Multimedia

- *Multi* - many; much; multiple
- *Medium* - a interleaving substance through which something is transmitted or carried on
- Any kind of system that supports more than one kind of media
- Multimedia means integration of continuous media (e.g. audio, video) and discrete media (e.g. text graphics, images) through which digital information can be conveyed to the user in appropriate way.

5 Basic kinds of Media / Elements of Multimedia

Data Types	**Media Types**
Number/Text	Text
Image	Image
Audio	Audio
Video	Video
	Animation/CGI

Representation Dimension of media:
Media are divided into two types in respect to time in their representation space:

1. **Time independent (discrete):** Information is expressed only in its individual value. E.g.: text, image, etc.
2. **Time dependent (continuous):** Information is expressed not only it's individual value, but also by the time of its occurrences. E.g.: sound and video.

Multimedia System

- A multimedia system is characterized by computer-controlled, integrated production, manipulation, storage and communication of independent information, which is encoded at least through a continuous (time-dependent) and a discrete (time-independent) medium.
- A **Multimedia System** is a system capable of processing multimedia data and applications.
- A **Multimedia System** is characterised by the processing, storage, generation, manipulation and rendition of Multimedia information.

Characteristics of a Multimedia System
A Multimedia system has four basic characteristics:

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

Categories of Multimedia

- Based on how multimedia programs are used, multimedia can be divided into two forms
  - Linear multimedia
  - Non-linear multimedia

Linear multimedia

- In linear multimedia, information is read or viewed in a continuous sequence.
- Usually, these presentations begin at a predetermined starting point and end at a predetermined end point.
- They can be automated so that each screen comes after a fixed time interval.
- Example: Powerpoint presentation is one of the most common examples of linear multimedia.

Non-Linear multimedia

- Non-linear multimedia information is not presented in sequential or chronological manner.
- Non-linear multimedia programs are usually interactive and require audience interaction.
- Example: One of the most common examples of this form of multimedia is the Web.

Fig: Linear Multimedia

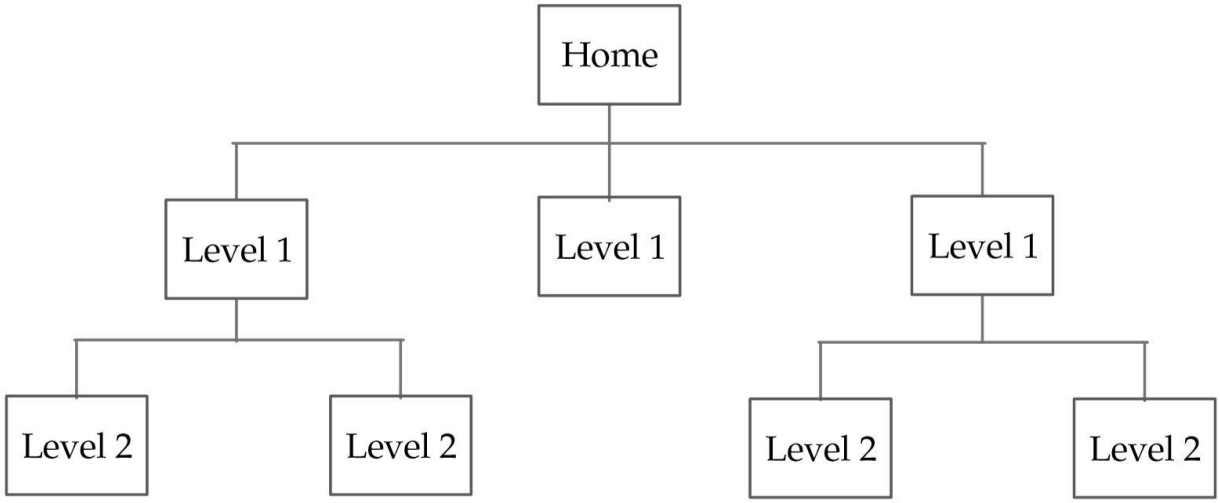


Fig: Non-linear Multimedia

Classification of Media:

1. The Perception media
2. The Representation Media
3. The Presentation Media
4. The Storage media
5. The Transmission media
6. The Information Exchange media

Perception media: Perception media help human to sense their environment. The central question is how human perceive information in a computer environment. The answer is through seeing and hearing.

- **Seeing:** For the perception of information through seeing the usual such as text, image and video are used.
- **Hearing:** For the perception of information through hearing media such as music noise and speech are used.

