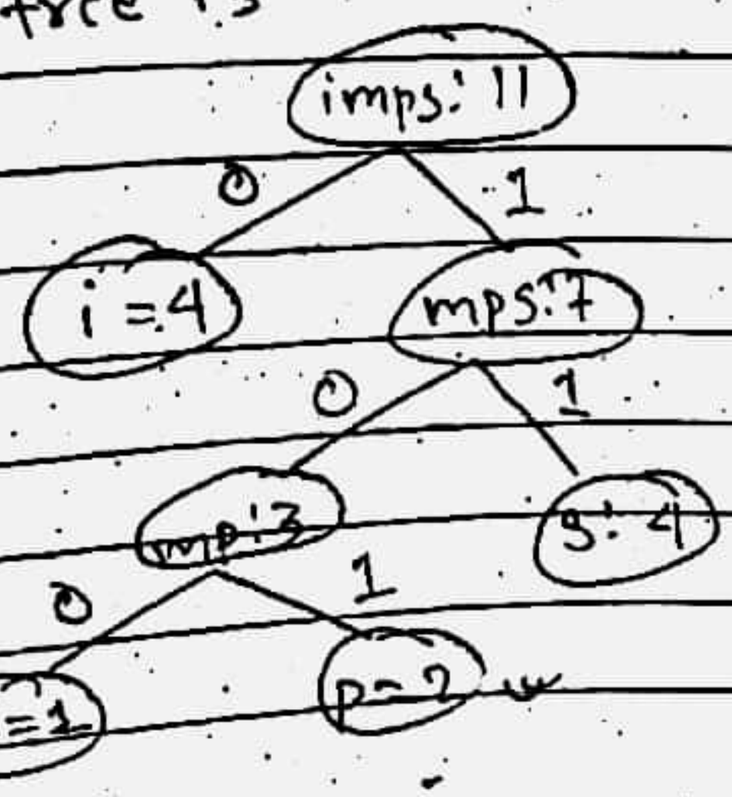
(2)



(3)



So, huffman tree is



m = 100

p = 101

s = 11

i = 0

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Following are the codes

Charactor	Frequency	Code	Codelength
m	1	100	3
p	2	101	3
s	4	11	2
i	4	0	1
	N = 11		

Now, Total number of bit using Huffman.

= freq(m) * codelength(m) + freq(p) * codelength(p) + freq(s) * codelength(s) + freq of (i) * codelength(i)

= 1×3 + 2×3 + 4×2 + 4×1

= 3 + 6 + 8 + 4

= 21 bits

If we havenot use Huffman then,

1 character = 1 byte = 8 bits

Total number of bits = N × 8 bit

= 11 × 8

= 88 bits

Bits saved = 88 - 21 = 67

Hence, in this way Huffman code reduce file size.

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Q. Why lossy data compression is sometimes preferred over lossless.

Reason:

1. Very small file size (Significantly reduce file size)
2. Lots of tools, plugins, and software support it.
3. Lossy compression is generally used for video & sound, where certain amount of information loss will not be detected by most users.

Chapter 6: User Interface Design

Q. Discuss the user interface design process for multimedia with block diagram.

Ans: UI design is an iterative process involving co liaisons between users and designers.

The 3 core activities in this process are.

(1) User analysis:

Understand what the users will do with the system.

(2) System Prototyping:

Develop a series of prototypes for experiment.

(3) Interface evaluation:

Experiment with these prototypes with users.

