Module 1

CHAPTER 1

# Introduction to Multimedia Systems

## Syllabus Topic : Overview

### What is multimedia ?

Multimedia is simply multiple forms of media integrated together. Media can be text, graphics, audio, animation, video, data, etc. An example of multimedia is a web page on the topic of Mozart that has text regarding the composer along with an audio file of some of his music and can even include a video of his music being played in a hall.

Besides multiple types of media being integrated with one another, multimedia can also stand for interactive types of media such as video games CD ROMs that teach a foreign language, or an information Kiosk at a subway terminal. Other terms that are sometimes used for multimedia include hypermedia and rich media.

***Multimedia is a computer-based interactive communications process that incorporates text, graphics, sound, animation, and video.***

The word multimedia is a combination derived from multiple and media. The word medium (the singular of media) means a transmission channel. For example, sound is transmitted through the medium of air, or electricity is transmitted through the medium of wires. Similarly, poetry could be considered a medium for transmitting our thoughts. Or for that matter, a painting is a medium for conveying what we observe. Similarly, a Hollywood director uses the medium of movies to tell a story. Multimedia is also a medium. To use it effectively, we have to understand not only how to create specific elements of multimedia, but also to design our multimedia system so that the messages we wish to convey are conveyed effectively. To be able to create effective multimedia, it is important for us to be sensitive to other multiple-media such as TV and films.

Multimedia is everything you can hear or see : texts, books, pictures, music, sounds, CDs, videos, DVDs, Records, Films, and more. Multimedia comes in many different formats. On the Internet you will find many of these elements embedded in web pages and today's web browsers have support for a number of multimedia formats.

Multimedia System is a system capable of processing multimedia data and applications. Multimedia System is characterized by the processing, storage, generation, manipulation and rendition of Multimedia information.

Coverage in Multimedia Systems includes :

- Integration of digital video and audio capabilities in computer systems.
- Multimedia information encoding and data interchange formats.
- Operating system mechanisms for digital multimedia.
- Digital video and audio networking and communication.
- Storage models and structures.
- Methodologies, paradigms, tools, and software architectures for supporting multimedia applications.
- Multimedia applications and application program interfaces, and multimedia end system architectures.

The development of powerful multimedia computers and the evolution of the Internet have led to an explosion of applications of multimedia worldwide. These days multimedia systems are used for education, in presentations, as information kiosks, and in the gaming industry. In fact, multimedia has applications everywhere : in businesses, at schools and universities, at home, and even in public places.

Advertising is perhaps one of the biggest industry's that use multimedia to send their message to the masses. Where one type of media, let's say radio or text can be a great way to promote an item, using multimedia techniques can significantly make an item being advertised better received by the masses and in many cases with greater results.

Multimedia in Education has been extremely effective in teaching individuals a wide range of subjects. The human brain learns using many senses such as sight and hearing. While a lecture can be extremely informative, a lecture that integrates pictures or video images can help an individual learn and retain information much more effectively. Using interactive CD ROM's can be extremely effective in teaching students a wide variety of disciplines, most notably foreign language and music.

## 1.1 Properties of Multimedia System

A Multimedia system has four basic characteristics :

(i) Multimedia systems must be computer controlled.

(ii) Multimedia systems are integrated.

(iii) The information they handle must be represented digitally.

(iv) The interface to the final presentation of media is usually interactive.

### 1. Independency

Multimedia system consists of different media such as sound, graphics, text, and video. These media should be independent. Multimedia system requires several levels of independence. Computer controlled video recorder stores audio and video information, but there is tight connection between audio and video. Both the media are coupled through the common storage medium of the tape.

## 2. Computer Support Integration

- So far we have been primarily concerned with each media type or format individually. We have noted that certain media (individually) are based on spatial and/or temporal representations, other may be static.
- Once we start to integrate media special and temporal implications become even more critical. For example, static text may need to index or label a portion of video at a given instant or segment of time and there the integration becomes temporal and spatial if the label is placed at a given location (or locations moving over time).
- Clearly, it is important to know the tolerance and limits for each medium as integration will require knowledge of these for synchronization and indeed create further limits.
- It is common (obvious) that media types are bundled together for ease of delivery, storage *etc.*
- Therefore, it is not surprising that formats have been developed to support, store and deliver media in an integrated form.
- By using multimedia system one should able to control media processing. Multimedia system should be programmable by professional user or end user (non professional user). When integrating different media you should also consider synchronization between media.
- The need for interchange between different multimedia applications probably running on different platforms has lead to the evolution of common interchange file formats. Many of these formats build on underlying individual media formats (MPEG, JPEG etc.)

## 3. Communication Systems

- A Variety of multimedia applications running on different platforms will need to communicate with each other particularly if they are running on a distributed network.
- The distributed environment enables interesting multimedia application. Here information cannot be created, processed, presented and store but distributed above the single computer boundary.
- Until recently the lack of a common interchange file format was a serious impediment to development of a market of multimedia applications.
- A common interchange format needs to be widely adopted (be supported by many applications) and be sufficiently expressive to represent a wide variety of media content.
- These may be conflicting requirements since only when a wide variety of media is supported will it be widely adopted.

- Propriety application on support a small variety of media they require and may not readily adapt to other formats. Fortunately some widely accept standard that support a wide variety of media (with open standards even) are now developed.
- The need for interchange formats are significant in several applications :
  - As a final storage model for the creation and editing of multimedia documents.
  - As a format for delivery of final form digital media. *E.g.* Compact Discs to end-use players.
  - As a format for real-time delivery over a distributed network.
  - For inter-application exchange of data.

## 4. Interactivity

- In a multimedia system, if the user has the ability to control what elements are delivered and when, the system is called an interactive system.
- Traditional mass media include television, film, radio, and newspapers.
- These are called mass media, since the communication processes are one way, originating from a source and being delivered to a mass audience.
- These technologies also combine audio, video, graphics, and text, but in a way that is inflexible.
- For example, a film has a predefined beginning, middle, and end, irrespective of the audience watching it. With the power of the computer, the same media could be manipulated by the audience.
- In this manner, the audience does not need to remain passive, but becomes the user of the system. Thus, the key difference between mass media and multimedia is the shift from audience to users and one-way communication to two-way communication. This is accomplished through interactivity.
- To communicate with the system, the user can use a variety of devices such as the keyboard, mouse, tracking ball, touch screen, and pen-based mouse. Thus while designing a multimedia application; we have to decide the level of interactivity we wish to provide to the user of the system.
- For example, in a direct-sales application, you can give different choices for a single product with different schemes. The buyers can select the products they wish to buy.

## 1.2 Global Structure of Multimedia

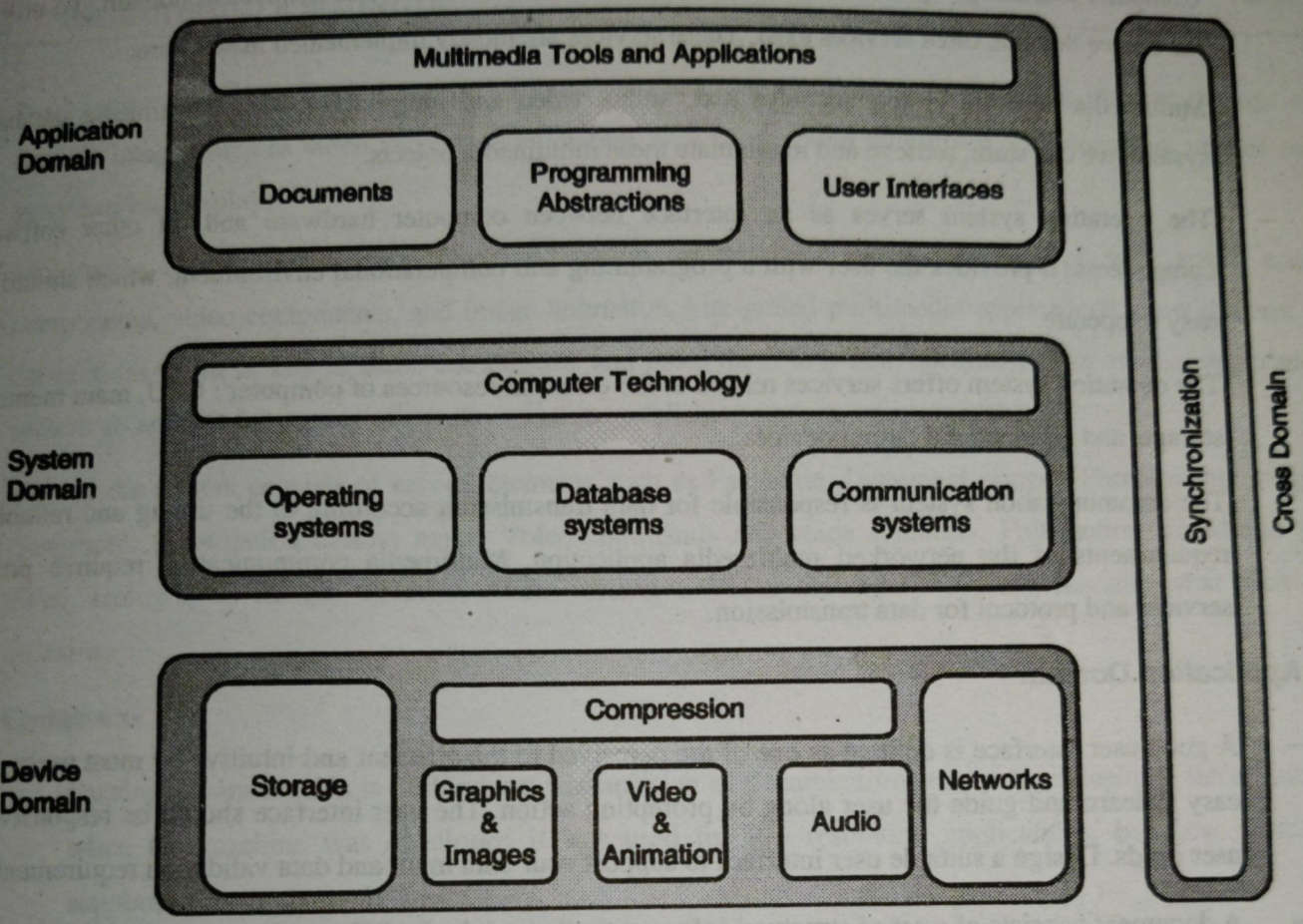


**Fig. 1.2.1 : Global structure of multimedia**

### 1. Device Domain

- The device domain contains all multimedia elements including text, audio, video, image, animation, graphics etc. It also consists of the compression and storage of these elements. It also specifies how these elements are digitized and processed.
- An audio technique includes MIDI, speech generation, speech analysis and speech transmission. A video technique includes Chroma sub sampling, CCIR and HDTV.
- A multimedia networking allows for the data exchange of discrete and continuous media among computers. This communication requires proper services and protocol for data transmission.
- For compression of multimedia data various compression schemes are used such as Packbit encoding (RLE), CCITT group 3 and 4 compression, JPEG, JPEG 2000, MPEG 1,2,4,7 are used.
- Optical storage media offer a higher storage density at lower cost. Compact Disk - Digital Audio (CD-DA) allows the digital storage of stereo audio information at a high level of quality.

**2. System Domain**

- Computer technology specifies the interface between device domain and the system domain. To utilize the device domain, three services exist. These services are mostly implemented in software.
- Multimedia database system includes text, audio, video and images. By using Multimedia database system, we can store, retrieve and manipulate these multimedia objects.
- The operating system serves as an interface between computer hardware and all other software components. It provides the user with a programming and computational environment, which should be easy to operate.
- The operating system offers services related to the essential resources of computer : CPU, main memory, storage, and all input and output devices.
- The communication system is responsible for data transmission according to the timing and reliability requirements of the networked multimedia application. Multimedia communication requires proper services and protocol for data transmission.

**3. Application Domain**

- A good user interface is defined as one of the perceived to the efficient and intuitive by most users. It is easy to learn and guide the user along by prompting action. The user interface should be responsive to user needs. Design a suitable user interface to support your data input and data validation requirements.
- A document consists of a set of structural information that can be in different forms of media, and during presentation can be generated or recorded.
- A document is aimed at the human perception of a human, and is accessible for computer representation.
- Many function of document handling and other application are accessible and presented to the user through a user interface.
- Abstraction is the process of hiding the details and exposing only the essential features of a particular concept. Abstraction reduces the complexity of program generation and maintenance.
- Abstraction of multimedia data serves as the fundamental building block for programming different multimedia application, especially editor and other document processing tools. The services of the system domain are offered to application domain through proper programming abstraction.

**4. Cross Domain**

- Synchronization in multimedia systems refers to the temporal relations between media objects in the multimedia system. Synchronization is addressed and supported by many system components including the operating system, communication system, database, documents and even often by application.
- Hence synchronization must be considered at several levels in multimedia system.

**Syllabus Topic : Objects and Elements of Multimedia**

## 1.3 Multimedia Elements

- High-impact multimedia applications, such as presentations, training, and messaging, require the use of moving images such as video and image animation, as well as sound intermixed with document images and graphical text displays.
- Multimedia applications require dynamic handling of data consisting of a mix of text, voice, audio components, video components, and image animation, kite-grated multimedia applications allow the user to cut sections of all or any of these components and paste them in a new document or in another application such as an animated sequence of events, a desktop publishing system, or a spreadsheet.
- Multimedia system consists of several elements such as Facsimile, Document images, Photographic images, Geographic information system maps, Voice commands and voice synthesis, Full-motion stored and live video, Holographic images, Fractals, Audio messages, Video messages. We now describe what each one contains.

### 1. Facsimile

- Facsimile transmission is nothing but transmission of document images over a telephone lines. Initially when fax machine was developed it was used for low resolution applications, but now days it is supporting for high resolution data.
- Facsimile is means of scanning and converting a document in coded information describing each pixel as white or black and sending over telephone lines.
- For facsimile transmission initially run-length encoding technique was used. Typical pixel density used for facsimile is 100 to 200 dpi (pixel/inch) ranges. The higher resolution is useful in enhancing the clarity of documents that contain intricate details or very small character font.

### 2. Document images

- Document imaging is the process of scanning paper documents, converting them to digital images that are then stored on CD, DVD, or other magnetic storage.
- With Microsoft Office Document Imaging, you can scan paper documents and convert them to digital images that you can save in Tagged Image File Format (TIFF) or Microsoft Document Imaging Format (MDI) to your computer's hard disk, network server, CD, or DVD. Microsoft Office Document Imaging also gives you the ability to perform Optical Character Recognition (OCR) either as part of scanning a document, or while you work with a TIFF or MDI file.
- By performing OCR, you can then copy recognized text from a scanned image or a fax into a Microsoft Word document or other Office program file.

- Document images are mostly black and white and used for reading purpose. Usually scanning is performed at 400 dpi or higher.
- Now a days some applications are using 600, 1200, 1800 dpi scanning of document images at high resolution requires very efficient compression and decompression techniques.

### 3. Photographic images

- Photographic images are used in many multimedia applications such as, patient medical histories, bank signature etc.
- Photographic images are mostly coloured or shaded and requires proper handling of soft shades and tone
- Examples of photographic images are greeting cards and weeding cards.

### 4. Geographic information system maps

- A **Geographic Information System (GIS)**, **Geographical Information System**, or **Geospatial Information System** is any system that captures, stores, analyzes, manages, and presents data that are linked to location(s). In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology
- It is used widely for natural resources and wildlife management as well as urban planning.
- GIS applications are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data, maps, and present the results of all these operations
- Example of GIS is an application shoeing the railroads or highway and other human made structure and text display showing attribute of features in the map.

### 5. Voice commands and voice synthesis

- **Voice commands** allows the user to divert computer operation by spoken commands i.e. voice command is when the user communicates with computer using voice as medium.
- Voice/speech recognition involves computers recognizing peoples' voices for the purpose of carrying out commands or directions to complete tasks. Voice recognition is identification of a person's voice and speech recognition is recognition of what someone is saying.
- Voice Synthesis involves computers generating human-like speech for the purpose of communicating with people. Voice recognition can be used when the trainees hands are already busy with tasks and another method for inputting information is needed.
- Example of voice commands are robotic commands for various activities and car intelligent voice

- **Voice synthesis** is used for presenting the result of an action to the user in synthesized voice i.e. voice synthesis is when the computer inform its user about a particular situation using voice as medium.
- Example of voice synthesis is sound which comes when the system completes booting.

### 6. Full-motion stored and live video

- Three-dimensional video techniques are being adapted to create the concept of virtual reality.
- CD-ROM technology has provided the basis for development of full-motion video.
- The technology is pervasive and is equally applicable to the office environment as it is to the play den.

