END TERM EXAMINATION

2015

Q1.

a. Discuss the classification of computer graphics.

Sol:

Interactive	Non-interactive
A reactive construct of mechanics, defined by rules and driven by external Inputs. Often a preconceived but in-complete and therefore not functional narrative structure is weaved into the construct.	A fixed, self-contained and preconceived passive experience, fictional or not, typically featuring a narrative, often with a beginning a middle and an end.
The audience members are participants and their interaction is vital element of the experience. The input provided can change the experience.	The audience members are observers and not able to interact.

b. What is the use of control points in a spline curve?

Sol: A spline curve is a representation for which it is easy to build an interface that will allow a user to design and control the shape of complex curves and surfaces. The general approach is that the user enters a sequence of points, and a curve is constructed whose shape closely follows this sequence. The points are called control curve that actually passes through each control point is called an interpolating curve, a curve that passes near to the control points but not necessarily through them is called an approximating curve.

Use of control points in spline curve:

1. The degree of a B-spline curve is separated from the number of control points. More precisely, we can use lower degree curves and still maintain a large number of control points.

2. We can change the position of a control point without globally changing the shape of the whole curve (local modification property).

3. Since B-spline curves satisfy the strong convex hull property, they have a finer shape control.

4. There are other techniques for designing and editing the shape of a curve such as changing knots.

c. Explain Homogenous coordinates and give its importance in transformation operations.

Sol: Homogenous coordinates: For a given 2D coordinates (x, y), we introduce a third dimension:

$$[x, y, 1]$$

In general, a homogenous coordinates for a 2D point has the form:

$$[x, y, W]$$

Two homogenous coordinates [x, y, w] and [x', y', w'] are said to be of the same (or equivalent) if

$x = kx'$

$y = ky'$ for some $k \neq 0$ where $k=2$

$w = kw'$

Therefore any [x, y, w] can be normalized by dividing each element by w:

$$[x/w, y/w, 1]$$

Homogeneous coordinate system combines transformations that coordinates are obtained directly from initial coordinates, by eliminating the calculation of intermediate coordinate values. Multiplicative and translational terms for 2-D geometric translations can be combined into a single matrix by expanding 2by2 matrix in 3by3 matrix. This allows us to express all transformation equations as matrix multiplication.

d. Differentiate between cavalier and cabinet projection.

Sol:

Cavalier projection	Cabinet Projection
Preserves lengths of lines perpendicular to the viewing plane.	Lines perpendicular to the viewing plane project at ½ of their length
3D nature can be captured but shape seems distorted.	A more realistic view than the Cavalier projection.

Can display a combination of front, side, and top views.	Can display a combination of front, side, and top views.

e. What is Anti-aliasing? How it is achieved?

Sol: In computer graphics, anti aliasing is a software technique for diminishing jaggiest-stair step-like lines that should be smooth. There are three main classes of anti-aliasing algorithms. As aliasing problem is due to low resolution, one easy solution is to increase the resolution, causing sample points to occur more frequently. This increases the cost of image production. The image is created at high resolution and then digitally filtered. This method is called super sampling or post filtering and eliminates high frequencies which are the source of aliases. The image can be calculated by considering the intensities over a particular region. This is called pre filtering. Pre filtering methods treat a pixel as an area, and compute color based on the overlap of the scene's objects with a pixels area. These techniques compute the shades of gray based on how much of a pixel area is covered by a object. Super sampling or post filtering is the process by which aliasing effects in graphics are reduced by increasing the frequency of the sampling grid and then averaging the results down. This process means calculating a virtual image at a higher spatial resolution than the frame store resolution and then averaging down to the final resolution. It is called post filtering as the filtering is carried out after sampling.

f. Why is Gouraud shading also referred as interpolation shading?

