CHAPTER 9

THREE DIMENSIONAL VIEWING

CONTENTS

9.0 OBJECTIVES:

After reading this chapter you will be able to:

- Learn about three dimensional viewing
- Compare different types of projections
- Discover the ideas of three dimensional clipping
- Differentiate between 2D and 3D viewing
- Compare 2D and 3D Clipping

9.1 INTRODUCTION:

In two dimensional viewing, the problem was to map the world coordinate system to the pixel position of the computer output device. In case of three dimensional viewing the thing is a bit different. Here we can select any special point from where we can observe the object. For example, we can observe the object from the front, from back or from the top. Not only that we can observe a scene standing in the middle of the object or we can see the object from inside an object for example we can observe a pyramid standing inside a particular point. All these must be transferred to two dimensional viewing frame because the screen is two dimensional. So we have to project the three dimensional object into two dimensional screen. So projection is also very important. In this chapter we shall discuss different issues of three dimensional views and clippings.

9.2 THREE DIMENSIONAL VIEWING:

The three dimensional viewing is just like taking pictures with a camera. We can take a picture of an object from different sides of the object, from different distance from the object. Also we can change the aperture of the camera from wide angle to telephoto to take a particular portion of the scene. Position of the camera determines the projection plane and aperture and distance of the camera specifies the clipping of the scene. A three dimensional viewing requires three important things. These are, (i) projection plane called the view plane (ii) centre of projection or view point and (iii) view volume.

9.2.1 VIEW PLANE:

View plane is the plane of projection. We can think the view plane as the film of the camera when the camera is place in the proper place and in the proper orientation for taking a picture. This can be defined by a reference point $P(x_1, y_1 z_1)$ and a unit vector normal to the projection plane i.e., $V = v_1i+v_2j+v_3k$ which is a unit vector and is normal or perpendicular to the projection plane or view plane.

9.2.2 VIEW POINT:

In general a camera is placed in front of scene. The position of the camera or to be particular the position of the film is called the view point or view reference point. In some literature it is defined as a fixed point on or inside the object to the projected.

9.2.3 VIEW VOLUME:

View volume bounds a region of the world coordinate space that will be clipped and projected onto the view plane. For a perspective view, the view volume, corresponding to the given window is a pyramid and for parallel projection the view volume is an infinite parallelopipe with the sides parallel to the direction of projections.

9.3 PROJECTIONS:

Projection means mapping the three dimensional object into two dimensional plane. It is just like taking the picture of a three dimensional object. There are two types of projections one is parallel projection and the other is perspective projection. In parallel projection, the coordinate are transformed to a view plane along parallel lines, in case of perspective projection, object coordinates are transformed to the view plane along the line coverage to a point called center of projection.

