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**Q.2** a. What is meant by the terms Multimedia and Hypermedia? Distinguish between these two concepts.

**Answer**:

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

**Hypermedia ---** An application which uses associative relationships among information contained within multiple media data for the purpose of facilitating access to, and manipulation of, the information encapsulated by the data.

b. Briefly explain why we need to have less than 24-bit colour representations (typically down to 8-bit) and why this is sometimes a problem? Give one example where 8-bit colour representation have an advantage in terms of image/video processing?

**Answer:**

Reasons are :

Need more video memory 24 bit colour is overkill for even most photorealistic images

1 million colour at max present, 24-bit allows for 16-17 Million colours. There a waste of video memory and bandwidth. Some video cards do not support 24-bit color (more a legacy issue, most modern PCs now support high end graphics). It is better to use 8-bit: as it is bandwidth friendly. Moreover, some video effects more easily coded by colour table manipulation rather than pixel manipulation e.g. Making objects fade to background, color overlay

c. What is VRML? Explain.

**Answer:**

The Virtual Reality Modeling Language (VRML) allows us to describe 3D objects, and combine them into interactive scenes and worlds. The virtual worlds - which can integrate 3D graphics, multimedia, and interactivity - can be accessed through the WWW (http). The remote users can explore the content interactively in much more sophisticated ways than clicking/scrolling. VRML is not a programming language like JAVA, nor is it a "Markup Language" like HTML. It is a modelling language, which means we use it to describe 3D scenes. It's more complex than HTML, but less complex (except for the scripting capability) than a programming language. VRML is a (text)file-format that integrates 3D graphics and multimedia: a simple language for describing 3D shapes and interactive environments. We can create(write) a VRML file using either any text editor or "wordbuilder" authoring software. To view a VRML file we need either a standalone VRML browser or a Netscape plug-in

**VRML 1.0** allowed to create static 3D worlds assembled from static objects, which could be hyperlinked to other worlds, as well as to HTML documents. Visitors of the worlds were able to "fly" or "walk" around the static objects, and the only way of interaction was possible by "clicking" on a hyperlinked object, which worked like a hyperlink on a www-page: dropped to the target of the link.

In **VRML 2.0** objects can be animated, and they can respond to both time-based and user-initiated events. VRML 2.0 also allows us to incorporate multimedia objects(for example sound and movies) in our scenes.

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**Q.3** a. List three distinct models of colour used in Multimedia. Explain why there are a number of different colour models exploited in multimedia data formats.

**Answer:**

Possible models:

- RGB
- CIE Chromaticity
- YIQ Colour Space
- YUV (YCrCb)
- CMY/CMYK

Different models reflect need to represent colour in a perceptually relevant model for effective compression. Different models also due to evolution of colour from Video (YIQ,YUV), Display (RGB) and Print (CMYK) media requirements.

b. What are the advantages and disadvantages of digital representation for video?

**Answer:**

Definition of Digital - A method of storing, processing and transmitting information through the use of distinct electronic or optical pulses that represent the binary digits 0 and 1.

**Advantages of Digital** –

- Storing video on digital devices, ready to be processed such as nois4e removal, cut and paste etc. and can be integrated into various multimedia applications
- Less expensive, More reliable and Flexible
- Easy to manipulate
- Direct access, which makes nonlinear video editing simple
- Repeated recording without degradation of image quality.
- Ease of encryption and better tolerance to channel noise.
- Compatibility with other digital systems
- Only digitised information can be transported through a noisy channel without degradation on Integrated networks

**Disadvantages of Digital** –

- Sampling Error
- Digital communications require greater bandwidth than analogue to transmit the same information.
- The detection of digital signals requires the communications system to be synchronised, whereas generally speaking this is not the case with analogue systems.

c. Compare between various standards for the transmission and reception of analog broadcast TV systems.

**Answer:**

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**Broadcast television systems** are encoding or formatting standards for the transmission and reception of terrestrial television signals. There are three main analog television systems in current use around the world: NTSC, PAL, and SECAM These systems have several components, including a set of technical parameters for the broadcasting signal, a encoder system for encoding color, and possibly a system for encoding multichannel television sound(MTS).

**Q.4** a. What do you understand by Huffman coding? What is the principle in generating the Huffman code?

**Answer:**

Huffman coding is a statistical technique which attempts to reduce the amount of bits required to represent a string of symbols. The algorithm accomplishes its goals by allowing symbols to vary in length. Shorter codes are assigned to the most frequently used symbols, and longer codes to the symbols which appear less frequently in the string. The Huffman code for an alphabet (set of symbols) may be generated by constructing a binary tree with nodes containing the symbols to be encoded and their probabilities of occurrence. Huffman coding is based on the frequency of occurance of a data item (pixel in images). The principle is to use a lower number of bits to encode the data that occurs more frequently. Codes are stored in a *Code Book* which may be constructed for each image or a set of images. In all cases the code book plus encoded data must be transmitted to enable decoding.

b. Briefly describe “Lossy Compression” method. Where is it used?

