UNIT 11: PROJECTIONS

UNIT STRUCTURE

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11.1 LEARNING OBJECTIVES

After going through this unit, you will be able to:

- Learn about Projection and its different types
- Learn about Parallel Projection and its classification
- Learn about Perspective Projection and Vanishing point
- Learn about anomalies in Perspective Projection
- Learn about Hidden Layer Projection and its techniques

11.2 INTRODUCTION

We have already been acquainted with the idea of the Hermite curve, Bezier curve and B-spline curves, Bezier surface, and B-spline surfaces in the previous unit.

In this unit, we will learn about Projection and its classification which is very important. Here we will also learn about hidden layer projection and its techniques. In the next unit, we will explore the concept of 3-D Geometric transformations that is Translation, rotation, scaling, reflection and shear transformations, and composite transformations.

11.3 PROJECTION

The process of representing a 3D object into a 2D medium is termed Projection. All graphics devices are 2D, such as the screen of the monitor, printout of the printer, etc. The projection was invented in 1756 by the Swiss mathematician, engineer, and astronomer Leonhard Euler Around. Projection is nothing but the transformation of an n-dimensional object into the n-1-dimensional object in the projection plane.

Important concepts related to Projection:

- **Projection Plane/ View Plane:** It is the plane on which an object's projection is formed.
- **Center of Projection:** it is the point from which projection is taken.
- **Projectors:** These are the lines coming from the center of the projection and hitting the projection plane after passing through a point in the object.

11.4 PROJECTION CLASSIFICATION

Mainly projection is divided into two types. These categories are Parallel Projection and Perspective Projection.

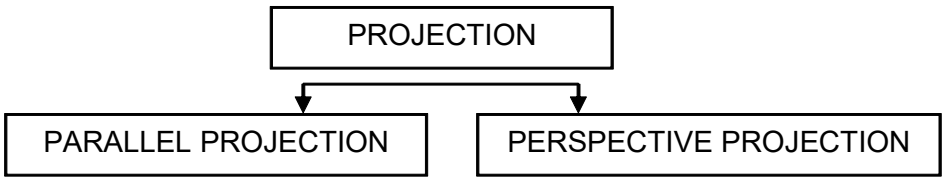


Figure 11.1: Types of Projection

- **Parallel Projection:** If the center of projection is at an infinite distance to the projection plane then it is termed parallel projection. The main types of parallel projection are shown in the following figure 11.2. The detail of parallel projection will be explained in the next section which is 11.5.

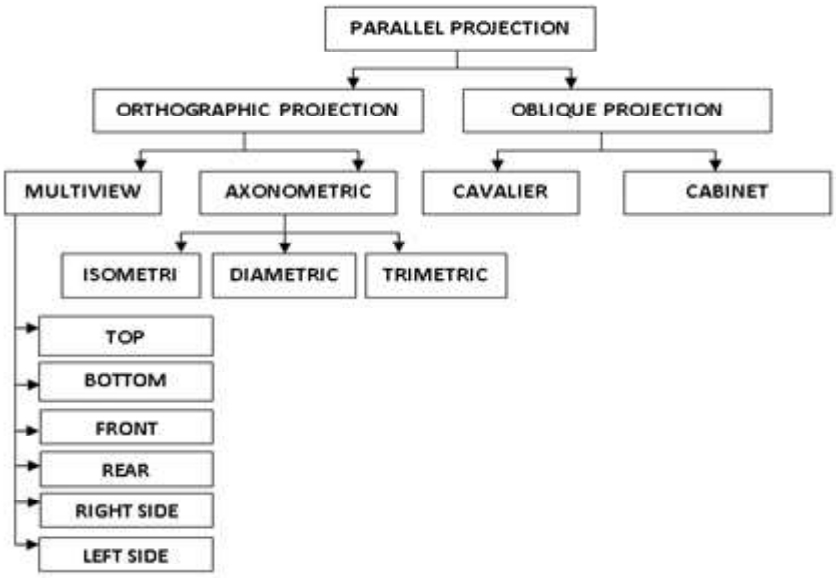


Figure 11.2: Types of Parallel Projection

- **Perspective Projection:** If the center of projection is at a finite distance to the projection plane then it is termed perspective projection. The main types of perspective projection are shown in the following figure. The detail of parallel projection will be explained in the next section which is 11.6.