Sol: Gouraud shading, also called intensity interpolation shading, eliminates intensity discontinuities, although not completely. Gouraud shading requires that the colors of all edges of a polygon are known in advance. This can be accomplished by applying the illumination model for each vertex of the polygon. Then linear interpolation is used to determine the color of each point inside the polygon. This can be done for each scan line. To speed things up however it's better to use forward differences. You just calculate the slopes of the lines once. Then you can use those values to calculate the intensity of a new point given the value of the previous point. Because Gouraud shading uses linear interpolation this is simply done by adding a constant value to the previous one.

g. What is the full form of “PIXEL”? What is the effect on picture quality of increasing or decreasing the number of pixel in a computer screen?

Sol: Full form of pixel is "Picture element" The more pixels used to represent an image, the closer the result can resemble the original. A pixel is actually a unit of the digital Resolution depends upon the size of the pixel. Usually, with any given lens setting, the smaller the size of the pixel, the higher the resolution will be and the clearer the object in the image will be. Images having smaller pixel sizes might consist of more pixels. The number of pixels correlates to the amount of information within the image.

h. Differentiate between Cel animation and path animation.

Sol: Cel Animation: Cel animation is based on a series of frames or cells in which the object is redrawn in each consecutive cel to depict motion. Cel comes from the word celluloid (a transparent sheet material) which was first used to draw the images and place them on a stationary background. A set of eight cels that can be used to create an animation. E.g. moving hands in two directions.

Path Animation: Path Based animation is the simplest form of animation and the easiest to learn. It moves an object along a predetermined path on the screen. The path could be a straight line or it could include any number of curves. Often the object does not change, although it might resize or reshaped. Path animation used to create the illusion of a bouncing ball. This can be relatively easy process, because you need only one object (the ball), rather than several objects as in Cel animation.

i. What do you mean by data compression? Differentiate between Lossy and Lossless compression.

Sol: Data compression is a process by which the file size is reduced be re-encoding the file data to fewer bits of storage the original file. The original file can then be recreated from the compressed representation using a reverse process called decompression.

Lossy techniques	Lossless techniques
In Lossy data compression original data is not exactly restored after decompression.	In lossless data compression original data is exactly restored after decompression.
Mainly used for image data decompression.	Mainly used for text data compression and decompression. It can also be applied to image compression.
Compression ratio is high.	Compression ratio is low.

j. For showing a cartoon or animation related content which kind of computer screen will be used, a screen with high or low persistence level? Explain with reason.

Sol: Persistence of vision refers to the optical illusion whereby multiple discrete images blend into a single image in the human mind and believed to be the explanation for motion perception in cinema and animated films. Persistence is defined as the time it takes the emitted light from the screen to decay to one-tenth of its original intensity. Lower-persistence phosphors require higher refresh rates to maintain a picture on the screen without flicker. A phosphor with low persistence is useful for animation a high-persistence phosphor is useful for displaying highly complex, static pictures. Although some phosphor have persistence greater than 1 second, graphics monitor are usually constructed with persistence in the range from 10 to 60 microseconds.

Q2: Find the pixel position using Bresenham Line Drawing Algorithm when scan converting from A (22, 12) to B(34,21).

Sol: (x1, y1)=(22,12)&(x2-x1)=(34,21)

$\Delta x=12, \Delta y=9$

$|m|=9/12<1$

$P0=2\Delta y-\Delta x=6>0$ therefore next point is(x_{k+1},y_{k+1}) and $P_{k+1}=P_k+2\Delta y-2\Delta x$

If value $P_k<0$ next point to plot is (x_{k+1}, y_k) and $P_{k+1}=P_k 2\Delta y$

k	P_k	x_{k+1},y_{k+1}
0	6	(23,13)
1	0	(24,14)
2	-6	(25,14)
3	12	(26,15)
4	6	(27,16)
5	0	(28,17)
6	-6	(29,17)
7	12	(30,18)
8	6	(31,19)
9	0	(32,20)
10	-6	(33,20)
11	12	(34,21)

Q3

a) Derive the transformation matrix that reflects an object about line y=x.

b) Magnify the triangle with vertices A (0,0) B(1,1) C(5,2) to twice its size while keeping C(5,2) fixed.