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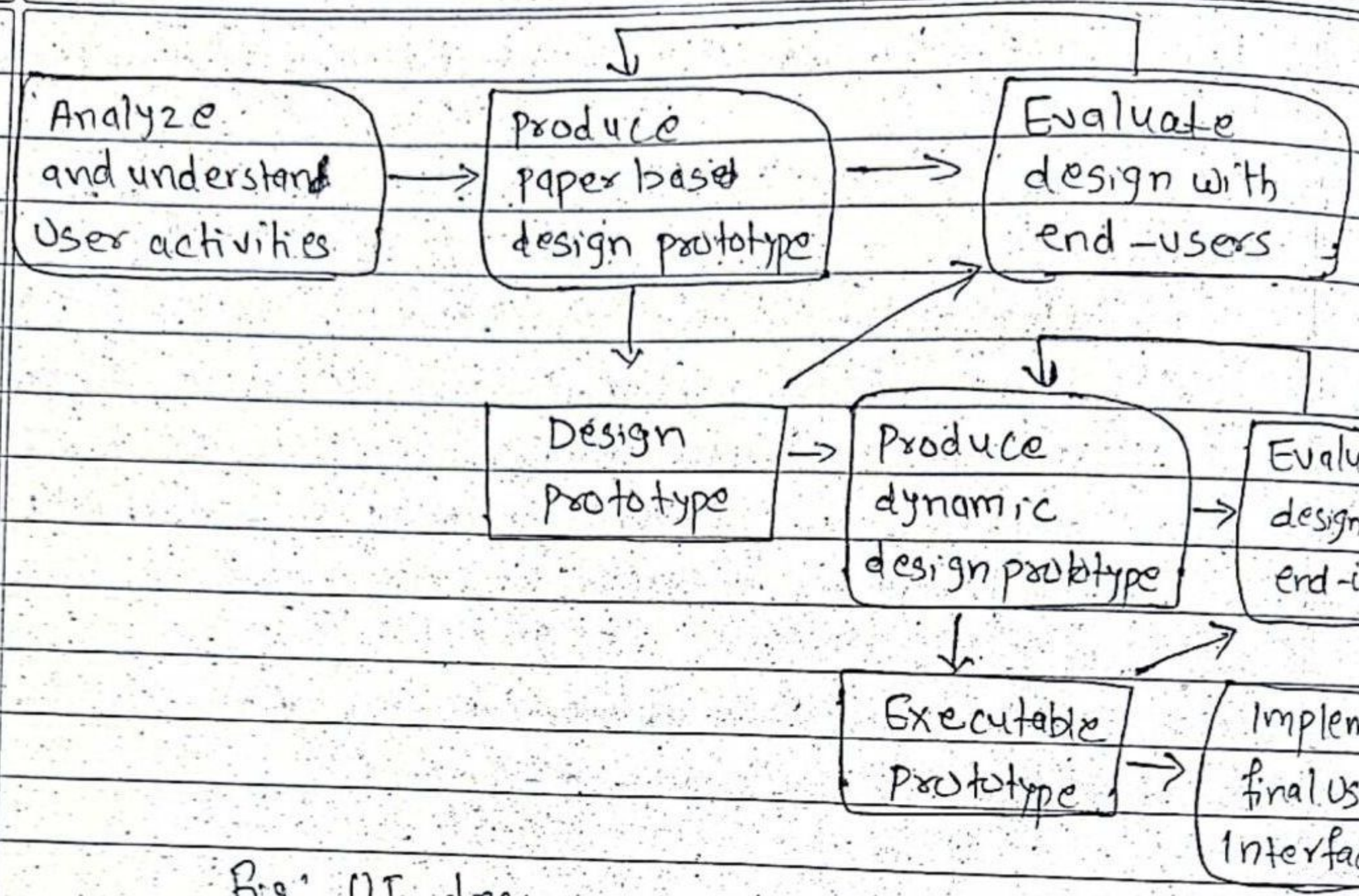

Fig: UI design process

(1) User Analysis:-

The main purpose of user analysis is to know what the user want to do with a system. It helps to know what user wants and helps designer to understand. Interviewing, ethnography are used for user analysis

(2) 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.

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(i) Paper prototyping:

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

(ii) Prototyping techniques:

In prototyping techniques, script-dri prototyping can be used. For this develop a se of scripts and screens using a tool such as Macromedia Director. When the user interact with these, the screen changes to next display. Visual programming and Internet-based prototypi can be used as prototyping techniques.