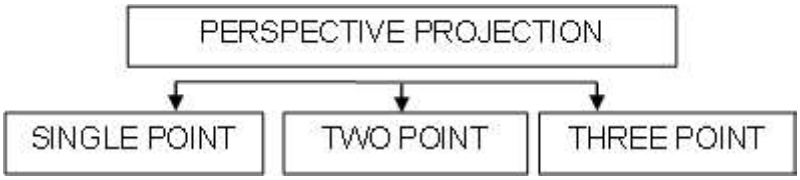


Figure 11.3: Types of Perspective Projection



EXERCISE

1. Define projection.
2. What is the need of projection?

11.5 PARALLEL PROJECTIONS

In parallel projection, coordinate positions are transformed to the view plane along parallel lines. A projection is said to be parallel if the center of the projection is at an infinite distance from the projected plane. Also here the projection lines are parallel to each other and extended from the object and intersect the view plane.

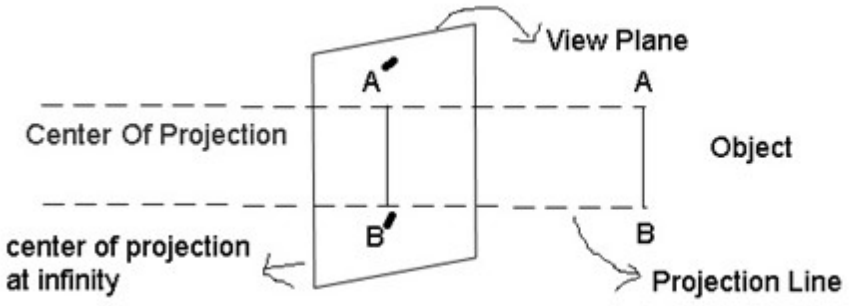


Figure 11.4: Parallel Projection

The major types of parallel projection are shown in figure 11.2. In this section, we will learn about the different types of parallel projection i.e. orthographic projection and oblique projection.

- **Orthographic Projection:** Here the direction of the projection is normal to the projection plane. In orthographic projection, lines are parallel to each other making an angle of 90 degrees with the view plane/ projection plane. There are mainly two types of orthographic projection i.e. a) Multi-view and b) Axonometric. The multi-view projection has 5 types they are they are: i) Top ii) Bottom iii) Rear iv) Right side v) Left side. Whereas Axonometric projection is divided into 3 types, they are i) Isometric, ii) Diametric and iii) Trimetric

By combining multi-view types that are top, bottom, rear, right side, and left side, we can construct the whole object that we want to project.

In axonometric projection, the direction of projection is not parallel to any of the three principal axis x, y, and z. the projection here is done using rotation and translation to manipulate the object such that at least three adjacent faces are shown. In isometric projection under axonometric projection, the direction of the projection makes equal angles with the three principal axis x, y, and z. In diametric projection, the direction of the projection makes an equal angle with exactly two of the principal axis. And lastly, in trimetric projection, the direction of the projection makes unequal angles with the three principal axis x, y, and z.

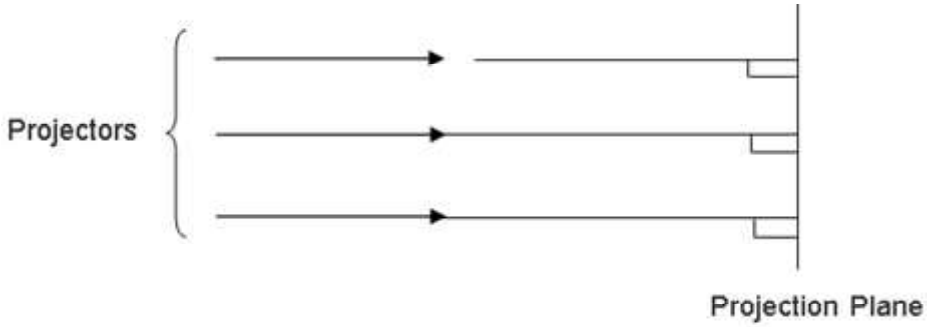


Figure 11.5: Orthographic projection: here projectors are perpendicular to the projection plane.