Sol: a) To reflect object about line y=x we have to follow following steps

Rotate the line y=x clockwise to coincide with x axis

Apply the reflection about x axis Ref(x)

Rotate the line back in counterclockwise wise

So transformation matrix will be

$T=R_{-45}R_0(x)\ R_{45}$

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & -1 \end{pmatrix}$$

$$\begin{pmatrix} \cos 45 & -\sin 45 & 0 \\ \sin 45 & \cos 45 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} \cos 45 & \sin 45 & 0 \\ -\sin 45 & -\cos 45 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

Sol b:

1. Translate the fixed point to the origin
2. Scale the object relative to the coordinate origin using eqn before

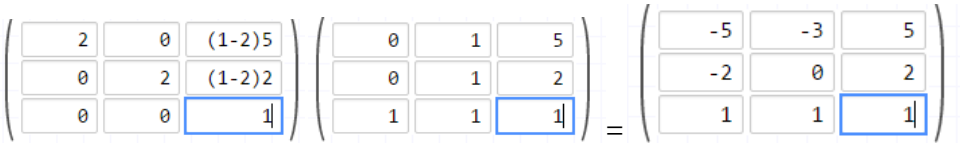
S (sx, sy) = $\begin{pmatrix} Sx & 0 & 0 \\ 0 & Sy & 0 \\ 0 & 0 & 1 \end{pmatrix}$

3. Translate the point back to its original position .Matrix can be represented as

Y (Xf,Yf)*S (sx,sy)*T(-Xf,-Yf)

$$\begin{pmatrix} Sx & 0 & (1-Sx)Xf \\ 0 & Sy & (1-Sy)Yf \\ 0 & 0 & 1 \end{pmatrix}$$

Therefore final coordinate matrix will be



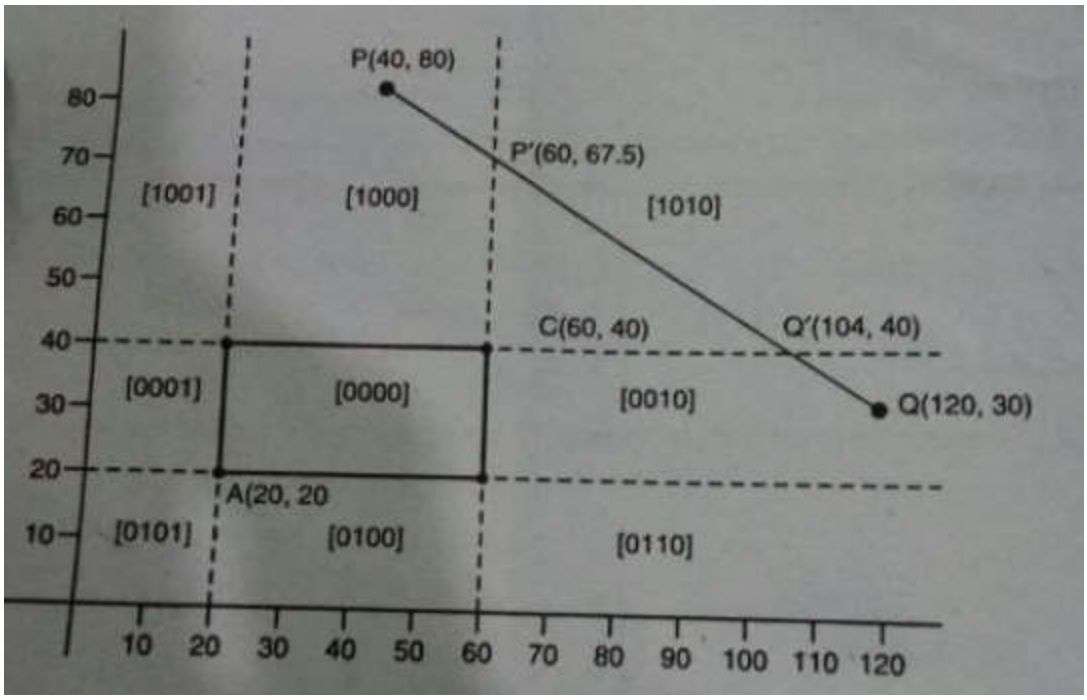
So the final coordinates of triangle after applying the given transformation are A (-5,-2),B(-3,0),C(5,2)