Representation media: Representation media are defined by internal computer representation of information. The central question is how the computer information is coded? The answer is that various format are used to represent media information in computer.

i. Text, character is coded in ASCII (American Standard Code for Information Interchange) code
ii. Graphics are coded according to CEPT (Conference of European Postal and Telecommunications Administration) or CAPTAIN (Character and Pattern Telephone Access Information Networks) video text standard.
iii. Image can be coded as JPEG (Joint Photographic Experts Group) format
iv. Audio video sequence can be coded in different TV standard format(PAL (Phase Alternating Line), NTSC (National Television System Committee), SECAM (Sequential color with memory) and stored in the computer in MPEG format)

Presentation Media: Presentation media refer to the tools and devices for the input and output of the information. The central question is, through which the information is delivered by the computer and is introduced to the computer.

- Output media: paper, screen and speaker are the output media.
- Input Media: Keyboard, mouse, camera, microphone are the input media.

Storage media: Storage Media refer to the data carrier which enables storage of information. The central question is, how will information be stored? The answer is hard disk, CD-ROM, etc.

Transmission media: Transmission Media are the different information carrier that enables continuous data transmission. The central question is, over which information will be transmitted? The answer is co-axial cable, fiber optics as well as free air.

Information exchange media: Information exchange media includes all information carrier for transmission, i.e. all storage and transmission media. The central question is, which information carrier will be used for information exchange between different places? The answer is combine uses of storage and transmission media. E.g. Electronic mailing system.

Properties of Multimedia System:

The uses of term multimedia are not every arbitrary combination of media. Justify.

1. **Combination of media:** A simple text processing program with in corporate image is often called a multimedia application. Because two media are processed through one program. But one should talk multimedia only when both continuous and discrete media are utilized. So text processing program with incorporated images is not a multimedia application.

2. **Computer support integrated:** computer is idle tools for multimedia application
3. **Independence:** An important aspect of different media is their level of independence from each other.

Multimedia- Applications

Multimedia plays major role in following areas

- Instruction
- Business
  - Advertisements
  - Training materials
  - Presentations
  - Customer support services
- Entertainment
  - Interactive Games
- Enabling Technology
  - Accessibility to web based materials
  - Teaching-learning disabled children & adults
- Fine Arts & Humanities
  - Museum tours
  - Art exhibitions
  - Presentations of literature
- Web page Design

Multimedia Skills

Members of a Multimedia Team

- A team of skilled individuals is required to create a good multimedia project.
- Team building refers to activities that help a group and its members function at optimum levels.
- The diverse range of skills required for a project is called the multimedia skillset.
- A multimedia team consists of the following:
  - Project Manager
  - Multimedia Designer
  - Interface Designer
  - Writer
  - Video Specialist
  - Audio Specialist
  - Multimedia Programmer
  - Producer for the Web Site
  - Computer Programmers

The **Project Manager** is responsible for:

- The overall development, implementation, and day-to-day operations of the project.
- The design and management of a project.
- Understanding the strengths and limitations of hardware and software.
- Ensuring people skills and organizational skills.
- Conveying information between the team and the client.

Multimedia designer - This team consists of:

- Graphics designers, illustrators, animators, and image processing specialists who deal with visuals, thereby making the project appealing and aesthetic.
- Instructional designers, who make sure that the subject matter is presented clearly for the target audience.
- Interface designers, who devise the navigational pathways and content maps.
- Information designers, who structure content, determine user pathways and feedback, and select presentation media.

An **Interface Designer** is responsible for:

- Creating a software device that organizes content, allows users to access or modify content, and presents that content on the screen.
- Building a user-friendly interface.

A **Multimedia Writer** is responsible for:

- Creating characters, actions, point of view and interactivity.
- Writing proposals and test screens.
- Scripting voice-overs and actors' narrations.

A **Video Specialist** needs to understand:

- The delivery of video files on CD, DVD, or the Web.
- How to shoot quality videos.
- How to transfer the video footage to a computer.
- How to edit the footage down to a final product using digital nonlinear editing system (NLE).

An **Audio Specialist** is responsible for:

- Locating and selecting suitable music talent.
- Scheduling recording sessions.
- Digitizing and editing recorded material into computer files.

Multimedia programmer, also called a software engineer:

- Integrate all the multimedia elements into a seamless project, using authoring systems or programming language.
- Writes codes for the display of multimedia elements, and to control various peripheral devices.
- Manages timings, transitions and record keeping.