User Interface Evaluation:

The goals of UI evaluation are to obtain feedback on how to improve the interface design a to assess if the interface meets its usability require

- Some evaluation of a user interface design shoul be carried out to assess its suitability. Full sca evaluation is very expensive and impractical fo most systems.
- Ideally, an interface should be evaluated again a usability specification.

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Q. Explain the general design guidelines for the multimedia user interface design and also mention the multimedia interface components.

Ans: The general design guidelines for multimedia user interface design are

① 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.

② Consistency:
The interface should be consistent in that, wherever possible, comparable operations should be activated in the same way.

③ Minimal surprise:
User should never be surprised by the behavior of a system.

④ Recoverability:
The interface should include mechanisms to allow users to recover from error.

⑤ User guidance:
The interface should provide meaningful

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feedback when errors occur and provide context-sensitive user help facilities.

(6) User diversity:

The interface should provide appropriate interaction facilities for different types of system user.

(7) Simplicity and easy to use.

Chapter 7:

Q. Explain the abstraction levels of programming in the multimedia system.

Ans:

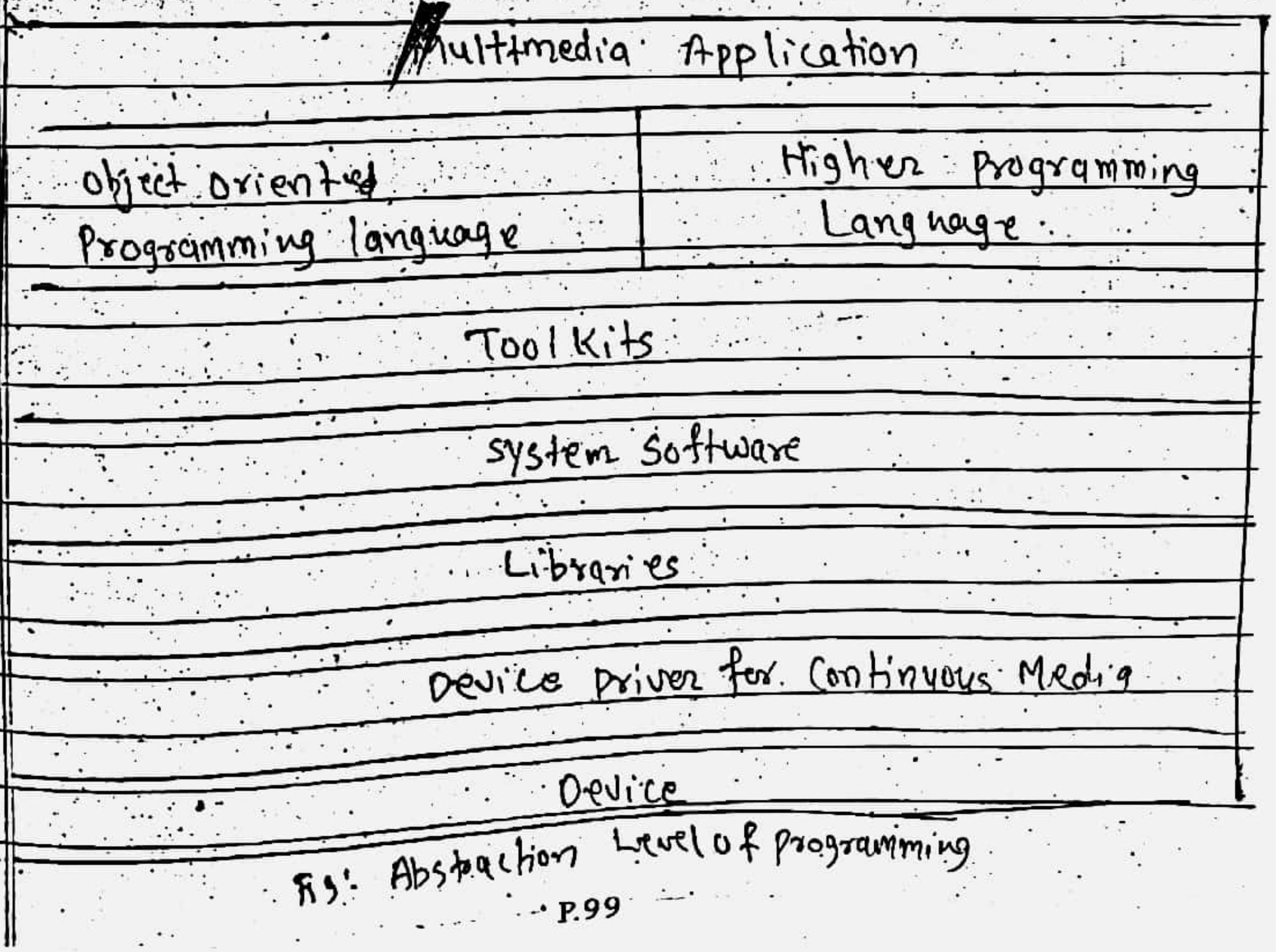

Fig: Abstraction Level of programming

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Abstraction Level in programming define different approaches with a varying degree of detail for representing accessing and manipulating data.

→ A multimedia application may access each level

→ A device is not part of operating system but is directly accessible to every component and application.

→ A library, the simplest abstraction level, includes the necessary functions for controlling the corresponding hardware with specific device ~~access~~ access operation.

→ As with any device, multimedia device can be bound through a device driver respectively the operating system.
Hence, the processing of the continuous data becomes part of the system software

→ Multimedia device drivers is embedded in operating system simplify considerably the implementation of device access and scheduling.

→ Higher Procedural Programming language most often used to implement commercial multimedia application

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The code generated from the compiler can be processe through libraries as well as through a system interface for continuous data.

→ Object Oriented environment provides the application with a class hierarchy for the manipulation of multimedia. The generated or interpreted code can be process and controlled through libraries and system interface for continuous media.

