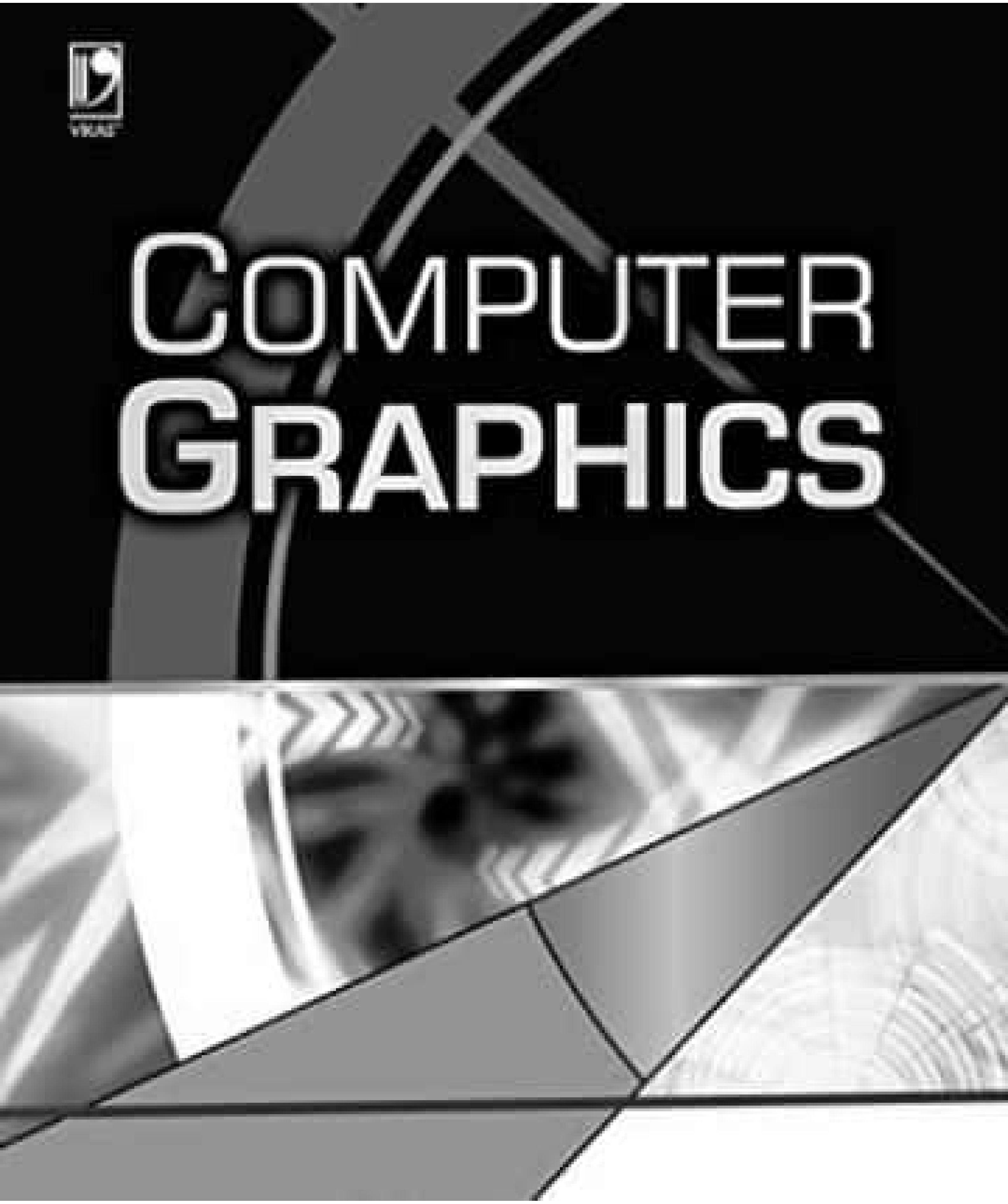

COMPUTER
GRAPHICS

CORE PAPER VII

GRAPHICS AND MULTIMEDIA

SYLLABUS.

- COMPUTER GRAPHICS -

UNIT 1 : Introduction and applications of Graphics.

Video Display Devices.

(i) CRT, Raster Scan display, Random scan display, Color CRT monitors, DVST, Flat - Panel Displays, ~~Input devices~~

(ii) Input display devices, Printers.

Output Primitives :

(i) DDA line drawing algorithm.

(ii) Bresenham's Circle drawing algorithm.

UNIT 2 : Basic Transformation of 2D :

(i) Translation, Rotation, Scaling and other transformations. Matrix Representations, Homogeneous coordinates and composite transformations.

Basic Transformation of 3D :

(i) Translation, Rotation, Scaling and other transformation

Projections :

(i) Parallel and Perspective projection.

UNIT 3 :

Polygon Clipping Algorithm :

(i) Sutherland Hodgeman clipping.

Visible Surface Detection Methods

(i) Visible surface detection.

(ii) Back Face detection

(iii) Depth - Buffer method

(iv) A Buffer Method

Polygon Surfaces

(i) Polygon tables, plane equation, Polygon meshes.

Filled Area Primitives : Boundry fill Algorithm.

Book : Computer Graphics c version

Donald D. Hearn / M. Pauline Baker.