### 7. Holographic images

- All of the technologies so far essentially present a single sided or outside view of information. Holographic images are giving the concept of virtual reality by allowing the user to get "Inside" innermost processing a part such as an various devices and view its operation from inside.
- **Holography** is a technique that allows the light scattered from an object to be recorded and later reconstructed so that when an imaging system (a camera or an eye) is placed in the reconstructed beam, an image of the object will be seen even when the object is no longer present. The image changes as the position and orientation of the viewing system changes in exactly the same way as if the object were still present, thus making the image appear three-dimensional.
- The photographic recording of image is called a hologram which appears to be unrecognizable pattern of strips and whorls but which when illuminated by laser beam organizes the light into 3D representation of original object.
- Hologram records intensity as well as phase.
- There are two types of holography namely continuous –wave laser holography and pulse- laser-holography.
    - **Continuous - Wave Laser Holography :** In this a beam of light is directed on an object in darkened room. A beam is reflected, scattered and diffracted by physical features of object and arrive on a photographic plate. At the same time part of original beam also arrive at the photographic plate. The two beams cause interference, which result in complex pattern. The developed plate is called hologram.
    - **Pulse-Laser-Holography :** In this moving object is made appear at rest when a hologram is produced with the extremely rapid and high-intensity flash of ruby laser. This approach is used for application such as wind tunnel experiment for aircraft wing design.

### 8. Fractals

- Fractals are found throughout nature. They are present in inorganic structures such as clouds and coastlines and in living structures, such as the circulation or intestinal systems in mammals. In living systems, this complex geometry has evolved to provide efficient solutions to a number of difficult problems, often related to fluid handling. This observation by itself suggests consideration of fractal structure to solve related engineering problems.
- **Fractal compression** is a lossy image compression method using fractals.
- The mathematical processing requires converting an image to a fractal, making compression a very demanding and time-consuming task. Hence once compressed, even a very complex fractal can be decompressed very rapidly.

### 9. Audio messages

- Audio messages are recorded by using microphone. Saved on HDD or send as electronic mail message as an attachment.
- Speed of decompression and playback of audio message with proper cadence is crucial for audio message playback to be comprehensible.

### 10. Video messages

- Video messages are recorded by using video camera (camcorder). Similar to audio message video message can be embedded in attachment to electronic mail messages.
- Storage and playback requirement are even more complex for video messages because of storage for each video shot.
- Video also require isochronous (playback at a constant rate) playback.

## 1.4 Objects of Multimedia System

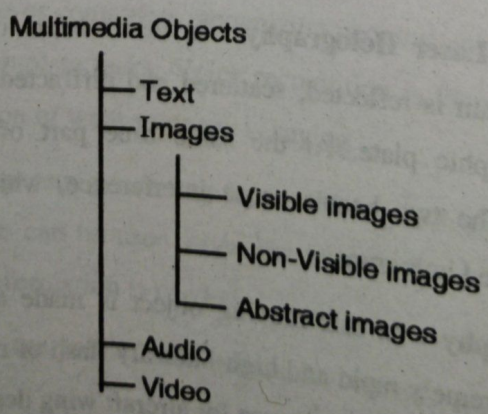


**Fig. 1.4.1 : Objects of multimedia system**

Text, image, audio, video are the objects of multimedia. Lets discuss it in detail.

### 1.4.1 Text

- Text is a basic building block of document. Text is simple data type that requires least amount of storage. In addition text data types can be made fields in database that can be indexed, searched and sorted.
- Basically, text data we are using for names, addresses, description, definition and variety of data attributes.
- Hypertext is an application of indexing text to provide a rapid search of specific text strings in one or more documents. Hypertext is an integral component of hypermedia document.
- A few words appearing in a predominantly graphic multimedia system can have a powerful effect. On the Internet, text is used much more than on stand-alone multimedia products, so it takes on an added importance.
- Also, text and art can be mixed together in interesting ways to reinforce the message being transmitted. Text can also be animated in interesting ways.

### 1.4.2 Images

There are many types of images such as documents images, facsimile systems, fractals, bitmap, metafiles and still pictures.

Information communicated through pictures (image) is easier to understand and retain. Image elements in a multimedia system could be still pictures (like photographs) converted to digital format with the help of scanners, or generated on the computer.

- **Non visible images :** These images are displayed as image but not stored as image. E.g. chart, graph.
- **Visible images** is an image which is displayed and stored as image. E.g. engineering drawing, images captured by camera.
- **Abstract images** are never stored but dynamically produced by computer using some formula e.g. visualization in windows media player, sinusoidal wave form.

### 1.4.3 Audio and Voice

- An audio objects stores information about sound.
- Audio can consist of music, speech, voice commands, telephone conversions and so on.
- Audio is one of the most appealing elements of any successful multimedia presentation.
- The impact of sound sets the mood and establishes the ambience of a presentation. It can be used in a number of ways in a multimedia application, for example, to reinforce a message or theme, to set the mood, or to catch the interest and alert the audience.

### 1.4.4 Full-Motion and Live Video

- **Full-motion** video is a computer system that is capable of displaying full video images and sound on a computer. Depending upon the compression being used by the computer and the computer hardware, the frames per second can vary. Computers not capable of displaying at least 24fps will notice the video being choppy.
- Full Motion Video (FMV) based games are video games that rely upon pre-recorded TV-quality movie or animation rather than sprites, vectors, or 3D models to display action in the game.

**Syllabus Topic : Multimedia System Architecture - IMA, Workstation, Network**

## 1.5 Multimedia System Architecture

Multimedia system architecture gives the idea about how to run multimedia application on our desktop. What type of interface is required and for hardware connecting what specifications are required ?

### 1.5.1 Multimedia Workstation Architecture

Fig. 1.5.1 describes architecture of multimedia workstation environment. In this Fig. 1.5.1 left-hand side is very similar to non-multimedia system. To design and develop multimedia application, we need to extend the existing non multimedia hardware and software i.e. right side of Fig. 1.5.1 shows new entities required for supporting multimedia application.

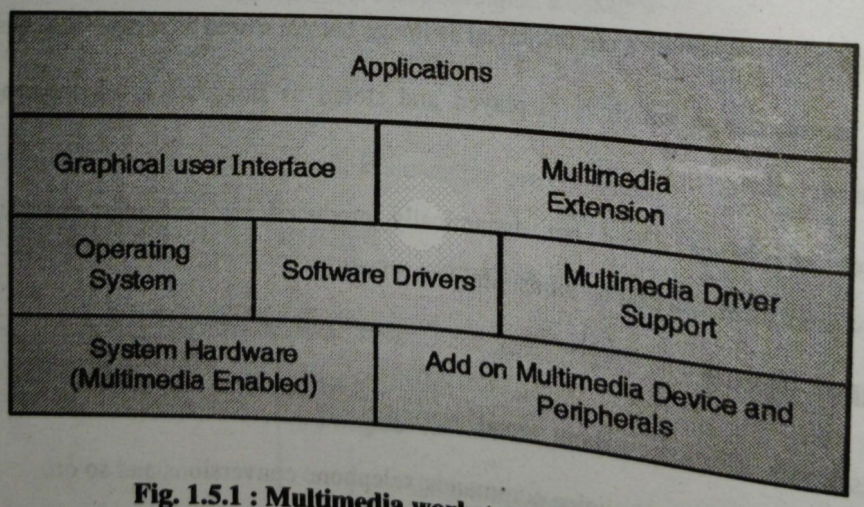


**Fig. 1.5.1 : Multimedia workstation architecture**

**1. Application**

In multimedia each object is compressed and then stored therefore while giving back it need to decompress. Application layer performs compression and decompression. Hence each architecture has application as the first layer. Multimedia applications such as educational, online training electronic messaging, multimedia repositories and video conferencing kind of applications we are using at very first level of architecture.

2. **General user Interface** 2

On our computer system we can access these applications which will provide graphical user interface for users those who will use the multimedia application. Multimedia application should interface with standard user interfaces such as Microsoft windows, X windows or with presentation manager.

3. **System hardware** 5

Multimedia enables means on board finicalities. i.e. system hardware present with the machine. Multimedia system should operate with or without special hardware required for multimedia such as DSP's with no change in application s/w and then how to get hardware interface with system those required for processing.

4. **Multimedia extension** 3

Extension is basically an extra finicality. Multimedia application like full-motion digital video requires extending the basic GUI provided by Windows. Example, due to web camera (add on) video - conferencing (extension) is possible.

5. **Add on multimedia devices and peripherals** 6

Printer, scanner, Microphone, Scanner, microphone, digital cameras each device require its own device controller and encoding hardware.

6. **Software Driver and Multimedia Driver Support** 4

Software drivers are required, so that the application can talk to devices. Use of software driver allows the user to interact with much wider range of peripherals and systems.

## 1.5.2 IMA Architecture Framework

- IMA is the accronym for **Interactive Multimedia Association**. IMA has a task group to define the architectural framework for multimedia to provide interoperability for multimedia products. It considers a number of machines and then divides into two parts viz. client and server.
- Server decides various class libraries for multimedia objects i.e. server decides what type data is and what is required to run the data, which software support is needed etc.
- Client defines various format conversions.
- Example, Sometimes on loading a webpage all errors are shown saying certain software support (let's sat Adobe Photoshop) is required, please install the plug-in. Thus information is given due to client-server working together.
- IMA architecture provides MIB. MIB is acronym for multimedia interface bus. MIB is fast and wide. MIB gives parallel 32 bits of data transfer.

- Since MIB is 32 bit, whereas other applications are of 8-16 bit, hence Application Compatibility Layer (ACL) is used (ACL act as buffer).
- System compatibility layer is used to achieve machine independence. That is this layer offers interface between multimedia application with system e.g. O.S.
- Hardware layer offers compatibility of hardware or add-on devices with multimedia applications through the computer system.
- Fig. 1.5.2 shows IMA based on MIB.

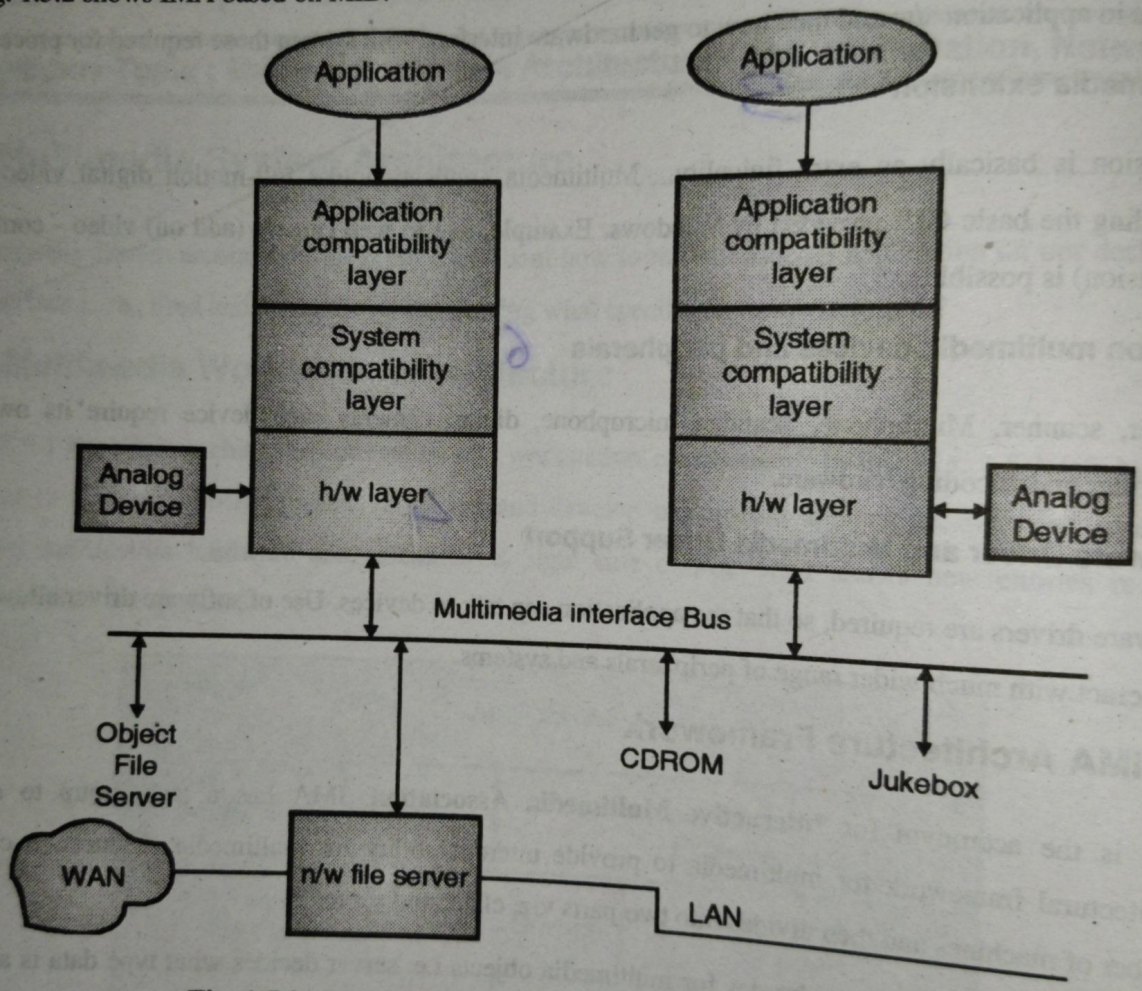


**Fig. 1.5.2 : Multimedia architecture based on Interface bus**

## 1.5.3 Network Architecture for Multimedia System

In multimedia system large volumes of image and video message are being transferred. Therefore multimedia system have special networking requirement.

We face three practical difficulties in traditional LAN. The problems are :

- Bandwidth is limited.
- TP and CC are not resistant to EMI and RFI, hence poor SNR (Signal to Noise Ratio).
- Error rate is high.

Solution to these problems is we use multimedia networking standard like Isochronous Ethernet, FDDI or ATM. The problem is solved because the entire above networking standard use fiber optic cable. For fiber optic cable Bandwidth is high and it is resistant to EMI and RFI, hence good SNR also error rate is low. Hence these operational capabilities have made ATM and FDDI.

Network architecture uses task based approach. In task based approach the bandwidth provided to audio/ video is maximum then followed by image and text and also bandwidth allocation is dynamic. Audio- video requires more bandwidth because the third dimension-time. Bandwidth for text is in bps, for images it is in kbps and for audio/ video it is in Mbps-Gpbs.

There are two techniques to transfer data between servers and they are data duplication and data replication. In data duplication the data is copied but consistency s not maintained. In data replication is coped but consistency is maintained.

## Syllabus Topic : Applications of Multimedia

## 1.6 Multimedia Applications

Document image is 1st very basis application of multimedia that requires to store large volume of data. The fundamental concepts of storage, compression and decompression and display technologies used for multimedia system were developed for document image management. Image processing and image recognition is a very different application to process the images. Image processing and image recognition are intended to recognizing objects by analyzing their raster images.

### 1. Document Imaging

- Document Imaging is a technology that takes the hardcopy of a document and converts it into a digital format.
- Document imaging makes it possible to store, retrieve and manipulate very large volume of data such as documents. Documents may contain data, pictures, graphical representation of data which we are using for official use at various organizations, companies, firms, government offices.
- Document image systems use workflows that are customized for the purpose for which being used. The workflow defines sequence for scanning images, performing quality check, performing data entry based on contents of images, indexing them, and storing them on optical media.
- **Advantages of using Document imaging systems are :**

  (1) Extremely high speed of sharing

  (2) Ease of availability

  (3) Longer life of document.

**2. Image Processing and Image Recognition**

- Digital image processing can be used to preprocessing (enhancement) of digital images, extracts the characteristics features of an image (region, boundary and skeleton). Image recognition is used in face recognition, fingerprint identification systems etc.
- **Digital image processing** is the use of computer algorithms to perform image processing on digital images. As a subcategory or field of digital signal processing, digital image processing has many advantages over analog image processing. It allows a much wider range of algorithms to be applied to the input data and can avoid problems such as the build-up of noise and signal distortion during processing. Since images are defined over two dimensions (perhaps more) digital image processing may be modeled in the form of Multidimensional Systems.
- Image synthesis is the process of creating new images from some form of image description.
- The objective of **image compression** is to reduce irrelevance and redundancy of the image data in order to be able to store or transmit data in an efficient form.

**3. Image Enhancement**

- Image enhancement will highlight some details of images by increasing sensitivity and contrast makes the picture darker by making borderline pixels black and increasing grey-scale level of pixels.
- Image enhancement capabilities might include following :
  - **Image calibration :** Image pixels adjust at predefined level.
  - **Real-time alignment :** Image is rotated by small angles in real time.
  - **Grey scale normalization :** Overall grey-level of picture is evaluated.
  - **RGB hue intensity adjustment :** Hue intensity we can adjust to predefined level to get the image with proper colors.
  - **Frame averaging :** Intensity level of frame is averaged to overcome the effects of very dark and very light areas by adjusting the middle tones.

