Computer graphics

1. **Explain refresh cathode ray tube?**

❖ A beam of electrons, emitted by an electron gun, passes through focusing and deflection systems that direct the beam toward specified positions on the phosphor coated area.

❖ The phosphor that emits a small spot of light at each position contacted by the electron beam

❖ One way to keep phosphor glowing is to redraw the picture repeatedly by quickly directing the electron beam back over the same points

❖ This type of display is called is called **refresh CRT.**

❖ Primary components of electron gun are:

- **Heated metal cathode:** Heat is supplied to the cathode by directing the beam through a coil of wire called the filament inside the cylindrical cathode structure.
- **Control grid:** Intensity of the electron beam is controlled by setting the voltage levels on the control grid, which is a metal cylinder that fits to the cathode.

❖ Different kinds of phosphorus are available

❖ Besides color the major difference between phosphors is their persistence

❖ The maximum number of points that can be displayed without overlap on a CRT is referred to as resolution.

❖ Another property is aspect ratio.

2. **Explain color CRT monitors?**

A CRT monitor displays color pictures by using a combination of phosphors that emit different colored light. By combining the emitted light from the different phosphors, a range of colors can be generated.

Two techniques:

- Beam penetration method
- Shadow mask method

Beam penetration method

- ✓ Display color pictures
- ✓ Two layers of phosphors, usually red and green
- ✓ A beam of slow electrons excites the outer red layer
- ✓ Fast electron penetrates through the red layer and excites the inner green layer
- ✓ An intermediate beam speeds, combinations of red and green light

Shadow mask method

- ✓ They produce a wider range of colors
- ✓ Has three phosphor color dots at each pixel position
- ✓ One emits red light, another emits green light, and the third emits a blue light
- ✓ The three beams are deflected and focused as a group on to the shadow mask, which contains a series of holes aligned with a phosphor dot patterns.
- ✓ When the three beams passes through a hole in the shadow mask, they activate a dot triangle, which appears as a small color spot on the screen.

3. Explain direct view storage tubes and liquid crystal displays.

Liquid crystal displays

- Refers to the compounds having crystalline arrangement of molecules flow of liquid.
- Two plates each glass plate contains a light polarized that are right angles to each other.
- Two types
  - Passive matrix LCD
  - Active matrix LCD

Direct view storage tubes

- Alternative method for maintaining a screen image
- Stores picture information as a charge distribution
- Very complex pictures can be displayed at very high resolutions
- To eliminate the picture section the entire screen must be erased
- The erasing and redrawing process can take several seconds for a picture.

4. Explain Raster scan systems.

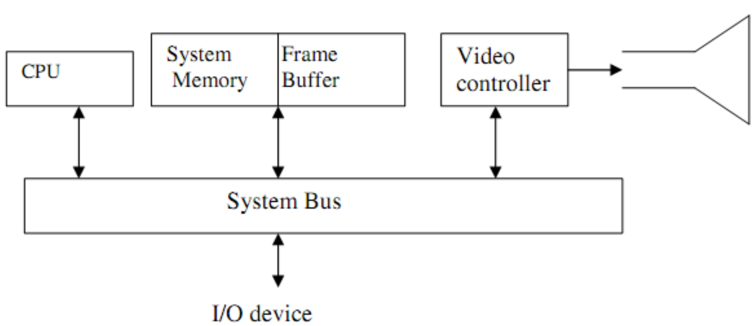
Several processing units contain a special purpose processor, called video controller or display controller.

Video controller

❖ A fixed area of the system memory is reserved for the frame buffer, and the video controller is given access to the frame-buffer memory

❖ Tow registers are used to store the coordinates of the screen pixels

❖ The value is stored in the frame buffer for this pixel position is then retrieved and used to set the intensity of the CRT beam



❖ Initially the x register is set to 0 and the y register is set to ymax

❖ Then the x register is incremented by 1, and the process repeated for the next pixel on the top scan line

❖ This process is repeated for each pixel along the scan line

❖ After the last pixels on the top scan line have been processed, the x register is reset to 0 and the x register is decremented by 1.