PART 1: COMPUTER GRAPHICS

UNIT 1

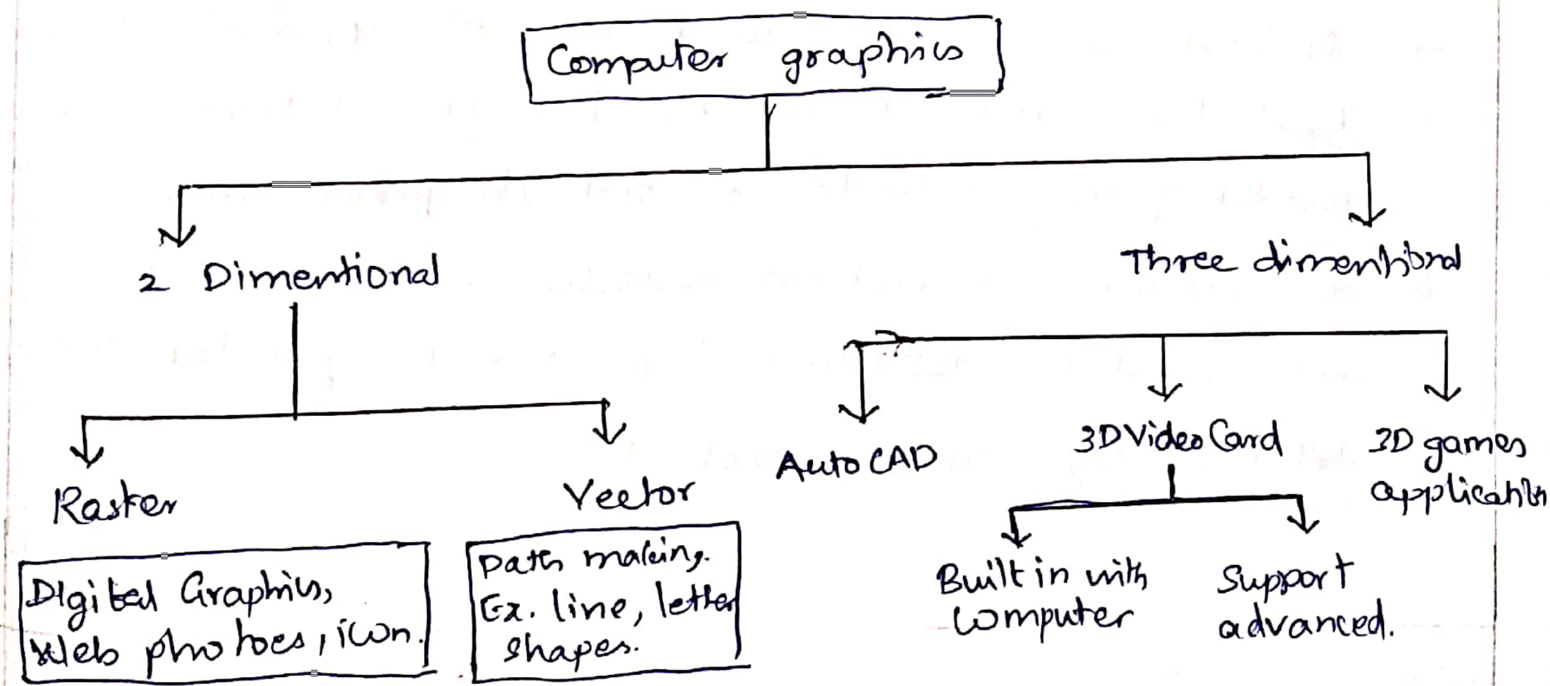
Introduction and Application of computer graphics

Definition of computer graphics:

Computer graphics is a visual image which is designed on the same surface like canvas or screen, to inform, illustrate or entertain. The graphics is visual representation of an object.

Types of Computer graphics

There are two types of computer graphics are 2Dimentional and 3 dimentional.



Example of 3D graphics Software :

Adobe illustrator, coreldraw, Adobe creative cloud, creative suite.

Applications of Computer Graphics :

1. CAD → Computer Aided Design methods are used in the design of buildings, automobiles, aircraft, space craft etc.,

2. In the begining designing process, the object are first display in a wire frame outline form that shows the overall shade and the internal features of objects.

3. Wire frame objects displays allows designers to quickly see the effects of interactive adjustments to design shades.

4. Animations can be used in CAD application.

5. Real time animations can be applied wire frame model of any vehicles to test its performance.

6. Animations in 'virtual reality' environments are used to determine how vehicle operators are affected by certain methods.

Some fields application used through computer graphics:-

(i) Presentation graphics :

Presentation graphics is used to produce illustrations for reports or generates 35mm slides or transparantly for projector presentation.

(ii) Computer Art :

* Artists use computer graphics method such as point brush programs (lumina), paint packages (pixel, paint and super paint).
* The paint brush programs allow the artists to brush paint graphics on the screen.
* The picture is printed on the graphics tablet electronically using styles, which can stimulate different strokes, brush ~~and~~ width and colour.
* Film animation requires 24 frames for each second in a animation sequence.

(iii) Entertainment :

* Computer graphics are used in making motion pictures, music, videos and TV shows.
* In music videos, graphic objects can be combined in live animating actions.

* Graphics and image processing techniques can be used to produce transformation of one person or object into another.

(iv) Education and Training:

Computer generated models for physical system, psycological system, population trends, or equipments such as color coded diagram which helps trainees understand the operation of the system.

(v) Visualisation:

* Producing graphical representation for scientific, engineering and medical data sets and process is called scientific visualisation.

* The term Business visualisation is used in connection with data sets related to commerce, industry etc.,

(vi) Image Processing:

It is a technique to modify or interact or interept it existing picture.

Applications of Image processing:

