BCA 4TH SEMESTER

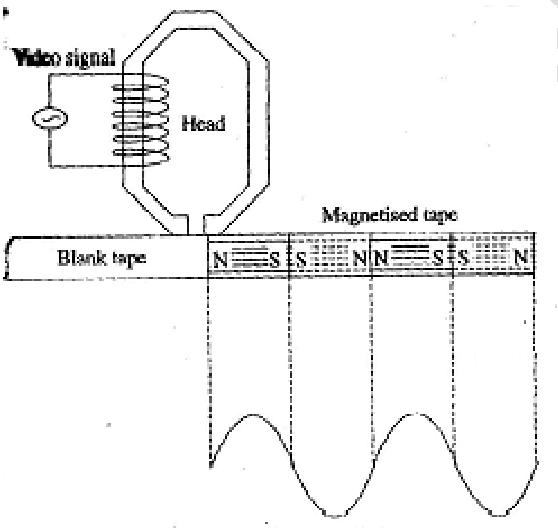
BASICS OF AUDIO AND VIDEO MEDIA

VIDEO RECORDING & REPRODUCTION

A camera tube converts brightness and colour of a picture into electrical signals called video signals

Method for recording video signals

- Recording on tape is done in the form of tiny magnets.
- Reproduction is done using the principle of electromagnetic induction
- Recording on disc is done in the form of tiny pits.
- Reproduction is done by sensing capacitance between stylus and pits
- When electrical signals consisting of alternating electric current pass through an electromagnet coil, magnetic flux is produced in the soft iron core of the electromagnet.
- The core has a small air gap of high reluctance.
- When a tape coated with magnetic material (iron oxide) of low reluctance is pressed against the gap, magnetic flux passes through the tape
- For playback , the varying magnetic field on the tape surface induces voltage in the coil, which is processed and reproduced



Digital Video Recording

• Digital video is made up of a series of orthogonal bitmap images (frames) which are displayed at a constant rate (FPS) and in rapid succession

• Colour depth (CD) of a video – greater the number of bits the more subtle the colour variations variations

• Bit Rate(BR) = W x H x CD x FPS

• Video Size = BR x T

• Pixels per frame = W x H

• Pixels per second = W x H x FPS

• Bits per frame = W x H x CD

- Decompressed video: BR = W x H x CD x FPS / CF
- Video Size(VS) = BR x T / CF
- Average Bits Per Pixel = CD / CF
- Transmission link should have the capacity to support BR of the video
- VS is proportional to duration (T) and BR
- BPP: 24 (uncompressed), 16 or 12 (chroma sampling), 8 or 1 (jpeg compression), and fractions for MPEG-1, MPEG-2, MPEG-4 video compression algorithms
- Video with constant BR is suitable for video conferencing
- Certain algorithms are used to adjust BPP to high for complex scenes and low for less demanding scenes
- Image capture formats in digital video camera – interlaced, de-interlaced
- Interlaced video: each frame is made up of two halves (fields) of an image. Odd numbered and even numbered lines of the frame are placed in each half
- De-interlaced cameras record every frame as distinct

VCD

- CD: developed (to record sound) by Sony and Philips (1982).
  Diameter – 120 mm, single side
- CD-Video (1987) to store 5 minutes music analog video
- VCD (1990) to store 83 minutes of audio and video. Played using DVD players
- Video specification: Codec - MPEG-1 (differences between successive video frames), BR – 1150 kbps, Rate control – CBR
- Audio specification: Codec – MPEG-1 Audio Layer II (clearly distinguished sound is recorded) recorded), Frequency – 44 1. KHz, O/P – stereo, BR – 220 kbps, Rate control - CBR
- First track contains metadata and menu information
- Windows Windows Media Player and VLC Player supports VCD (Windows (Windows Vista platform onwards, Linux, Mac OS)
- CD-i DV (for movies), XVCD, KVCD, Double VCD (stores 100 minutes of video), Digital Video Interface (stores 72 minutes of video), Super VCD, VHS (it can accommodate 10 hours of video)

DVD

- Developed by Sony and Pacific Digital Company (1994)

- Computers with DVD-ROM drive (1997)
- DVD players players read DVD, decrypt decrypt data with CSS, interpret interpret and adhere to DVDs regional restrictions, decode MPEG-2 video stream, decode sound according to the audio format, generate an o/p analog/digital video signal (HDMI)
- Playback formats: MP3, VCD, DivX, Dolby Digital and Digital Theatre Systems
- Video connections connections: composite composite video, S-video, component component video, SCART, HDMI
- DVD players with USB ports, bluetooth and wi-fi facilities