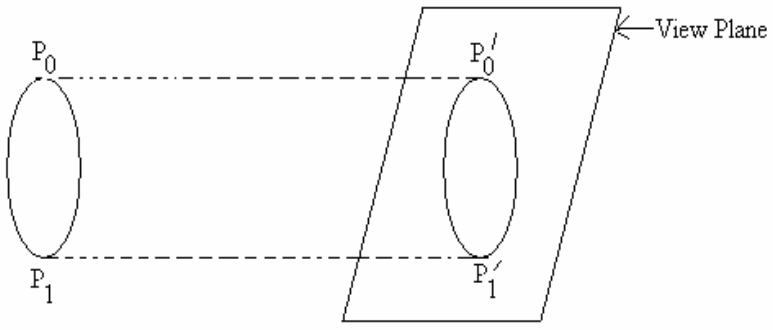

Fig-9.1: Parallel Projection

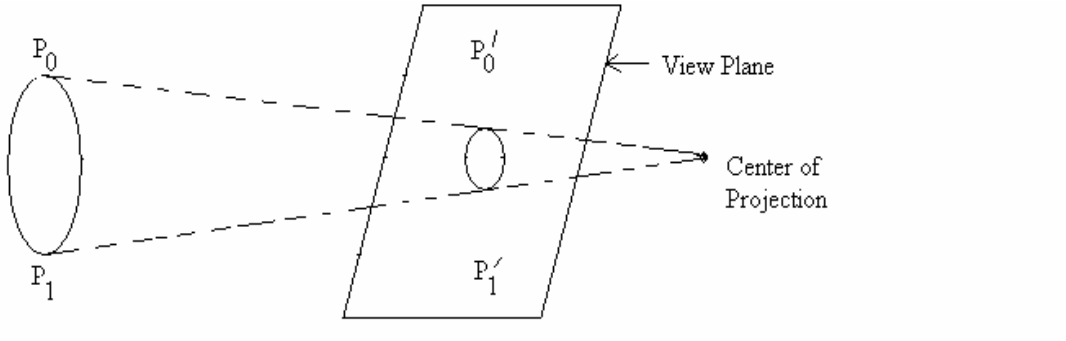

Fig-9.2: Perspective Projection

9.3.1 PARALLEL PROJECTION:

Parallel projection can be specified with projection vector. This vector states the direction of the projection lines. There are two types of parallel projections

(i) Orthographic parallel projections and

(ii) Oblique parallel projections.

Orthographic parallel Projection: If the projection vector is perpendicular to the view plane then the projection is called orthographic parallel projection.

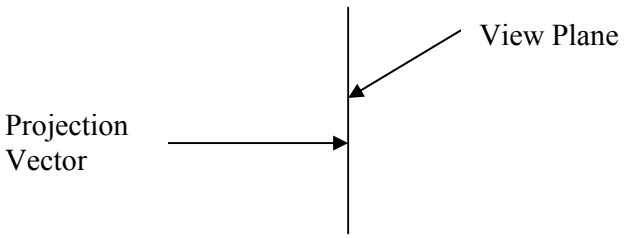

Fig-9.3: Orthographic Projection

Oblique parallel projections: If the projection vector is not perpendicular to the view plane, then we have an oblique parallel projection.

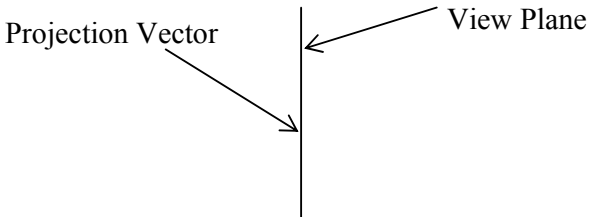

Fig-9.4: Oblique Projections

Orthographic projections are commonly used to produce front, side and top view of an object. The front and side views are called elevations. The top view is called plan view.