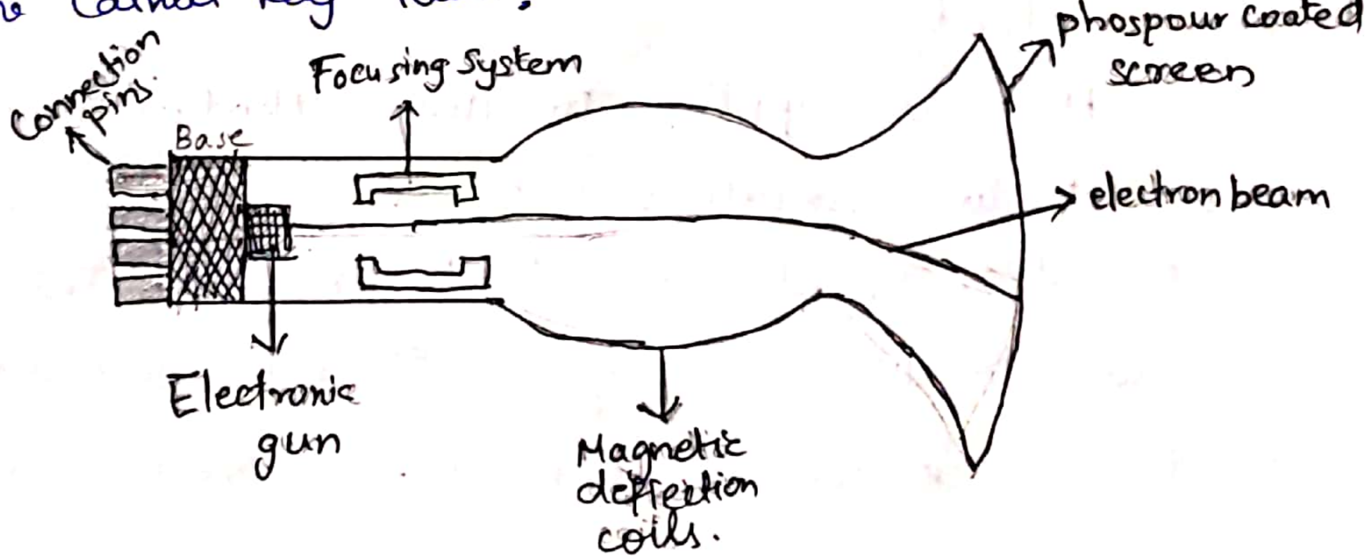
* Improving picture quality
* Machine perception of visual information.
* GUI, having main compo
* nents called window that allows to display multiple windows with the working area.
* Menu and icons are also available with interfaces for fast selection of processing operations.

Video Display Devices

The primary output devices in a graphic system is video monitor. The operations of most video monitors is based on standard technologies.

I. Cathod Ray tube:

The primary output device in a graphic system is video monitor. The main element video monitor is the Cathod Ray tube.



Premitive operations of CRT:

(1) A beam of electrons (cathod rays) emitted by an electron gun passes through focusing and deflection system that directly beamed towards specified position on the phosphor coated screen.

(2) The phospor emits a small spot of light at each position contacted by the electron beam.

(3) Since the light emitted by the phospour ~~glo~~ fades away rapidly and ~~so~~ thus we need to keep phospour glowing, it redraws the picture by directing the electron beam back over the same screen point quickly.

This is called refreshed CRT.

~~Pre~~

Components and functions in CRT:

Primary components of electron gun in CRT is the heated ~~method~~ metal cathod and control grid.

Metal Cathod:

Heat is supplied to the cathod by directing a current to a small coil of wire, called fillament, inside the cylindrical cathod structure. This causes electrons to be "boiled off" with hot cathod surface. Inside the CRT envelope, the negatively charged electrons are then accellerated towards the phospour coating by a high positive voltage.

Focusing and Accelerating system: (control grid).

The accelerating voltage can be generated with the positively charged metal coating on the inside of the CRT envolope, near the phospour coated screen or accelerating anode can be used. The focusing system in CRT is needed to force the electron beam to convert into a small spot as it stricks the phospour.

Additional focusing hardware is used in high precition system to keep the beam in focus at all screen position.

Phospour coated screen.

Different kinds of phospour are available for use in a CRT. The major difference between phospours is their persistance. The lower persistance phospour required high refresh rate to maintain a picture on the screen without ~~fict~~ flicker. Phospour with low persistance is used for animations. High persistance phospour is useful for displaying highly complex and standing pictures.

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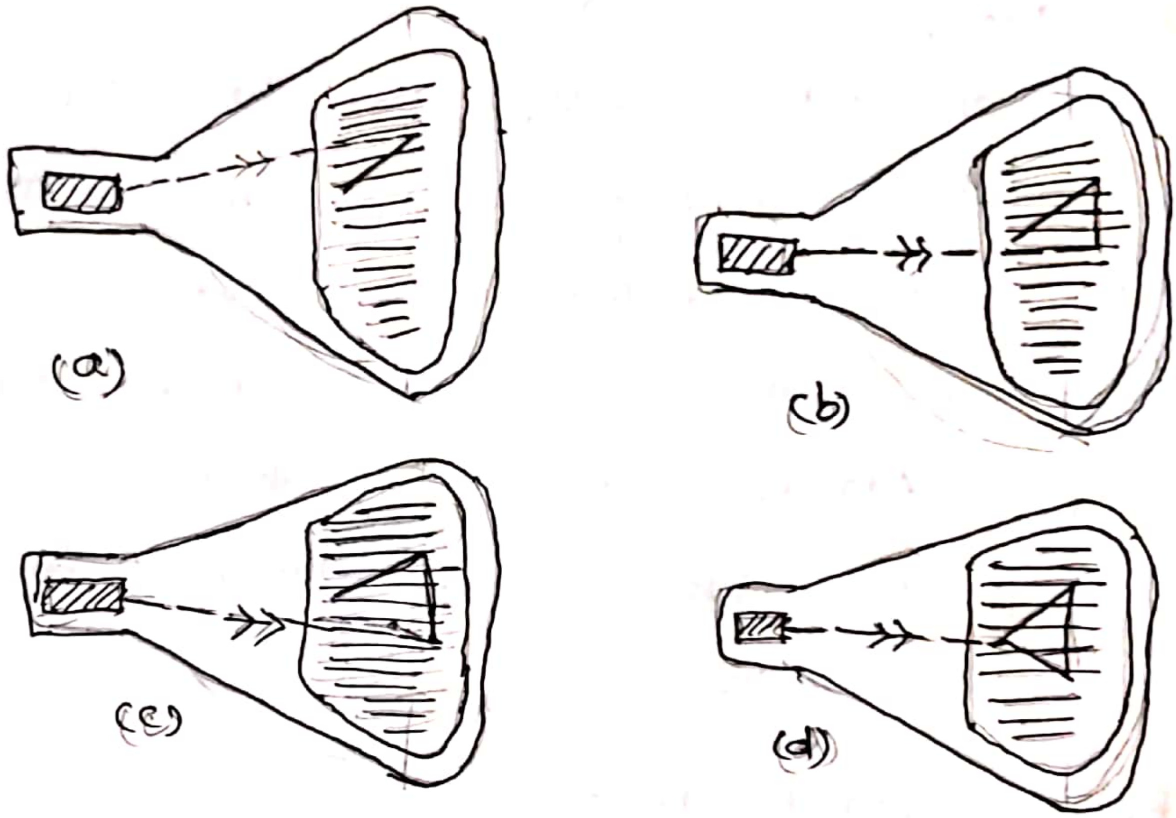
III (a) RASTER SCAN DISPLAY :

It is a most common type of graphic monitor employing in a CRT. This is based on ~~techno~~ television ~~techno~~ technology.