• Software Software: VLC player, MPlayer MPlayer, PowerDVD PowerDVD, WinDVD

Blu-ray Disc

• Developed by Sony (2006)

• To store high-definition video of resolution up to 1920 x 1080 pixels, 60 fps

• BD-RE recorder uses digital rights management standard (provide better security)

• File system: universal disk format 2.5

• Application format: Blu-ray Disc Audio/Video (BDAV), BD Movie (BDMV), BDMV recording specification for BD-RE and BD-R, Real-time Recording and Editing Format (subset of BDMV), high fidelity pure audio (a high definition audio disc)

• Player profiles: BD-Audio, BD-Video

Video Compression

• Moving Pictures Expert Group-1: temporal redundancy

• Resolution: 4095 x 4095 (12 bits), BR: 100 mbps

• MPEG-2: lossy compression compression

• Used in digital TV broadcasting, DVD videos/players

• MPEG-4: Used in web or streaming media, CD distribution, telephone telephone and videophone videophone, broadcast broadcast TV applications applications

• MPEG-4 Part 2: used by DivX, Xvid, Nero Digital, 3ivx and Quick Time 6

• MPEG-4 Part 10: used by x264 encoder encoder, Nero Digital Digital AVC, Quick Time 7 and Blu-ray disc

• Features: VRML support for 3D rendering, object-oriented composite files (audio, video and VRML objects), support for externally specified DRM, interactivity of various types

Functions:

- Enable efficiency in coding standards over MPEG-2
- Capability for mixed media data encoding (audio, video and speech)
- Enable robust transmission
- Capability to interact with receiver generated audio-visual scene
- Technologies allowed: creation of adaptable and flexible multimedia objects
- Interaction with various animated objects
- Interpretation and transformation of data into other signal types
- Implementation of a standardised DRM signaling – IPMP
- H.26 by VCEG
- Video compression formats: H.120 (in 1984), H.261 (in 1990), H.262, H.263 (in 1995), H.263+ (in 1998), H.263++ (in 2000), H.264 (Advanced Video Coding standard), H.265 (High Efficiency Video Coding released in 2013)

MPEG-1 standard

- The MPEG-1 standard was primarily targeted for multimedia CD-ROM applications at a bit rate of 1.5 Mbits/sec.
- The standard is generic in the sense that it specifics a syntax for the representation of the encoded bitstream and a method of decoding.
- Unlike JPEG, MPEG-1 does not stipulate use of specific algorithms for bitstream generation and allows substantial flexibility.
- The syntax supports operations such as motion estimation; motion compensated prediction; Discrete Cosine transforms (DCT); quantization and variable length coding.
- The standard supports a number of parameters that can be specified in the bit-stream itself and a variety of picture sizes, aspect ratios etc. are permissible.
- In addition, MPEG-1 standard supports the following application specified features:
    - Frame–based random access of video: This is achieved by allowing independent access-points (I-frames) to the bit-stream.
    - Fast-forward and fast reverse (FF/FR) searches: This refers to the scanning of the compressed bitstream to search for the desired portions of the video stream.
    - Reverse playback of video
    - Edit ability of the compressed bit stream
    - Reasonable coding / decoding delay of about 1 sec to give the impression of interactivity.

MPEG-2 standrd

- MPEG-2 was given the charter to provide video quality not lower than NTSC/PAL and up to CCIR 601 quality.
- MPEG-2 addresses the emerging applications like digital cable television distribution, high definitions televisions (HDTV), satellite digital video broadcasts, networked multimedia through ATM etc.
- Compression, coding and transmission of high quality multi-channel, multimedia signals for terrestrial broadcast, digital, cable TV distribution, broadband networks etc.
- Defining profiles and levels as the subset of syntax to suit wide range of applications.
- Scalable bit stream
- Error-correction capabilities
- Backward compatibility with MPEG-1, so that every MPEG-2 compatible decoder can decode a valid MPEG-1 bit stream

MPEG-4 standard

- In 1994, the MPEG committee introduced a new standardization phase, called MPEG-4, which finally became a standard in 2000.
- Unlike its predecessors, MPEG-4 coding did not remain confined to the domain of rectangular-sized pictures but adopted an object based coding concept in which arbitrarily shaped and dynamically changing individual audio-visual objects in a video sequence can be individually encoded, manipulated and transmitted through independent bitstream.
- It was standardized to address a wide range of bit-rates- from very low bit rate coding (5-64 Kbits/sec) to 2 Mbits/sec for TV/film applications.
- In recent times, MPEG-4 has found widespread applications in internet streaming, wireless video, digital video cameras as well as in mobile phones and mobile palm computers.
- Two additional features of MPEG-4, namely sprite coding and the abilities to combine synthetic and natural video
- The MPEG-4 standard was conceptualized with an objective to standardize algorithms for audio-visual coding in multimedia applications, with flexibility for interactions, universal accessibility and high compression.
- Following features can be listed as its objectives:
  (a) Support for content-based manipulation and bit stream editing,

  (b) Ability to combine synthetic scenes or objects with natural scenes and objects,

  (c) Provisions for efficient random access of video frames or objects.