Multimedia Producer for the Web:

- Web site producers put together a coordinated set of pages for the Web
- They also co-ordinate updates and changes.

Hardware Components

- To develop a multimedia project, you usually need a fast (high specifications) computer
- High specs include the speed and storage space of the computer

- Hardware components are divided into 5 categories:
    - System Devices
    - Memory and Storage Devices
    - Input Devices
    - Output Devices
    - Communication Devices

System Devices
Essential components for a computer
Devices include:
- Microprocessor
- Motherboard
- Memory

Microprocessor
- Heart of the computer.
- Microprocessor is the one that performs the computer operations.

Motherboard
- Device in the computer that contains the computer's basic circuitry and other components.
- Contains computer components like microprocessor, memory, basic input/output system (BIOS), expansion slots and interconnecting circuitry.

Memory and Storage Devices

RAM (Random Access Memory)

- Primary memory that locates the operating system, application programs and data in current use.
- It is called "random access" any storage location can be accessed directly or randomly.
- Much faster than the hard disk, floppy disk and the CD ROM.
- RAM is a short term memory storage device, hard disk is the long term memory storage device.

Hard Disk

- Stores and provides access to large amounts of data on electro magnetically charged surface.
- Contains a part called disk cache which is responsible for improving the time it takes to read from or write to a hard disk.
- Other type of hardware cache inside a computer is cache memory.
- Cache stores something temporarily.

Compact Disc (CD)

- Small medium that can store data pertaining to audio, video, text and other information in digital form.
- Are Read-Only devices; however newer technology allows users to record as well.

CD-ROM (Compact Disc, Read-Only memory)

- Can store data in the form of text, graphics and sound
- There are a few types of CD ROMs:
    - CD Recordable (CD-R): Once data recording is completed, it becomes CDROM which data cannot be deleted or edited.
    - CD-Rewritable (CD-RW)

Input Devices

Keyboard

- Is the primary text input device for your computer.
- Its role became limited to dealing with text and for some commands only.
- Contain certain function keys, such as escape key, tab, cursor movement keys and shift and control keys

Mouse

- A small device that you move across a pad in order to point to a place on a display screen and thus execute a command by clicking it.
- Is an integral part of any personal computer. A cable connects the mouse to the computer.

Microphone

- Is another input device that can interpret dictation.
- Also enable us to input sound like the keyboard is used for text.

Output Devices

Digital camera

- A device that records stores photographic images in digital form that can be fed to a computer as the impressions are recorded and stored in the camera to be loaded into the computer.

Printer

- A device, which on receiving the signal from computer transfers the information to paper

Monitor

- Is a device for display.
- It is just like a television set and is measured diagonally from two opposing corners of the picture tube.
- The standard monitor size is 14 inches. Very large monitors can measure 21 inches diagonal or greater.

Amplifier

- An electronic device that increases the power of a signal.
- Amplifiers are used in audio equipments. They are also called power amplifiers.
- Speakers with built-in amplifiers have become an integral part of the computers today.
- Important for any multimedia project.

Communication Devices

Modem

- A device that modulates digital signals going out from a computer or other digital device to analog signals and then demodulates the analog signal to convert it to a digital signal to be inputted in a computer.
- Modems help your computer to connect to a network.

Other Hardware Devices

Video capture

- Is one of the most important hardware to be used for multimedia work on a personal computer.
- Video-capture results will depend on the performance and capacity of all of the components of your system working together.
- Video capture from analog devices like video camera requires a special video capture card that converts the analog signals into digital form and compresses the data.

Sound Card

- A device that attaches to the motherboard to enable the computer to input, process, and deliver sound.
- The sound card generates sounds; records sound from analog devices by converting them to digital mode and reproduce sound for a speaker by reconverting them to analog mode.

Video Adapter

- Device that provides extended capability to a computer in terms of video.

- The better the video adapter, the better is the quality of the picture you see.
- A high quality video adapter is a must while designing a multimedia project.