* In Raster Scan system, the electron beam swept across the screen one row at a time from top to bottom.
* The electron-beam move across each row, the beam intensity is turned one or off, to create the pattern of illuminated sparks.
* Picture definition are stored in a memory area are called refresh buffer or frame buffer.
* This area hold the set of intensity values for all the screen pixels. (points).

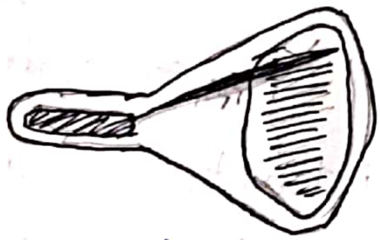
* The stored intensity values are then retrieved from the refresh buffer and painted on the screen one row at a time.
* Each screen point is refered to as pixels or pel.
* The capacity of raster screen system to store intensity information for each screen points, that make it well suited for realistic display of scenes containing subtle shading and color pattern.
* Home television sets and printers are examples of other system using a raster-scan method.
* Intensity range for pixel position depends on the capacity of the raster system.
* In a simple black and white system, each screen points is either on or off, so only one bit per pixel is needed to control intensity on screen.
* For a bilevel system, a bit value 1 indicates the electron beam is ~~to~~ turned on and 0 indicates the
* Beam is turned off.
* Additional bits are required for high intensity and colour. Upto 24 bits per pixel is ~~incl~~ included in high quality systems, which require several megabytes of storage for the frame buffer.

~~* A system with 24 bits per pel~~

* A system of 24 bits per pixel on screen resolution of 1024 * 1024 requires 3MB of storage for the frame buffer.
* On black and white system with one bite per pixel, the frame is commonly ~~used~~ called as ~~pi~~ bitmap.
* For system with multiple bits per pixel, the frame buffer is often refered as pixmap.

(b). RANDOM SCAN DISPLAY :

In this display, the CRT has electron beam directed only to the parts of the screen, where a picture is to be drawn. ~~This monitor~~



This monitor draws a picture one line at a time, because it is a vector display, also known as stroks writing or caligraphic displays. Refresh rate depends on the number of lines displays.

The picture definition is stored in a memory is refreshed to as refreshed buffer. To display a specified picture, the system cycles through the set of commands in the display file, drawing each component line inturn, after all line drawing command have been processed, the system cycle gets back to the first line command in the list.

This display designed to draw all the component lines of pictures. It takes 30 to 60 times each second to retrive the information. This display is only designed to line drawing applications not for displaying realistic pictures.

This display have high resolution than raster. It also produce smooth drawing, because the CRT beam directly following the line path.

~~DIRECT~~ ~~VF~~

II. DIRECT VIEW STORAGE TUBES (DVST):-

- It is used to store the picture information inside the CRT instead of refresh buffer.
- It is stored the picture information just behind the phospour coated screen.
- It used two electron guns. One is primary gun and the other is flood gun.

(a) Primary gun → stores picture pattern.

(b) Flood gun → Maintain the picture display.

Advantages :

1) No refresh is needed.

2) Complex pictures can be displayed with very high resolution without flickness.

Disadvantages :

1) Selected parts of the picture cannot be erased.

2) To eliminate picture selection the entire picture has been erased and modified the picture redrawn.

III. FLAT – PANEL DISPLAY

This type of displays reduced value volume weight and power requirments compared with CRT. The significant feature in the display is thinner than CRT, Hangened on walls also wear them on our wrists.

Example : Small TV monitors, calculators, pocket video games, laptop computers, adverticement board in elevators.

There are two categories of ~~flat~~ flat bed,

(i) Emitted displays [emitters]

(ii) Non-emissive displays [non-emitters].

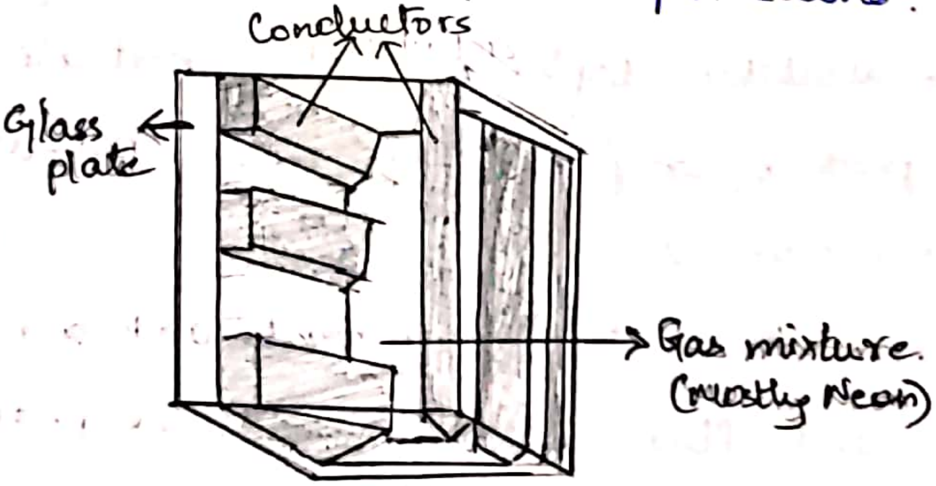
Flat bed

emitters: To convert electrical energy into light. ex., LED

non emitters: It use optical effect to convert light into graphical pattern. ex., LCD

(a) Plasma Panel:

- Gas Discharge displays.
- It is constructed by filling a region between two grasses plates with a mixture of gases that usually includes neons.
- A series of horizontal ribbons built in one side of a glass and vertical ribbons on other side.
- Firing voltage applied to pair of horizontal and vertical ribbon conductors causes the gas at the intersection of two conductors to break down into a glowing plasma of electrons and ions.
- Picture definition are stored in refresh buffer, the refresh rate is 60 frames per second.



