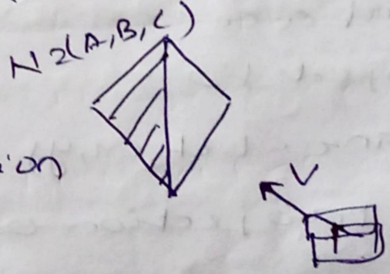
Backface Detection

- It is a fast and simple object space method for identifying the backface of a polygon which is based on inside or outside test.
- A point P(x, y) is inside a polygon surface with parameter A, B, C, D if

$$Ax + By + Cz + D < 0.$$

- When an inside point is along the line of sight to be a surface the polygon must be backface.
- Consider the normal vector N to a polygon surface which is cartesian component the polygon is backface.

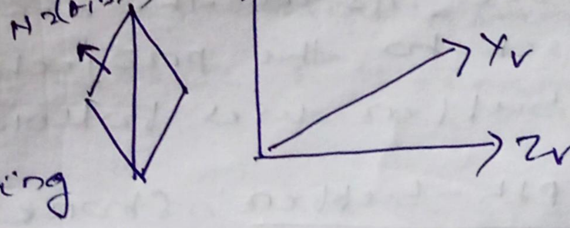
$$V \cdot N > 0.$$



- If the object description have been converted the projection co-ordinate our viewing dirn is parallel to the viewing axis z_v axis then

$V = (0, 0, V_z)$ and

$$V \cdot N = V_z \cdot C$$

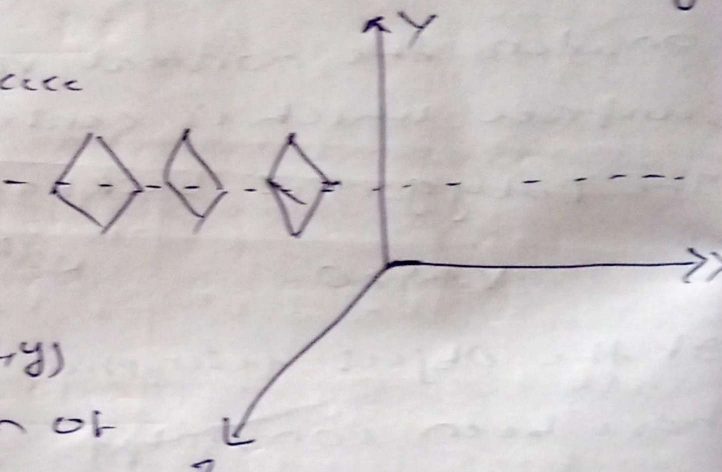


- In right hand viewing system the polygon is backface if $C < 0$.
- In left hand viewing system the polygon is backface if $C > 0$.

* Visible surface detection or hidden surface elimination is the process of identifying which part of a scene are visible from a choosen viewing system.

Z-buffer/Depth-buffer method:

- It is an image space method for visible surface detection.
- Here the object depth is usually reduce from the view plane along z-axis of a viewing system
- S_1, S_2, S_3 are surface of an object.
- These surface are project to view plane. Let (x,y) be the projection of (x,y,z) on the projection plane.



- So by measuring z-value of a point we can detect which surface should be visible. As in the diagram surface S_1 is closest to the projection plane
- Z-buffer uses following two buffer

1) **Depth-buffer**: Store depth value for each (x,y) position as surface are processed.

ii) Refresh-buffer: store the intensity value for the point P(x,y) where z-value is calculated.

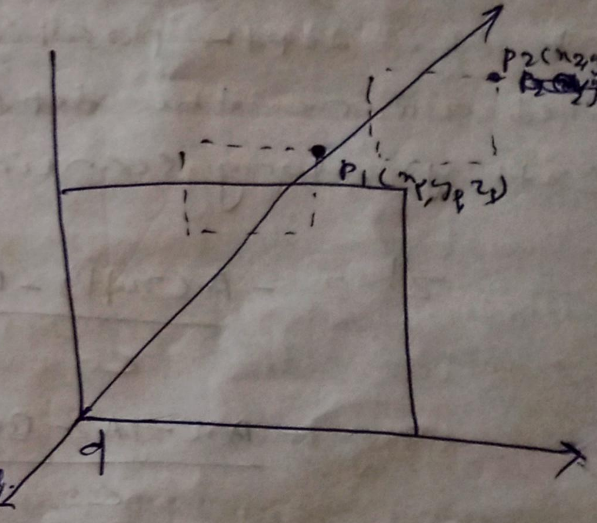
- scan convert each polygon surface one at a time.
- calculate the depth at each (x,y) pixel position.
- the calculated depth is compared to the value of previously store in the depth buffer.
- if the calculated depth is smaller than the value store in the depth buffer the new depth value is store and surface intensity at that position is determined.