Multimedia Softwares

Graphics Design

- Adobe Photoshop
- Adobe Illustrator
- Adobe In Design
- Corel Draw
- Corel Paint

Audio Editing

- Windows Sound Recorder
- Sony Sound Forge
- Audacity
- Sound Booth

Video Editing

- Window Movie Maker
- Adobe Premiere Pro
- AVID Express Pro
- Final Cut Pro

Animation

2D Animation

- Flash
- Toon Boom
- After Effects

3D Animation

- 3DS MAX
- Maya
- Softimage
- Blender
- Cinema 4D
- Z Brush

Visual Display System

Cathode-ray tube

The cathode-ray tube (CRT) is a vacuum tube that contains one or more electron guns and a phosphorescent screen and is used to display images. It modulates, accelerates, and deflects electron beam(s) onto the screen to create the images. The images may represent electrical waveforms (oscilloscope), pictures (television, computer monitor), radar targets, or other phenomena.

In television sets and computer monitors, the entire front area of the tube is scanned repetitively and systematically in a fixed pattern called a raster. In color devices, an image is produced by controlling the intensity of each of the three electron beams, one for each additive primary color (red, green, and blue) with a video signal as a reference. In all modern CRT monitors and televisions, the beams are bent by magnetic deflection, a varying magnetic field generated by coils and driven by electronic circuits around the neck of the tube, although electrostatic deflection is commonly used in oscilloscopes, a type of electronic test instrument.

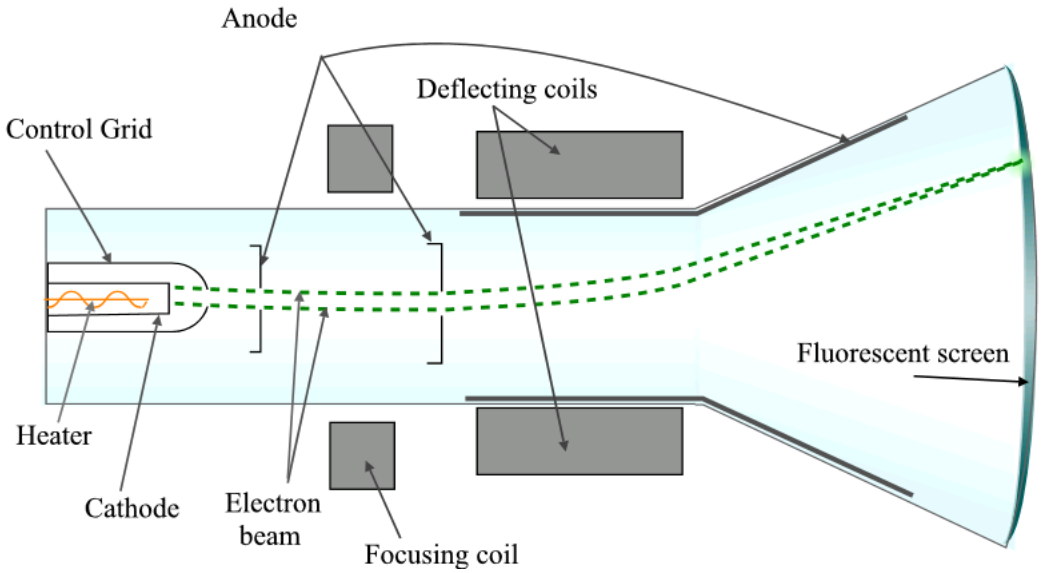


Fig: Florescent coated Black and White CRT

Color CRTs

Color tubes use three different phosphors which emit red, green, and blue light respectively. They are packed together in stripes (as in aperture grille designs) or clusters called "triads" (as in shadow mask CRTs). Color CRTs have three electron guns, one for each primary color, arranged either in a straight line or in an equilateral triangular configuration (the guns are usually constructed as a single unit). (The triangular configuration is often called "delta-gun", based on its relation to the shape of the Greek letter delta Δ.) A grille or mask absorbs the electrons that would otherwise hit the wrong phosphor. A shadow mask tube uses a metal plate with tiny holes, placed so that the electron beam only illuminates the correct phosphors on the face of the tube; the holes are tapered so that the electrons that strike the inside of any hole will be reflected back, if they are not absorbed (e.g. due to local charge accumulation), instead of bouncing through the

hole to strike a random (wrong) spot on the screen. Another type of color CRT uses an aperture grille of tensioned vertical wires to achieve the same result.
Two type:

i. Beam Penetration Method
ii. Shadow Mask Method

i. Beam Penetration Method:

