

Q2 (a) Write various uses of computer graphics.

Answer

1. User interface: Most of the applications that run on personal computer and workstations have user interfaces that rely on desktop window systems to manage multiple simultaneous activities, clicking facilities that allow user to select menu items, icons and other objects on the window.
2. Graphs plotting in commercial applications: To create 2D and 3D graphs of mathematical, physical and economic function, histograms, bar and pie charts, spreadsheets, task scheduling charts etc. So CG is used to clarify complex phenomena and to facilitate informed decision making.
3. Desktop publishing: The use of graphics for the creation and dissemination of information has increased since the advent of desktop publishing on personal computers. Desktop publishing set up columns for entering text and rearranges the text and rearranges the text in the columns to fit the new size. We can mix graphics in to the text and this is possible because these system treats text as a graphics object, knowing the precise position coordinates, rotation, size and style of every letter.
4. Computer aided design: It allow for speedy, simple design of buildings mechanical systems, floor plans, pcb. CAD systems save time and energy, when revising designs. CAD systems are user friendly.
5. Simulation, animation and video games: Simulation indicates a touch of visualization, which makes the process of simulation more convincing. Many CAD softwares are available for simulation. Another area is cartooning .cartoon characters are modelled in the computer as 3D shape descriptions

Q2 (b) Consider a raster system with resolution of 640 x 480. What size of frame buffer (in bytes) is needed to store 12 bits per pixel.

Answer

Resolution = 640 x 480

Size of frame buffer = 640 x 480 pixels
 = 640 x 480 x 12 bits
 = (640 x 480 x 12) / 8 bytes
 = 460800 bytes

Q3 (b) Digitize a line from (1, 2) to (12, 18) on a raster screen using Bresenham's straight line algorithm.

Answer

Algorithm:-

integer is integer floor function.

sign returns -1,0,1 as its arguments is ≤ 0 , $=0$, >0

/* appropriate the line length so that we can move along either of x or y axis */

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    if abs(x2 - x1) = abs(y2 - y1)
    { len= abs(x2-x1); }
else
{
len = abs(y2 - y1);
}
dx=(x2-x1) / len;
dy= (y2 -y1)/ len;
x= x1 + 0.5 * sign(dx);
y=y1+0.5 * sign(dy);
i=1;
while( i<=len)
{
putpixel (integer(x),integer(y));
x= x+dx;
y=y+dy;
i=i+1;
};

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Q4 (a) Explain 2D transformation for scaling and rotation transformation. Use suitable example.

Answer

There are times when we require a change of scale to suit our requirements.

Scaling Transformation of the form:

$$S = \begin{Bmatrix} s_x & 0 \\ 0 & s_y \end{Bmatrix}$$

The contents of matrix S do matter when we are multiplying our points on the plane with it. Suppose the scaling matrix S were identity matrix.

$$S = \begin{Bmatrix} s_x & 0 \\ 0 & s_y \end{Bmatrix}$$

Then the image would not change, as anything multiplied by identity matrix would remain the same.

Rotation Transformation of the form:

Suppose, we have a point $Q1=[x1, y1]$ and we rotate it about the origin of an angle θ to get a new position

$Q2 = [x2, y2]$. Now these rotations can be anticlockwise and clockwise.

This form of rotation is performed in three transformation steps:

1. Translate the point (xc, yc) to the origin.
2. Rotate about the origin by the specified angle.

3. Translate the center of rotation back to where it belong that is where it started.

Q4 b What are the new coordinates of the point P (2, -4) after the rotation by 30 degrees.

Answer

The given point is (2, -4) and it has to be rotated by 30 degrees.

$$(2 \ -4) \begin{Bmatrix} \sqrt{3}/2 & 1/2 \\ -1/2 & \sqrt{3}/2 \end{Bmatrix} = \begin{Bmatrix} (\sqrt{3} + 2) & (1-2\sqrt{3}) \end{Bmatrix}$$

The new coordinates of the point are = $(\sqrt{3} + 2) \ (1-2\sqrt{3})$

Q5 (a) Explain Cohen-Sutherland line clipping algorithm. Use a suitable example.

Answer

step1: compute the outcodes for each of the vertices of the given polygon.