**4. Image Animation**

Image animation technology was developed by Walt Disney and brought into every home in the form of cartoon. Animation is the rapid display of sequence of images in order to create an illusion of motion. Images can be of two type : computer generated or captured (scanned). Computer created digital images are displayed sequentially at controlled speed. It is used successfully in designing moving parts such as automobile engines.

**5. Image Annotation**

Image annotation is the process by which a computer system automatically assigns meta-data in the form of captioning or keywords to a digital image.

There are two ways to do this :

1. A text file stored along with image.
2. Small image is stored with the original image.

These two schemes are illustrated in Fig. 1.6.1.

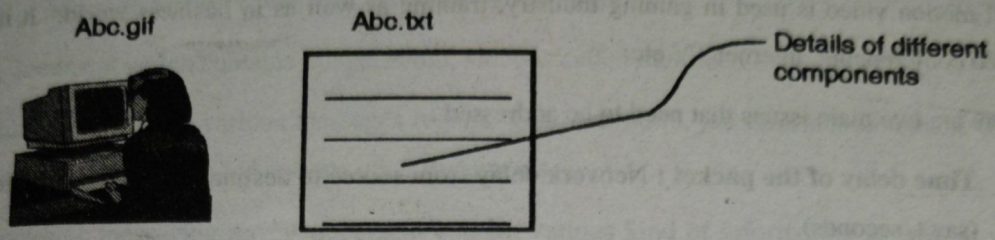


**Fig. 1.6.1 : Image annotation by maintaining two separate files**

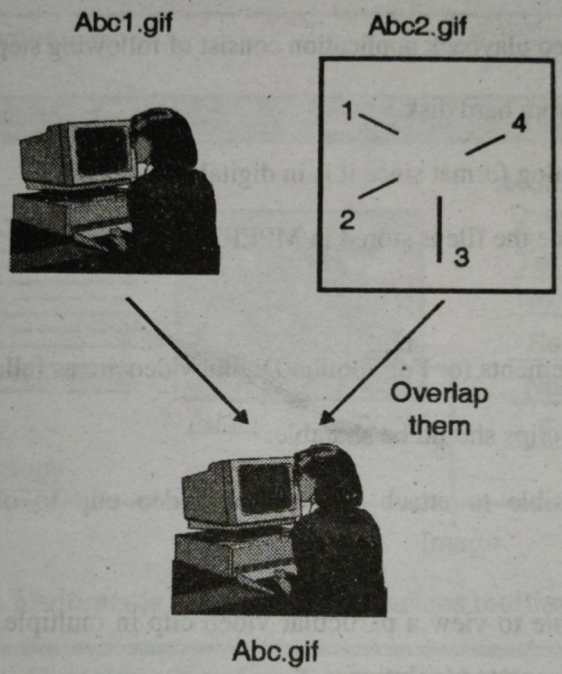


**Fig. 1.6.2 : Image annotation by maintaining a single file**

## 6. Optical Character Recognition

It is the translation of image of hand written, typewritten or printed text into machine-editable digital text. OCR technology is used in bar code readers. OCR actually converts document image in editable word processing format. First character is scanned and predefined grid is applied and image is converted in digital form. The digital form is compared with predefined characters and if cutoff percentage is achieved, it is recognized as that particular character. Cutoff is generally 75%.

## 7. Digitizer

A graphics tablet or a digitizing tablet is computer input device that allows one to hand-draw images and graphics, just like we do with a pen on paper. Digitizer consists of a flat surface upon which you can draw images with an attached stylus.

Digitizer are of two types :

1. **Active digitizer (Battery powered) :** No need to touch.
2. **Passive digitizer :** You need to touch.

## 8. Full Motion Digital Video

- Full motion video is used in gaming industry, training as well as in business world. It is also used in video conferencing, internet TV etc.
- There are two main issues that need to be addressed :
  (a) **Time delay of the packet :** Network delay from source to destination must be < some Max. Delay (say $t_1$ seconds).
  (b) **Buffer under run :** frame $F_{n-1}$ must be in the playout buffer before frame $F_n$ is rendered.
- Full motion Digital video playback application consist of following steps :
  (a) Retrieve the file from hard disk.
  (b) Convert it into analog format since it is in digital form.
  (c) Uncompress it since the file is stored in MPEF format.
  (d) Play the video.
- Some of the core requirements for Full motion Digital video are as fallow :
  (a) Full motion video clips should be sharable.
  (b) It should be possible to attach full motion video clip to other documents such as memos, presentation.
  (c) It should be possible to view a particular video clip in multiple resolution screens without storing separate clips for separate resolution.
  (d) User should able to adjust color and brightness associated with clip.
  (e) User should able to mix sound from other sources.
  (f) Full motion clips should be indexed.

## 9. Multimedia E-mailing

- Ordinary email is not multimedia application, but any attachment makes the e-mail message a hypermedia document.
- A hypermedia document is a multimedia document flowing over the internet.

- Multimedia E-mailing system requires a sophisticated infrastructure consisting of the following to support it :
  - Electronic messaging system provides message store and forward facility.
  - Message transfer agents to route messages to their final destinations.
  - Message servers where user can store the message.
- A document which contains image, audio, video is called multimedia document.
- This page conveys various messages regarding current news, job information, email, we can download music, photos, audio and various other documents.
- Electronic messaging means document content various kind of information as well as we can send this document as a mail to other end.

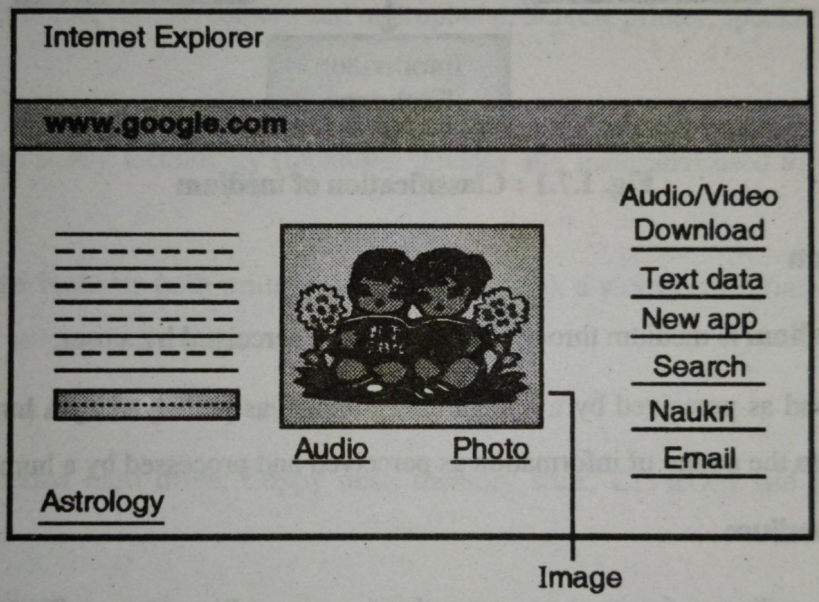


**Fig. 1.6.3 : Multimedia document with various multimedia element**

## Syllabus Topic : Types of Medium

## 1.7 Types of Medium

Medium is means for distribution and presentation of information. Classification based on perception (text, audio, video) is appropriate for defining multimedia Medium can be Classified into :

1. Perception Medium
2. Representation Medium
3. Presentation Medium
4. Storage Medium
5. Transmission Medium
6. Information Exchange Medium

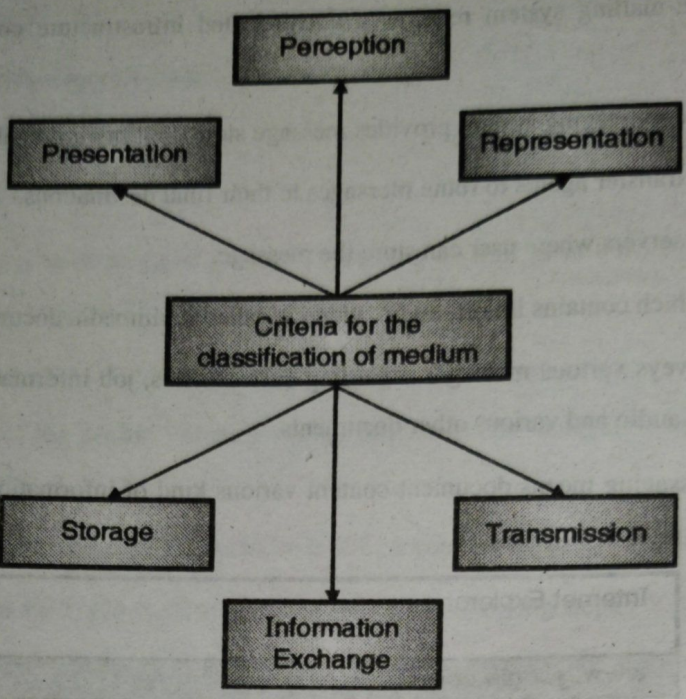


**Fig. 1.7.1 : Classification of medium**

### 1. Perception Medium

- **Perception medium** is medium through which data are perceived by a user;
- **Example :** sound as perceived by a human ear; graphics as perceived by a human eye. The perception medium refers to the nature of information as perceived and processed by a human.

### 2. Representation Medium

- Representation medium refers to the construction in any medium (especially the *mass media*) of aspects of 'reality' such as people, places, objects, events, cultural identities and other abstract concepts. Such representations may be in speech or writing as well as still or moving pictures.
- For example,
  - Text is encoded using ASCII. American Standard Code for Information Interchange is a character-encoding scheme based on the ordering of the English alphabet. ASCII codes represent text in computers, communications equipment, and other devices that use text.
  - Audio is coded using pulse-code modulation. Pulse-code modulation (PCM) is a method used to digitally represent sampled analog signals, PCM stream is a digital representation of an analog signal, in which the magnitude of the analogue signal is sampled regularly at uniform intervals, with each sample being quantized to the nearest value within a range of digital steps.
  - Image is coded using JPEG (Joint Photographic Expert Group).

- Video sequence can be coded in different TV standard format (PAL, SECAM, NTCE) and stored in computer using MPEG format.

### 3. Presentation Medium

- The ***presentation medium*** is the medium into which the stored document, which has been distributed over the distribution medium, is converted to facilitate viewing or reading by the end user.
- Presentation mediums engage the range of human of senses (e.g. visual, auditory, kinaesthetic).
- Mental activity is stimulated through our five senses, with the visual sense being the most powerful. As the old saying goes, "a picture paints a thousand words". Research shows that the greater the combination of our senses that are stimulated in learning, the more successful the learning is likely to be.
- **Examples :** Keyboard, mouse, camera and microphone, Screen, printer, speaker.

### 4. Storage Medium

- Storage medium is any technology (including devices and materials) used to place, keep, and retrieve data.
- The term storage includes both primary storage (memory), a storage medium usually means a place to hold secondary storage such as that on a hard disk or tape.
- Storage media can be arranged for access in many ways.
- Hard drive, external hard drive, floppy disk, memory stick, CD-ROM and Recordable DVD are all storage devices.

### 5. Transmission Medium

- Transmission medium describes the type of physical system used to carry a communication signal from one system to another.
- **Transmission medium** (plural *transmission media*) is a material substance (solid, liquid, gas, or plasma) that can propagate energy waves. For example, the transmission medium for sound received by the ears is usually air, but solids and liquids may also act as transmission media for sound.
- The absence of a material medium (the vacuum of empty space) can also be thought of as a transmission medium for electromagnetic waves such as light and radio waves. While material substance is not required for electromagnetic waves to propagate, such waves are usually affected by the transmission media they pass through, for instance by absorption or by reflection or refraction at the interfaces between media.
- **Examples** of guided transmission media are metallic cable (twisted-pair cable, coaxial cable) and optical fibres. **Examples** of unguided ***transmission media*** are the radio signals and satellite.

### 6. Information Exchange Medium

- The Information Exchange ***Medium*** is the medium used to transport the stored encoded document to the presentation or viewing device.
- Information Exchange ***Technology*** refers to the technology used to distribute or deliver the stored encoded document from one point to another
- Example of information exchange medium is Email.

## 1.8 Evolving Technologies for Multimedia Systems

Multimedia applications use a number of technologies generated for both commercial business applications as well as video game industry. Access of multimedia application on windows and other operating system cause rapid increase in use of these applications for various day-to-day uses. Because of that there interface is required between application software such as our multimedia system and operating system which we are using on our machine.

### 1. Hypertext

- Hypertext is an innovation to the paradigms of computing user interfaces that attempts to overcome the limitations of written text. Hypertext, instead of remaining static like traditional text, will dynamically "branch or perform on request".
- Thus hypertext makes possible the organization of material in ways that partially overcome the linearity inherent in written text.
- The prefix hyper - (Modern Greek term for over or beyond) signifies the overcoming of such constraints. The most frequently discussed form of hypertext document contains automated cross-references to other documents called hyperlinks. Selecting a hyperlink causes the computer to load and display the linked document.
- Documents referenced by hypertext can themselves be static (prepared and stored in advance) or dynamically generated (in response to user input). Therefore a well-constructed system using hypertext can encompass, incorporate or supersede other conventions of user-interface paradigms, such as menus and command lines, and can be used to access both static collections of cross-referenced documents and interactive applications.
- The documents and applications can be local or can come from anywhere with the assistance of a computer network like the Internet.
- The most famous implementation of hypertext is the World Wide Web.
- Hypertext implements organisation of non-sequential data by natural association of information rather than hierarchical filing structures as paper-based text documents.

## 2. Hypermedia document

- **Hypermedia** is used as a logical extension of the term hypertext in which graphics, audio, video, plain text and hyperlinks intertwine to create a generally non-linear medium of information. This contrasts with the broader term *multimedia*, which may be used to describe non-interactive linear presentations as well as hypermedia
- Hypermedia is a term created by Ted Nelson, and used in his 1965 article Complex information processing : a file structure for the complex, the changing and the indeterminate. It is used as a logical extension of the term hypertext, in which graphics, audio, video, plain text and hyperlinks intertwine to create a generally non-linear medium of information.
- This contrasts with the broader term multimedia, which may be used to describe non-interactive linear presentations as well as hypermedia. Hypermedia should not be confused with hypergraphics or super-writing which is not a related subject.
- The World Wide Web is a classic example of hypermedia, whereas a non-interactive cinema presentation is an example of standard multimedia due to the absence of hyperlinks.
- The first hypermedia system was the Aspen Movie Map, while the first truly universal hypermedia was Hypercard. Most modern hypermedia is delivered via electronic pages from a variety of systems.
- Basically hypermedia document is nothing but document which contain text data in addition with images, audio and video objects.
- The availability of fast networks has allowed this transformation to computer based electronic hypermedia documents.

## 3. Hyper speech

- **Hyper speech :** A mechanism to connect telephony voice applications that are deployed at different sites. We introduced an underlying protocol, HSTP that provides synchronization of the telephony call with the application logic at the time of call transfer from one site to another.
- In the design of HSTP, we ensured that no change is required to existing communication standards, both in the IP world and in the circuit-switched PSTN network.
- Hyper speech is also supported without enforcing any changes to current standard voice programming languages such as Voice XML and SALT. Ability to provide a Hyper speech link to other voice applications can enable several cross-organizational applications such as a travel reservation and music purchase, where the payment is made by a secure voice application that is hosted by the bank.
- Hyper speech can also support browsing of these voice applications across organizations. Increased connectivity across the different voice applications is likely to lead to a web of voice applications.

- In the future, the role of HSTP in a purely Voice-over-IP (VoIP) environment. It is likely that HSTP can be made more efficient by exploiting some of the session management capabilities offered by VoIP, when the last mile connectivity to the user is also over IP.
- Usability aspects of interconnected voice applications will also be a key area of UI research. Based on the adoption of HSTP, future voice application specification languages such as Voice XML and SALT should be enhanced to provide tags specific to handle Hyper speech content. The Voice Brow should also be made to support the HSTP protocol.

**4. HDTV and UDTV**

- Requires substantial processing power. High performance microprocessors and DSPs and HDTV and UDTV (High Definition Television and Ultra Definition Television).
- Parallel development in the electronics industry is to raise the resolution levels of commercial television broadcasting.
- Better known TV broadcasting standards are, NTSC (National Television Standard Committee) PAL (Phase Alternate Line) SECAM (System Couleur Avec Memoire) NHK (Nippon Hoso Kyokai). Developments for HDTV and UDTV benefit the computer industry as the basic technologies for display and communications merge.
- Development in progress for digital codes, modulators, and demodulators for terrestrial NTSC and wide-band satellite broadcasting.
- CAD/CAM and imaging technology use resolutions of 150 dpi/approximately 3000 pixels on a 20-inch-wide-display - equals digital UDTV quality.
- A typical display image with a 2550 × 3300 pixel resolution - 7.5 Mbits for uncompressed storage.