**Answer:**

Lossy compression is a method of compressing data (digital multimedia) and then decompressing it to retrieve the data, though the decompressed one may be slightly different than the original one. Lossy compression method is used to compress multimedia data comprising of digital audio, video and still images. Although, digital still images do not need to be compressed, still lossy method serves as an important compression tool for it, especially for websites that have number of images.

c. What is MIDI? How is a basic MIDI message structured?

**Answer:**

**Definition of MIDI:** a protocol that enables computer, synthesizers, keyboards, and other musical device to communicate with each other.

Structure of MIDI messages:

- MIDI message includes a status byte and up to two data bytes.
- Status byte
- The most significant bit of status byte is set to 1.
- The 4 low-order bits identify which channel it belongs to (four bits produce 16
- possible channels).
- The 3 remaining bits identify the message.
- The most significant bit of data byte is set to 0.

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**Q.5** a. When compression ratio is low for an image data using lossless compressio technique? What methods are adopted for higher compression ratio? Also describe when Distortion measure is used?

**Answer:**

Compression ratio is low for an image data using lossless compression techniques such as Huffman coding arithmetic coding, LZW, when image histogram is relatively flat.

For image compression in multimedia applications where higher compression ratio is required lossy methods are usually adopted. In lossy compression the compressed image is usually not the same as the original image but it this meant to form a close approximation to the original image perpetually. To quantitatively describe how close the approximation is to the original data some form of distortion measure is required.

Distortion measure is a mathematical quantity that specifies how close an approximation is to its original using distortion criterion. For image distortion we need to find the numerical difference between the original and reconstructed data. Three types of numerical distortion used in image compression techniques are:

a) Mean Square Error(MSE): if we are interested to find average pixel difference
b) Signal –to-Noise ratio(SNR): if we are interested in the size of the error relative to signal. In this we can take the average square of the original data sequence and Mean Square Error.
c) Peak Signal –to-Noise ratio(PSNR): It measures the size of the error relative to peak signal.

b. What is the significance of JPEG standard? Describe any two modes that JPEG standard support.

**Answer:**

JPEG is designed for compressing either full-color or gray-scale images of natural, real-world scenes. JPEG is a lossy compression algorithm. When we create a JPEG or convert an image from another format to a JPEG, we are asked to specify the quality of image we want. Since the highest quality results in the largest file, we can make a trade-off between image quality and file size. The lower the quality, the greater the compression, and the greater the degree of information loss. JPEGs are best suited for continuous tone images like photographs or natural artwork; not so well on sharp-edged or flat-color art like lettering, simple cartoons, or line drawings. JPEGs support 24-bits of color depth or 16.7 million colors. JPEG is actually just a compression algorithm, not a file format. JPEG compression introduces noise into solid-color areas, which can distort and even blur flat-color graphics. All Web browsers most support JPEGs, and a rapidly growing number support progressive JPEGs

**JPEG Modes:** The JPEG standard supports numerous modes (variations). Some of the commonly used ones are:

**Sequential Mode**. This is the default JPEG mode. Each gray-level image or color image component is encoded in a single left-to-right, top-to-bottom scan. We implicitly assumed this mode in the discussions so far. The 'Motion JPEG' video codec uses Baseline Sequential JPEG, applied to each image frame in the video.

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**Progressive Mode.** Progressive JPEG delivers low-quality versions of the image quickly, followed by higher-quality passes, and has become widely supported in web browsers. Such multiple scans of images are of course most useful when the speed of the communication line is low. In Progressive Mode, the first few scans carry only a few bits and deliver a rough picture of what is to follow. After each additional scan, more data is received, and image quality is gradually enhanced. The advantage is that the user-end has a choice whether to continue receiving image data after the first scan(s). Progressive JPEG can be realized in one of the following two ways. The main steps (DCT, quantization, etc.) are identical to those in Sequential Mode.

**Q.6** a. What does MPEG-1 and MPEG-2 standard signify for? State weakness of MPEG-1 over MPEG2. Also differentiate between them.