(b) Thin firm electroluminar display :-

- It is similar to construction of plasma panel. But the difference is the region between the glass plates is filled with phosporous.

- It requires more power than plasma.
- It is good in colour and gray scale display.

(c) Light Emitting Diode (LED):-

The matrix of diode arranged in the form of pixel position of displays. The picture definition is stored in refreshed buffer. It use scan line to refreshing a CRT. The information read from buffer and converted to voltage levels than applied to the diodes, to produce the light pattern in the display.

(d) Liquid Crystal Display (LCD):-

It is commonly used in small systems such as ~~called~~ Calculators, laptop computers, portable devices etc., It produce a picture by passing polarised light (with the vibration).

It uses crystal components and arranged as a molecule and flow like a liquid. The picture definition is stored in refreshed buffer and the refreshed rate is 60 frames per seconds.

IV. COLOR CRT MONITORS:

This monitor display colour pictures by using combination of phosporous, which emits different coloured light. There are two techniques for producing coloured display.

1- Beam peneteration method.

2. Shadow mask method.

1) Beam Peneteration Method :-

It uses two layer of phospours (Red and green) coated inside the CRT screen display colours. The display colour depends on how far the electrons beam penetrate into phospour layer.

* If slow layer electrons exites, only The outer red layer gets a hit.
* Fast electrons penetrate through red layer and exictes at The inner green layer.
* The Combination of Red and green layers emitted orange and yellow colours.

They speed up the electrons or controlled by the beam accelleration voltage. This method is commonly used in Random scan monitors.

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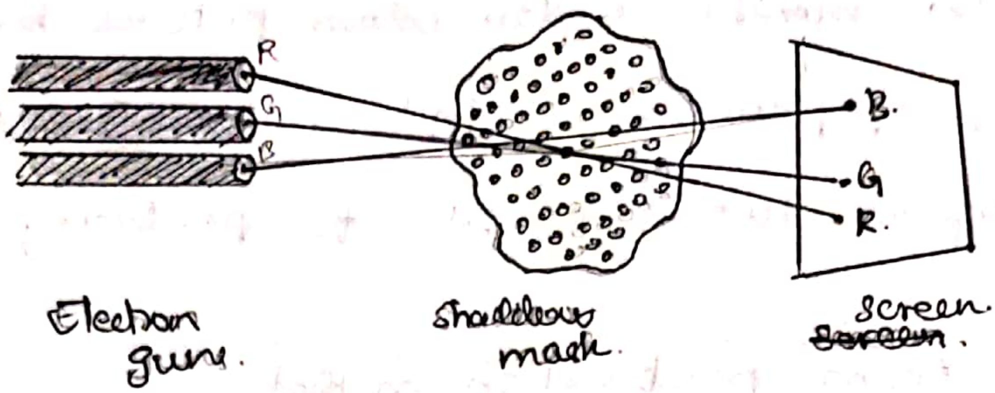
2) Shadow Mask Method :-



- It produces wide range of colours. It has three phospour colour dots at each pixel position.
- One phospour ~~colo~~ dots emits 3 colours [Red, Green, Blue].
- The three electron beams are deflected and focused as a group onto a shadow mask which contains the series of holes allined with the phospour dot pattern.

Input Devices and Printers

Various devices are available for data input on graphics workstations. Most systems have a keyboard and more additionally, devices are specially designed for the interactive input. This includes mouse, traceball, spaceball, joystick, and digitaliers. Some other input devices used for specific applications were data glove, touch ~~pens~~ panels, image scanners and voice systems.

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1) Keyboard :-

Keyboard is the most common input devices used today. The individual keys for letters, numbers and special charecters are collaboratively known as charecter keys. This keyboard layout is derived from the typewritting keyboard. Apart from alphabet ~~keys~~ and numeric keys, it also has function keys for performing different functions.

2) Mouse :

A mouse is a small held box used to position the screen cursor. Wheels or rolers on the bottom of the mouse can be used to correct the amounts and direction of moment. ~~an~~ Another method for detecting mouse motion is ~~sensor~~ optical sensor. One, two. or three buttons are ~~used~~ usally included on the top of the mouse for signally certain operations.

3) Trackballs and space balls :-

A traceball is a ball that can be rotated with fingers or palm of the hand, to produce screen cursor movement. Potantiometer, attached to the ball measures the amount ~~of~~ and direction of rotation. Trace ball is often mounted on keyboard or other devices such as z mouse. While traceball is 2D potantial dèvice, spaceball is ~~as~~ used for 3D potantial ~~and~~ is used in VR system.

4) Joysticks :

A joystick consists of a small, vertical lever mounted on a base that is used to steer the screen cursor around. Most Joysticks select screen positions with actual stick movement ; others should respond to pressure on stick. Some joysticks are mounted on keyboard and some are stand alone units. One or more buttons can be programmed to act as an input switches to signal certain actions once a screen position has been selected

5) Data glove :

Data glove is ~~use~~ glove that is used to grasp a "virtual" object. The glove is connected to the series of sensors that detect hand and finger motions Electromagnetic coupling between transmitting antennaes and recieving antennas is used to provide information about the position and orientation of the hand. A 2D projection of the scene is viewed on a screen and 3D projection of the scene is viewed with a handset.

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6) Touch Panels.