**5. Fuzzy logic**

- Fuzzy logic is a form of many-valued logic derived from fuzzy set theory to deal with reasoning that is fluid or approximate rather than fixed and exact. In contrast with "crisp logic", where binary sets have two-valued logic, fuzzy logic variables may have a truth value that ranges in degree between 0 and 1.
- Put more simply, fuzzy logic is a superset of conventional (boolean) logic that has been extended to handle the concept of partial truth, where the truth value may range between completely true and completely false.
- FL requires some numerical parameters in order to operate such as what is considered significant error and significant rate-of-change-of-error, but exact values of these numbers are usually not critical unless very responsive performance is required in which case empirical tuning would determine them. Generally, FL is so forgiving that the system will probably work the first time without any tweaking

– Fuzzy Logic has been found to be very suitable for embedded control applications. Several manufacturers in the automotive industry are using fuzzy technology to improve quality and reduce development time. In aerospace, fuzzy enables very complex real time problems to be tackled using a simple approach. In consumer electronics, fuzzy improves time to market and helps reduce costs. In manufacturing, fuzzy is proven to be invaluable in increasing equipment efficiency and diagnosing malfunctions.

**Syllabus Topic : Interaction Techniques**

## 1.9 Interaction Techniques

Multimedia communication is the field referring to the representation, storage, retrieval and dissemination of machine-processable information expressed in multiple media, such as text, image, graphics, speech, audio, video, animation, handwriting and data file. Multimedia communication originated in a confluence of two technological trends. The first involved the development of multimedia computing, and the second involved advances in networking that allowed reliable widespread delivery. Multimedia communication includes Audio communication (telephony, sound broadcasting), data, text, image communication (data transfer, fax) and video communication (video telephony, TV/ HDTV). Multimedia communication model is influenced by manufacturer-dependent solution for PCs and workstation, including application software and intelligent network concept.

### 1.9.1 Interactive Multimedia Services on Internet

The combination of multimedia technology and Internet is currently attracting a considerable amount of attention from developers and potential users alike. However, although many new products are being announced and marketed, the majority of the information on the Web still consists of just images and text, and the few "multimedia" items are in reality only short video clips with little interactive functionality. An interactive multimedia system should based on the integration of commercial products, provides some original functions for enhanced user interaction, whilst still maintaining complete compatibility with the rapidly evolving context of the Web. It should also allows the same "product" to be delivered over connections of different capacity by selectively decreasing the bandwidth dedicated to the video part of the data.

It is already possible today using the Internet to listen to music and to radio news, to view short video sequences, and to talk to remote users by means of special applications that emulate the functions of a normal telephone. Nevertheless, it is also true to say that the use of multimedia information via a network is still restricted to more or less experimental applications. This, together with the trend towards more extensive use of multimedia information, has created an opportunity that developers are pursuing very actively.

All of the development effort notwithstanding, a certain number of problems remains that hinder more extensive use of multimedia data on Wide-Area Networks (WANs). The most significant of these is certainly constituted by the severe bandwidth limitations of the networks : while recent technologies, such as ATM, allow bandwidths of hundreds of megabytes on any length of link, the majority of Internet users are still connected via a

dial-up telephone line and a modem capable of operating at 28.8 kbit/s at most. It is also not unusual for other bottlenecks to occur between the user and the service provider, especially at times of heavy traffic, which slow down the overall speed of the link even further. Another closely related problem is the low predictability and high variability of the overall data rate that can be achieved at any particular time on a given link.

The result is that the Internet user wanting to access video material will need the patience to wait for a long time before the whole file is downloaded, and will then be rewarded with the disappointing experience of a video lasting a few seconds and displaying a picture barely larger than a postage stamp.

In addition, the possibility for interaction with the video clip will generally be limited to start/stop commands, such as can be found on a domestic video recorder.

### 1.9.2 Technical Solution

The MM system can be completely integrated with the WWW technology, and the client application is indeed a normal Web browser to which specific "plug-ins" has been added.

Two classes of service are foreseen, which reflect the two situations of a user connected to the server via the public Internet (typically via a 28.8 kbit/s dial-up connection), or via Intranet (normally a Local Area Network, or LAN). In the first case, the use of video material is precluded by the bandwidth limitations of the connection. Consequently, the system only provides high-quality audio, which can be integrated and synchronised with text, still images, and animations. In the second case, the system also supports high-quality video, whilst the ability to integrate and synchronise it with other types of material remains unchanged. The architecture of the MM system consists of a server acting both as a Web and multimedia server, connected with the local client workstations via a switched Ethernet LAN, and accessible from remote stations via the public Internet.

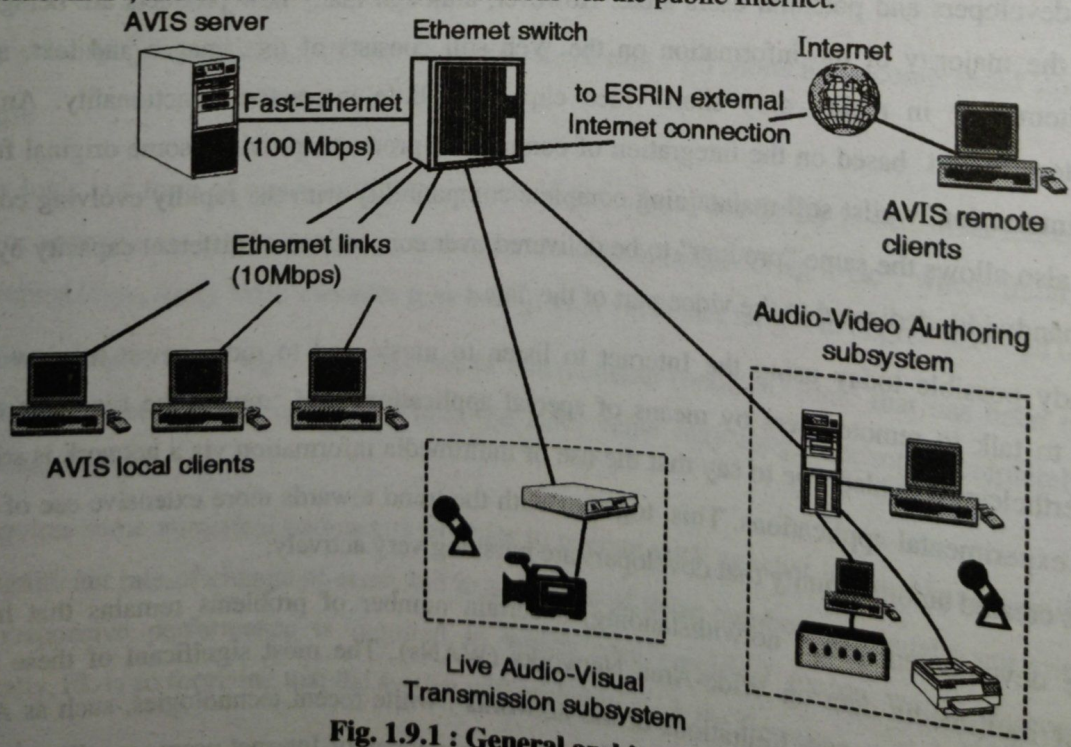


**Fig. 1.9.1 : General architecture**

It is also possible to include a live television broadcast in the multimedia material accessible on the server. The authoring of the application (graphics, animations, audio and video editing) is performed on a PC-based station, equipped with an MPEG video compression card and commercial authoring software (Adobe Premiere for the video, and Macromedia Director for the animations).

MPEG was chosen as the format for the video data as part of the general policy to favour public standards over proprietary ones in the hope of maintaining openness towards new developments. The term "hope" is used because, in a domain as active and as broad as Internet, one cannot exclude the possibility of a proprietary standard becoming the "de facto" choice at some stage. MPEG 1 was chosen in preference to MPEG 2 because of the latter's greater bandwidth requirement and the definitively higher cost of the hardware and software required for authoring and displaying MPEG 2 files.

The commercial product chosen for the audio streaming function is RealAudio by Progressive Networks. Two complementary approaches have been followed for the distribution of video data :

- The use of a commercial product Stream works by Xing Technologies, which has the desired capability of adapting the same video material to the transmission through channels of different bandwidth; this is achieved by reducing, in an intelligent and configurable way, the quality of the video that is actually transmitted (e.g. by reducing the frame rate) and at the same time maintaining the quality of the audio.
- The use of standard protocols for access on the LAN (UDP, NFS) to the video stream by a specific component developed as part of the project in the form of a plug-in for the browser; this plug-in handles both the display of the data and the interaction with the user.

### 1.9.3 User Interaction

The functionality supporting the interaction with the user is very high compared with that for the customary Web applications. In addition to the usual browsing and navigation functions, it is possible to :

- Synchronise the display of new HTML pages with the audio stream, by using a skip-to function to go to predefined positions in a video sequence using controls of the type found on a normal video recorder.
- Display, at the user's request, information relating to the content at any specific moment of a video sequence; this further information may itself contain pointers to other items of information.
- Skip from a predetermined position in a video sequence to other points or sequences.
- Select the language of choice for the subtitles during the display of a video stream.

The plug-in developed to carry out these functions is based on Java and JavaScript for the management of the on-screen controls and the interactivity with the user, and on the MCI standard interface (Multimedia Common Interface) for the integration of the multimedia drivers.

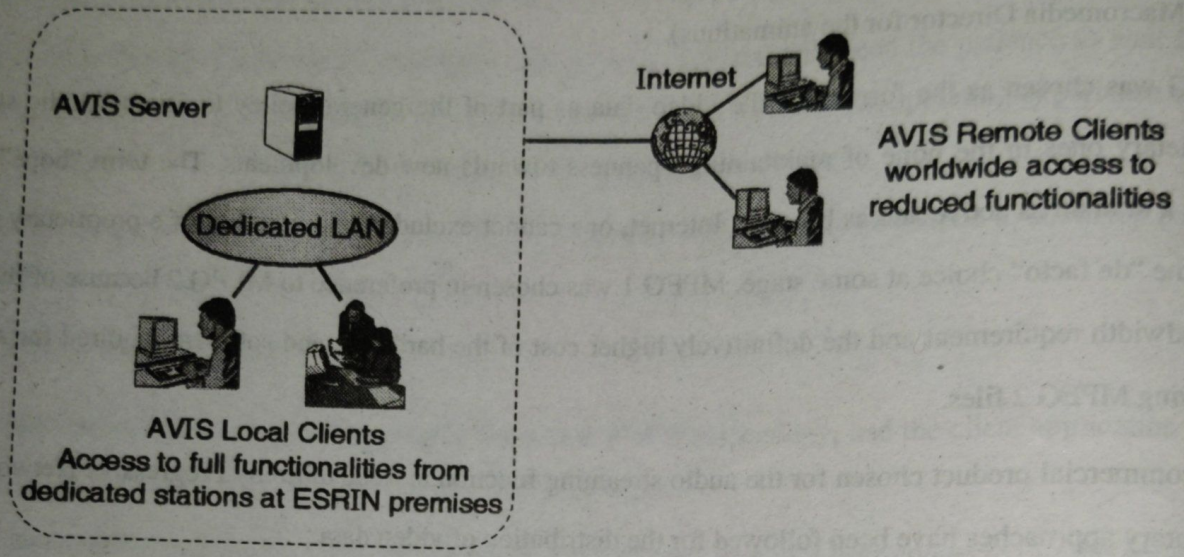


**Fig. 1.9.2 : Multimedia-capable Web client**

One interesting feature of the system, which is a direct result of the design choices that were made, is the ability to provide the same navigation paths for both classes of service foreseen. In the case of access via a low-bandwidth channel, the video material is simply replaced with a selection of stills extracted from the video itself, which remains synchronised with the original audio stream in unaltered quality.

## 1.10 Peripherals of Multimedia Systems

The peripherals of multimedia systems are :

1. Multimedia Input Peripherals
2. Multimedia Output Peripherals
3. Multimedia Storage Peripherals

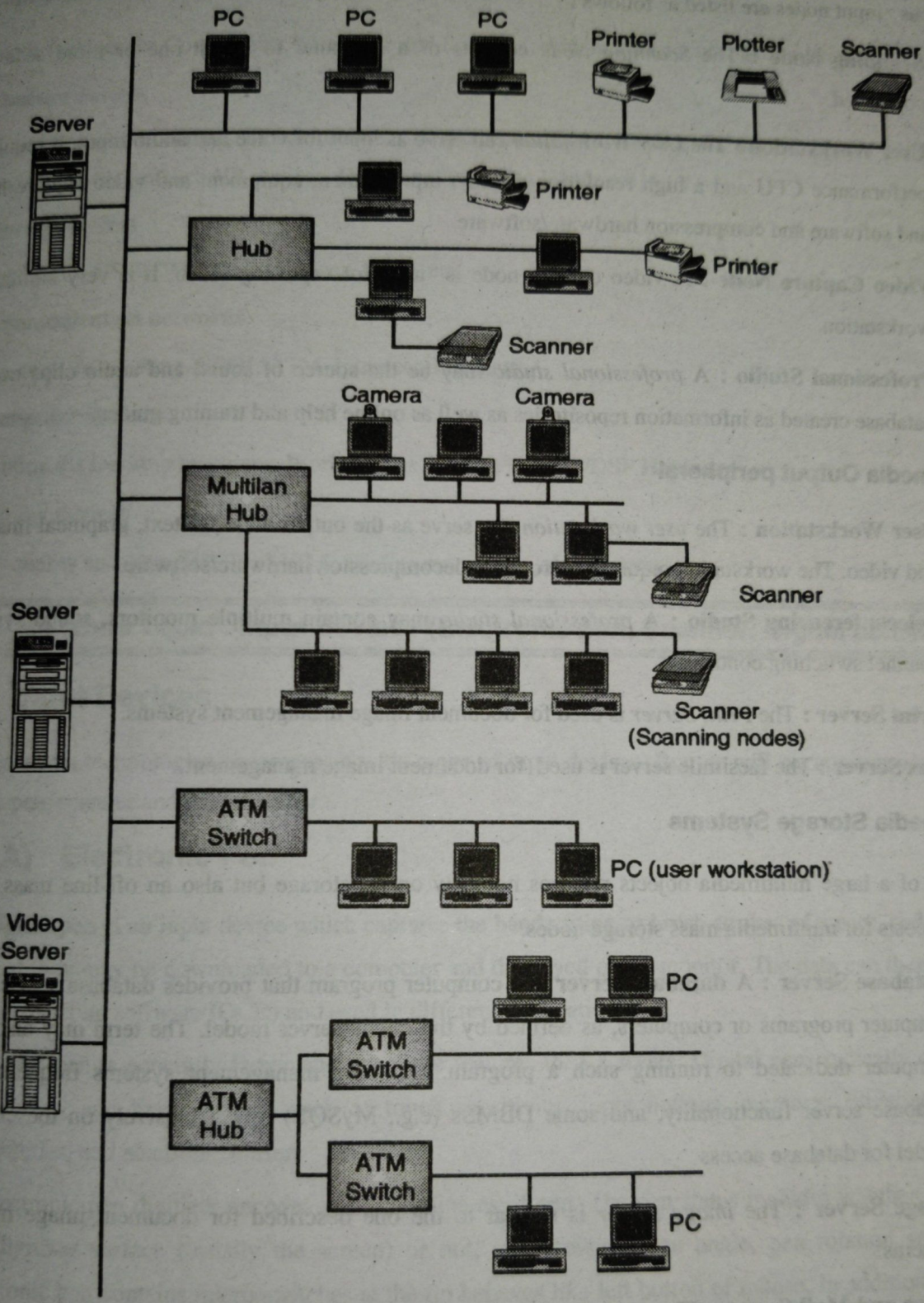


**Fig. 1.10.1 : Component of MM system**

## 1. Multimedia input peripherals

A multimedia system includes a variety of inputs including user work station, scanning node, video capture node etc.

Various input nodes are listed as follows :

- **Scanning Node :** The *Scanning Node* consists of a computer to which one or more scanners are connected.
- **User Workstation :** The *User Workstation* can serve as input for voice and audio input. It requires high performance CPU and a high resolution display, input camera equipment and video capture hardware and software and compression hardware/software.
- **Video Capture Node :** A video capture node is used for capturing video. It is very similar to user workstation.
- **Professional Studio :** A *professional studio* may be the source of sound and audio clips used in the database created as information repositories as well as online help and training guides.

**2. Multimedia Output peripheral**

- **User Workstation :** The *user workstation* can serve as the output node for text, graphical image, audio and video. The workstation requires appropriate decompression hardware/software.
- **Teleconferencing Studio :** A *professional studio* may contain multiple monitors, sound systems and channel switching controls.
- **Print Server :** The *Print Server* is used for document image management systems.
- **Fax Server :** The facsimile server is used for document image management.