**Answer:**

MPEG1 and MPEG2 are both standards for the generic coding of moving pictures and associated audio information. These standards describe the combined lossy compression of audio and video procedure which allows the storage and transmission of moving pictures with audio. The compression standard for VHS quality digital video with a CD audio down to 1.5 Megabits per second is MPEG-1. In MPEG-1, the compression ratio of video without losing too much quality is 26:1 and the ratio or audio is 6:1. This type of compression makes it viable for digital audio and TV broadcasting as well as the creation of video CDs. As a consequence, this lossy audio and video format has become hugely popular due to its wide compatibility. Various products and applications use the MPEG-1 standard especially the audio format it introduced, the extremely popular MP3. Then again, the older MPEG1 has some weaknesses that were addressed by its successor, the MPEG2. These said **weaknesses** are:

- The audio compression is limited to two channels.
- There is no standardized support for interlaced video with poor compression when used for interlaced video
- It has a limited standardized profile — Constrained Parameters Bitstream — which was incompatible for video with higher resolutions. MPEG1 might support 4k video but there was no practical way to encode video for higher resolutions. Identification of hardware capable of support is also limited.
- It supports only one color space — 4:2:0.

MPEG2 can be considered as an enhanced MPEG1 in terms of quality as it is used for DVD productions. MPEG2 can capture audio/video in higher resolutions and use higher bitrates,. MPEG2 can't be played with MPEG1 players since MPEG2 streams are incompatible with those of MPEG1. Basically, one may consider MPEG2 as an MPEG1 that supports higher resolutions and capable of using higher and variable bitrates. However, MPEG1 performs better in lower bitrates than MPEG2. The **comparisons** between the two are given below:

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1. MPEG2 succeeded the MPEG1 to address some of the older standard's weaknesses.

2. MPEG2 has better quality than MPEG1.

3. MPEG1 is used for VCD while MPEG2 is used for DVD.

4. One may consider MPEG2 as MPEG1 that supports higher resolutions and capable of using higher and variable bitrates.

5. MPEG1 is older than MPEG2 but the former is arguably better in lower bitrates.

6. MPEG2 has a more complex encoding algorithm.

b. Differentiate between I-Frame and P-Frame and their coding.

**Answer:**

In the field of video compression a video frame is compressed using different algorithms These different algorithms for video frames are called **picture types** or **frame types**. The major picture types used in the different video algorithms are **I** and **P** . They are different in the following characteristics:

- An **I-frame** is an 'Intra-coded picture', in effect a fully specified picture, like a conventional static image file: that is it is treated as independent image . P-frames hold only part of the image information, so they need less space to store than an I-frame, and thus improve video compression rates. **I**-frames are the least compressible but don't require other video frames to decode. I-frames coding performs only spatial redundancy removal
- A **P-frame** ('Predicted picture') are not independent holds only the changes in the image from the previous frame. They are coded by forward predictive coding method. For example, in a scene where a car moves across a stationary background, only the car's movements need to be encoded. The encoder does not need to store the unchanging background pixels in the P-frame, thus saving space. **P**-frames can use data from previous frames to decompress and are more compressible than I-frames. Temporal redundancy removal is included in P-frame coding.

**Q.7** a. What is the significance of MPEG-7? Explain object-based visual coding in MPEG-7

**Answer:**

MPEG-7 called " Multimedia content description interface,' will be a standardized description of various types of multimedia information associated with the content itself to allow fast and efficient search, browse and retrieval of multimedia of interest to the user. IS is finalized in 2001. Various proposals using standardized content set are interactively evaluated/revised at each MPEG meeting. It does not comprise the automatic extraction of descriptors and features. It also does not specify the search engine (or any other program) that can make use of the descriptors. It however, has standardized.

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1. A set of description schemes and descriptors

2. A language to specify description schemes i.e., description definition language (DDL)

3. A scheme for coding the description allowing easy indexing, efficient storage and transmission.

It embraces existing standard descriptions for text (HTML, SGML, RDF etc) if they are appropriate for the MPEG-7 descriptions for audio-visual data. It also had standardized the linking between the descriptions of audio-visual data and text data. It will consider other standardization activities such as SMPTE/EBU task force, DVB-SI, CEN/ISSS MMI, etc. It also addresses copyright, authentication and integrity issues as appropriate. MPEG-7 bitstream syntax is also standardized along with a decoder for coded descriptors. In summary, MPEG-7 is designed to facilitate a truly integrated multimedia search engine. The tutorial will discuss the current retrieval schemes such as Four Eyes, NeTra-V, WebSeek, MARS, VideoQ, QBIC, ARTISAN, STAR, ORBIT, VisualSeek, WebClip, DrawSeek, VideoTrails, VideoBase, Vortex, MUVIS, DARWIN, MetaSeek, InLumine, and SaFe. Note that each one of these schemes is designed for retrieval of a specific type of data (images or video or audio). Also there is no compatibility among these schemes.

b. What is the significance of ADPCM in speech coding? Explain G.726 ADPCM.