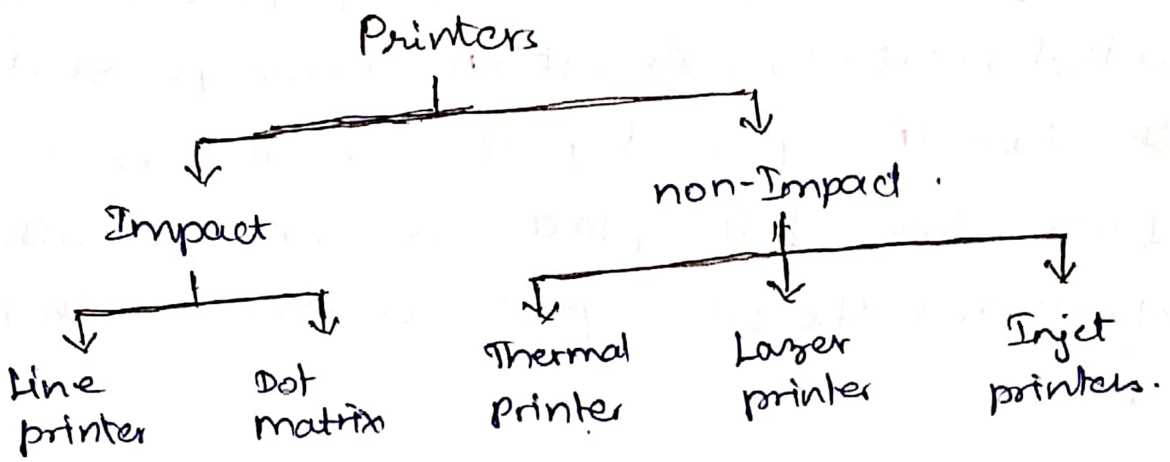
Touch panels allows displayed objects or screen positions to be selected with the touch of a finger. A typical applications of touch panels is for the selection of processing options that are represented with graphical icons. Plasma panels are designed with touch screens. Touch input can be recorded using optical, electrical, or acoustical methods.. An electric touch panel is constructed with two transparent plates seperated by a small distance. One of the plates is connected with conducting material and the other plate is covered with resistive material.

7) Light pen

The pen shaped devices are used to select screen positions by detecting the light coming from points on the CRT system screen. They are sensitive with short brush. One the selection through light pen is done, it generates the electric pulse that causes the coordinate position of the electron beam to be recorded. Although light pens are still with us, they are not popular as they have several disadvantages as compared to other input devices that have been developed.

Printers (Hardcopy devices) :-

Printer is an output device that prints text or images on paper or other media (like transparancies). By printing you create what is known as 'hard copy'. There are different kinds of printers, which vary in their speed and print quality.



* Impact printers press formed characters faces against an Inkjet ribbon on the paper.

Line Printers : A high speed printer capable of printing an entire line at a time. It is attached with typecase, bands, chains, drums or wheels on the top. The limitations are they can print only one font, they cannot print graphics.

Dot Matrix: It prints one line of 8 or 14 points at a time, with print head moving across a line. They are similar to typewritters. They are normally slow. The speed is around 300 characters per second.

*. Non Impact printers are much quicker than impact printer as Their printing heads do not strike the paper.

Laser printers: The laser beam creates a charge distribution on a rotating drum coated with a photo electric material, such as selenium. ~~It can print 180 times to 3000 lines per minute~~. One of the chief characteristics is their resolution, that range from 300 dpi to 1200 dpi.

Inkjet Printers: Inkjet method produces output by squirting ink in horizontal rows across a roll of paper wrapped in a drum. A desktop inkjet plotter with a resolution of 360 dpi is also at market. The electrically charged ink stream is deflected by electric field to produce dot-matrix patterns.

Electrothermal printers: It uses heat in dot matrix pattern print head to output pattern on heat sensitive paper. They are expensive and used widely in fax machines and calculators.

~~Output~~ Pre~~mittres~~

Output Premitives

Digital Differential Analysis Line Drawing Algorithm :-

Algorithm:

① Start Algorithm

② Declare x, y, x_1, y_1, x_2, y_2

③ Get the value of x_1, y_1, x_2, y_2

④ Calculate $dx = x_2 - x_1$

$dy = y_2 - y_1$

⑤ If abs(dx) > abs(dy) then

steps = abs(dx)

else

steps = abs(dy)

⑥ Calculate $x_{inc} = dx/steps$ and $y_{inc} = dy/steps$.

⑦ put pixel(x, y) [Assigning $x_1 \Rightarrow x$ and $y_1 \rightarrow y$].

⑧ $x = x + x_{inc}$; $y = y + y_{inc}$.

Set pixel (Round(x)', Round(y))

⑨ Repeat the step 8, until the value of $x = x_2$.

⑩ End algorithm.

Illustration

Let us calculate DDA line from (2,3) to (6,15).

$x_1 = 2$ $y_1 = 3$ $x_2 = 6$ $y_2 = 15$

$dx = x_2 - x_1 = 6 - 2 = 4.$ $dy = y_2 - y_1 = 15 - 3 = 12.$

$4 < 12$ $\therefore$ steps = abs [dy] = 12.

$x_{inc} = \frac{dx}{steps} = \frac{4}{12} = \frac{1}{3}$; $y_{inc} = \frac{dy}{steps} = \frac{12}{12} = 1.$

$\boxed{x_{inc} = 0.33}$ $\boxed{y_{inc} = 1}$

Assign $x=2, y=3$, ~~set~~pixel(x,y)
= pixel(2,3).

① $x = 2 + 0.33 = 2.33.$
$y = 3 + 1 = 4$ ... pixel(2,4)

② $x = 2.33 + 0.33 = 2.66$
$y = 4 + 1 = 5$ ... pixel(3,5).

③ $x = 2.66 + 0.33 = 2.99.$
$y = 5 + 1 = 6$ .... pixel(3,6).
plotted

④ $x = 2.99 + 0.33 = 3.32$
$y = 6 + 1 = 7$ .... pixel(3,7).