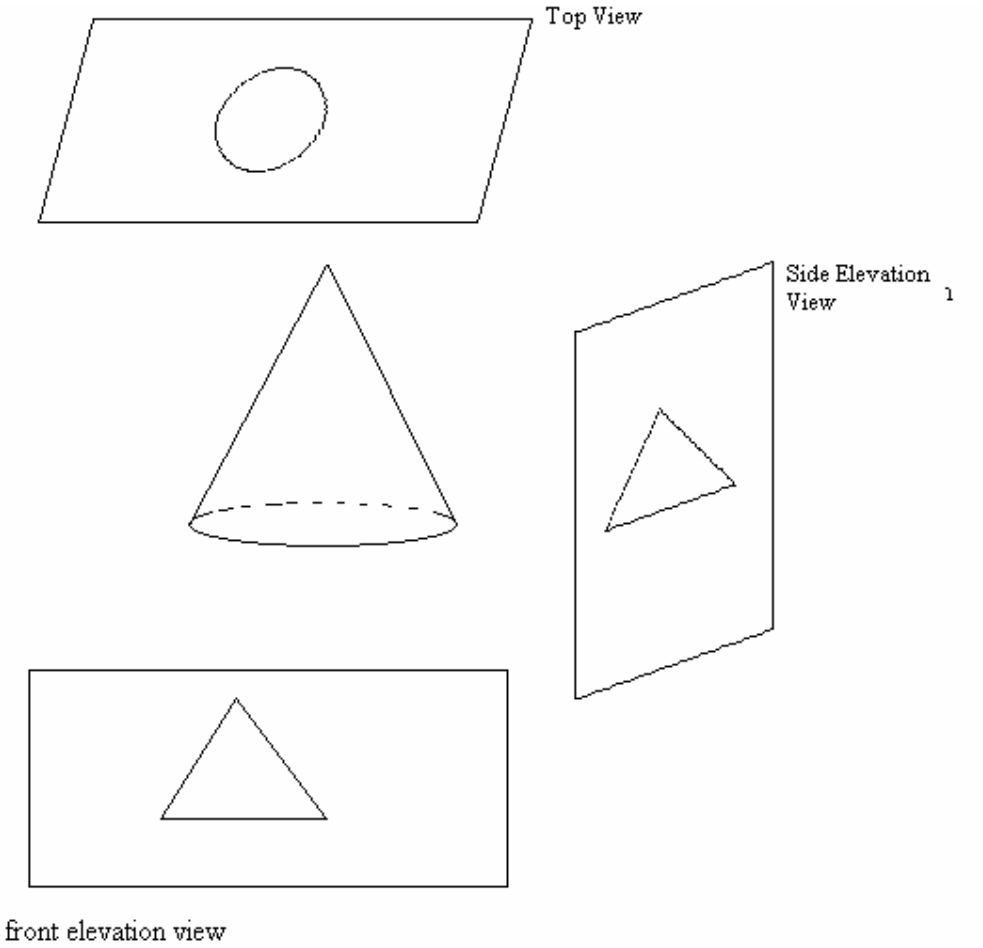

Fig-9.5: Orthographic Projection of a Cone

An oblique projection can be obtained by projecting points along parallel lines not perpendicular to the view plane.

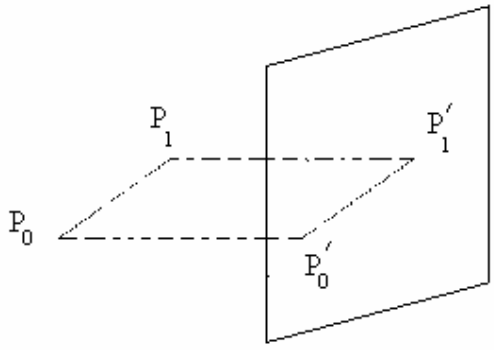

Fig-9.6: Oblique Projection

9.3.2 PERSPECTIVE PROJECTION:

The perspective projection means projection which will converge to a projection reference point. In this case if the same size object is placed in two different distances from the view plane their size on the view will be proportion to their distance from the view plane. So it is also possible that two different objects of different size may appear as same size object on the view plane if they are placed to the distance from the view plane proportional to their size.

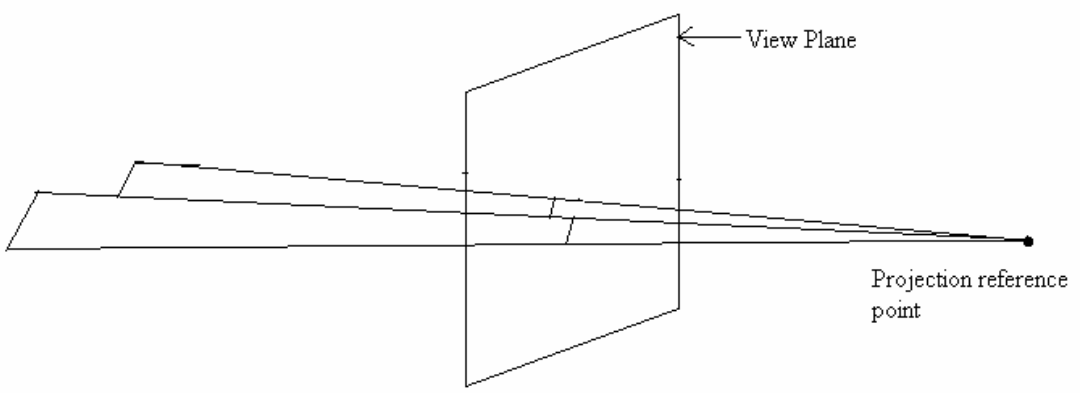

Fig-9.7: Perspective Projection

In the Fig-9.7, though the objects are not same but they are placed at different distance from the view plane and their size on the view plane are same. The following picture (Fig-9.8) illustrates the projection of a point on a view plane.