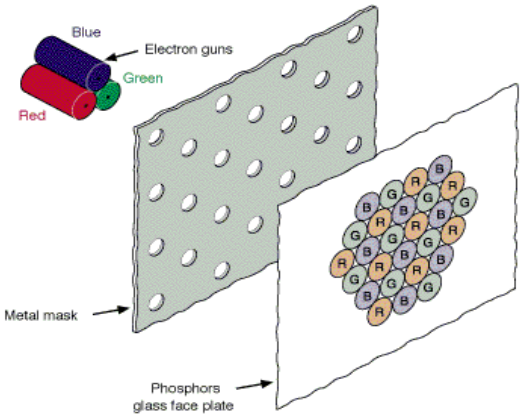
- Two different layers of phosphor coating used Red (outer) and Green (inner)
- Display of color depends on the depth of penetration of the electron beam into the phosphor layers
  - A beam of slow electrons excites only the outer red layer
  - A beam of very fast electrons penetrates thru the red phosphor and excites the inner green layer
  - When quantity of red is more than green then color appears as orange
  - When quantity of green is more than red then color appears as yellow
- Screen color is controlled by the beam acceleration voltage.
- Only four colors possible, poor picture quality

ii. **Shadow Mask Method:**

- The inner side of the viewing surface of a color CRT consists of closely spaced groups of red, green and blue phosphor dots.
- Each group is called a *triad*
- A thin metal plate perforated with many small holes is mounted close to the inner side of the viewing surface. This plate is called *shadow mask*
- The shadow mask is mounted in such a way that each hole is correctly aligned with a triad in color CRT
- There are three electron guns one for each dot in a triad
- The electron beam from each gun therefore hits only the corresponding dot of a triad as the three electron beams deflect
- A triad is so small that light emanating from the individual dots is perceived by the viewer as a mixture of the three colors
- Thus, a wide range of colors can be produced by each triad depending on how strongly each individual phosphor dot in a triad is excited.
- Two types:

i. A Delta –Delta CRT

- A triad has a *triangular (delta) pattern* as are the three electron guns
- Main drawback of this type of CRT is that a high precision display is very difficult to achieve because of technical difficulties involved in the alignment of shadow mask holes and the triad on one to one basis



ii. A Precision Inline CRT

- A triad has an *in-line pattern* as are the three electron guns
- The introduction of this type of CRT has eliminated the main drawback of a Delta-Delta CRT
- But a slight reduction of image sharpness at the edges of the tube has been noticed
- Normally 1000 scan lines can be achieved
- The necessity of triad has reduced the resolution of a color CRT
- The distance between the center of adjacent triads is called a *pitch*
- In very high resolution tubes, pitch measures 0.21 mm (0.61 mm for home TV tubes)
- The diameter of each electron beam is set at 1.75 times the pitch
    - For example if a color CRT is 15.5 inches wide and 11.6 inches high and has a pitch of 0.01 inches
    - The beam diameter is therefore 0.01 x 1.75 = 0.018 inches
    - Thus the resolution per inch is about 1/0.018 = 55 lines
    - Hence the resolution achievable for the given CRT is 15.5 x 55 = 850 by 11.6 x 55 = 638
- The resolution of a CRT can therefore be increased by decreasing the pitch
- But small pitch CRT is difficult to manufacture because it is difficult to set small triads and the shadow mask is more fragile owing to too many holes on it .
- Besides the shadow is more likely to warp from heating by the electrons

Analog signal (audio, video) representation

Analog signal

- Continuous signal for which the time varying feature (variable) of the signal is a representation of some other time varying quantity, i.e., *analogous* to another time varying signal.
- ex.: in sound recording, fluctuations in air pressure representing the actual sound “is analogus” to the variations induced by a vibrating diaphragm in the electrical current/voltage produced by the coil/condensor in an electromagnetic microphone; in radio modulation of a sinusoidal carrier wave (e.g. amplitude modulation – AM, frequency modulation – FM)

- Advantages:
  - Has the potential of infinite resolution of the signal (high density)
  - Processing is simple
- Disadvantages:
  - noise – as the signal is copied and re-copied or transmitted over long distances random variations occur
  - impossible to recover from noise/distortion

