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Assignment-5

Section-A

1) What is vanishing point?

Ans The vanishing point is the point in a perspective drawing where parallel lines appear to converge, creating the illusion of depth.

2) Mention the two approaches for hidden surface elimination or visible surface detection.

Ans Object-Space Approach :- Compares objects directly to determine visibility.

Image Space Approach :- Determines visibility pixel by pixel.

3) What is Perspective Foreshortening?

Ans It is the effect in perspective projection where objects appear smaller as they move further from the viewer creating a sense of depth.

4) Give one advantage and disadvantage of parallel projection?

Ans Advantage

Maintains the true size and shape of objects

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Disadvantage
Lacks depth perception.

5½ Define Orthographic Projection ?
Ans Orthographic projection is a type of parallel projection where the projection lines are perpendicular to the projection plane.

Section-B

1½ What is projection? Explain in detail?
Ans Projection is a method to map 3D objects onto a 2D plane, such as a screen or paper for visualization.

There are 2 types of projections :-
1½ Parallel Projection :- Projection lines are parallel to each other.

→ It preserves the objects true shape and size

→ No depth perception.

It is further classified into 2 types :-
a½ Orthographic Projection :- In this lines are perpendicular to the plane.

b½ Oblique Projection :- lines are tilted showing more sides of the object

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2) Perspective Projection :- Projection lines converge at a vanishing point.

→ Simulates depth and distance

→ Objects appear smaller as they get farther

Importance of Projection

→ Visualizes 3D objects on 2D surfaces.

→ Perspective projection adds realism with depth perception.

→ Parallel projection is used for accurate technical drawings.

2) Explain parallel projection. Give its advantage and disadvantage?

Ans Prallel projection is a technique where the projection lines are parallel to each other and intersect the projection plane at a consistent angle. It is commonly used to represent 3D objects in 2D while maintaining their true size and shape.

Types of parallel projection :-

① Orthographic Projection :- Projection lines are perpendicular to the projection plane.

Common views :- Top, front and side views used in technical drawings.

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② Oblique Projection :- Projection lines are at an angle other than 90° to the ~~per~~ projection plane.

Shows more than one face of an object providing more detail.

Advantages :- Preserves true size and shape
→ Simple and ideal for technical drawings.

Disadvantages :- No depth perception or realism.
→ Limited use in visual simulations or games.

Parallel projection is used where precision is required such as in engineering and architecture.

3) What is perspective projection? What are types of perspective projection?

Ans Perspective projection is a technique where 3D objects are projected onto a 2D plane, with projection lines converging at a single point called the vanishing point. It creates a realistic representation of objects by simulating depth and distance.

Types of perspective projection :-

① One-point perspective :- All lines converge at a single vanishing point.

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→ Used for views along a straight path like hallways.

(2) Two point perspective :- lines converge at two vanishing points usually on the horizon.
→ common for visualizing corners of objects or buildings.

(3) Three - point perspective :- lines converge at three vanishing points (two on the horizon and one above or below).
→ Used for tilted or exaggerated views, creating dramatic effects.

Key feature
⇒ Add realism to 3D objects on a 2D plane.

⇒ Objects appear smaller as their distance from the viewer increases.

Section - C

1) Explain the Back - Face removal algorithm in detail?

Ans The Back - Face Removal Algorithm eliminates surfaces of 3D objects that face away from the viewer, improving ~~reder~~ rendering efficiency by reducing the number of polygons to process.

A polygonal surface is considered a back -

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face. If its normal vector points away from the viewer. This is determined using the dot product of the surface normal and the viewing vector.

Steps of the Algorithm

1) Determine Normal vector.
Calculate the normal vector N using the cross product of two edges of the polygon.

2) Check viewing direction.
Assume viewing direction V aligns with the z-axis.

3) Dot product Test.
→ Compute $N \cdot V$
→ If $N \cdot V > 0$, the surface is a back-face and removed.

4) Repeat
Apply this test to all polygons.

Mathematical condition

For a polygon defined by vertices $P_1(x_1, y_1, z_1)$, $P_2(x_2, y_2, z_2)$ and $P_3(x_3, y_3, z_3)$:-

1) Compute Edges:-
$$E_1 = P_2 - P_1$$
$$E_2 = P_3 - P_1$$
2) Compute Normal vector.
$$N = E_1 \times E_2 \text{ (cross product)}$$
3) Back-face condition

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If $N_z > 0$ in view space the polygon is a back-face.

Advantages :- Reduces rendering workload
→ Simple to implement.

Disadvantages :- Ineffective for non-convex objects or overlapping surfaces

2) Explain the Z-Buffer algorithm in detail?

Ans The Z-Buffer algorithm removes hidden surface by comparing the depth (z-value) of objects at each pixel, ensuring only the closest surface is visible.

Steps :-

① Initialize Buffers:-
→ Z-Buffer stores depth value and Frame Buffer stores color values.

→ Set Z-Buffer to infinity and Frame Buffer to the background color.

② Process Each Pixel:-
→ Calculate the z-value of each polygon at each pixel.

→ If the z-value is closer than the existing value in the Z-Buffer update both

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buffers.

③ Repeat:-
Process all polygons and display the frame Buffer.

④ Display final image:-
Use the color values from the Frame Buffer to display the image.

Advantages:-
→ Simple and easy to implement
→ Handles overlapping objects efficiently.
→ Works well for complex 3D scenes.

Disadvantages:-
→ High memory usage for Z-Buffer and Frame Buffer.
→ Inefficient for transparent surfaces as it only considers the closest object.

Applications
Used in real-time rendering systems like games, simulations and 3D modeling software to handle visibility.

3) Explain the Scan-line algorithm in detail?

Ans The Scan-line algorithm processes one horizontal line (Scan-line) at a time to determine visible surfaces and

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fill pixels for rendering 3D objects.

Steps

1) Edge Table (ET) :- Store polygon edges sorted by their starting y-coordinate.

2) Activate Edge Table (AET) :- Track edges intersecting the current scan line.

3) Process Each Scan line :-
→ Add edges from ET to AET and remove completed edges.

→ Sort edges in AET by x-coordinates.

→ Compare depth (z-values) to determine visible surfaces and fill pixels.

4) Repeat :- Continue until all scan-lines are processed.

Advantages :-
→ Efficient for overlapping polygons.

→ uses less memory than Z-Buffer.

Disadvantages :-
→ Complex depth and edge calculations

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→ Not suitable for transparency.

The Scan line algorithm is ideal for 3D rendering by processing one line at a time for visibility.

—X—