❖ The procedure is repeated fro each successive line

Frame buffer locations and the corresponding screen positions are referenced as Cartesian coordinates.

5. Explain the following: 1. Joysticks 2. Touch panels 3. Image scanners 4. Data glove

- **Joysticks**
  - ❖ Consists of small vertical liver mounted on a base
  - ❖ Used to move the cursor around the screen
  - ❖ The screen cursor is moved according to the distance
  - ❖ One or two buttons is usually intended for signaling certain actions
- **Touch panels**
  - ❖ Three types
    - Optical touch panel
    - Electrical touch panel

- Acoustical touch panel

❖ Allow selecting the screen position with the touch of finger. Touch input can be recorded using optical, electrical methods

➢ **Image scanners**

❖ Drawings, color and black and white photos or text can be given as an input to the computer with an optical scanning mechanism.

❖ According to reflected light intensity the gradations of gray scale or color can be stored in an array

➢ **Data glove**

❖ Constructed with a series of sensors that can detect hand and finger motions

❖ The transmitting and receiving antennas can be structured as a set of three mutually perpendicular cols, forming a three dimensional Cartesian coordinates system.

❖ Electromagnetic coupling between the three pairs of coil is used to provide information about the position and orientation of hand.

6. Explain in detail about the DDA scan conversion algorithm?

The digital differential analyzer is a scan conversion algorithm based on calculation either Δy or Δx using the following euations

$$\Delta y = m \, \Delta x$$

$$\Delta x = \Delta y / m$$

Sample the line at unit intervals in one coordinate and determine corresponding integer values nearest the line path for the coordinates

Sample at X intervals ($\Delta x = 1$) and compute each successive Y value as

$$Y_{k+1} = Y_k + m$$

For lines with positive slope greater than 1, reverse the roles of X and Y. Sample at unit Y intervals ($\Delta y = 1$)and calculate each successive X value as

$$X_{k+1} = X_k + 1/m$$

Algorithm

Step 1: Input the line endpoints and store the left endpoint in (x1, y1) and right endpoint in (x2, y2)

Step 2: Calculate the values of Δx and Δy using $\Delta x = xb - xa$, $\Delta y = yb - ya$

Step 3: if the values of $\Delta x > \Delta y$ assign values of steps as Δx otherwise the values of steps as Δy

Step 4: Calculate the values of X increment and Y increment and assign the value x= xa and y = ya

Step 5: for k=1 to steps do

X = X + X increment

Y= Y + Y increment

Putpixel(ceil(x), ceil(y),15)

Step 6: End

2. Explain Bresenhams line drawing algorithm?

In Bresenham's approach the pixel position along a line path are determined by sampling unit X intervals. Starting from the left end point(X_0, Y_0)of a given line we step to each successive columns and plot the pixel whose scan line Y-value is closest to the line path.Assuming the K^{th} step in process, determined that the pixel at (X_k, Y_k)decide which pixel to plot in column X_{k+1}.The choices are (X_{k+1}, Y_k) and (X_{k+1}, Y_{k+1})

Algorithm:

Step 1: Input the line endpoints and store the left endpoint in (X_0, Y_0)

Step 2: Load (X_0, Y_0) in to the frame buffer

Step 3: Calculate constants Δx, Δy, $2\ \Delta y$, $-2\ \Delta x$, and obtain the decision parameters as

$$P0 = 2\ \Delta y - \Delta x$$

Step 4 : At each X_k along the line, starting at k = 0, perform the following test

If Pk < 0, the next point to plot is (X_{k+1}, Y_k) and

$$P_{k+1} = P_k + 2\ \Delta y$$

Otherwise, the next point to plot is (X_{k+1}, Y_{k+1}) and

$$P_{k+1} = P_k + 2\ \Delta y - 2\ \Delta x$$

Step 5: Repeat step 4 Δx times

3. Explain Midpoint Circle algorithm?

Algorithm

Step 1:Input radius r and circle center(Xc, Yc)and obtain the first point on the circumference of a circle centered on the origin as