**3. Multimedia Storage Systems**

Storage of a large multimedia objects requires not only online storage but also an off-line mass storage to contain costs for multimedia mass storage nodes.

- **Database Server :** A **database server** is a computer program that provides database services to other computer programs or computers, as defined by the client–server model. The term may also refer to a computer dedicated to running such a program. Database management systems frequently provide database server functionality, and some DBMSs (e.g., MySQL) rely exclusively on the client–server model for database access
- **Image Server :** The *image server* is similar to the one described for document image management systems.
- **Voice and Mail Server :** The *voice mail server* is typically connected to a DB and is primarily used for voice mail messages resulting from internal as well as external telephone calls.
- **Audio Server :** The *audio Server* manages all digitized voice and audio objects such as digitized telephone messages.
- **Video Server :** Video Objects have characterized different from image object in that they may or may not be required online for long periods.

### Components of Multimedia System (In General)

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

- **Capture devices**

  Video Camera, Scanners, Video Recorder, Audio Microphone, Keyboards, mice, graphics tablets, 3D input devices, tactile sensors, VR devices. Digitising/Sampling Hardware

- **Storage devices**

  Hard disks, CD-ROMs, Jaz/Zip drives, DVD, etc.

- **Communication networks**

  Ethernet, Token Ring, FDDI, ATM, Intranets, Internets.

- **Computer systems**

  Multimedia Desktop machines, Workstations, MPEG/VIDEO/DSP Hardware

- **Display devices**

  CD-quality speakers, HDTV, SVGA, Hi-Res monitors, Colour printers etc.

## Syllabus Topic : Input Devices (Electronic pen, Scanner, Digital camera)

## 1.10.1 Input Devices

Multimedia technologies encompass a wide range of input devices. But we will we concentrate on only three electronic pen, scanner and digital camera.

## 1.10.1(A) Electronic Pen

- A **digital pen** is an input device which captures the handwriting or brush strokes of a user, and digitizes them so that they may be downloaded to a computer and displayed on its monitor. The data can then be interpreted by handwriting software (OCR) and used in different applications.
- A digital pen is generally larger and has more features than a stylus. Digital pens typically contain internal electronics, and have features such as touch sensitivity, input buttons, memory, Bluetooth transmission capabilities, and electronic erasers
- In electronic pen digitizer encodes x, y co-ordinates of pen. The pen status includes whether pen is touching the digitizer surface (usually the screen) or not, pen pressure, pen angle, pen rotation and so on. Most electronic pen contains micro switches at the tip behaves like left button of mouse. In addition, some pens are capable of measuring pressure level at surface that can be encoded as part of pen status.

### 1. Digitizer

Digitizer touch screens have sensors in the screen to recognize pressure or a change in the electronic current going through them. Digitizer encode x,y coordinates of pen.

**2. Pen diver**

- Pen driver is pen device driver that interact with the digitizer to receive all the digitized information about pen location. Pen system should generate x, y coordinate 120 times per second.
- Pen driver builds pen packets for recognition context manager.

**3. Recognition Context Manager**

RC manager is heart of the pen system. It works with the device driver, recognizer, dictionary and application to perform the recognition and requested task. RC manager is responsible for routing the inking message directly to display deriver. If the pen behaves like mouse, the RC manager sends messages to window to process those pen messages as mouse messages.

**4. Recognizer**

The conversion of handwriting to text is performed by a technology component called a recognizer. Recognizers are written specifically for each supported language. Their default behavior is to recognize vocabulary words that appear in a dictionary for a particular language.

**5. Dictionary**

The recognizer feeds the character to dictionary system. Pen system uses dictionary to validate the recognition result. The recognized word is compared against dictionary word to achieve the best possible validation

**6. Display Driver**

The display driver under windows is dynamic link library which interacts with graphics device interface and display hardware. Display driver renders the objects whether characters, symbols, or graphical object on the screen.

## 1.10.1(B) Scanner

A **scanner** is an acquisition peripheral for scanning documents, i.e. converting a paper document to a digital image. Scanner is one of the input device that basically we are using for multimedia applications.

Document imaging is one of the multimedia application in that scanner is important input device to scan or to capture the images. Scanner acts as the camera eye and takes a photograph of document, creating an unaltered electronic pixel representation (of image) of the original.

### ☞ Characteristics of a scanner

A scanner is generally characterized by the following elements :

- **Resolution :** Expressed in *dots per inch* (referred to as *dpi*), the resolution defines the fineness of the scan. The order of magnitude of the resolution is around 1200 per 2400 dpi. The horizontal resolution is very much dependent on the quality and number of captors, whereas vertical resolution is closely linked to the accuracy of the drive motor.

- However it is important to distinguish the optical resolution, which is the actual resolution of the scanner, from the **interpolated resolution**. Interpolation is a technique involving defining intermediate pixels from among actual pixels, by calculating the mean of the colours of neighbouring pixels. This technology helps achieve good results but the *interpolated resolution* thus defined is in no way a criterion that can be used to compare scanners.
- **The format of the document :** Depending on their size, scanners are able to accommodate documents of different sizes, generally A4 (21 × 29.7 cm), or more rarely A3 (29.7 × 42 cm).
- **Acquisition speed :** Expressed in *pages per minute* (*ppm*), the acquisition speed represents the scanner's ability to pick up a large number of pages per minute. The acquisition speed depends on the document format and the resolution chosen for the scan.
- **Physical characteristics :** Other elements may be taken into account when choosing a scanner :
  - Size, in terms of the physical dimensions of the scanner.
  - Weight.
  - Electricity consumption, expressed in Watts (W).
  - Operating and storage temperatures.
  - Noise level : Scanners can be very noisy, and this may cause considerable disturbance.
  - Accessories : The drivers and user manual are usually provided, but you must check that connection cables are also provided; if not they must be purchased separately.

### How a scanner works ?

The operating principle for a scanner is as follows :

- The scanner moves over the document line by line.
- Each line is broken down into "basic dots" which correspond to pixels.
- A captor analyses the colour of each pixel.
- The colour of each pixel is broken down into 3 components (red, green, blue).
- Each colour component is measured and represented by a value. For 8-bit quantification, each component will have a value between 0 and 225 inclusive.
- The rest of this article will specifically describe the operation of a flat scanner, although the operating mode for a hand scanner or sheet-fed scanner is exactly the same. The only difference is in the feeding of the document.
- A flat scanner has a motor-driven lighted slot which scans the document line by line under a transparent glass panel on which the document is placed, with the scanning side face down.

– The high-intensity light emitted is reflected by the document and converges towards a series of captors via a system of lenses and mirrors. The captors convert the light intensities received into electrical signals, which are in turn converted into digital data by an *analogue-digital converter*.

### ☞ Types of scanners

Scanners come in wide variety of models with range of sizes, functions, speeds and resolutions.

1. Flatbed scanner
2. Rotary drum scanner
3. Handheld scanner

### 1. Flatbed Scanners

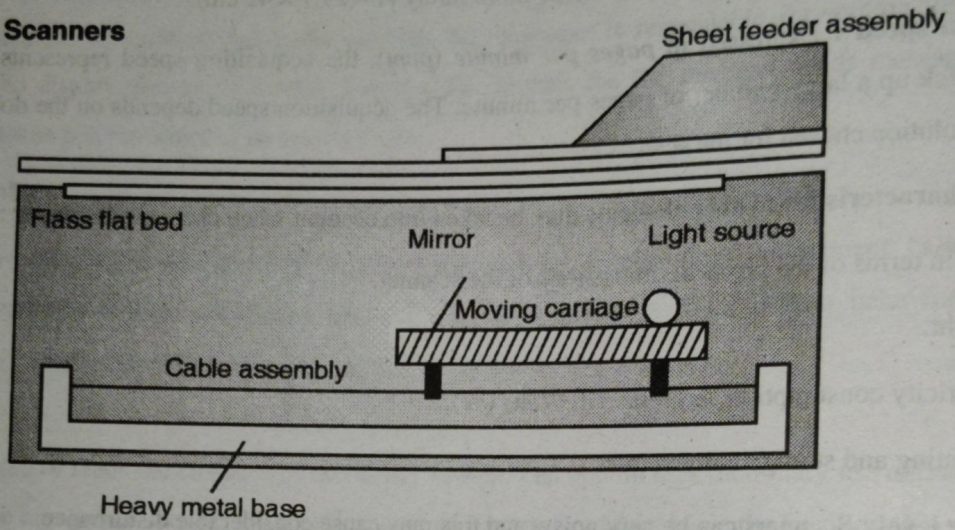


**Fig. 1.10.2 : Typical flatbed scanner**

A flatbed scanner has a clear pane of glass covering the inner workings and components. A fluorescent or xenon light sits underneath the pane and lights up the image placed on the scanner. Sensors placed below the light contain shades of red, blue and green. These lights and sensors strobe and reflect against the image. When the image is placed on the scanner, the upper covering is laid down on top of the image. This cover blocks out ambient light and any other light source in the area. The sensors run along the glass pane, reading the image based on its light reflection. This works only with images that have a solid background such as colored writing on a white page. It also involves work on the part of the user, to place the image correctly into the scanner and press the right button to begin the scanning process.

### ☞ Components of flat bed scanner

i. **Glass :** Glass is the first element in a flat bed scanner. To scan an image or document, open the scanner and place the document face down on the glass. Because the scanner uses light reflected from the document through the glass, the quality of the scanner's glass can affect the quality of the final scan. Most scanners use good quality tempered glass.

ii. **Light Source :** Flat-bed scanners have a built-in light source. In many scanners, the light source is LED lights. Other scanners use fluorescent bulbs. The light source is usually connected to a ballast or other voltage regulator to ensure consistency of light over the scan pass.

iii. **Sensor :** The sensor in a scanner is the device that "reads" the light reflected from the document or image. Most scanners use a Charge Coupled Device (CCD) array. A few scanners use a CMOS type sensor, and still others use a Contact Image Sensor (CIS). Regardless of the technology used, a sensor array contains light-sensitive diodes that convert analog light waves into a digital signal. Some scanner arrays contain three rows of sensors. Each row is calibrated to measure red, blue or green light. Other, usually older, scanner models use filters placed either in front of the light source or over the sensor array to filter red, green or blue light.

iv. **Carrier :** The sensor and light are mounted on a carrier that moves down the length of the scanner. The carrier moves at a constant rate and is driven by an electrical stepping motor using either a drive belt or a rack and pinion system.

### The Scanning Process

- Once a document or image has been placed on the glass, the carriage moves to a calibration strip inside the scanner case.
- The sensor takes a series of measurements to calibrate color balance, contrast and brightness. Once calibrated, it moves to the start of the area of the document to be scanned and scans the selected area by taking a series of "slices" of the image. Circuitry in the scanner then assembles these slices sequentially to create the whole image for transfer to a computer.
- Once the scan is complete, the image is transferred to a computer. This usually is done via a USB or FireWire interface. Some older scanners use SCSI interfaces for image transfer.

## 2. Rotary Drum Scanner

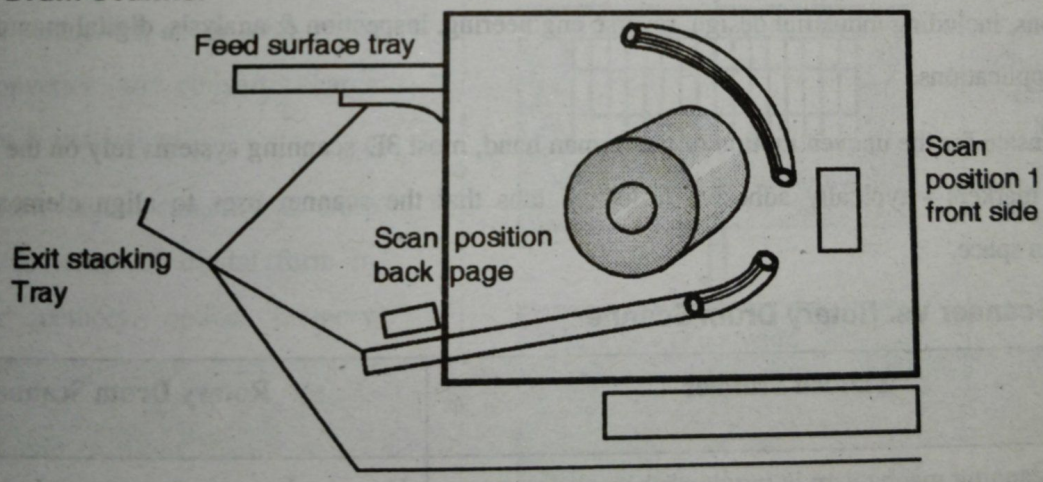


**Fig. 10.1.3 : Rotary drum scanner**

- In case of flatbed scanner at a time we can scan only one side of paper. But mechanism of rotary drum scanner is somewhat different that is in which two digital cameras with CCD array are mounted in a fixed position near the drum.
- As per the name suggest this scanner contains drum to wrap the paper and two set of belts three set roller guides to guide the paper.

- So this rotary drum scanner will scan both the sides of papers in single attempt and scanning mechanism with CCD array is same like flatbed scanner.
- A fixed CCD array absorbs reflected light and generates analog voltage which in turn gets converted to a digital value.
- Color handheld scanners work just like grey scale scanners except that they need 3 passes on scanline to capture, Red, Green and Blue components.
- First pass reacts to Red pixels, second pass to the Green pixels and third pass to the Blue pixels.

### 3. Handheld Scanner

- Hand scanners come in two forms : document and 3D scanners. Hand held document scanners are manual devices that are dragged across the surface of the image to be scanned. Scanning documents in this manner requires a steady hand, as an uneven scanning rate would produce distorted images - a little light on the scanner would indicate if the motion was too fast.
- They typically have a "start" button, which is held by the user for the duration of the scan; some switches to set the optical resolution; and a roller, which generates a clock pulse for synchronization with the computer.
- Most hand scanners were monochrome, and produced light from an array of green LEDs to illuminate the image. A typical hand scanner also had a small window through which the document being scanned could be viewed.
- While popularity for document scanning has waned, use of hand held 3D scanners remains popular for many applications, including industrial design, reverse engineering, inspection & analysis, digital manufacturing and medical applications.
- To compensate for the uneven motion of the human hand, most 3D scanning systems rely on the placement of reference markers - typically adhesive reflective tabs that the scanner uses to align elements and mark positions in space.

### ☞ Flatbed Scanner Vs. Rotary Drum Scanner

| Sr. No. | Flatbed Scanner | Rotary Drum Scanner |
|---|---|---|
| 1. | Here scanning mechanism is moving whereas document is stationary. | Here is document moving whereas scanning mechanism is stationary. |
| 2. | It can scan one side at a time. | It scans both the sides at same time. |
| 3. | It is slower. | It is faster. |
| 4. | Skewing of the paper is more. | Skewing of the paper is less. |
| 5. | It can scan pages of book from book by opening the book and placing it on the flatbed. | It can't scan book. |

## 1.10.1(C) Digital Camera

Digital camera works on CCD Mechanism to capture the image. Major difference between Digital camera and Traditional camera is roll of film. Earlier, Traditional camera uses roll of film but digital camera does not contains roll of film. Digital camera captures image and stores in digital form. Advantage of digital camera is no film processing is required like traditional camera and image we can directly download to computer without scanning. Digital camera is compatible for various multimedia applications because of its small size and better output quality and Fast speed.

### Working of Digital camera

- Digital camera is based on CCD mechanism.
- As we have seen in case of scanner, CCD consists of cells arranged in fixed array on surface.
- CCD cells will get charged by intensity of reflected light from surface of input image.
- Analog voltage will get generated by charge on to the cells.
- CCD cells data will again send to the A-D converter to convert charge voltage to digital values.
- This is how digital camera can store the data in terms of digital form in computer memory, optical memory devices.