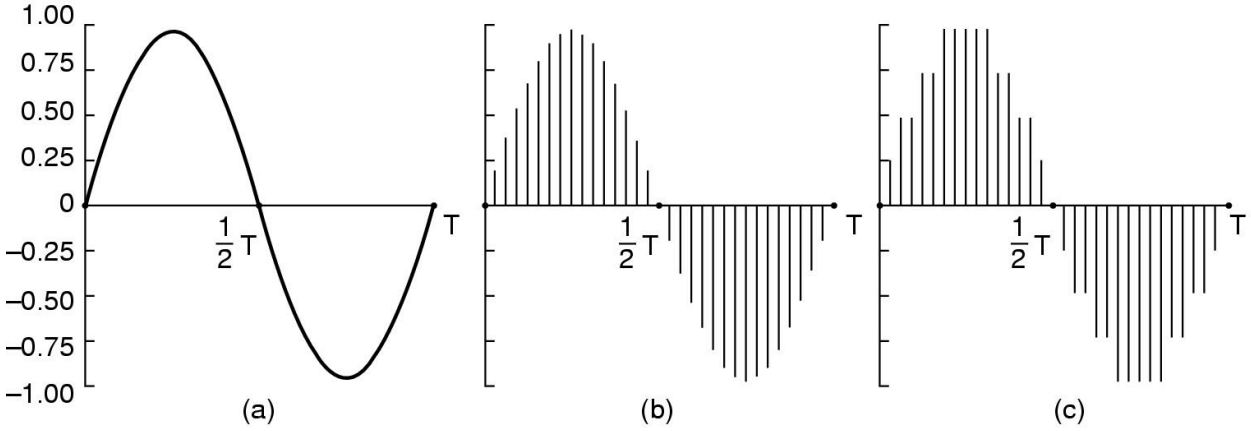
Digital signal (audio, video) representation

- Digital signal = a signal which is represented as a sequence of numbers (usually in binary numbers)
  - ex.: digital image – matrix of pixels, digital sound – vector of sound amplitudes
- Advantages:
  - as opposed to analog signals, degradation of the signal (i.e. noise) can not only be detected but corrected as well
  - scales well with the increased complexity of the system
- Disadvantages:
  - it is error prone (due to quantization and sampling)
  - it has lower resolution than analog signals

Analog-to-digital signal conversion

- converting a continuous analog signal into a discrete digital signal has 2 sub processes:
  - *sampling* - conversion of a continuous-space/time (audio, video) signal into a discrete-space/time (audio, video) signal
  - *quantization* - converting a continuous-valued (audio, video) signal that has a continuous range (set of values that it can take) of intensities and/or colors into a discrete-valued (audio, video) signal that has a discrete range of intensities and/or colors; this is usually done by rounding, truncation or other irreversible non-linear process of information destruction

- Audio encoding – example



(a) a sine wave
(b) sampling the sine wave
(c) quantizing the samples to 3 bits (i.e. 2^3 = 8 quantization levels)

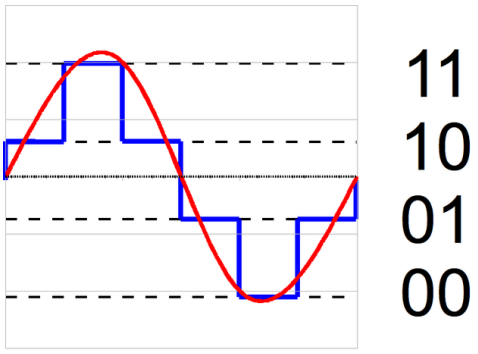


Fig: 2-bit resolution with 4 levels

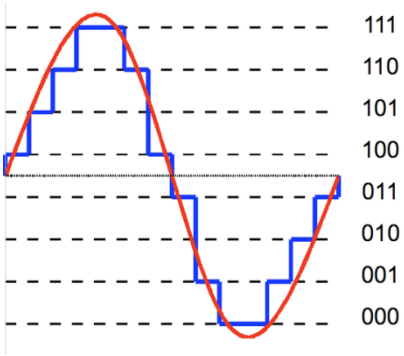


Fig: 3-bit resolution with 8 levels

Nyquist Sampling Theorem

The Nyquist Sampling Theorem states that:

- A bandlimited continuous-time signal can be sampled and perfectly reconstructed from its samples if the waveform is sampled over twice as fast as its highest frequency component.
- **Nyquist limit:** the highest frequency component that can be accurately represented:

  $$F_{max} < f_s/2$$

- **Nyquist frequency:** sampling rate required to accurately represent up to fmax:

  $$F_s > 2f_{max}$$

- No information is lost if sampling above 2fmax.

Quantization Error

- The difference between an input value and its quantized value (such as round-off error) is referred to as **quantization error**.
- A device or algorithmic function that performs quantization is called a **quantizer**.
- An analog-to-digital converter is an example of a quantizer.