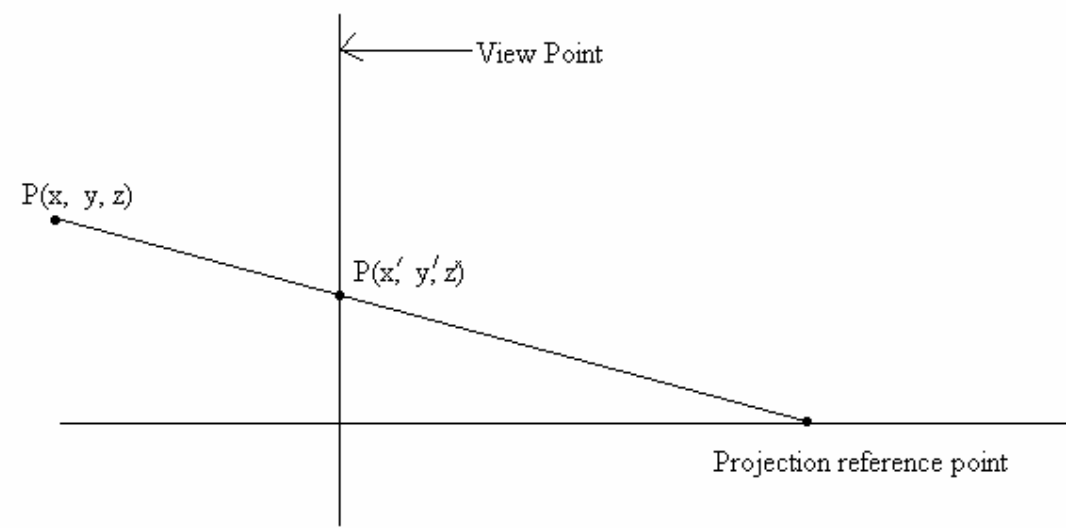

Fig-9.8: Perspective Projection of a Point on a Plane

When three dimensional objects are projected on a view plane, any set of parallel lines, that are not parallel to the view plane appears on the view plane as a set of converging lines. The set of parallel lines, parallel to the view plane will appear as parallel line. In case of parallel lines not parallel to the view plane, will vanish to a particular point. This point is called vanishing point. Each set of parallel lines will have separate vanishing point and a scene may have any number of vanishing points. The vanishing point for any set of lines that are parallel to any principal axis of an object is called the principal vanishing point. The vanishing point will be on the opposite side of the view plane where projection reference point is placed.

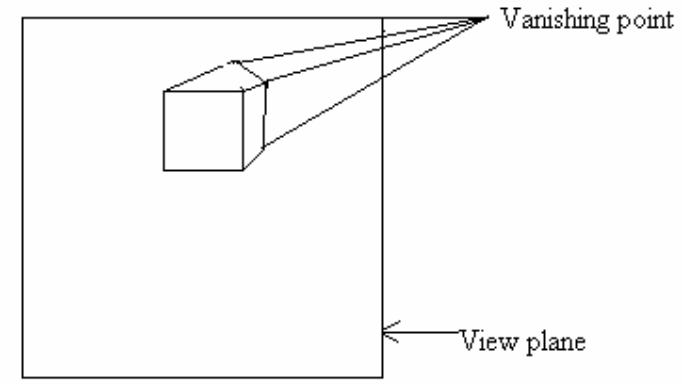

Fig-9.9: Vanishing Point

9.4 CLIPPING:

In this section we shall discuss general ideas of three dimensional clipping. In case of three dimensional clipping the clipping process identifies and saves all the surfaces which are inside the view volume. Anything outside the view volume are discarded and will not be displayed. Clipping in 3D is different from the clipping in 2D in the sense that in 2D there are four straight line window boundaries against which the clipping is performed but in the case of 3D there are six planes against which, the clipping is performed.

9.4.1 DIRECT CLIPPING:

Direct clipping is relatively simple. In this type of clipping we have to check the line and points whether they are outside the volume boundary surfaces

or not. If both the end points are outside a single boundary surface then that line is discarded. If both the end points are inside to the all of the boundary surfaces, then the line is saved otherwise the intersection of a line and the boundary is found. To clip a polygon surface, we can clip the individual polygon edges and then construct the clipped object.