Q4. Given a clipping window A (20, 20), B(60,20), C(60,40), D(20,40). Using Cohen-Sutherland algorithm find the visible portion of the line segment joining the points P (40, 80) and Q (120, 30).

Sol:
The region code or out code for point(x,y) is set according to:
Bit 1 = sign(y-ymax) = sign(y-40)
Bit 2 = sign (ymin-y) = sign(20-y)
Bit 3 = sign(x-xmax) = sign(x-60)

And sign(a) = 1, if a is positive or 0 otherwise.
So P(40,80) is 1000 and Q(120,30) is 0010 and since (1000) AND (0010) is 0000 ,according to algorithm the line has to be clipped.
Intersection points with the window boundaries are calculated using the line equation parameters

1. Considered a line with the endpoints (x1,y1) and (x2,y2)
2. The y-coordinates of an intersection with vertical window boundary can be calculated using:



$y = y1 + m(b_{oundary} - x1)$

where $b_{oundary}$ can be said to either wxmin or wxmax

1. The x-co-ordinate of an intersection with the horizontal window boundary can be calculated using

   $x = x1 + (boundary - y1)/m$

Where y $b_{oundary}$ can be set to either wymin or wy_{max}
m = -5/8 the slope is negative so we will calculate intersection point on vertical line x = 60 as the region code of P(40,80) suggests that the line is in the middle region and due to negative slope will extend towards
So, y = y1 + m(xboundary - x1) i.e. y = 80 + (-5/8)(60 - 40) = 67.5.
So the intersection P^n is (60, 67.5) with region code 1010.
Now, find out the intersection point Q' of line P'(60, 67.5) and Q(120, 30) along the horizontal line Y = 40.
x = x1 + (yboundary-y1)/m i.e. x = 120 + (40 - 30)(-5/8) = 104.

So the intersection point is Q 10 4, 40 reason code 10 no body. Speed and queue data in same region so according to algorithm the line is completely outside the window and needs to be flipped.

Q – 5 What are the major difference between Bezier curve, B-spline curve and hermite curve? Make a comparison between them and suggest which curve should be used in computer graphics.

Sol: Bezier curves are parametric curves used frequently in modeling smooth surfaces in computer graphics and many other related fields. These curves can be scaled indefinitely. Linked Bezier curves contain paths that are combinations that are intuitive and can be modified. This tool is also made use of in controlling motions in animation videos. When programmers of these animations talk about the physics involved, they are in essence talking about these Bezier curves. Bezier curves were first developed by Paul de Castlejau using Castlejau's algorithm, which is considered a stable method to develop such curves. However, these curves became famous in 1962 when French designer Pierre Bezier used them to design automobiles.

The most popular Bezier curves are quadratic and cubic in nature as higher degree curves are expensive to draw and evaluate. An example of the equation of Bezier curve involving two points (linear curve) is as follows :-

$B(t) = P_0 + t(P_1 – P_0) = (1 – t)P_0 + tP_1, t\varepsilon[0,1]$

B-Spline curves are considered as a generalization of Bezier curves and as such share many similarities with it. However, they have more desired properties than Bezier curves. B-Spline curves require more information such as degree of the curve and a knot vector, and in general involve a more complex theory than Bezier curves. They however possess many advantages that off set this shortcoming. Firstly, a B-Spline curve can be a Bezier curve whenever the programmer so desires. Further B-Spline curve offers more control and flexibility than Bezier curve. It is possible to use lower degree curves and still maintain a large number of control points. B-Spline, despite being more useful are still polynomial curves and cannot represent simple curves like circles and ellipses. For these shapes, a further generalization of B-Spline curves known as NURBS are used.