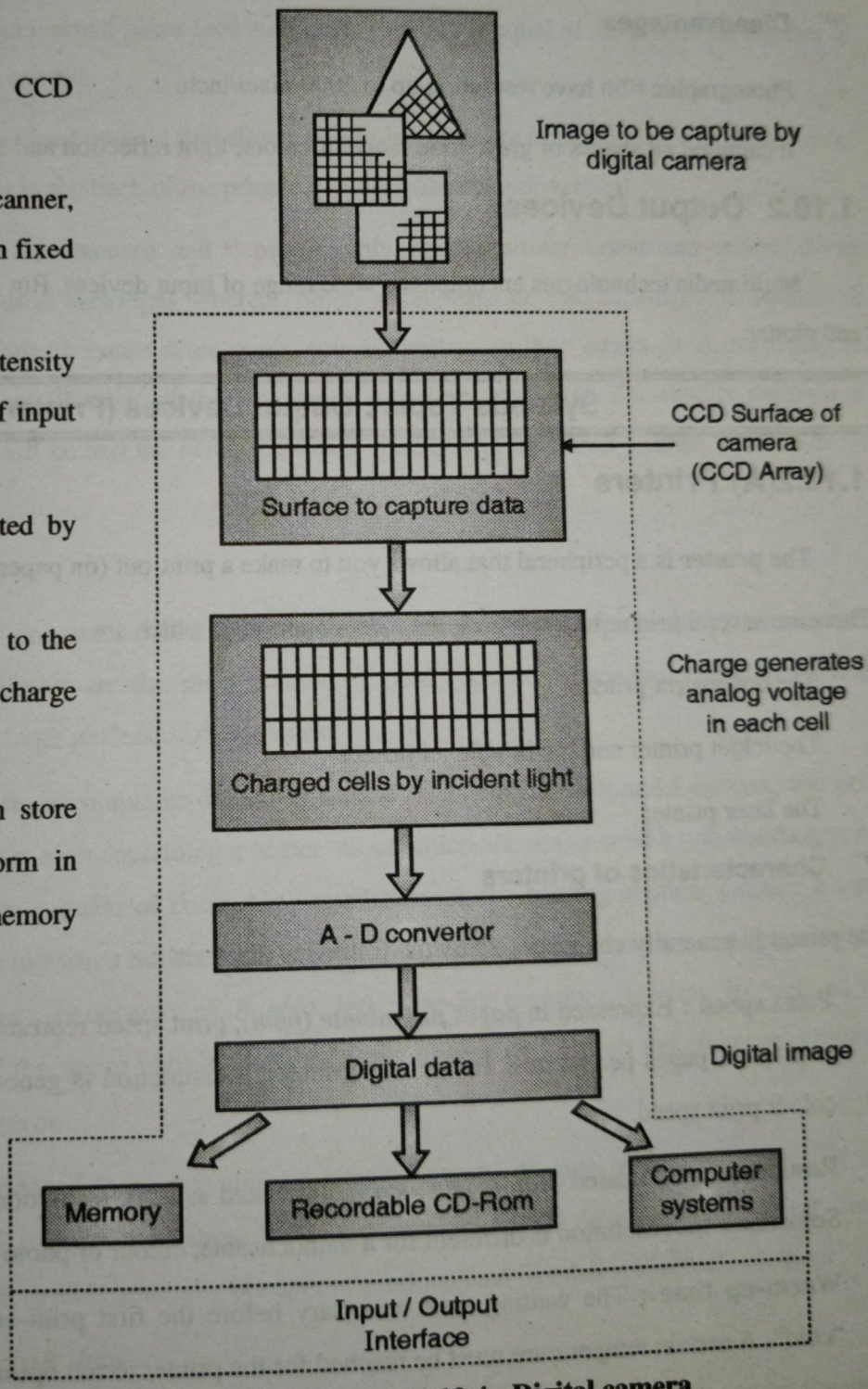


**Fig. 1.10.4 : Digital camera**

**Advantages**

- Smaller size.
- Better efficiency.
- Roll of film is not required.
- Film processing is not required.
- Directly we can download to computer memory, optical memory and so on.

**Disadvantages**

- Photographic film have resolution up to 2000 pixel/inch.
- It captured all shades of grey, wide range of colors, light reflection and shadows very perfectly.

## 1.10.2 Output Devices

Multimedia technologies encompass a wide range of input devices. But we will we concentrate on only printer and plotter.

**Syllabus Topic : Output Devices (Printers, Plotters)**

## 1.10.2(A) Printers

The **printer** is a peripheral that allows you to make a print-out (on paper) of computer data.

There are several printer technologies, the most common of which are :

- The dot-matrix printer
- The inkjet printer and the bubble jet printer
- The laser printer

**Characteristics of printers**

The printer is generally characterized by the following elements :

i. **Print speed :** Expressed in *pages per minute* (*ppm*), print speed represents the printer's ability to print a large number of pages per minute. For colour printers, a distinction is generally made between monochrome and colour print speed.

ii. **Resolution :** Expressed in *dots per inch* (abbreviated as *dpi*), resolution means the sharpness of printed text. Sometimes the resolution is different for a monochrome, colour or photo print-out.

iii. **Warm-up time :** The waiting time necessary before the first print-out. A printer cannot print when it is "cold". A certain temperature must be reached for the printer to run optimally.

iv. **Onboard memory :** The quantity of memory that allows the printer to store print jobs. The higher the amount of memory, the longer the printer queue can be.

v. **Paper format :** Depending on their size, printers are able to accept different sized documents, generally in A4 format (21 × 29.7 cm) or less frequently A3 (29.7 × 42 cm).

vi. **Paper feed :** The method of loading paper into the printer, characterising the way in which blank paper is stored. The paper feed can change depending on where the printer will be placed (rear loading is advised for printers that will be up against a wall). The main paper feed modes are :

- The **feed tray**, which uses an internal paper feed source. Its capacity is equal to the maximum number of sheets of paper that the tray can fit.
- The **sheet feeder** is a manual feed method that allows you to insert sheets of paper in small quantities (of about 100). The sheet feeder in the back of the printer is either horizontal or vertical.

vii. **Cartridges :** Cartridges are rarely standard and depend highly on the printer brand and model. Some manufacturers favour multicoloured cartridges whereas others offer separate ink cartridges. Separate ink cartridges are on the whole cheaper because often one colour is used more than others. It is interesting to examine the printing cost per sheet. The size of the ink drop is especially important. The smaller the drop of ink, the lower the printing cost will be and the better the image quality will be. Some printers produce drops that are 1 or 2 picolitres.

### 1. Inkjet printer

An **inkjet printer** is a type of computer printer that creates a digital image by propelling variable-sized droplets of ink onto paper. Inkjet printers are the most commonly used type of printer and range from small inexpensive consumer models to very large professional machines

Most consumer inkjet printers, from companies including Canon, Hewlett-Packard, and Lexmark, use print cartridges with a series of tiny chambers each containing a heater, all of which are constructed by photolithography. To eject a droplet from each chamber, a pulse of current is passed through the heating element causing a rapid vaporisation of the ink in the chamber to form a bubble, which causes a large pressure increase, propelling a droplet of ink onto the paper (hence Canon's tradename of *Bubble Jet*). The ink's surface tension, as well as the condensation and thus contraction of the vapor bubble, pulls a further charge of ink into the chamber through a narrow channel attached to an ink reservoir.

The inks used are usually water-based (*aqueous*) and use either pigments or dyes as the colourant. The inks used must have a volatile component to form the vapour bubble, otherwise droplet ejection cannot occur. As no special materials are required, the print head is generally cheaper to produce than in other inkjet technologies.

Thus we can summarize the process into 3 steps :

- The squirt is initiated by heating the ink to create a bubble until the pressure forces it to burst and hit the paper.

- The bubble then collapses as the element cools.
- The resulting vacuum draws ink from the reservoir to replace the ink that was ejected.

### 2. Laser printer

A **laser printer** is a common type of computer printer that rapidly produces high quality text and graphics on plain paper. As with digital photocopiers and multifunction printers (MFPs), laser printers employ a xerographic printing process but differ from analog photocopiers in that the image is produced by the direct scanning of a laser beam across the printer's photoreceptor.

The printer receives the document in form of file. This file is generated by the application that actually issues the print command to the printer. This file is nothing but logical image of the document and such an image is quite essential to guide the printer for accurate printing. At initial stage of the printing, a light sensitive drum is given a positive charge with the help of a wire and the drum starts revolving. This wire is known as corona wire.

As the drum starts revolving, the printer shines a laser beam on the surface of drum to create some discharge points. In this way laser draws the letters and images to be printed as pattern of electrical charges. In order to draw the pattern on drum, the laser receives the page data (tiny dots that make up text and images) one horizontal line at a time. Also, the laser does not move the beam itself instead it emits the beam on a movable mirror. The mirror moves and shines the beam through series of lenses on the surface of the drum.

After the pattern is set, the printer coats the negatively charge surface of the drum with toner - a type of fine black powder. Since the toner is positively charged, it sticks only on negative discharged points on the drum. It is something like writing some words on the wall with glue and then rolling over some color powder on the words. The powder sticks to the glue-coated part of the wall and you end up with words written on the wall with powder.

With powder pattern attach, the drum rolls over the sheet of paper coming from paper tray. This paper sheet is positively charged. The positive charge is strong enough to attract the negatively charged toner particles from the drum. The toner particles leave the drum and go onto the paper. At this point, the Image is on the paper; however, the particles are held only by their opposite charge.

The printer passes the pages through the user, a pair of heated rollers. As the paper passes through these rollers, the loose toner powder melts, fusing with the fibers in the paper. The fuser rolls the paper to the output tray and you have the finished page. The fuser also heats up the paper itself, which is why pages are always hot when they come out of a laser printer.

Lastly, the drum is cleaned to remove any toner particles left on its. Then the drum surface passes the discharge lamp. The bright light of the lamp exposes the entire surface of the drum, erasing the pattern of electric charges. Then corona wire reapplies the positive charge to the drum, making drum ready for next printing job.

Various manufacturers of laser printers categorize the working of laser printer that we just discussed, in six steps.

i. **Conditioning :** The drum is prepared for use and corona wire passes electric charge to the drum.

ii. **Writing :** The laser beam and movable lens together write an image of document on the surface of drum. The image on the drum is nothing more than dots of electric charge and is invisible at this point.

iii. **Developing :** During this step, the toner (fine black powder) is applied on the surface of the drum. The document image turns into black.

iv. **Transferring :** The image transfers to the paper. The toner particles leave the drum and go onto the paper.

v. **Fusing :** The toner particles are melted on the surface of paper and attached permanently with the fibers of paper. This is done by passing the paper, with toner particles clinging to it, from fuser roller which applies heat and pressure on paper.

vi. **Cleaning :** In this last step toner is cleaned from the drum and then an erase or discharge lamp is focused on drum to neutralize any electric charge left on the drum.

## 1.10.2(B) Plotter

- A **plotter** is a computer printing device for printing vector graphics. In the past, plotters were widely used in applications such as computer-aided design, though they have generally been replaced with wide-format conventional printers.
- Pen plotters print by moving a pen or other instrument across the surface of a piece of paper. This means that plotters are restricted to line art, rather than raster graphics as with other printers.
- Pen plotters can draw complex line art, including text, but do so very slowly because of the mechanical movement of the pens. Pen plotters are often incapable of creating a solid region of color, but can hatch an area by drawing a number of close, regular lines.
- This was often the fastest way to efficiently produce very large drawings or color high-resolution vector-based artwork when computer memory was very expensive and processor power was very limited.
- Hewlett Packard and Tektronix produced small, desktop-sized flatbed plotters in the late 1960s and 1970s. The pens were mounted on a traveling bar, whereby the y-axis was represented by motion up and down the length of the bar and the x-axis was represented by motion of the bar back and forth across the plotting table. Due to the mass of the bar, these plotters operated relatively slowly.
- One category, introduced by Hewlett Packard's MultiPlot for the HP 2647, was the "word chart", which used the plotter to draw large letters on a transparency.
- This was the forerunner of the modern Powerpoint chart. Plotters are used primarily in technical drawing and CAD applications, where they have the advantage of working on very large paper sizes while maintaining high

resolution. Another use has been found by replacing the pen with a cutter, and in this form plotters can be found in many garment and sign shops.

- Pen plotters speed is measured by pen speed and acceleration rate, instead of by page printing speed. A pen plotter's speed is primarily limited by the type of pen used, so the choice of pen is a key factor in pen plotter output speed. Indeed, most modern pen plotters have commands to control slewing speed, depending on the type of pen currently in use.
- There are many types of plotter pen, some of which are no longer mass produced. Technical pen tips are often used, many of which can be renewed using parts and supplies for manual drafting pens. Early HP flatbed and grit wheel plotters used small, proprietary fiber-tipped or plastic nib disposable pens.
- One type of plotter pen uses a cellulose fiber rod inserted through a circular foam tube saturated with ink, with the end of the rod sharpened into a conical tip. As the pen moves across the paper surface, capillary wicking draws the ink from the foam, down the rod, and onto the paper.
- As the ink supply in the foam is depleted, the migration of ink to the tip begins to slow down, resulting in faint lines. Slowing the plotting speed will allow the lines drawn by a worn-out pen to remain dark, but the fading will continue until the foam is completely depleted.
- Also, as the fiber tip pen is used, the tip slowly wears away on the plotting medium, producing a progressively wider, smudged line.

## Syllabus Topic : Storage Devices (Juke box, DVD)

### 1.10.3 Storage Devices

- Storage Devices are the data storage devices that are used in the computers to store the data. The computer has many types of data storage devices. Some of them can be classified as the removable data Storage Devices and the others as the non removable data Storage Devices.
- The data Storage Devices come in many sizes and shapes. And more over the technology used for the storage of the data over them is also altogether different.
- The storage devices are one of the most important components of the computer system. The memory is of two types; one is the primary memory and the other one is the secondary memory.
- The primary memory is the volatile memory and the secondary memory is the non volatile memory. The volatile memory is the kind of the memory that is erasable and the non volatile memory is the one where in the contents cannot be erased.
- Basically when we talk about the data storage devices it is generally assumed to be the secondary memory.

- The secondary memory is used to store the data permanently in the computer. The secondary storage devices are usually as follows: hard disk drives – this is the most common type of storage device that is used in almost all the computer systems.
- The other ones include the floppy disk drives, the CD ROM, and the DVD ROM. The flash memory, the USB data card etc.
- The storage devices are used to record the data over any storage surface. The memories may also be of different types depending upon the architecture and the design like the optical data storage memory, magnetic media storage and the mechanical storage media etc and also the flash memory devices etc.

### 1.10.3(A) Optical Storage Media

- The Optical Storage devices are those Storage devices in which data is burnt and removed by using a focused optical beam.
- In optical tape storage, optical disk storage and in optical card storage the optical techniques are used combined with other techniques such as magneto optical storage technique which is used for WORM Drives, Optical Disk Libraries, Jukeboxes, Write-Once-Read-Many Devices, Optical Storage, Optical Jukeboxes, Write-Once-Read-Many Drives, and WORM Devices.
- Every PC has a CD-ROM drive and we will discuss how it works. Unlike magnetic storage devices such as hard drives, and floppy disks a majority of optical storage devices are read only. But in the market of writable and re-writable CD-ROM devices, it is very difficult for these devices which are capable of writing to, and reading from optical disks.
- The disadvantage of writing data with optical devices is time consuming, more technically challenging, and is much less reliable compared with magnetic storage. Initially, in the beginning music and software industry was opposing the sale of re-Writable CD-ROM drive; as they are commonly raise the question about the usage of these devices for piracy.
- The CD-R/W drive has become one of the most popular computer components sold and installed into consumer computer systems.
- Sony brought a ton of experience in digital recording. Initially the two companies were battling to create competing standards but they inked an agreement for a cooperative development project to create a single standard.
- A special LED (Light Emitting Diode) is used to generate the laser beam, which passes through a beam splitter. A small, computer controlled electric motor is used to move and position the laser lens head in the correct position to read the required data. A photo-detector picks up the reflections of the laser beam and interprets the data.

- A CD is only readable from one side. A label is placed on the other so you know which side is the data side of the disc. Even with the protective plastic coating, the disc is still just plastic, and as such can be easily scratched or gouged if mishandled.
- You can easily end up doing more harm than good if you don't properly care for your discs. Of course it's best to not get the disc dirty in the first place; then you will never have to worry about accidentally scratching it while cleaning. A lens cleaning cloth can be purchased from any camera store, and is perfect for cleaning CDs without the risk of an accidental scratch.
- The optical storage devices such as magneto optical storage such as WORM Drives, Optical Disk Libraries, Jukeboxes, Write-Once-Read-Many Devices, Optical Storage, Optical Jukeboxes, Write-Once-Read-Many Drives, and WORM Devices are largely used in this competitive market as it produces good results when compared to other technologies. Thus, the optical storage devices are boon for the competitive writing and for removing the data from the disk.

## 1. CD-ROM

CDs are everywhere these days. Whether they are used to hold music, data or computer software, they have become the standard medium for distributing large quantities of information in a reliable package. Compact discs are so easy and cheap to produce .

### (a) Physical construction of CR-ROM

- A CD is a fairly simple piece of plastic, about four one-hundredths (4/100) of an inch (1.2 mm) thick. The diameter of the disc is 120 mm.

