Segment -

- Display file is divided into number of subparts, is known as segment.
- Individual segments combined together form a scene.
- Attributes are -
  i) Visibility
  ii) Image transformation.

i) Visibility - Set to ON or OFF state.
- Used to indicate whether a particular segment is visible or not.
- ON ⇒ visible
  OFF ⇒ Not visible.

ii) Transformation -
- Translation, scaling, rotation, reflection.

Segment Table -

Segment Name	Segment Start	Segment Size	Visibility	Scale X	Scale Y	Trans X	Trans Y
1	-	-	ON	-	-	-	-
2	-	-	OFF	-	-	-	-

Segment Name -
- Used to decide which segment would be visible and which would not be visible.
- Used to uniquely identify a particular segment.

- Segment number is an integer number from 1 to onwards.

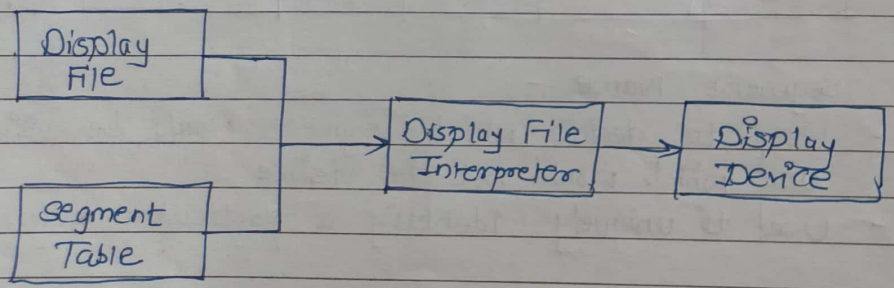
visibility [2] = OFF.

- The name of the segment acts as an index of segment table.
- We must know the location of segment.

Segment start :
Determine the start position of the segment from segment start.

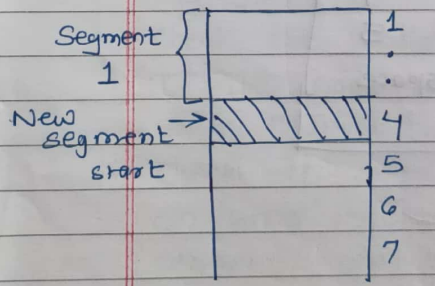
Segment size :
No. of instructions required to draw a particular object is nothing but the size of that particular segment.

When the image is displayed on the screen, the instructions required for drawing that object is stored in the display file.
Display file interpreter interprets the instructions from the display file in consultation with segment table.



Operations on segment -

1. Creation of segment -
- Algorithm :
1. Check if any other segment is open, check the Flag value.
   If Flag ≠ 0 then display error, "other segment is open" and goto step 7.
2. If Flag = 0, then it means no segment is open and set the Flag value to the name of new segment.
3. If the name of the segment is not valid then display error message "Invalid segment" and goto step 7.
4. See the next free space in the display file as the segment start attribute.
5. Initially segment size is zero and set all values to default.
6. Display message new segment is open.
7. Stop.



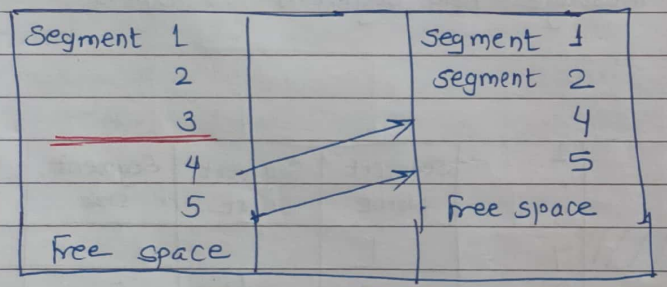
Segment Name	Segment start	Segment Size	Visibility
1			
2	4	0	ON

2. Closing of a segment -

1. Check if any other segment is open, if Flag ≠ 0, display error "other segment is open" goto step 6.
2. If Flag = 0, it means no segment is open. and set the Flag value to the name of new segment.
3. Not valid name.
4. Set Flag = 0.
5. Stop.

Deletion of segment -

- Not required - Delete it.
- If required later - Set visibility OFF.
- Check a valid name of the segment.
- Size of the segment should be non-zero.