Q. Explain the abstractions for programming such as libraries system software, higher programming languages and object-oriented approach.

Ans: Libraries:

→ The processing of continuous media is based on set of functions which are embedded into libraries and libraries are provided together with the corresponding hardware.

→ The device driver or library controls all available functions and also supports each device.

→ Some libraries considered as extensions of the graphical user interface whereas other libraries consist of control instruction passed as control blocks to corresponding driver.

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(B) System Software:

→ Instead of implementing access to multimedia devices through individual libraries, the device access can become part of operating system.

Data as Time Capsules

→ 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 40 ms.

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.

C) Higher Programming Languages

→ It can rely on library functions when continuous media programming is integrated.

→ As an alternative, it is possible to access abstractions such as constraints and event handlers in the operating system.

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→ Integrated programming of applications with continuo media inside higher programming languages leads to simpler and clearer programming.

(D) Object-Oriented Approaches

→ Object Oriented approaches main function is to find its class in certain hierarchy.

→ Important properties of object-oriented system are:

1. Inheritance
2. Polymorphism.

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Applications

Q: How can you apply multimedia system in tele-service?

Ans: Tele-services are services provided by communication system which are based on and make use of audio and video data.

(A) Based on conversational Service:

→ A conversational service supports conversation between remotely located end users.
→ In this service, bi-directional delivery is done in synchronous mode.
E.g: Video conferencing.

(B) Based on Messaging Service:

→ A messaging service provides an exchange of message between a sender and receiver where the end users are human beings and exchange of message in both directions is done asynchronously.
Example: Mailing System

(C) Based on Retrieval Service:
→ A retrieval service provides an exchange of message between a sender and receiver, where sender are called client and receiver as server.

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→ The client requests information from the server, where the information is stored, the server retrieves the information and sends it back.
Example: Google cloud.

(D) Based on Tele-action service

→ Tele-action means to act a distance. Such actions include reading or writing some informatio to a remote location or possibly both.
Example: Banking System.