⑤ $x = 3.32 + 0.33 = 3.65$
$y = 7 + 1 = 8$ .... pixel(4,8).

⑥ $x = 3.65 + 0.33 = 3.98$
$y = 8 + 1 = 9$ ... pixel(4,9)
plotted

⑦ $x = 3.98 + 0.33 = 4.31$
$y = 9 + 1 = 10$ ... pixel(4,10).

⑧ $x = 4.31 + 0.33 = 4.64$
$y = 10 + 1 = 11$ ..... pixel(5,11).

⑨ $x = 4.64 + 0.33 = 4.97$
$y = 11 + 1 = 12$ .... pixel(5,12)
plotted

⑩ $x = 4.97 + 0.33 = 5.3$
$y = 12 + 1 = 13$ .... pixel(5,13)

⑪ $x = 5.3 + 0.33 = 5.63$
$y = 13 + 1 = 14$ .... pixel(6,14)

⑫ $x = 5.63 + 0.33 = 5.96$
$y = 14 + 1 = 15$ pixel(6,15)
plotted

x_2 now becomes x.

$\therefore$ stops algorithm.

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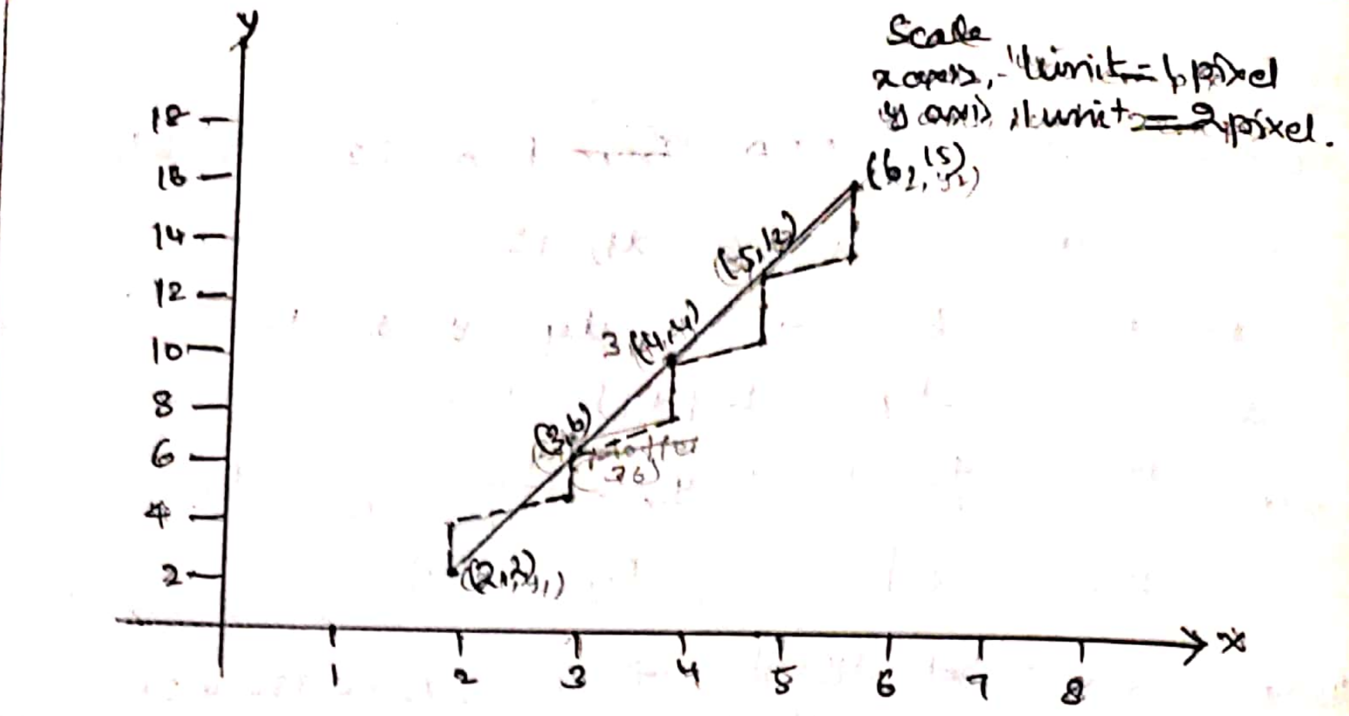


Bresenham's Circle Drawing Algorithm :-

Algorithm :

1. Start Algorithm.
2. Get the radius of the circle r and coordinate of center of circle c. (x_c, y_c)
3. ~~D = 3 - 2r initiate decision~~ x and y are going to be point $x=0$ $y=R$.
4. ~~Plot the circle (x, y)~~ Calculate $D = 3-2r$ initiate parameter
5. plot the circle $(x_c, y_c), (x_p, y_p)$
6. If $D<0$ then

   $D = D+4x+6.$ $x = x+1$; $y = y.$

   else

   $D = D+4(x-y)+10$ $x = x+1$; $y = y-1.$
7. If $x=y$, goto step 8 else go to step ~~4~~ 5.
8. End algorithm.

Illustration :

(1). let $x=0$, $R=10$, $x_c=1$, $y_c=2$. $\boxed{x_c = 2 \text{ \& } y_c = 2}$

as $x=0$, $y=R=10$,

$D = 3-2R = 3-2(10) = 3-20 = -17$.

(1) → plot circle (2, 2, 0, 10).

$D<0$ $[-17<0]$.

$D = D+4x+6 \rightarrow -17+4(0)+6 = -17+6 = -11$.

$x = 0+1 = 1$; $y = 10$. $1 \neq 10$.

(2) → Plot circle (2, 2, 1, 10).

$D<0$ $(-11<0)$

$D = -11+4(1)+6$

$= -11+4+6 = -1$.

$x = 1+1 = 2$.

$y = 10 = 10$.

(3) → plot circle (2, 2, 2, 10).