Before Deletion

Segment Name	Segment Start	segment Size	Visibility	Transformations
1	1	6	ON	
2	7	4	ON	
3	11	5	ON	
4	16	3	ON	
5	19	6	ON	

After Deletion :

Segment Name	Segment Start	Segment Size	Visibility	Transformations
1	1	6	ON	
2	7	4	ON	
3	11	5	ON/OFF	
4	16-5 = 11	3	ON	
5.	19-5 = 14	6	ON	

Algorithm -

i) Check the valid name of segment to be deleted.
ii) If the name is not valid then display an error "Invalid segment name" and goto step 7.
iii) Check if any other segment is open, then display an error message "Cannot delete already open segment" goto step 7.
iv) If size = 0, no processing.
v) Make the size zero. All the below segments to be shifted.

vi) set the flag = 0
vii) stop.

Renaming of segment -

Segment	1	Segment	1
	2		2
	3		3
	4		4
	5		5
Free space		segment 6	

Before Renaming

Segment Name	Segment Start	Segment Size	visibility
1	1	6	ON
2	7	4	ON
3	11	5	ON
4	16	3	ON
5	19	6	ON

Name	Start	Size	Visibility
1	1	6	ON
2	7	4	ON
3	11	5	ON
4	16	3	ON
5	19	6	ON
6	-	-	OFF

Name	Start	Size	Visibility
1	1	6	ON
2	7	0	OFF/ON
3	11	5	ON
4	16	3	ON
5	19	6	ON
6	7	4	ON

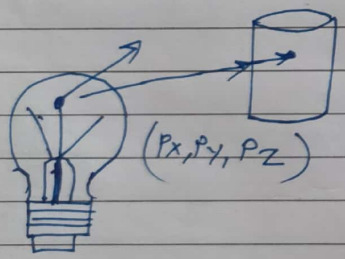
Illumination Models and Shading Algorithm -

Sources of light -

- There are number of objects that produce or emit light ; known as light emitting sources.
- Ex: Sun, Moon, Stars, Lamp etc.

1. Point source :

- Surface of the object to be illuminated is larger than source of light.
- Gives off equal amounts of light in all directions.
- Polygons or parts of polygons which are closer to light appear brighter than those that are away.
- Omnidirectional - Equal light in all directions.
- A bare bulb



2. Distributed light -

- Surface of the light emitting source is greater than the object surface.

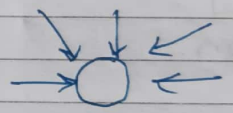
Illumination Model -
Used to calculate the intensity of light that is reflected a given point on surface.

✱ Ambient Light / Diffuse Light :

- General level of illumination that does not come directly from a light source.
- It consists of light that has been reflected and reflected so many times, no longer coming from a particular direction.
- The surface that is not exposed directly to light source, still will be visible if nearby objects are illuminated.
- Intensity ⇒ I_a.

$$I = I_a \cdot k_a$$

k_a ⇒ Ambient Reflection coefficient
Ranges from 0 to 1.



✱ Diffuse Reflection.

- When surface is lit by the light, it absorbs some amount of light while the remaining light is reflected.
- Smooth surface reflects more light compared to rough surface.
- Shininess of the surface depends on the amount and direction of reflected light. Known as diffuse reflection.

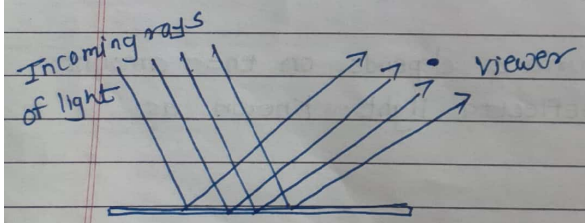
Coefficient of reflection / Reflectivity = $\frac{\text{light reflected from source}}{\text{Total incoming light}}$

⇒ White source reflects all light
Coefficient = Closer to 1
⇒ Black source absorbs all light
Coefficient = near to 0

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

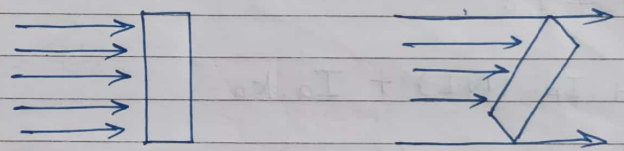
I_p ⇒ Point of intensity
K_d ⇒ Reflectivity, varies from 0 to 1.
N ⇒ Surface Normal
L ⇒ Light direction.