**Answer:**

**Adaptive differential pulse-code modulation** (**ADPCM**) is a variant of differential pulse-code modulation (DPCM) that varies the size of the quantization step, to allow further reduction of the required bandwidth for a given signal-to-noise ratio. Typically, the adaptation to signal statistics in ADPCM consists simply of an adaptive scale factor before quantizing the difference in the DPCM encode ADPCM was developed in the early 1970s at Bell Labs for voice coding, by P. Cummiskey, N. S. Jayant, and James L. Flanagan In telephony, a standard audio signal for a single phone call is encoded as 8000 analog samples per second, of 8 bits each, giving a 64 kbit/s digital signal known as DS0. The default signal compression encoding on a DS0 is either μ-law (mu-law) PCM (North America and Japan) or A-law PCM (Europe and most of the rest of the world). These are logarithmic compression systems where a 13 or 14 bit linear PCM sample number is mapped into an 8 bit value. This system is described by international standard G.711. Where circuit costs are high and loss of voice quality is acceptable, it sometimes makes sense to compress the voice signal even further. An ADPCM algorithm is used to map a series of 8 bit μ-law (or a-law) PCM samples into a series of 4 bit ADPCM samples. In this way, the capacity of the line is doubled. **The technique is detailed in the G.726 standard**. Some ADPCM techniques are used in Voice over IP communications. ADPCM was also used by Interactive Multimedia Association for development of legacy audio codec known as ADPCM DVI, IMA ADPCM or DVI4, in the early 1990s

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**Q.8** a. What do you understand by RSVP? State its features.

**Answer:**

RSVP stands for Resource ReSerVation Protocol. RSVP is the network control protocol that allows data receiver to request a special end-to-end quality of service for its data flows. Real-time applications use RSVP to reserve necessary resources at routers along the transmission paths so that the requested bandwidth can be available when the transmission actually takes place. RSVP is a main component of the future Integrated Services Internet which can provide both best-effort and real-time service.

**RSVP Features are given be**

- **RSVP flows are simplex**:-RSVP distinguishes senders and receivers. Although in many cases, a host can act both as a sender and as a receiver, one RSVP reservation only reserves resources for data streams in one direction.
- **RSVP supports both multicast and unicast, and adapts to changing memberships and routes**. RSVP is designed for both multicast and unicast. Since the reservations are initiated by the receivers and the reservation states are soft, RSVP can easily handle changing memberships and routes. A host can send IGMP (Internet Group Management Protocol) messages to join a multicast group. Reservation merging enabkes RSVP to scale to large multicast groups without causing heavy overhead for the sender.
- **RSVP is receiver-oriented and handles heterogeneous receivers** :-In heterogeneous multicast groups, receivers have different capacities and levels of QoS. The receiver oriented RSVP reservation requests facilitate the handling of heterogeous multicast groups. Receivers are responsible for choosing its own level of QoS, initiating the reservation and keeping it active as long as it wants. The senders divide traffic in several flows, each is a separate RSVP flow with different level of QoS. Each RSVP flow is homogeneous and receivers can choose to join one or more flows. This approach makes it possible for heterogeneous receivers to request different QoS tailored to their particular capacities and requirements.
- **RSVP has good compatibility:-** Efforts have been made to run RSVP over both IPv4 and IPv6. It provides opaque transport of traffic control and policy control messages in order to be more adaptive to new technologies. It also provides transparent operation through non-supporting regions

b. State the three domains where MPEG-4 has proven to be successful. Also list features of MPEG-4.

**Answer:**

MPEG-4 is an ISO/IEC standard developed by MPEG (Moving Picture Experts Group), the committee that also developed the Emmy Award winning standards known as MPEG-1 and MPEG-2. These standards made interactive video on CD-ROM, DVD and Digital Television possible. MPEG-4 builds on the proven success of three fields:

- Digital television;

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- Interactive graphics applications (synthetic content);
- Interactive multimedia (World Wide Web, distribution of and access to content)

MPEG-4 provides the standardized technological elements enabling the integration of the production, distribution and content access paradigms of the three fields.

**Scope and features of the MPEG-4 standard**

The MPEG-4 standard provides a set of technologies to satisfy the needs of authors, service providers and end users alike.