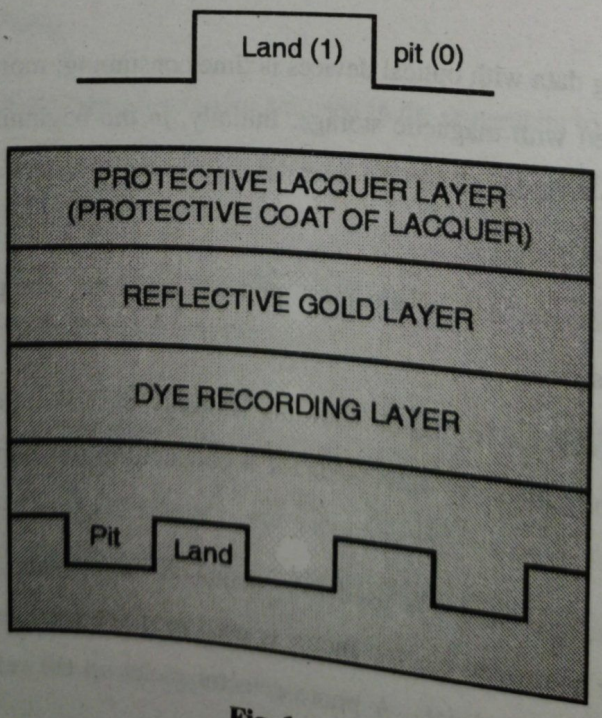


Fig. 1.10.5

- The center hole is 15 mm in diameter. The area closest to the center hole is the clamping area, and no data is written in this area. The clamping area is generally 26 mm to 33 mm wide, measured from the center of the disc. Most of a CD consists of an **injection-molded piece of clear polycarbonate plastic**.
- During manufacturing, this plastic is impressed with microscopic bumps arranged as a single, continuous, extremely long spiral track of data. Once the clear piece of polycarbonate is formed, a thin, reflective aluminum or gold layer is sputtered onto the disc, covering the bumps. Then a thin lacquer layer is sprayed over the aluminum to protect it.
- CD has a single spiral track of data, circling from the inside of the disc to the outside. The fact that the spiral track starts at the center means that the CD can be smaller than 4.8 inches (12 cm) if desired, and in fact there are now plastic baseball cards and business cards that you can put in a CD player. CD business cards hold about 2 MB of data before the size and shape of the card cuts off the spiral.

The advantages of using CD-ROM include :

- Capability to store large amounts of information Ability to store data, graphics, audio, and video on the same disc.
- Durability - since the optical head of the CD-ROM drive never contacts the disc, there is no danger of a head crash, wear and tear, or accidental data corruption that magnetic media suffer.

**(b) CD - ROM Standards**

There are numerous standards describing the ways in which information must be stored on a compact disc, depending on how it is to be used. These standards are set out in documents called books, each of which has a colour assigned to it :

i. **Red book** (also called RedBook audio) : Developed in 1980 by Sony and Philips, it describes the physical format of a CD and the encoding method for an audio CD (sometimes called CD-DA for Compact Disc - Digital Audio). It defines a sample rate of 44.1 kHz and 16-bit resolution (in stereo) for recording audio data.

ii. **Yellow book** : Developed in 1984 in order to describe the physical format for data CDs (CD-ROM for Compact Disc - Read Only Memory). It includes two modes :

- **CD-ROM Mode 1**, used for storing data with error-correction (called ECC, for Error Correction Code) in order to avoid losing data due to degradation of the disc.
- **CD-ROM Mode 2**, used for storing compressed graphical, video, and audio data. To be able to read this type of CD-ROM, a drive must be Mode 2 compatible.

iii. **Green book** : Physical specifications for a CD-I (CD Interactive, by Philips)

iv. **Orange book** : Physical format for writable CDs. It is divided into three sections:

- **Part I :** The CD-MO format (magneto-optical disks)

- **Part II :** The CD-WO format (Write Once, now called CD-R)
- **Part III :** The CD-RW format (CD Rewritable)

v. **White book :** Physical format for video CDS (VCD)

vi. **Blue book :** Physical format for "Extra" CDs (CD-XA)

**2. Video CD (VCD)**

- Support for a special CD format for the storing of compressed video information is defined as part of the "white book" specification. Through the use of MPEG compression it is possible to store 74 minutes of full-motion video in the same space that uncompressed "red book" audio uses! This format is called *video CD* or sometimes *VCD*.
- Playing video CDs requires either a video CD player or a CD-ROM drive that is video CD compatible. Since the compression algorithm used for video CD, MPEG-1, is rather unsophisticated, the quality of these disks has not been anything to write home about.

**3. WORM Optical Drive (Write Once Read Many)**

- **Write Once, Read Many** (alternatively **Write One, Read Multiple** or **WORM**) refers to computer data storage systems, data storage devices, and data storage media that can be written to once, but read from multiple times.
- WORM was discovered as a desirable property for data backups and archives, to prevent erasure (accidental or deliberate) and tampering. Various regulatory agencies require data such as health information and transaction records to be archived reliably and securely over a long period of time.
- Therefore, WORM capability has been intentionally added to otherwise rewritable media such as magnetic tape data storage and hard disk drives. The media can be written to, but the written portion immediately becomes read-only.

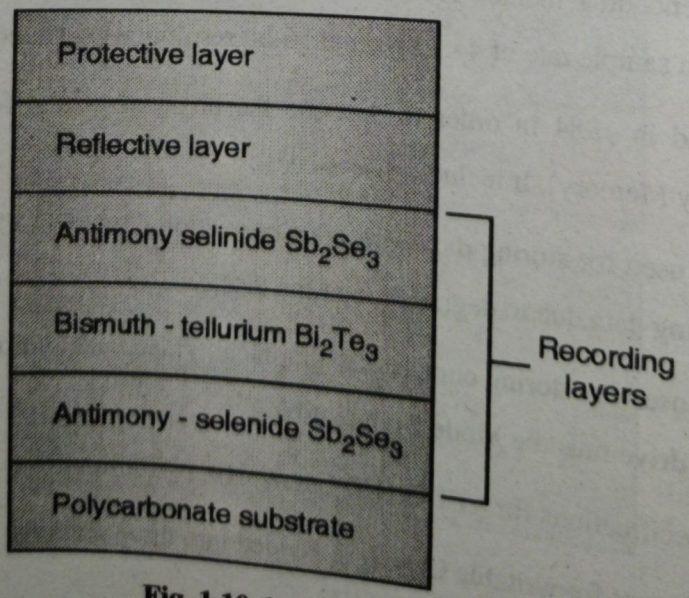


**Fig. 1.10.6 : Layers on WORM**

- The present invention provides a write-once-read-many optical recording medium comprising a substrate, a recording layer comprising any one of bismuth and an oxide of bismuth, an overcoat layer and a reflective layer in this order from a laser beam incident plane, wherein the write-once-read-many optical recording medium has a reflectivity of 35% or less when a laser is applied to the flat part of the substrate or a write-once-read-many optical recording medium comprising a substrate, an undercoat layer, a recording layer comprising any one of bismuth and an oxide of bismuth, an overcoat layer and a reflective layer in this order from a laser beam incident plane, wherein the write-once-read-many optical recording medium has a reflectivity of 35% or less when a laser is applied to the flat part of the substrate.

### Write-Once, Read-Many Recording Technique

- Write-once recording is an irreversible process that uses heat from a laser beam to make holes in the surface of the optical disk. Once the record is created, it cannot be altered.
- If the data needs to be written again, a new record is created, but the space used by the original entry is not recovered.
- This type of media is advantageous in instances where a permanent record is needed (for example, signed application forms), or when data is stored that will never be altered or updated (for example, in the case of items being stored on microfiche, completed forms, or X-rays). Because of the permanent nature of the data recorded, you can access WORM optical disks an unlimited number of times (read-many).

## 4. Magneto-optical Technology

- MO systems includes basic of both magnetic and optical storage systems.
- MO systems writes magnetically and read optically.

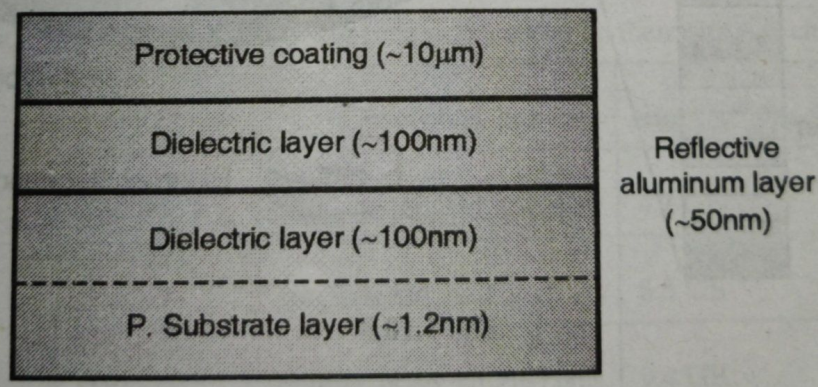


**Fig. 1.10.7 : Layered diagram for MO disk**

- All magnetic material have characteristic temperature, called as curie temperature above which they lose complete magnetization due to complete disordering of their magnetic domains.
- To generate curie temperature it will use laser beam.
- Laser beam when switched on, heats the spot on magneto-optical disk to it curie temperature (approx. 300° F or 150° c).

- This momentary rise in temperature makes the spot extra sensitive to magnetic field.
- In technical term, coercivity of point is said to be zero under influence of high temperature.
- Coercivity is defined as resistance to change as a result of magnetic field.
- At this zero coercivity the magnetic polarity of spot on disk is altered.
- This laser beam is then switched off and spot quickly coals down with its new magnetic polarity.

**Write/erase cycle**

- The MO disk consists of a series of layers, each one of them offering support to distinct aspects of the implementation of the respective technology.

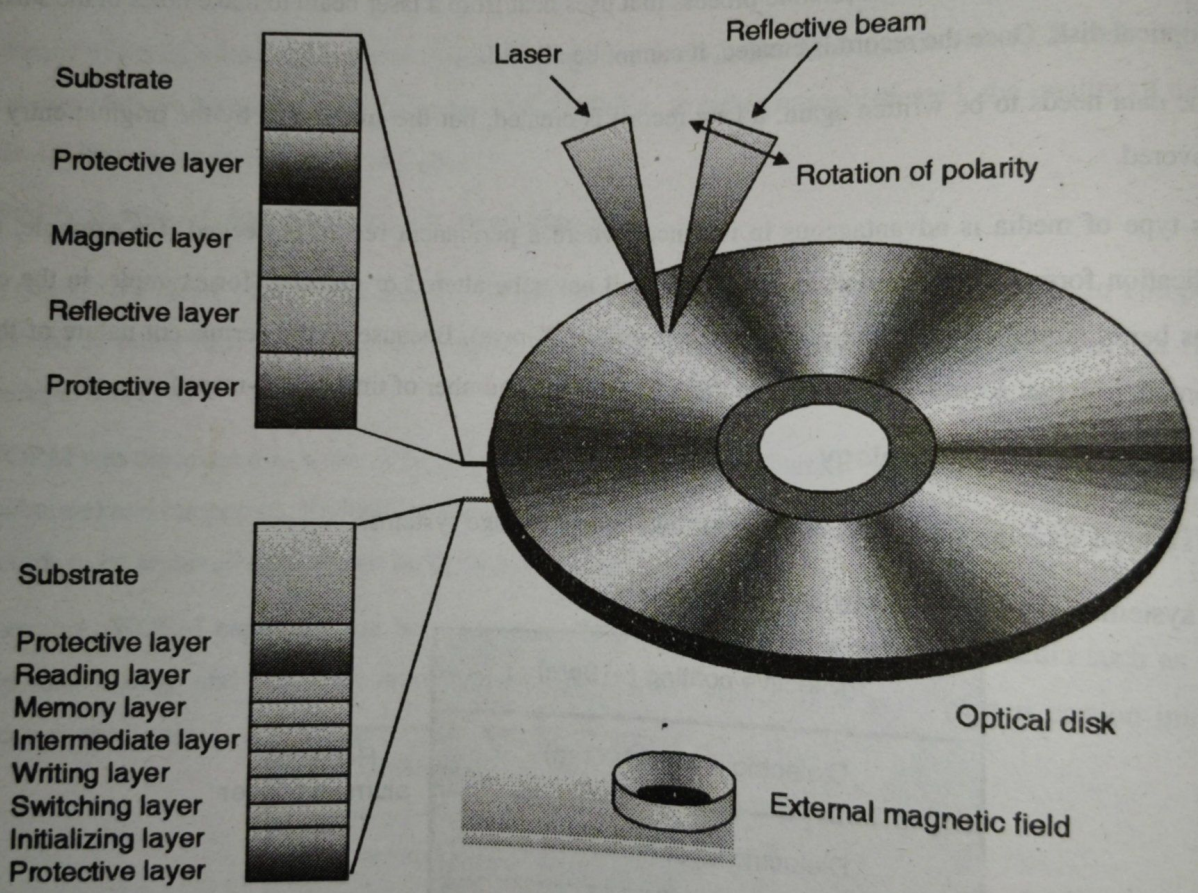


**Fig. 1.10.8**

- First, a high power laser-beam raises the temperature of a particular point at the active layer on a MO medium. When at the same time BIAS magnetic field is applied perpendicularly to the medium, the local temperature of the particles at the region of this point goes up to the "Curie point (180-200 °C). Then, the direction of magnetization on this particular point becomes reverse (angle change). After the laser beam is switched off, the magneto-optical layer cools down very rapidly.
- The information is then fixed on the medium and it can be altered only by using a laser beam and a BIAS magnet again. The data is more securely stored compared to conventional magnetic disks, on which even a small magnet can cause loss of data.

## 5. DVD (Digital Versatile Disc)

- The DVD (Digital Versatile Disc, or less commonly Digital Video Disc) is an "alternative" to the Compact Disc (CD) with six times as much storage space.
- The DVD is designed to make data addressable and accessible at random (non-sequentially). It has a complex structure which provides greater interactivity.
- DVD is plastic discs of 12 cm in diameter and 1.2 mm thick, which are read using a laser beam. DVD burners use a red laser with a wavelength of 635 nm or 650 nm.
- The main reason to use DVDs is their storage capacity, which makes them an excellent medium for video. A 4.7 GB DVD can store more than two hours of compressed video in MPEG-2 (Motion Picture Experts Group), a format used for compressing images while still keeping them high-quality.

### Structure of DVD

#### i. Physical structure

DVDs exist in both "single layer" and "dual layer" (DL) versions. Dual layer discs are made up of a translucent, gold-based semi-reflective layer and an opaque, silver-based reflective layer, separated by a bonding layer. In order to read both these layers, the drive has a layer which can change its intensity by modifying its frequency and focus :

- with low intensity the beam is reflected off the outer gold surface;
- with higher intensity, the beam passes through the first layer is reflected off the inner silver surface.

The inner layer, however, has a lower density. Additionally, it stores the information "upside down" on an inverted spiral, in order to limit latency when moving from one layer to the other. DVD discs are generally divided into four families, each with different storage capacities depending on their physical characteristics :

| Type of disc | Characteristics | Storage capacity |
|---|---|---|
| DVD-5 | single-sided, single layer | 4.7 GB |
| DVD-9 | single-sided, dual layer | 8.5 GB |
| DVD-10 | double-sided, single layer | 9.4 GB |
| DVD-17 | double-sided, dual layer | 18 GB |

**ii. Logical structure**

A DVD is essentially made up of three zones, which represent the *information area* :

- The **Lead-in Area** (or *LIA* for short) only contains data which describes the disc's contents (this information is stored in the *Table of Contents*, or **TOC**). The Lead-in Area lets the DVD player/drive follow the spiralling pits in order to synchronise itself with the data found in the *program area.*
- The **Program Area** is the area which contains the data.
- The **Lead-Out Area** (or *LOA* for short), containing null data (silence on an audio DVD) marks the end of the DVD.
- Besides the three areas described above, a recordable DVD contains a *PCA* (*Power Calibration Area*) and an *RMA* (*Recording Management Area*) located before the Lead-In Area.
- The PCA can be seen as a testing area for the laser, so that it can calibrate its power depending on the kind of disc being read. This area is what makes it possible to sell blank CDs that use different dyes and reflective layers. Each time it is readjusted, the burner notes that it has carried out a test. Up to 99 tests are allowed per disc.