(E) Based on Distribution Service:

→ Distribution services are services for the distribu on of information to different remote sites.
→ They are one-way communication from broadcastin source to the remote destinations.
Example: TV broadcasting

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Q. Application of multimedia in education:

→ Books and Newspapers can be interactive multimedia documents which may be electronically distributed to the home / user's declared address which saves time and money for both parties

(A) Based on Graphics:

Graphics are two-dimensional figures or illustration. Using graphics in education will increase student-understanding. It will enhance their memory skills because pictures are easy to remember.

(B) Based on Audio

→ Audio comfort students by conducting live online discussion via audio tools & platform.

→ Learning by audio also can help disable people such as blind people.

(C) Based on Video:

→ Video can provide visual simulation for students so that they can have a better understanding in learning.

→ Video in surgical training is helpful to students for better understanding which they didnot able by reading.

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(D) Based on Animation:

→ Animation improve student's creativity while bringing fun in learning.

Example:

Student may not understand flow of blood over the heart by just lecture of teacher. But student can have clear concept when they learn with animated clips.

Q Application of multimedia in entertainment

1. Entertainment and Fine Arts:

- Multimedia is heavily used in the entertainment industry, especially to develop special effects in movies and animations.

2. Gaming:

- Multimedia games are a popular past-time and are software programs available either as CD-ROMs or online

→ Some video games also use multimedia feats

Multimedia applications that allows user to actively participate instead of just sitting by as passive recepients of information are called as Interactive Multimedia

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3. Cinema
   - Morphing
   - Superimposition
   - Animation
   - Digital Recasting.

4. Interactive Movies
5. Virtual Reality
6. Cyber-Sports
7. Music
8. Videos
9. Reading books.
10. Digital Recording.
11. Meeting people at virtual environment

- Based on virtual Reality (Gaming)
- Based on Interactive Audio (Google play music)

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Q. What do you mean by authoring tools? Mention different types of authoring tools and explain it.

→ Multimedia authoring tools provide the framework for organizing and editing the elements of a multimed project.

Authoring tool provides an integrated environment for combining the content and functions of a project. It enables the developer to create, edit and import data.

In multimedia authoring system, multimedia elements and events are often regarded as objects. Each object is assigned properties and modifiers.

Types of authoring tools

1. Card and page based tools
2. Icon-based, event-driven tools
3. Time-based tools

(A) Card and page based tools

- Card-and page-based authoring systems provide a simp and easily understood metaphor for organizing multimedia elements.
- Cards are developed that have different elements assoc ated with them and are put in stacks. It contains media objects such as buttons, text fields, and graphic objects.
- It provides a facility for linking objects to

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pages or cards. You can link the cards by allowing the user to click on buttons or other elements and jump to a different card in the stack.

E.g: Hypercard, ToolBox

- Easy to understand metaphor
- 1 screen = 1 card = 1 page
- Easy to used

(B) Icon Based, Event-Driven Tools

- Icon-based, event-driven tools provide a visual programming approach to organize and present multimedia.
- Multimedia elements and interaction cues are organized as objects in a flowchart.
- Flowchart can be built by dragging appropriate icons from a library, and then adding the content.
- With icon-based programs, you use symbols in a flow chart.
- Each icon represents a particular event
- An advantage of icon-based programs is that you can easily see how a title is structured, that is the flow of a program and especially the branching.

  Eg: Multimedia Authoware
- clear structure
- Easy editing and updating
- difficult to learn
- expensive

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(c) Time-Based Tools.

- Time-based tools are best suited for messages with a beginning and an end.
- Some time-based tools facilitate navigation and interact control.
- Time Based Authoring Programs use a movie metaphor Like a movie on videotape, you start the multimedia titl and it plays untill some action causes it to pause or sto

Eg Macromedia's Director and Flash are time-based development environments.

- Good for creation animation
- Branching, user control, interactivity
- Expensive
- Steep learning curve for advances features
- Easy to put animation and interactive movies.
- Interactive menus
- Increase in file size

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Dithering:

Dithering is the process by which we create illusions of the colour that are not present actually. It is done by random arrangements of pixels.

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 closely placed small objects from a distance, they will look like merged together.