(X0, Y0) = (0, r)

Step 2: Calculate the initial values of the decision parameter as

$$P0 = 5/4 - r$$

Step 3: At each position starting at k perform the following test:

If Pk < 0, the next point to plot is (X_{k+1}, Y_k) and

$$P_{k+1} = P_k + 2\ X_{k+1} + 1$$

Otherwise the next point is (X_{k+1}, Y_{k+1}) and

$$P_{k+1} = P_k + 2\ X_{k+1} + 1 - 2\ Y_{k-1}$$

Step 4: Determine symmetry points in the other seven octants

Step 5: Move each pixel position(X, Y) onto the circular path centred on (Xc, Yc) and plot the coordinate values as

$$X = X + X_c \qquad Y = Y + Y_c$$

Step 6: Repeat steps 3 through until X>=Y

$P_k + 1 = P_k + 2\,\Delta Y$

Other wise, the next point is (X_{k+1}, Y_{k+1}) and

$P_k + 1 = P_k + 2\,\Delta Y - 2\,\Delta X$

Step 5: Repeat steps 4 ΔX times

4. Explain Ellipse generating Algorithm?

Algorithm

Step 1:Input radius r_x, r_y and ellipse center$(X_c, Y_c)$and obtain the first point on the circumference of a circle centered on the origin as

$(X_0, Y_0) = (0, r_y)$

Step 2: Calculate the initial values of the decision parameter in region 1 as

$P1_0 = r_y^2 - r_x^2\, r_y + 1/4\, r_x^2$

Step 3: At each position starting at X_k position in region 1,starting at k = 0, perform the following test:

If $P_k < 0$, the next point to plot is (X_{k+1}, Y_k) and

$P1_{k+1} = P1_k + 2\, r_y^2 X_{k+1} + r_y^2$

Otherwise the next point is (X_{k+1}, Y_{k-1}) and

$P1_{k+1} = P1_k + 2\, r_y^2 X_{k+1} - 2r_y^2\, Y_{k+1} + r_y^2$

Step 4: Calculate the initial values of the decision parameter in region 2 as

$P2_0 = r_y^2\,(X_0 + 1/2)^2 + r_x^2\,(Y_0 - 1)^2 - r_x^2\, r_y^2$

Step 5: At each position starting at Y_k position in region 2,starting at k = 0, perform the following test:

If $P_k > 0$, the next point to plot is (X_k, Y_{k-1}) and

$P2_{k+1} = P2_k - 2\, r_y^2 Y_{k+1} + r_x^2$

Otherwise the next point is (X_{k+1}, Y_{k-1}) and

$P2_{k+1} = P2_k - 2\, r_y^2 Y_{k+1} - 2r_x^2\, Y_{k+1} + r_x^2$

Step 6: Determine symmetry points in the other three octants

Step 7: Move each pixel position(X, Y) onto the circular path centred on (Xc, Yc) and plot the coordinate values as

$X = X + X_c \qquad Y = Y + Y_c$

Step 8: Repeat steps for region 1 until $2\, r_y^2 X >= 2\, r_y^2 Y$

5.Explain Boundary fill Algorithm?

- If the boundary is specified in a single color, the fill algorithm proceeds outward pixel-by-pixel until the boundary color is encountered. This is called boundary fill algorithm
- The boundary fill procedure accepts as input the coordinates of an interior point (x, y), a fill color, and a boundary color.
- Starting from (x, y), the procedure tests the neighboring positions to determine whether they are boundary color.
- If not, they are painted with the fill color, and the neighbors are tested.
- This process continues until all pixels up to the boundary color for the area have been tested
- Two methods
- 4- connected
  - 4 neighbouring points are conected
- 8-connected
  - correctly fill the interior of the area defined

6.Explain reflection and shear.