- **Oblique Projection:** Here, the direction of the projection is not normal to the projection plane. In this projection, we can view the object better than in the orthographic projection. Here projections are non-perpendicular to the view plane. An example of this projection can be seen in the form of the shadow of any object due to sunlight. There are mainly two types of oblique projection. They are a) Cavalier and b) Cabinet.

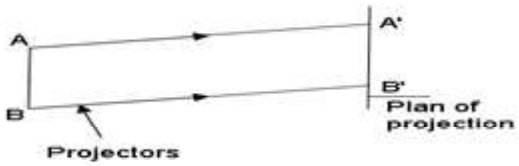


Figure 11.6: Oblique Projection

  - **Cavalier Projection:** if the projected line is making an angle of 45 degrees with the projection plane, as a result, the line of the object length will not change.
  - **Cabinet Projection:** it makes a 63.4-degree angle with the projection plane. Here lines perpendicular to the viewing surface are projected at ½ their actual length.



CHECK YOUR PROGRESS

Q 1: What is isometric projection?

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Q 2: Why parallel projection is used?

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11.6 PERSPECTIVE PROJECTIONS

In perspective projection, the center of projection is at a finite distance from the projection plane or view plane. The visual effect in perspective projection is similar to the human visual system. Here object appears smaller as the distance from the center of the projection increases. It is difficult to determine the exact size and shape of the object in perspective projection. There are three types of perspective projection. i.e. a) one-point perspective projection, b) two-point perspective projection and c) three-point perspective projection.

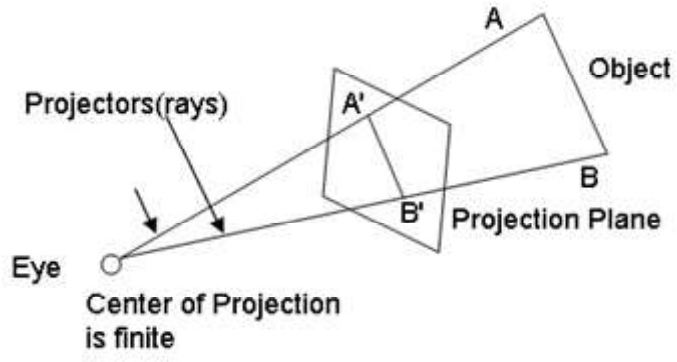


Figure 11.7: Perspective Projection

Vanishing Point: The point where all line meet is termed a vanishing point.

- **One Point:** There is only one vanishing point in one point perspective projection. And it is simple to draw

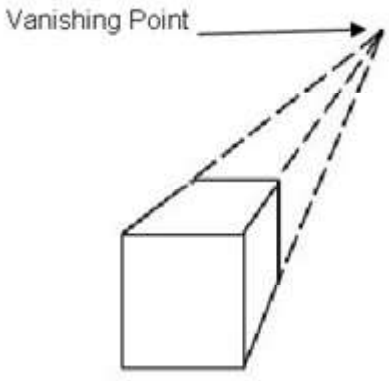


Figure 11.8: One-point perspective projection

- **Two Points:** There are two vanishing points in the two-point perspective projection. One point is in the x-direction and the other is in the y -direction. This gives a better impression of depth.

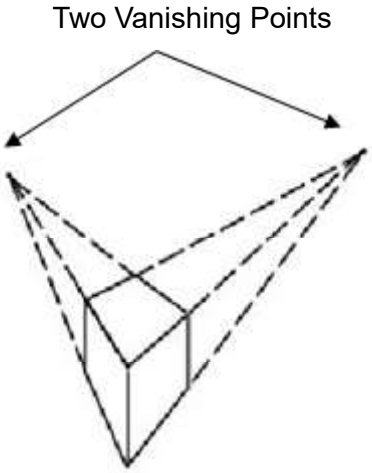


Figure 11.9: Two-point perspective projection

- **Three Points:** There are three vanishing points in the three-point perspective projection. It is most difficult to draw. Here all three principal axes have a finite vanishing point.