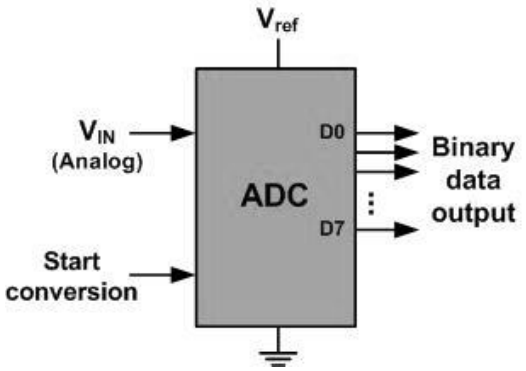


Fig: 8-Bit Analog to Digital Converter

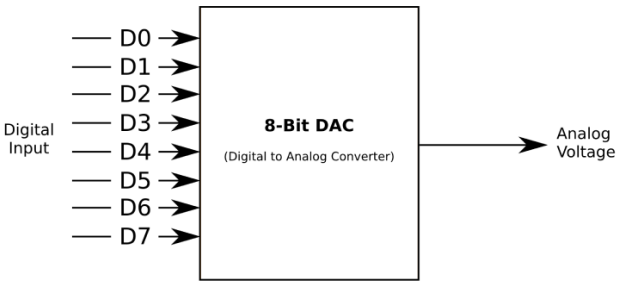


Fig: 8-Bit Digital to Analog Converter

Huffman Coding Algorithm

- Huffman coding algorithm was invented by David Huffman in 1952.
- It is an algorithm which works with integer length codes.
- A Huffman tree represents Huffman codes for the character that might appear in a text file. Unlike to ASCII or Unicode, Huffman code uses different number of bits to encode letters. If the number of occurrence of any character is more, we use fewer numbers of bits.
- Huffman coding is a method for the construction of minimum redundancy codes.
- Huffman tree can be achieved by using compression technique.
- Data compression have lot of advantages such as it minimizes cost, time, bandwidth, storage space for transmitting data from one place to another.
- In regular text file each character would take up 1 byte (8 bits) i.e. there are 16 characters (including white spaces and punctuations) which normally take up 16 bytes. In the ASCII code there are 256 characters and this leads to the use of 8 bits to represent each character but in any test file we do not have use all 256 characters. For example, in any English language text, generally the character 'e' appears more than the character 'z'. To achieve compression, we can often use a shorter bit string to represent more frequently occurring characters. We do not have to represent all 256 characters, unless they all appear in the document.
- The data encoding schemes broadly categorized in two categories.
    - Fixed Length Encoding Scheme
    - Variable Length Encoding Scheme

The following general procedure is applied for construction a Huffman tree:

- Search for the two nodes having the lowest frequency, which are not yet assigned to a parent node.
- Couple these nodes together to a new interior node.
- Add both the frequencies and assign this value to the new interior node.
- The procedure has to be repeated until all nodes are combined together in a root node.

Construct a Huffman tree by using these nodes.

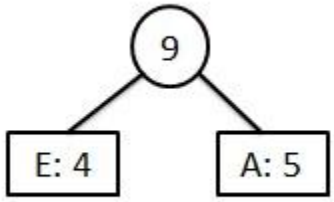
Value	A	B	C	D	E	F
Frequency	5	25	7	15	4	12

Solution:

Step 1: According to the Huffman coding we arrange all the elements (values) in ascending order of the frequencies.

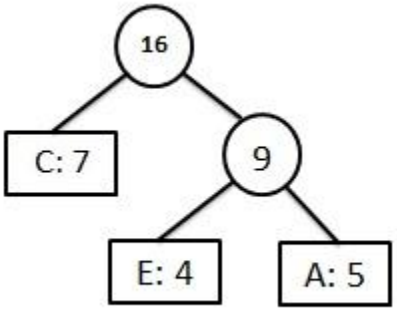
Value	E	A	C	F	D	B
Frequency	4	5	7	12	15	25

Step 2: Insert first two elements which have smaller frequency.