Hermite curves are very easy to calculate also they are very effective. They are used to smoothly interpolate between key points(like object movement in key frame animation or camera control).Understanding the mathematical background of hermite curves will help you understand the entire family of splines.

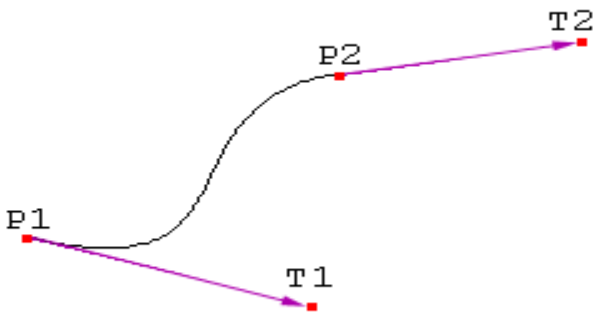
To calculate a hermite curve you need the following vectors:

P1: the start point of the curve

T1: the tangent (e.g. direction and speed) how the curve lefts the start point

P2: the endpoint of the curve

T2: the tangent(e.g. direction and speed) how the curve enters the endpoint.



These 4 vectors are simply multiplied with 4 hermite basis functions and sum together.

h1 (s) = 2s^3 – 3s^2 + 1

h2 (s) = -2s^3 + 3s^2

h3 (s) = s^3 – 2s^2 + s

h4 (s) = s^3 – s^2

Hermite curves should be used in computer graphics because it's a free form curve.

Q6:

(a) Explain Z-buffer algorithm. How an A-buffer method removes the drawbacks of Z-buffer algorithm?

Sol: The basic idea is to test the Z-depth of each surface to determine the closest surface. In this method each surface is processed separately one pixel at a time across surface. The depth values for a pixel are compared and closest surface determines the color to be displayed in frame buffer. It is applied very efficiently on surface of polygon. Surfaces can be processed in any order. To overrides the closer polygon from the far ones, two buffer named frame buffer and depth buffer are used.

Depth buffer is used to store depth values for (x y) position as surfaces are processed.

Frame buffer is used to store intensity value of [0, 1]. The 0 value represents back clipping plane and 1 represent front clipping plane.

Algorithm steps:

1. Set the buffer values
   Depth buffer (x, y)= 0
   Frame buffer (x, y) = background color
2. Process each polygon (one at a time)
   For each projected (x, y) pixel position of polygon calculate depth z.
3. If z > depth buffer (x, y)
   Compute surface color
   Set depth buffer (x, y) = z
   Frame buffer (x, y) = surface color (x, y)

Z-buffer algorithm cannot be applied to find color of pixel if overlapping surfaces are different.

A-buffer method is an extension of depth buffer method. The A-buffer expands on the depth buffer method to allow transparencies.

Each position in A-buffer has two fields:-

Depth field: it sores a positive or a negative real number.

Intensity field: It stores surface intensity information or pointer value.

The surface buffer in the A-buffer includes

- RGB intensity components
- Opacity parameters
- Depth
- Percentage of area coverage
- Surface identifier

The algorithm proceeds just like depth buffer algorithm. The depth and opacity values are used to determine final color of a pixel.

(b) Discuss the various Multimedia Authoring Tools in detail.

Sol: Multimedia authoring tools are also known as author ware. It is a program that helps the author write hypertext or multimedia application. There are various features of authoring tools such as editing and organizing feature, programming feature, interactivity feature. There are three types of authoring tools:

1. **Card and page based tools** provides a simple and easily under stable metaphor for organizing multimedia elements. It contains media objects such as button, text files and graphics. It provides facilities for linking objects to pages.