Step 2: if both the outcodes come out to be zero, then the sides 'k' is within the window part and is fully visible. So retain it and go to step 3.

Step 3: if both the outcodes are non-zero, compute the value of 'AND' operation between them.

Step a: if the value comes out to be non-zero, the side 'k' is completely outside the window port, so is fully invisible and because will be rejected go to step 3.

Step b: If the value comes out to be zero, the side may need clipping go to step d.

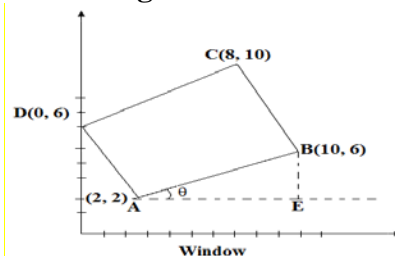
Step c: If one of the two outcodes is zero, the sides requires to be clipped, go to step d.

Step d: the equation of the side using the intersection formula

$$(x-x_1)(y_2-y_1) = (y-y_1)(x_2 - x_1)$$

Step e: Find intersections of the side 'k' with each of the edges of the windowport. Pushing the segments towards the edge of the windowport, and get the new fresh outcodes. Go to step b.

Q5 (b) Use Sutherland-Hodgman algorithm for line clipping to clip a line [(0, 0), (10, 10)] against rotated window shown in figure.



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Q6 (a) Describe the use of Bezier curves and its working principle used in computer graphics.

Answer

Bezier curves are used in computer graphics to produce curves which appear reasonably smooth at all scales. This curve construction is based on certain control points. Working: - For a set of four points p_0, p_1, p_2, p_3 we associate a curve with the following properties:

1. It starts at p_0 and ends at p_3 .
2. When it starts from p_0 it heads directly towards p_1 , and when it arrives at p_3 it is coming from the direction of p_2 .
3. The entire curve is contained in the quadrilateral whose corners are the four given points.

These are used in CG as they are very efficient to construct, since a simple recursion process means that the basic arithmetic operation needed to build the points along one is just division by two.

For this reason the most efficient implementation use scaled integers instead of floating point numbers as basic numerical data.

Q6 (b) What do you understand by oblique parallel projections? How it is different from perspective projection?

Answer

Oblique projections have their projections that are not perpendicular to the projection plane.

i.e. $(q,p,r) \neq (a,b,c)$

There are two common oblique parallel projections:

1. Cavalier parallel projections: The lines perpendicular to projections plane are preserved in length, i.e. $L=1$

$$\left\{ \begin{array}{cccc} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ \cos \theta & \sin \theta & 0 & 0 \\ 0 & 0 & 0 & 1 \end{array} \right\}$$

Cabinet parallel projections: - Lines perpendicular to projection plane are $\frac{1}{2}$ their true length, i.e. is $L=1/2$

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

Q7 (a) Explain the method of back face detection with the help of example.

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Q8 (b) Explain the method of frame by frame animation technique for expert animator.

Answer

Key frame systems were developed by classical animators such as Walt Disney. An expert animator would design an animation by drawing certain intermediate frames, called key frames. Then other animators would draw the in between frames.

The sequence of steps to produce a full animation would be as follows:

1. Develop a script or story for the animation.
2. Layout a story board, i.e. a sequence of informal drawings that shows the form, structure, and story of the animation.
3. Record a sound track.
4. Produce a detailed layout of the action.
5. Correlate the layout with the soundtrack.
6. Create the key frames of the animation. The key frames are those where the entities to be animated are in positions such that intermediate positions can be easily inferred.
7. Fill in the intermediate frames called tweening.
8. Make a trial film called a pencil test.

9. Transfer the pencil test frames to sheets of acetate film, called “cels” .these may have multiple planes e.g. a static background with an animated foreground.
10. The cels are then assembled in to a sequence and filmed.

With computers the animator would specify the key frames and the computer would draw the in between frames “tweening”. Many different parameters can be interpolated but care must be taken in such interpolate if the motion is to be look “real”.

The simplest type of interpolation is linear the computer interpolates points along a straight line.

Text Book

Computer Graphics, Amarendra N. Sinha, Arun D Udai, TMH, 2008