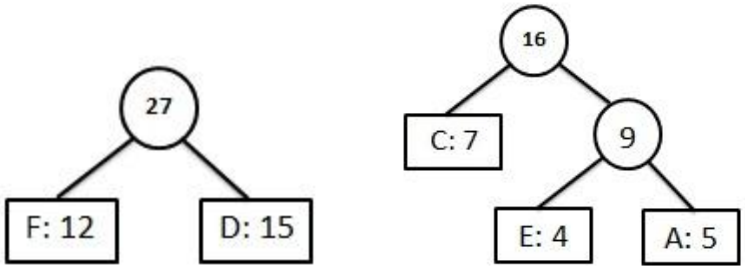
Value	C	EA	F	D	B
Frequency	7	9	12	15	25

Step 3: Taking next smaller number and insert it at correct place.



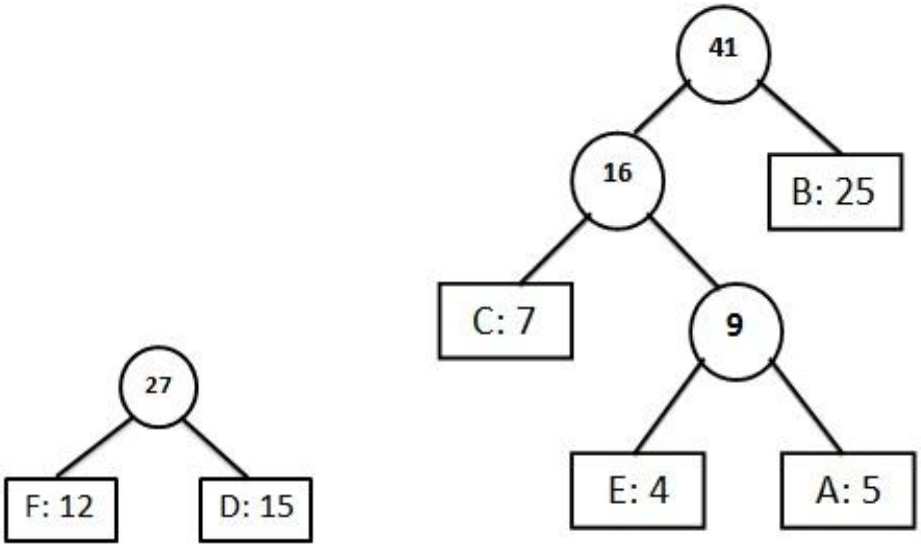
Value	F	D	CEA	B
Frequency	12	15	16	25

Step 4: Next elements are F and D so we construct another subtree for F and D.



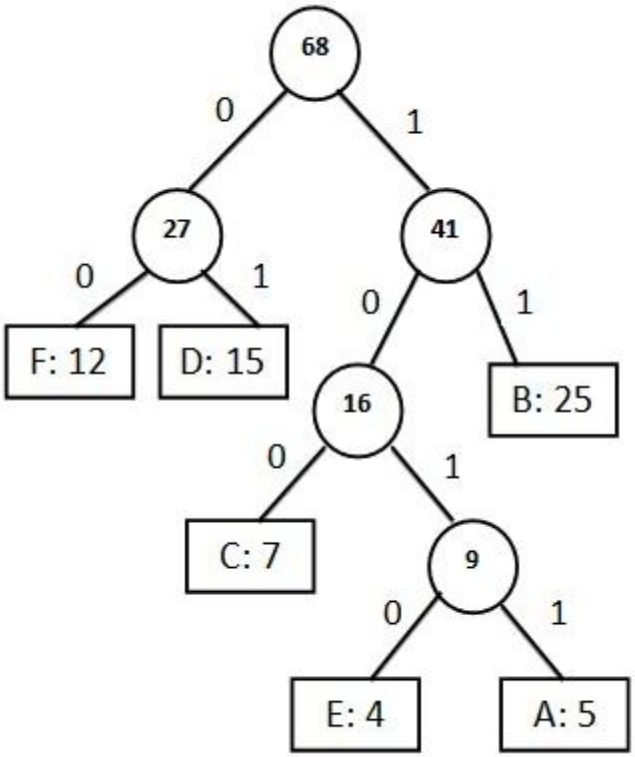
Value	CEA	B	FD
Frequency	16	25	27

Step 5: Taking next value having smaller frequency then add it with CEA and insert it at correct place.



Value	FD	CEAB
Frequency	27	41

Step 6: We have only two values hence we can combined by adding them.



Huffman Tree

Value	FDCEAB
Frequency	68

Construct a Huffman tree by using these nodes. (Classwork)

Value	A	E	I	S	T	P	\n
Frequency	10	15	12	3	4	13	1