* Specular Reflection -
- When light falls on any surface, most of it is reflected back.
- Directional.
- Shiny materials ⇒ high specularity
  Matte materials ⇒ low specularity

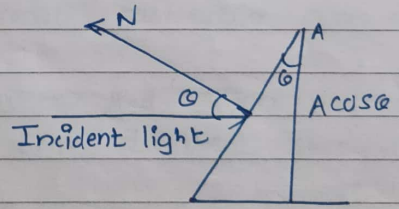


If the diffuse reflection scattered from the surface is equal in all directions, independent of viewing directions, is known as ideal diffuse reflector / Lambertian reflector.

Point source illumination -
- Though Lambertian surface reflects same amount of light in all directions, brightness depends on viewing direction.
- Perpendicular ⇒ looks brighter
- As angle increase, less light falls on the surface.



Angle of incidence -
θ be the angle between the incident light and the reflected light.



If the surface is perpendicular to incident light, angle bet^n incident light and reflected light 0, fully illuminated.

As the angle increases brightness drops off.

I_p ⇒ Intensity of point light source.

$$I_{diff} = K_d \cdot I_p \cdot \cos\theta$$

$$\cos\theta = N \cdot L$$

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

Combining the ambient light and point light source to compute total diffuse reflection

$$I = I_{diff} + I_a$$

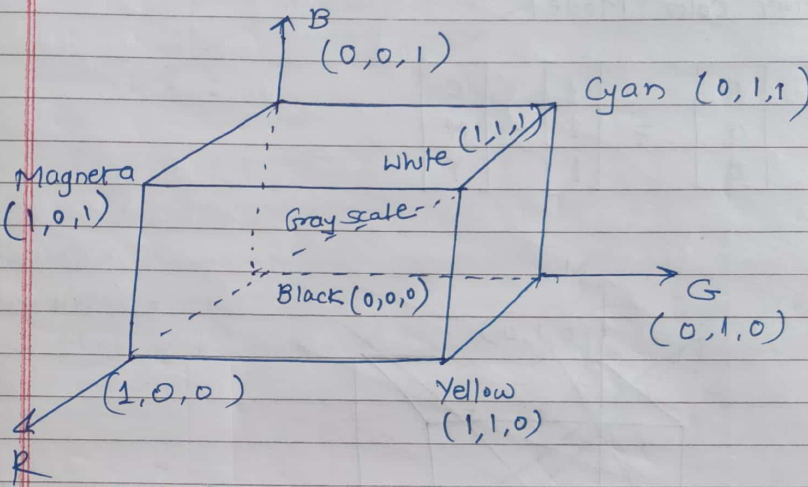
$$= K_d \cdot I_p \cdot (N \cdot L) + I_a \cdot k_a$$

$$= K_d \cdot k_a + I_p (1 + N \cdot L)$$

Color Model ⇒

1. RGB color model :

- Process of creating more colors using a few primary colors.



Additive color model ⇒ Used to display color.
Subtractive color model ⇒ Printing inks to produce color.

Common addictive color model ⇒ RGB
Common subtractive color model ⇒ CMYK.

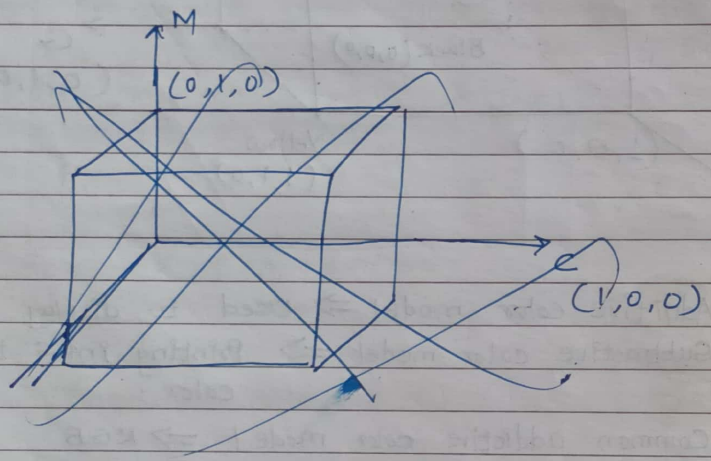
RGB ⇒ Red, Green and Blue color mixed together to form different array of colors.