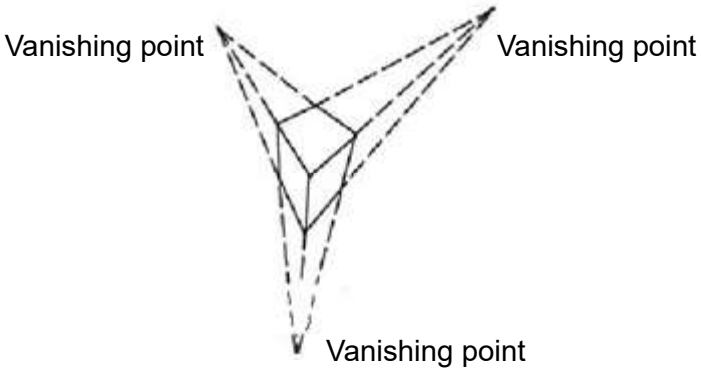


Figure 11.10: Three-point perspective projection



CHECK YOUR PROGRESS

Q 3: Define vanishing point

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11.7 HIDDEN LAYER PROJECTION

Hidden layer projection is a process through which surfaces that should not be visible to the user are prevented from being rendered. One of the most challenging problems in computer graphics is the project the hidden parts from images of solid objects.

There are two types of hidden surface detection algorithms: a) Object space methods and

- Image-space methods.
- Object space method: Here the parts of the objects are compared. After the comparison, visible, invisible or hardly visible surface is determined. Normally it determines the visible surfaces or layers.
- Image-space methods: In this method, pixels' position is determined. It is used to locate the visible surface instead of a visible line. Each point is detected for its visibility.

Following are some examples of algorithms used for hidden Layer or surface detection:

- Back Face Removal Algorithm
- Z-Buffer Algorithm
- Painter Algorithm
- Scan Line Algorithm
- Subdivision Algorithm
- Floating horizon Algorithm



CHECK YOUR PROGRESS

Q 4: Define hidden layer projection.

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11.8 LET US SUM UP

- Projection is the process of converting a 3D object into a 2D object.
- Parallel Projection is used to display a picture in its true shape and size.
- When projectors are perpendicular to the view plane then is called orthographic projection.
- In perspective projection farther away object from the viewer, small it appears. This property of projection gives an idea about depth.
- In Perspective projection lines of projection do not remain parallel.

- The Center of projection is the location of the eye on which projected light rays converge.
- Hidden layer projection is a process through which surfaces that should not be visible to the user are prevented from being rendered.



11.9 FURTHER READINGS

1) D. Hearn and P.M. Backer, Computer Graphics, Prentice Hall of India, 1986.
2) W. Newman and R.F. Sproul, Principles of Interactive Computer Graphics, McGraw Hill Publication, 1980.
3) W.K. Giloi, Interactive Computer Graphics, Prentice Hall of India, 1978.



11.10 ANSWERS TO CHECK YOUR PROGRESS

Ans. to Q No1: Isometric projection is a method for visually representing three-dimensional objects in two dimensions in technical and engineering drawings. It is an axonometric projection in which the three coordinate axes appear equally foreshortened and the angle between any two of them is 120 degrees.

Ans. to Q No 2: Parallel projections are used by architects and engineers for creating working drawing of the object, for complete representations require two or more views of an object using different planes. Parallel Projection use to display a picture in its true shape and size.

Ans. to Q No 3: The vanishing point is a point at which receding parallel lines seem to meet when represented in linear perspective.

Ans. to Q No 4: Hidden layer projection is a process through which surfaces that should not be visible to the user are prevented from being rendered.



11.11 MODEL QUESTIONS

Q 1: What is projection? Explain with the help of an image.

Q 2: Differentiate between parallel projection and perspective projection.

Q 3: What do you mean by the center of projection?

Q 5: Define view volume.

Q 6: Explain the different techniques for hidden layer projection.

Q 7: What is the use of projection in computer graphics?

Q 8: Define perspective projection and its types.

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