9.4.1 CANONICAL CLIPPING:

In this case the view volume is mapped into a unit cube which is called normalized view volume or canonical view volume. The clipping is then performed on this canonical view volume. In canonical view volume parallel projections are the unit cubes whose faces are defined by x = 0, y = 0, z = 0, x = 1, y = 1, z = 1. In canonical clipping, the computation involved is minimum.

9.5 3DGGRPHICS PIPELINING:

We have introduced pipelining in two dimensional graphics system. This idea is also there in 3D graphics system. In pipelining, we divide our task into several parts so that we can do the entire task one after another in a simpler way and in an independent way. In this system the object definition is passed to the modeling transformation system. Viewing is carried out after this. After viewing transformation the projection is carried out. The 2D viewing transformation is performed after that. At the end the scan conversion is performed and the scan converted pixel information is then stored in the display frame buffer for the display of the scene on the monitor. The figure of graphics pipeline is given below.

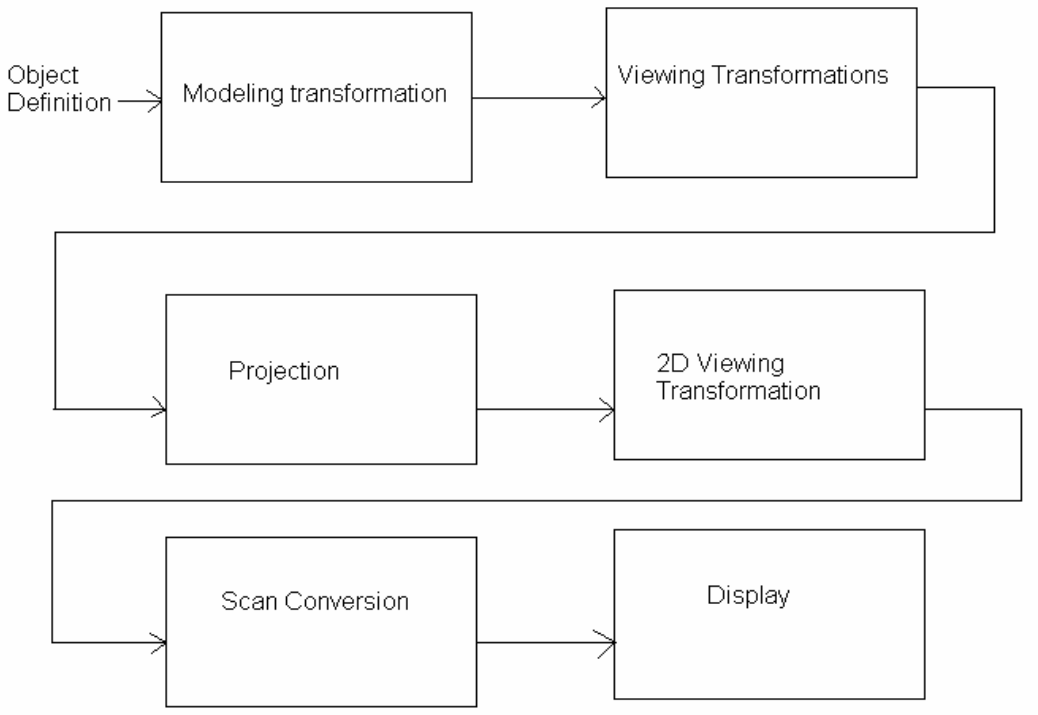

Fig-9.10: 3D Viewing Pipeline

9.6 KEY WORDS:

- Elevation View
- Oblique Projection
- Orthographic Projection
- Perspective Projections
- Projection
- Vanishing Point
- View Volume
- Viewing

9.7 SAMPLE QUESTIONS:

9.7.1 Define view plane, view point and view volume.

9.7.2 What do you mean by projection? What are the different types of projections?

9.7.3 What do you mean by orthographic and oblique projection?

9.7.4 Explain the perspective projection.

9.7.5 What is vanishing point?

9.7.6 What do you mean by direct and canonical clipping?

9.7.7 What do man by 3d graphics pipelining?