  (d) Better visual quality at comparable bit rates, as compared to its earlier standards.

  (e) Ability to encode multiple views, for example stereoscopic video

  (f) Provisions for error robustness to allow access to a variety of wireless and wired networks, storage media

(g) Scalability with fine granularity in content, quality and complexity.

H.261 and 263 standards

- Apart from the MPEG, the International Telecommunication Union-Telecommunications Standards Sector (ITU-T) also evolved the standards for multimedia communications at restricted bit-rate over the wireline and wireless channels.
- The ITU-T standardization on multimedia first started with H.261, which was developed for ISDN video conferencing.
- The next standard H.263 supported Plain Old Telephone Systems (POTS) conferencing at very low bit-rates (64 Kbits/sec and lower).
- The most recent and advanced standard H.264 offers significant coding improvement over its predecessors and supports mobile video applications.

H.261

- The H.261 standard developed in 1988-90 was a fore runner to the MPEG-1 and was designed for video conferencing applications over ISDN telephone lines.
- Baseline ISDN has a bit-rate of 64 Kbits/ sec and at the higher end, ISDN supports bit-rates having integral multiples (p) of 64 Kbits/sec. For this reason, the standard is also referred to as the p x 64 Kbits/sec standard.
- In addition to forming a basis for the MPEG-1 and MPEG-2 standards, the H.261 standards offers two important features:
  a) Maximum coding delay of 150 msec. It has been observed that delays exceeding 150 msec do not provide direct visual feed back in bi-directional video conferencing

  b) Amenability to VLSI implementation, which is important for widespread commercialization of videophone and teleconferencing equipments.

The H.261 standard supports two picture formats:

i) Common Intermediate Format (CIF), having 352 x 288 pixels for the luminance channel (Y) and 176 x 144 pixels for each of the two chrominance channels U and V. Four temporal rates, 30, 15, 10 or 7.5 frames/ sec are supported. CIF images are used when $p \geq 6$, that is for video conferencing applications.

ii) Quarter of Common Intermediate Format (QCIF) having 176 x 144 pixels for the Y and 88 x 72 pixels each for U and V. QCIF images are normally used for low bit-rates applications like videophones (typically p =1). The same four temporal rates are supported by QCIF images also. H.261 frames are of two types
- I-frames: These are coded without any reference to previously coded frames.
- P-frames: These are coded using a previous frame as a reference for prediction.

H.263

- During the development of H.263, the target bit-rate was determined by the maximum bitrate achievable at the general switched telephone network (GSTN), which was 28.8 Kbits/sec at that time. At these bit-rates, it was necessary to keep the overhead information at a minimum.
- The other requirements of H.263 standardization were:
  - Use of available technology
  - Interoperability between the other standards, like H.261
  - Flexibility for future extensions
  - Quality of service parameters, such as resolution, delay, frame-rate etc.
  - Subjective quality measurements.

  Based on all these requirements an efficient coding scheme was designed. Although it was optimized for 28.8 Kbits/sec, even at higher bit rates up to 600 Kbits/sec, H.263 outperformed the H.261 standard.

H.264 standard

- The video coding standards released by the International Telecommunication Union (ITU) in the 1990s, H.261 and H.263 along with its extensions H.263 + triggered wide range of applications, which did not remain restricted to ISDN and Public Switched Telephone Networks (PSTN) domain, but proliferated to mobile wireless networks, LAN/internet delivery of video stream etc.
- The need for further improvement in coding efficiency by at least two times for the same fidelity was soon realized. In 1998, the Video Coding Experts Group (VCEG) of the ITU invited proposals for a new video coding project, named H.26L which would have two times better coding efficiency over a broad range of applications.
- In December 2001, the VCEG and the Motion Pictures Experts Group (MPEG) formed a Joint Video Team (JVT).
- Their combined efforts resulted in the new coding standard H.264. This also forms the Part-10 (Advanced Video Coding) of MPEG-4 and is therefore referred to as H.264 / AVC standard.