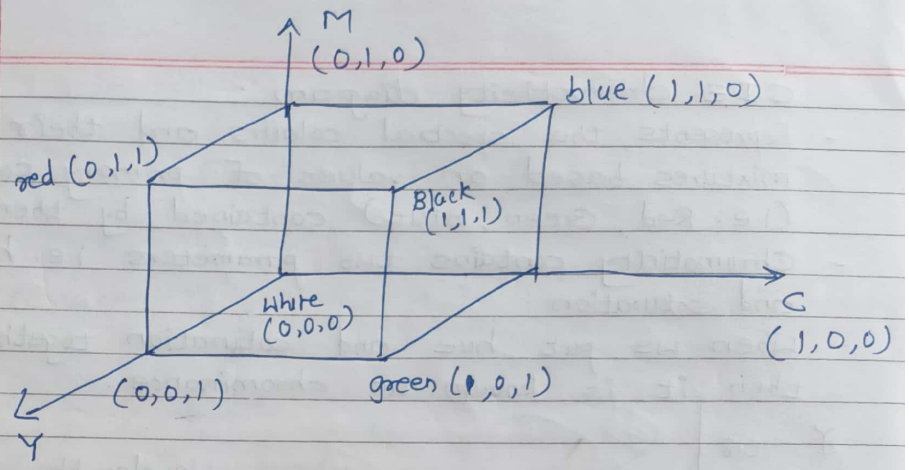
Least intensity ⇒ Black color.
Maximum intensity ⇒ White color.

$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

* CMY Color Model.

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} C \\ M \\ Y \end{bmatrix}$$

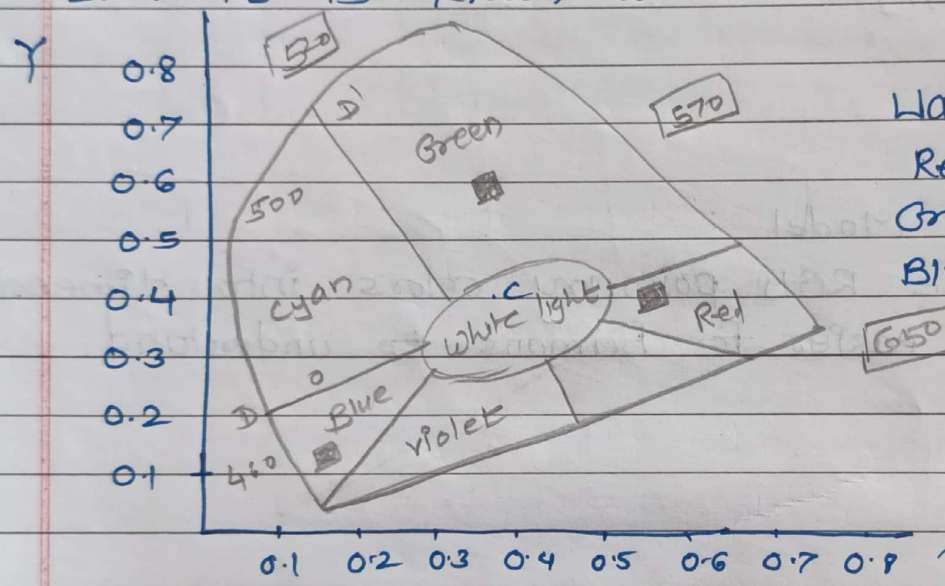




* HSV Color Model :
Remaps the RGB primary colors into dimensions that are easier for humans to understand.

CIE chromaticity diagram.

- Represents the spectral colours and their mixtures based on values of primary colours (i.e. Red, Green, Blue) contained by them.
- Chromaticity contains two parameters i.e. hue and saturation.
- When we put hue and saturation together then it is known as chrominance.



Wavelength
Red - 700nm
Green - 546.1 nm
Blue - 438.nm

- Represents visible colours using X and Y as horizontal and vertical axis.
- Various saturated pure spectral colours are represented along the perimeter of curve representing R, G, B
- Point C marked in chromaticity diagram represents a particular white light