Reflection

- It is a mirror image of an object
- Rotating about 180 degree
- Flat object moving in the xy plane
- Reflection about y axis flips x coordinates
- Reflection point as pivot point is same as above
- To obtain the transformation matrix for reflection diagonal is y = -x
- Sequence
  - Clockwise rotation by 45 degree
  - Reflection about y axis
  - Counter wise rotation by 45 degree

Shear

- Internal layer cause to slide over each other called shear
- Transforms coordinate position as

$$X' = x + shx \cdot y' \quad , \quad Y' = y$$

Shift in the position of objects relative to shearing reference lines are equivalent to translations.

7.Explain Liang Barsky line clipping

- Faster line clipper of the parametric equation of a line segment
- Line parallel to one of the clipping boundaries
- Line intersects the extension of boundary k
- If u1 > u2 line is outside the clipping window
- Else inside the clipping window
- Clipping is done using the reflection in the clip window.

8.Explain Sutherland Hodgeman polygon clipping

- Clipping polygon which lies inside the clipping window
- Four possible cases
  - If the first vertex is outside the window boundary and the second vertex inside
  - If the first vertex is inside the window boundary and the second vertex outside
  - If both are outside
  - If both are inside
- Repeat the process of algorithm
- Convex polygon are correctly clipped using this clipping
- Concave and convex polygon are also used

9.Explain about clipping operations

- Clip a picture from either outside or inside a region known as clipping
- Also called as clipping algorithm
- The region against the object is known as clip window
- Clipping operations on different types of objects
  - Point clipping
  - Polygon clipping
  - Area clipping
  - Line clipping
  - Curve clipping
  - Text clipping
  - Polygon and line clipping are the standard clipping components

10. Explain Depth sorting method

- Both image and object space operations.
- Perform the basic function
- Surface are sorted in order of decreasing depth
- Surface are scan converted in order, starting with the surface of greatest depth
- Often referred as painters algorithm
- Test listed in the order of increasing difficulty
- Surface do not overlap
- Projections of the two surfaces on to the view plane do not overlap

11. A Buffer Method

- Extension idea of the depth buffer method
- It represents an antialiased, area averaged, accumulation-buffer method.
- Only one visible surface
- Two fields

  Depth field: Stores a positive or negative real number

  Intensity field: Stores a surface intensity information or a pointer value
- Data for each surface in the linked list includes
  - RGB intensity components
  - Opacity parameters
  - Depth
  - Percent of area coverage
  - Surface identifier
  - Pointer to next surface

12. Explain Back face detection method and Depth buffer method

Backface Detection method

- Fast and simple object space method
- For identifying the back faces of a polyhedron
- Based ion inside outside test
- Plane parameters A, B, C, D
  $Ax + By + Cz + D < 0$
- Inside point is along the line of sight to the surface
  $V.N = V_z C$
- Polygon is back face if $C < 0$
- Polygon cannot see on any face if $C = 0$
- Z component value is $C <= 0$

Depth Buffer Method

- To compare the surface depths at each pixel position on the plane projection
- Also referred as z- buffer method
- Two buffer areas
- Depth buffer to store depth values
- Refresh buffer to store intensity values
- Depth value for a surface position (x, y)
  $Z(-Ax - By - D)/C$
- Depth z' of next position (x + 1, y)
  $Z'(-A(x + 1)-By - D)/C$

13. Explain the three dimensional display methods?

- **Parallel projection:** The production of the 2D display of the 3D scene is called projection. Project points on the object surface along the parallel lines on to the display plane. Different 2D views of objects can be produced by projecting the visible points

- **Perspective projection**: Done by the projecting points to the display plane along the converging points. Causes the objects farther from the viewing point should be smaller of the same sized object present here.

- **Depth CUEING**: Basic problem for visualization techniques is called depth cueing. Some 3D objects are without depth information.

- **Visible line and surface identification:** To highlight the visible lines. Display visible lines as dashed lines. Removing the invisible lines

- **Surface rendering:** Lightening conditions in the screen. Assigned characteristics Degree of transparency. How rough or smooth the surfaces are to be.

- **Exploded and cutaway views**
- **Three dimensional and stereoscopic views.**