Advantages:

a) Easy to understand.
b) Easy to use.
c) It consumes very less time for developing action.

Disadvantages:

a) Few applications run only on one platform.
b) Card and pages tools are not powerful as unique stand alone.

2. **Icon based event driven tools** are simplest event driven authoring objects. Its provision of simple branching has ability to go to another section of multimedia production. Multimedia elements and interaction are organized in flow chart. The software required is icon author and author wave.

Advantages:

a) It has a clear structure.
b) Easy to edit and update the elements.

Disadvantages:

a) Learning process is very difficult.
b) Very expensive in nature.

3. **Time based tools:** are best suited for a message with a beginning and an end so that a message can be passed within a stipulated time period. Few time based tools fascinate navigation and interactive control. The software required is Adobe's Directors.

Advantages:

a) These tools are good for creating animation.
b) Branching, user control interactivity.

Disadvantages:

a) Steep learning curve for advance features.
b) Very expensive.

Q 7: (a) what are shading models? Enlist and explain any one of them in brief.

Sol. List of various shading models:-

1. Flat shading
2. Gourand shading
3. Phong shading

Flat shading

Flat shading is a lighting technique used in 3D computer graphics to shade each polygon of an object based on the angle between the polygon's surface normal and the direction of the light source, their respective colors and the intensity of the light source. It is usually used for high speed rendering where more advanced shading techniques are too computationally expensive. As a result of flat shading all of the polygon's vertices are colored with one color, allowing differentiation between adjacent polygons. Seculars highlights are rendered poorly with flat shading: If there happens to be a large secular component at the representative vertex, that brightness is drawn uniformly over the entire face. If a specula highlight doesn't fall on the representative point, it is missed entirely. Consequently, the specula reflection component is usually not included in flat shading computation.

(b) How the MIDI files are generated for audio and video information? Explain in brief.

MIDI (Musical Instrument Digital Interface) is a protocol designed for recording and playing back music on digital synthesizers that is supported by many makes of personal computer sound cards. Originally intended to control one keyboard from another, it was quickly adopted for the personal computer. Rather than representing musical sound directly, it transmits information about how music is produced. The command set includes note-ones, note-offs, key velocity, pitch bend and other methods of controlling a synthesizer. The sound waves produced are those already stored in a wavetable in the receiving instrument or sound card.

Since a MIDI file only represents player information, it is far more concise than formats that the sound directly. An advantage is very small file size. A disadvantage is the lack of specific sound control.

With a program that provides this interface, you can create music using a standard keyboard or other input device. You or others can then play your MIDI-conforming creation with the same or another program and a sound card as a music synthesizer. The MIDI program may come with a graphical user interface that looks like a sound studio control room. Many sound cards come as a package with MIDI software (for example, Media Vision's Pro Audio Studio 16).

The MIDI protocol uses eight-bit serial transmission with one start bit and one stop bit, has a 31.25 Kbs data rate, and is asynchronous. Connection is made through a five-pin DIN plug, of which three pins are used.

Q8: What are the different compression techniques? Discuss any one image compression algorithm in detail. How does it handle different image formats?

Sol: Data compression is a process by which the file size is reduced by re-encoding the file data to use fewer bits of storage than the original file. The original file then can be recreated from the compressed representation using a reverse process called decompression.

There are mainly two types of compression:

Lossless compression: It ensures that you can recreate the original file bit for bit in its storage, which means there is no data loss during compression and decompression. This type of compression usually a must if you are compressing text files or certain proprietary formats.