- For authors, MPEG-4 enables the production of content that has far greater reusability, has greater flexibility than is possible today with individual technologies such as digital television, animated graphics, World Wide Web (WWW) pages and their extensions. Also, it is now possible to better manage and protect content owner rights.
- For network service providers MPEG-4 offers transparent information, which can be interpreted and translated into the appropriate native signaling messages of each network with the help of relevant standards bodies.
- For end users, MPEG-4 brings higher levels of interaction with content, within the limits set by the author. It also brings multimedia to new networks, including those employing relatively low bitrate, and mobile ones. An MPEG-4 applications document exists on the MPEG Home page (mpeg.chiariglione.org), which describes many end user applications, including interactive multimedia broadcast and mobile communications.

**Q.9** a. What are the various techniques of animation in multimedia? Also explain principles of animation.

**Answer:**

Computer animation encompasses a variety of techniques on a computer. Figures are created and/or edited on the computer using 2D bitmap graphics or created and edited using 2D vector graphics. Animation is the rapid display of a sequence of images of 2-D artwork or model positions in order to create an illusion of movement. It is an optical illusion of motion due to the phenomenon of persistence of vision. Various techniques of **traditional Animation** and **computer animation** are:-Full Animation, Rotoscoping, -Clay/Stop -motion Animation (gumby)
-Cut out animation (southpark). **Computer Animation** (computer assissted animation) encompasses a variety of techniques, the unifying factor being that the animation is created digitally on a computer. This animation takes less time than previous traditional animation.-2d animation and 3d animation.

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**2D animation :** In this figures are created and/or edited on the computer using 2D bitmap created and edited using 2Dvector graphic . This includes automated computerized versions of traditional animation techniques such as of, interpolated morphing, onion skinning and interpolated rotoscoping.

**3D animation:** is digitally modeled and manipulated by an animator. To manipulate a mesh, it is given a digital skeletal structure that can be used to control the mesh. This process is called rigging. Various other techniques can be applied, such as mathematical functions (ex. gravity, particle simulations), simulated fur or hair, effects such as fire and water and the use of motion capture to name but a few, these techniques fall under the category of 3D dynamics. Well-made 3D animations can be difficult to distinguish from live action and are commonly used as visual effects for movies.

b. Explain the commonly used DVD formats in multimedia.

**Answer:**

When DVD technology first appeared in households, users were simply watching movies.. But just as CD technology evolved so that users could record and erase and re-record data onto compact discs, the same is now true of **DVDs**. There are so many different DVD formats — DVD+R, DVD+RW, DVD-RAM, DVD-R, DVD-RW, DVD-ROM.

**DVD+R and DVD+RW**

DVD+R and DVD+RW formats are supported by Philips, Sony, Hewlett-Packard, Dell, Ricoh, Yamaha and others.DVD+R is a recordable DVD format similar to CD-R. A **DVD+R** can record data only once and then the data becomes permanent on the disc. The disc cannot be recorded onto a second time. **DVD+RW** is a re-recordable format similar to CD-RW. The data on a DVD+RW disc can be erased and recorded over numerous times without damaging the medium.

Note: DVDs that have been made using a +R/+RW device can be read by most commercial DVD-ROM players.

The crucial difference among the standards is based on which standards each manufacturer adheres to as different manufacturers support different standards. The different variations on the term DVD (e.g. +R, -R, -ROM, and so on) describe the way data is stored on or written to the disc itself. These are called physical formats.

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**DVD-R, DVD-RW DVD-RAM and DVD-ROM**

These formats are supported by Panasonic, Toshiba, Apple Computer, Hitachi, NEC, Pioneer, Samsung and Sharp. These formats are also supported by the DVD Forum.

**DVD-R** is a recordable DVD format similar to CD-R and DVD+R. A DVD-R can record data only once and then the data becomes permanent on the disc. The disc cannot be recorded onto a second time. There also are two additional standards for DVD-R disks:

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DVD-RG for general use, and DVD-RA for authoring, which is used for mastering DV video or data and is not typically available to the general public.

**DVD-RW** is a re-recordable format similar to CD-RW or DVD+RW. The data on a DVD-RW disc can be erased and recorded over numerous times without damaging the medium. DVDs created by a -R/-RW device can be read by most commercial DVD-ROM players.

**DVD-RAM** discs can be recorded and erased repeatedly but are compatible only with devices manufactured by the companies that support the DVD-RAM format. DVD-RAM discs are typically housed in cartridges.

**DVD-ROM** was the first DVD standard to hit the market and is a read-only format. The video or game content is burned onto the DVD once and the DVD will run on any DVD-ROM-equipped device. DVD-ROMs are similar to CDs.

## Text Books

1. Fundamentals of Multimedia, Ze-Nian Li and Mark S. Drew, Pentice Hall, Edition – 2007.

2. Principles of Multimedia, Ranjan Parekh, Tata McGraw-Hill, Edition 2006.

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