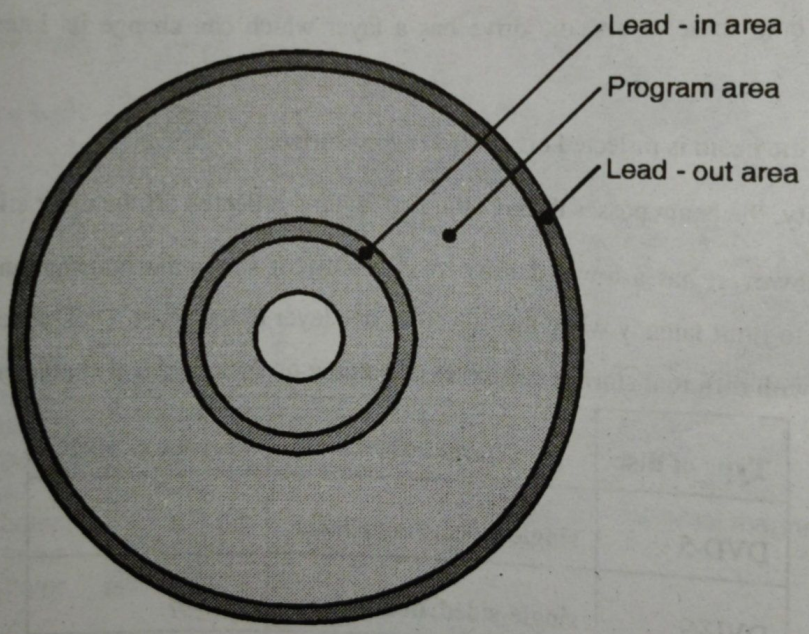


**Fig. 1.10.9**

**Standard DVD formats**

The official specifications for DVD are divided into five books :

- Book A for DVD-ROM;
- Book B for DVD Video;
- Book C for DVD Audio;

- Book D for writeable (DVD-R) and rewritable (DVD-RW) DVDs. The DVD-R format is Write-Once, while DVD-RW is a rewritable format, which lets data be rewritten using a phase-change metallic alloy;
- Book E for rewritable DVDs (also called DVD-RAM, for *DVD Random Access Memory*). DVD-RAM is a rewritable medium which uses phase-change technology to record data. DVD-RAMs are actually cartridges which are composed of a case and a DVD. Some cartridges are removable, so that a DVD-RAM can be played in a DVD player.

### Standard DVD recording formats

There are currently three recordable DVD formats :

- DVD-RAM by Toshiba and Matsushita. This format is mainly used in Japan.
- **DVD-R/DVD-RW**, supported by the DVD Forum. DVDs in DVD-R format can only be recorded once, while DVD-RWs can be rewritten up to about 1000 times. The DVD-R format, as well as DVD-RW, can store up to 4.7 GB on a disc.
- **DVD+R / DVD+RW**, supported by Sony and Philips within the DVD+RW Alliance, which also includes Dell, Hewlett-Packard, Mitsubishi/Verbatim, Ricoh, Thomson and Yamaha.

### Structure of a video DVD

A video DVD may contain data for standalone DVD players, as well as additional data that can be read by a computer. A video DVD has a hierarchical folder organisation for storing video and audio data. It normally relies on the following structure :

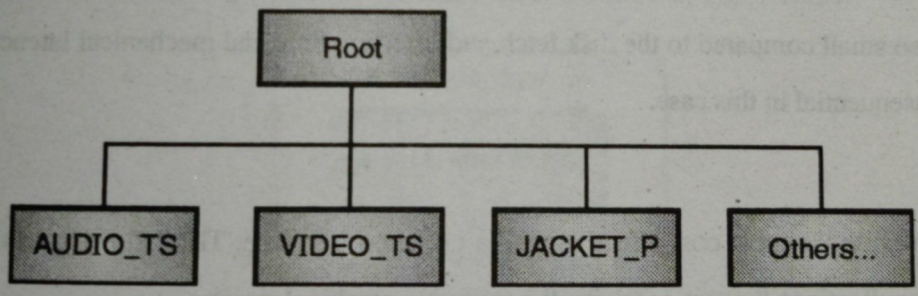


**Fig. 1.10.10**

The main directory, named *VIDEO_TS* (for *Video Title Sets*), holds the DVD video files. The *AUDIO_TS* directory is for DVD audio, but it is sometimes required by certain DVD players. *JACKET_P* contains images of the DVD's cover art. Lastly, you can also add other folders to it, which can be read by a computer.

## 6. Juke box (Optical Disk Library)

The difference in musical jukebox and optical jukebox is that optical disk library, the platters are optical and contain objects such as data, audio, video and images. Instead of a turn able, an optical disk has one or more optical drives.

Another difference is optical disk library uses a very high speed and accurate servo-controlled electromechanical robotically elevator mechanism for moving the optical platters from a drive and return it to its slot on the stack after the disk has finished playing. Optical disk libraries range from desktop jukeboxes with on 5 1/4" drive and a 10-slot optical disk stack for up to 10 GB of storage to large libraries using as many as four 12" drives with an 80-slot optical disk stack for up to terabytes of storage.

A jukebox may contain drives of different types, including WORM, rewritable or multifunction. Jukebox can contain one or more drives. The drive is daisy chained on a SCSI bus with their own SCSI IDs. The robotics device also behaves as a SCSI device with its own SCSI ID, thereby allowing programmatic control of the device. The size of jukebox varies from small desktop versions.

### ☞ Way of Using

Jukebox based optical disk libraries can be networked so that multiple users can access the information. Optical disk libraries serve as near-line archive for audio and video servers for audio and video objects stored as part of old but nit purged office mail.

### ☞ Performance

The best case performance is achieved when the required information is in an optical disk which is already mounted in a drive. The worst case performance is when the required information is on the platter and which is not mounted in a drive and all drives have other mounted disk volumes.

The optical disk library logic can be unmounted and returned to its slot. The required disk volume is then fetched by the robotics and inserted into the drive and spun to its rated speed (20-25 S). The disk access and transferred time are so small compared to the disk fetch and insertion time and mechanical latencies for the robotics that are almost inconsequential in this case.

### ☞ Application

Optical disks provide the most cost effective media i.e. almost on-line. The following examples illustrate the types of multimedia applications that are good candidates for hierarchical storage.

- Police records with fingerprints and mug shots require multimedia applications. Video interviews of witnesses and criminals, and their associated documents, can be stored permanently on WORM disk libraries to provide a vast resource database.
- Insurance companies can photograph or video clips of vehicles and accident scene and store them on optical disk for use during processing claims.
- City and country Government use optical storage for maintaining near-line electronic database of paper files on properties and constituents for tax records, deed recording and so on.

**Syllabus Topic : Multimedia Databases**

## 1.10.4 Multimedia Database Management

Multimedia database is a kind of database like any other database containing multimedia collections. Multimedia is defined as the combination of more than one media, they may be of two types-static and dynamic media. Text, graphics and images are categorized as static media; on the other hand, objects like animation, music, audio, speech, video are categorized as dynamic media. Graphic images may consist of cliparts, photographs, logos and custom drawings. Sound consists of voice narration, speech, music etc.

Video data encompasses sound as well as photos. To manage these data multimedia database management system is essential. Multimedia database management system can be defined as a software system that manages a collection of multimedia system can be defined as a software system that manages a collection of multimedia data and provides access to users to query and retrieve multimedia objects.

Generally, multimedia database contains text, image, animation, video audio, movie sound etc. But, all data are stored in the database in binary form.

## 1.10.4(A) Multimedia Database Management System

- The main task of multimedia database management system is to abstract from the details of storage access and storage management.
- Multimedia Database Management System (MDBMS) is embedded between the application domain and the device domain. Location of MDBMS in multimedia system is shown in Fig. 1.10.11.

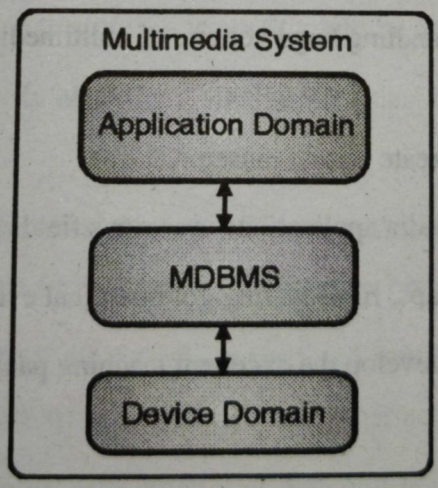


**Fig. 1.10.11 : Location of MDBMS**

- MDBMS is part of system domain. It is integrated into system domain through the operating system and communication component. Integration of MDBMS into system is shown in Fig. 1.10.12.

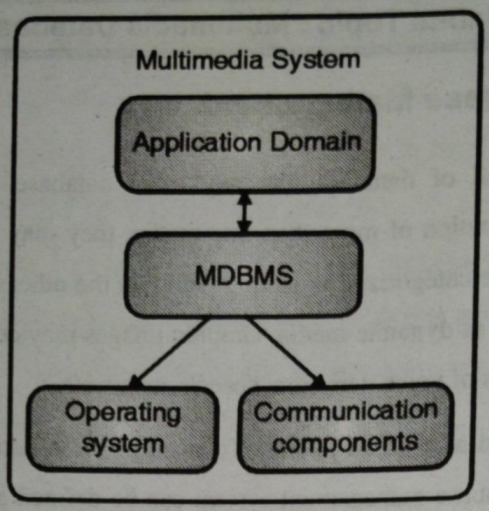


**Fig. 1.10.12 : Integration of MDBMS into system**

- The design of a multimedia database management system is unlikely to follow in the footsteps of the design of a traditional database management system due to following characteristics of multimedia objects :
  - Multimedia objects are complex and therefore less completely captured in a MDBMS.
  - Multimedia objects are audiovisual in nature.
  - Multimedia objects are context dependence
  - Queries looking for multimedia objects are fuzzy in nature.

☞ **Why Multimedia Database ?**

Following arguments will try to justify the requirements of multimedia database as explained below :

- Multimedia database is capable of handling huge volume of multimedia objects which a general database fails to do effectively.
- Multimedia Database will help to create virtual museum.
- It will surely help to develop multimedia applications in various fields like teaching, medical sciences.
- Preserving decaying photographs, maps, films having got historical evidence or national importance.
- Using multimedia database, we can develop the excellent teaching packages.
- Helps multi-user operations.

☞ **Properties of MDBMS**

Following are the properties of MDBMS :

1. **Persistence of data**

Data outlive processing programs and technologies, e.g. companies have to keep data in database for several decades.

2. **Consistent view of data**

   Synchronisation protocols provide a consistent view of data in a multi-user system.

3. **Security of data**

   Transaction concepts ensure security and integrity protection in case of system failure. Recovery of lost data.

4. **Query and retrieval of data**

   Query languages such as SQL (Structured Query Language) enable formulating database queries.

   Each entry has its state information that can be retrieved correctly.

## 1.10.4(B) Characteristics of MDBMS

A MDBMS (Multimedia Database Management System) can be characterized based on its objective at the time of handling multimedia objects :

1. **Corresponding Storages Media :** Multimedia data should be stored according to characteristics of storage media.
2. **Descriptive Search Methods :** user should have content-based access to multimedia information.
3. **Device-independent Interface :** The interface to multimedia database should be device dependent.
4. **Format independent Interface :** Database queries should be independent of media format. MMDBMS should provide information in formats requested by the applications (GIF, TIFF, SUN Raster,...).
5. **View Specific and Simultaneous data Access :** Object sharing is the capability for different documents to share parts of their contents. Such a capability is especially necessary for multimedia documents as the amounts of storage space required to store a document might be quite large.
6. **Management of Large Amounts of Data :** MMDBMS must be capable of handling and managing large amounts of data
7. **Relational Consistency of Data Management :** This requirement ensures multimedia database consistency through rules, which impose some form of execution order on concurrent transactions.
8. **Real time data Transfer :** DBMS must perform read and write operations of continuous data in real time. Continuous data transfer should have higher priority than other action.
9. **Long Transaction :** The transfer of large amount of data will take a long time and must be done in a reliable fashion.

## 1.10.4(C) Multimedia Database Content

Multimedia database generally holds the following multimedia components like-text graphic, animation, sounds, video etc.

1. **Text :** In multimedia applications, text is being used. Reason is that a longer text reading is difficult by the smaller screen resolution. At the same time, when a piece of information fails to communicate to other using other multimedia elements, text is mandatory. Text should be used only such case where it able to eliminate potential information ambiguity.

2. **Speech :** Speech is continuous concept. Speech can introduce, give survey, stimulate and tell. Speech is ideals as an additional explanation of text.

3. **Graphic :** It is a very powerful multimedia component. The real strength of graphic is to maintain context. Graphics are discrete concepts. The user himself determines viewing moments and duration. In this way, graphics are very suitable for individual studying and analyzing of connections. The combination with text is good because both are discrete representations. Graphic approve more interpretation than the image and can be used better for the support of mental model.

4. **Image :** The image is very much related by its photorealistic representation to the concrete content. User moods can be influenced by images. In this case the combination of image with sound will be very much effective.

5. **Animation :** Animation is also a component in multimedia database. It can be defined as the change in the characteristics of an object over a period of time. Animation files require more storage space than graphic files involving signal image.

6. **Sound :** Sound as music or speech has a power to invoke emotions. Music can stimulate moods positively in reviving or relaxation of mind and body; whereas sound as noise helps to irritate people. The combination of sound with animation will really have a realistic effect on users.

7. **Video :** Video is the most powerful of all the multimedia components. It helps to portray the real world events. It will also help to grasp the more delicate and complicated situation/ ideas into minds.

## 1.10.4(D) Structure of Multimedia Database

Multimedia database structure can best be explained with following components :

1. Data Analysis
2. Data modelling
3. Data Storage
4. Data Retrieval
5. Query Language
6. Multimedia Communication

1. **Data Analysis**

In data analysis generally two questions are often asked : How are these data structured ? How can these data be accessed ? Data can be stored in the database in either unformatted (unstructured) from or formatted (structured) form. Unstructured data are presented in a unit where the content cannot be retrieved by accessing any structured details. Structured data are stored in variables, fields or attributes with corresponding values. Multimedia data are stored in database as raw, registering and descriptive data types. Raw data are generally represented by the pixels in the form of a bytes and bits. For example, in image can be represented in pixel and to get the image it is essential to know the size of the image.

2. **Data Modelling**

Data model deals with the multimedia objects, which has already been explained in the previous section. Data model concentrates on conceptual design of the multimedia database in order to execute certain operations like, media object selection, insertion, querying and retrieval etc. Time based multimedia like video, audio and animation involve notions of data flow, timing, temporal composition and synchronization. These notions are quite different from conventional data like textual data flow. One of the gravest problems of multimedia database system is the description of the structure of time constraint media for querying, updating retrieval and presentation.

3. **Data Retrieval**

The ultimate objective of any multimedia database is how to access multimedia information effectively. With respect to access, multimedia object can be classified into two active and passive objects. The objects, which are not participating in the retrieval process, are called passive objects. In a really multimedia database environment all object should be active objects.

4. **Query language**

In order to retrieve multimedia data from database system, query language is provided to fulfill this purpose. In a DBMS process, user queries are processed by defining a query languages as part of DBMS. It is an unseparated part of DBMS. A multimedia query language must have ability to handle complex, spatial, and temporal relationships. A powerful query language should have to deal with keywords, index to keywords and contents of multimedia objects. Traditional DBMS deals with exact match query. Generally, there are two types of queries used in databases. They are well defined query and fuzzy query. In a well defined query, the user must know what they are intended to search. The second one is called fuzzy where the properties of query objects are ambiguous. In such a situation, multimedia data quires can be divided into the sub-groups like keyword querying, semantic querying and visual querying. Keyword querying is still popular because of its simplicity. Semantic query is the most difficult query method in terms of its indexing and pattern matching. Visual querying is used in QBIC (Query By Image Context) through icon leading to content search in the domain of image.

5. **Multimedia Communication**

Communication is the sole objective of any information system. Distributed multimedia system with sophisticated features are capable of satisfying multiuser environment allowing more than one user to communicate at each other simultaneously.

## 1.10.4(E) Operations on Data

A MDBMS must offer, for all the data types corresponding operation for archival and retrieval. The media related operations will be handled as part of query language.

Different classes of operation needed are :

- Insert operation
- Output operation
- Modification operation
- Deletion operation
- Comparison operation
- Evaluation operation

Each of these operations is explained as follow :

1. **Input (Insert / record) operation**
   - Data will be written to the database.
   - The raw and registering data ate always needed, descriptive data can be attached later.
2. **Output (Play) operation**

   Reads the raw data from the database according to the registering data.
3. **Modification**
   - Changing of raw, registering and descriptive data.
   - Modification can also be understood as a data conversion from one format to another.
4. **Deletion operation**
   - Removes an entry from the database.
   - The consistency of the data must be preserved.
5. **Comparison**
   - Many queries to the MDBMS consist of a search and retrieval of the stored data.
   - Queries are based on comparison information.

- Individual patterns in the particular medium are compared with the stored raw data.
- Pattern matching, search in descriptive data, etc.

6. **Evaluation**

Generation of the corresponding descriptive from the raw and registering data.

## Review Questions

Q. 1 Explain the properties of multimedia systems.

Q. 2 Explain global structure of multimedia system.

Q. 3 Write note on Multimedia Applications.

Q. 4 Draw and explain the workstation based architecture for multimedia systems. Also specify the hardware and software expected at each layer (if any) considering an example.

Q. 5 Give the multimedia applications and explain.

Q. 6 Explain architecture of MM system.

Q. 7 Explain evolving technologies of multimedia systems.

*Chapter Ends...*

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