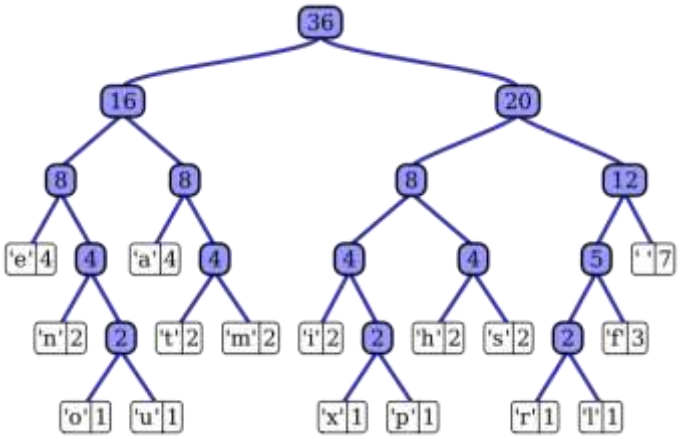
Lossy compression: this type of compression is done mainly on media files for example image, video files. Depending on the usage of files , certain amount of loss in quality might acceptable to save space. More than the loss in quality not detectable for all practical purposes.

Huffman code: Huffman code is a particular type of optimal prefix code that is used in lossless data compression. The output from his algorithm is seen as a variable length code table for encoding a source symbol.

Algorithm of Huffman code:

1. Scan text that is to be compressed and tally occurrence of all characters.
2. Prioritized characters based on number of occurrences in text.
3. Build Huffman code tree based on prioritized list.
4. Perform traversal of tree to determine all code words.
5. Text was again scanned and create new file using the Huffman codes.

Example of an Huffman tree:

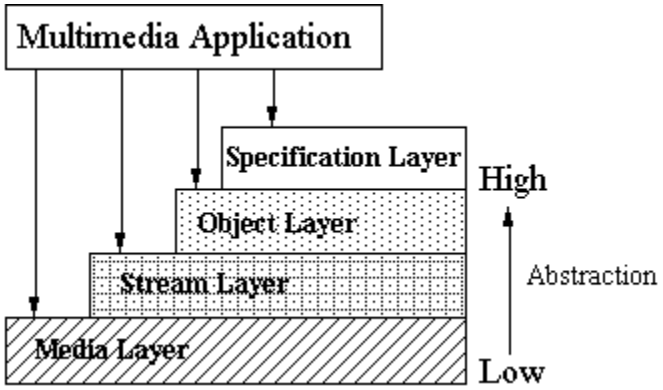


Lossless compression saves images in formats such as PNG or GIF

Q9: Explain Reference model for Multimedia synchronization with the help of diagram.

Sol: Synchronization in multimedia refers to temporal relationships between media objects in the multimedia system. Synchronization between media object comprises relationship between times dependent media object as well as time independent objects. It may need to occur at different levels in a multimedia system, its support is found in databases, communication system and their applications.

A reference model is needed to understand requirements of synchronization identify and structure runtime mechanism which can support these requirements, identify interfaces and compare solutions for multimedia synchronization system.



Reference model for multimedia synchronization systems

Media Layer: An application operates on single continuous media stream which is treated as sequence of LDUs. It provides access to files and devices. Networking component must be taken into account.

Stream Layer: It operates on a continuous media stream as well as on groups of media stream. In a group all streams are presented in parallel by using mechanism inter stream synchronization.

Continuous media is seen as data flow with implicit time constraints, individual LDUs are not visible. An application using stream layer is responsible for starting, stopping and grouping streams. It is also responsible for synchronization with time independent media objects.

Object Layer: Object layer operates on all media streams and hides differences between continuous and discrete media. Application that interacts with this layer will be presented with a view of complete synchronized presentation. It is responsible for the correct schedule of the overall presentation.

Specification Layer: This layer contains applications and tools that are allowed to create synchronization specifications for e.g. multimedia document editor, authoring tools).

It is also responsible for mapping user required QoS parameters to qualities offered at abject layer interface.

Synchronization specifications can be :

- **Interval- based:** Specifications of temporal relations between time intervals of the presentation of media objects.
- **Axes- based:** It allows presentation events to be synchronized according to the shared axes for e.g. a global timer.
- **Control flow- based:** At specified points in presentation they all are synchronized.
- **Event- based:** Events in presentation trigger presentation action.