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

Sound Editing tools:

Sound editing tools let the programmer hear sound as well as visualize it. One can cut/copy and paste sound and edit it with great accuracy. Integrating sound into multimedia project is very easy by using sound editing tools like Cool edit.

Cool edit can be used to record ones own

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music, voice, or any other audio. It makes us a professional as far as handling of sound is concerned. One can edit, mix the sound with any other audio and add effects to it. One can record sound from a CD, Keyboard, or any other sound played through the sound card. The other feature of this software is that it can read and write MP3, which is the hot sound format in the present times. Once the recording is complete, the sound file can be converted into any desired format. In other words, there is a similarity in these editing tools - what photoshop can do to images; cool edit can do for sound.

Sound Forge is another professional quality sound editing tool that is used in multimedia work.

MIDI :

MIDI (Musical Instrument Digital Interface) is an industry-standard protocol that enables electronic musical instruments and other equipment to communicate, control and synchronize with each other and to exchange system data.

Devices such as computers, synthesizers, keyboard controllers, sound cards, samplers and drum machines.

MIDI doesnot transmit an audio-signal or media. The sounds are generated by the synthesizer, which receives the MIDI data.

- MIDI - In port: Allows data to be received by a MIDI - compliant device
- MIDI - out port: is used for transmitting data.
- MIDI - Thru port: is used for linking a number of MIDI devices with a single transmitter.

- A MIDI network is a combination of hardware and software that provides interconnectivity between a group of MIDI devices, such as synthesizers, controllers, and sequencers.

- A synthesizer is an electronic musical instrument that uses one or more sound generators to create waveforms which are then processed and combined in order to generate musical sounds.
- MIDI synthesizers provide musical tones and percusion based on the input of MIDI software messages.

- A music sequencer is an application or a device designed to record and playback musical notation.
- A MIDI sequencer records MIDI software message sequences & provides some sort of editing capabilities.

- A sampler is an electronic musical instrument which plays back recordings (or "samples") that are loaded or recorded onto it to perform or compose music.

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Softwares used in animation

(1) Adobe photoshop
(2) Anime studio
(3) Adobe Flash
(4) Auto desk 3DS Max
(5) Cinemas 4D, E
(6) Adobe After effects

Q. Explain the components used to build multimedia system.

→ Multimedia system is a system capable of processing multimedia data and applications. It is characterised by the processing, storage, generat manipulation and rendition of multimedia information.

Components used to build multimedia system:

(1) Capture device:
Video camera, video recorder, audio microphone Keyboard, mice, graphics tablets.

(2) Storage device:
Hard disk, CD-ROMS, DVD-ROM

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(3) Communication System
→ Local Network, Intranets, Internet

(4) Computer System
→ MPEG / VIDEO / DSP Hardware

(5) Display Device
→ CD-quality speakers, SVGA, colour printers

Presentation media refers to tools and devices for the input and output of information

Storage media refer to a data carrier which enables storage of information.

Transmission medium characterizes different information carrier, that enable continuous data transmission.

Information exchange medium includes all information carriers for transmission i.e all storage and transmission media.

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analog

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Higher programming language.

(1) Media as Types:
→ define data type for video and audio
→ read.
→ merging.

(2) Media as file.
Another way of programming continuous media data is consideration of continuous media stream as files instead of data type.

file1 = open(microphone)
mix(file3, file1, file2)
merging 2 audio file & output through speaker.
use file to input & output.

(3) Media as process
— For time dependency.
→ process such as set-volume, set-loudness.

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object oriented language are able to meet the requirement
It is used to design and implement multimedia applicat

Class : interface
camera
operation: zoom and set_back_light.
↓
zoom operation need to transform
absolute values into necessary relative parameters.

Object:
All object derived from same class include same
operation.
contains set of operation called methods.
A VCR object (Video Cassette Recorder) ↓
play : operation
play_operation maps to VCR device driver.

Inheritance:
Class: Camera → parent
→ zoom, autofocus
Method.
↓
professional camera.

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Polymorphism:

Same name of method in several class with different implementation.

e.g:

play function used with audio & video data.

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