Algorithm:

1) initialize the depth buffer and refresh buffer so that for all buffer position (x,y)

depth(x,y) = 0.

refresh(x,y) = I background.



2) for each position on polygon surface compare depth value to previously store depth value in depth buffer to determine visibility

i) calculate the depth z for each (x,y) position on the polygon.

11) If $z <$ depth (x, y) then set

depth $(x, y) = z$

refresh $(x, y) = I_{surface}(x, y)$

$I_{background}$ = value of background intensity

$I_{surface}(x, y)$ = projected intensity value on the surface at pixel position (x, y).

Calculation of Depth:

$$Ax + By + Cz + D = 0.$$

$$\Rightarrow z = \frac{-Ax - By - D}{C}$$

If the depth position (x, y) has been determine the depth z' of the next position $(x+1, y)$ along scanline is obtained by

$$z' = \frac{-A(x+1) - By - D}{C}$$

$$= \frac{-Ax - A - By - D}{C}$$

$$= \frac{-Ax - By - D}{C} - \frac{A}{C} = z - \frac{A}{C} \quad \text{--- (3)}$$

$$x' = x - \frac{1}{m}$$

$$y' = y - 1$$

$$\Rightarrow z' = \frac{-A(x - \frac{1}{m}) - B(y-1) - D}{C}$$

$$\Rightarrow z' = \frac{-Ax - By - D}{C} + \frac{A/m + B}{C}$$

$$\Rightarrow z' = z + \frac{A/m + B}{C}$$

$$\Rightarrow \boxed{z' = z + B/C}$$

Illumination model: It is also known as shading model or lightning model.

- It is used to calculate the intensity of light that is reflected at a given point on surface

- There are three factor on which light effect depend on

1) Light source:

Light source is the light emitting source. There are 3 types light source

1) Point source: It is source that emit rays in all direction. eg. bulb in a room.

2) Parallel source: can be considered as a point source which is far from the surface (sun).

3) Distributed source: Ray originate from a finite area.

Their position, electromagnetic spectrum and shape determine the lightning effect.

2) Surface: When the light fall on a surface part of it is absorbed. Now the structure decides the amount of reflection and absorption of light.

- The position of the surface and position of all nearby surface also determine the light source lightning effect.

3) Observer: The observer position and sensor spectrum sensitivities also effect the lightning effect.

1. Ambient Illumination

Assume you are standing on a road facing a building with glass exterior and sun rays are falling on that building reflect back from it and the falling on the object under observation this would be Ambient Illumination. In this case where source of light is indirect

2. Diffuse Reflection

It occurs on the surface which are rough and grainy. In this reflection the brightness of a point depend upon the angle made by the light source and the surface

- the reflected intensity I_{diff} of a point on the surface is

$$I_{diff} = K_d I_p \cos(\theta) = K_d I_p (N \cdot L)$$

where I_p: the point light intensity

K_d: the surface diffuse reflectivity

value of K_d varies from 0 to 1.

N: surface normal

L: light dir^n.

3) Specular Reflection:

When light falls on any shiny or glossy surface most of it is reflected back such reflection is known as specular reflection

Color model:

A color model is an ordery system for creating a whole range of colors from a smallest set of primary color.

- There are two types color models
i) Subtractive

ii) Additive

i) Subtractive: This model uses printing ink: color perceived in this model is reflected light

ii) Additive: This models ~~use~~ use light to display color color perceived in additive models as the result of transmitting light

~~RGB~~ There are four color models in your syallebus i.e XYZ, RGB, YIQ and CMY. out of this four two are very very important i.e RGB and CMY.

RGB: It is a additive color model for computer displays uses light to display color, color result from transmitting light

-> Red + Green + Blue = white

CMY: It is a subtractive color model.

- It is the standard color model used in offset printing for full color documents because such printing uses inks of these three basic color. It is often called three color printing.

-> cyan + magenta + yellow = Black

YIQ: It is use in U.S commercial color television. broadcasting (NTSC). It is a rotation of the RGB color space such that the Y-axis contains the luminance information allowing backwards compatibility with black-and-white colour TV, which display only axis of the colour space.

XYZ: X, Y and Z are extrapolation of RGB created mathematically to avoid negative number. In 1931 there were not any computer and are called tristimulus value. Y means luminance, Z is somewhat equal to blue. and X is a mix of cone response curve chosen to be orthogonal to luminance and non negative.