$D<0$ $[-1<0]$

$D = -1+4(2)+6$

$= -1+8+6 = -1+14$

$= +13$

$x = 2+1 = 3$.

$y = 10 = 10$.

(4) → plot circle (2, 2, 3, 10).

$D>0$ $(13>0)$.

$\therefore D = 13+4(3-10)+10$

$= 13+4(-7)+10$

$= 23-28 = -5$.

$x = 3+1 = 4$

$y = 10-1 = 9$.

(5). plot circle (2, 2, 4, 9).

$D<0$ $(-5<0)$.

$D = -5+4(2)+6$.

$= 1+8 = 9$.

$x = 4+1 = 5$.

$y = 9$.

(6). plot circle (2, 2, 5, 9)

$D > 0 \quad (9 > 0)$

$x = 5 + 1 = 6.$

$y = 9 - 1 = 8.$

$\therefore D = 9 + 4(5 - 9) + 10$

$= 9 - 16 + 10 = -3.$

(7) plot circle (2, 2, 6, 8).

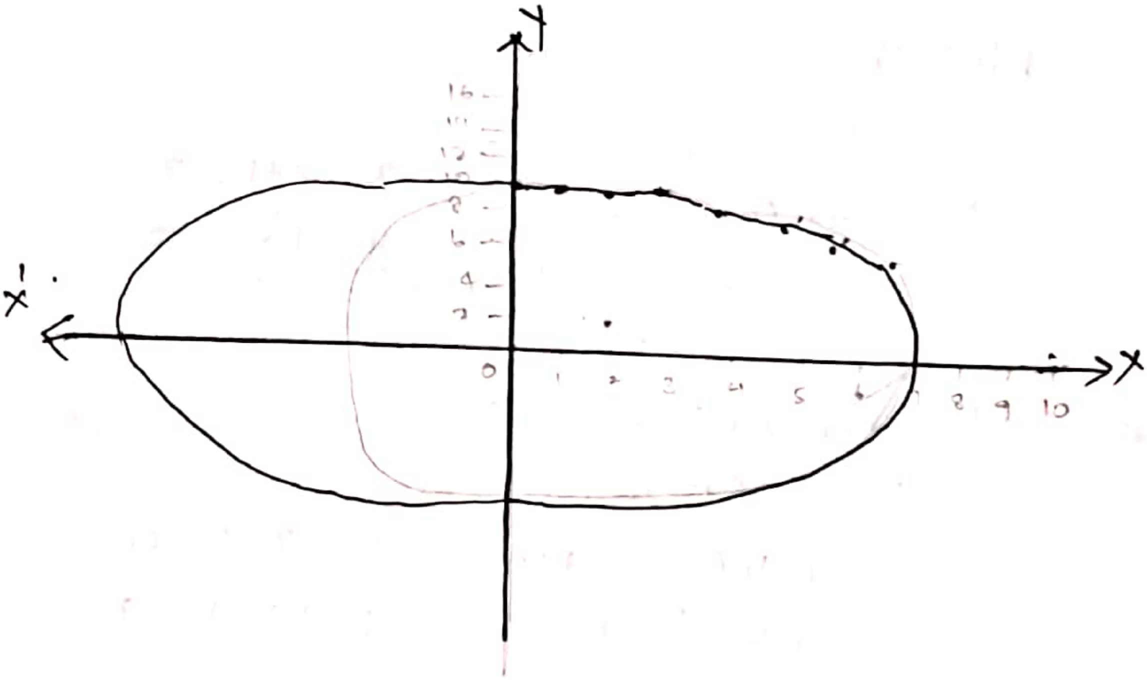
$D < 0 \quad (-3 < 0).$

$\therefore D = -3 + 4(6) + 6 = 3 + 24 = 27.$

$x = 6 + 1 = 7.$

$y = 8 - 1 = 7.$

plot circle (2, 2, 7, 7).



UNIT 2

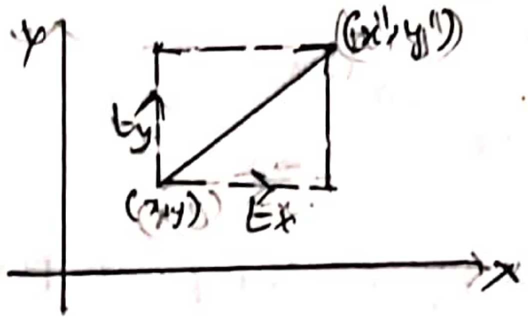
Basic Transformations of 2D and 3D objects. And its Projections

I. BASIC TRANSFORMATIONS OF 2D OBJECTS :

- It includes translation, Rotation, Scaling, ~~shearing~~ and

1. Translation :

- It moves an object in a 2D plane from one position to another plane.
- To move an object in such plane, the translation coordinate (t_x and t_y) were added to the original point (x, y) so gets the new position (x', y').



(t_x, t_y) are refered to as shift/vector coordinates.

From the above diagram and the given data,

$$x' = t_x + x. \quad -①$$

$$y' = t_y + y. \quad -②$$

Forming the matrix representation from equation ① and ②,

$$P' = \begin{bmatrix} x' \\ y' \end{bmatrix} \qquad P = \begin{bmatrix} x \\ y \end{bmatrix} \qquad T = \begin{bmatrix} t_x \\ t_y \end{bmatrix}$$

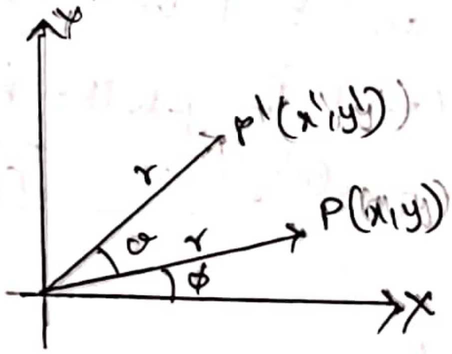
$$P' \begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}$$

$$\boxed{P' = P + T}$$

Here T is called as translation matrix.

2. Rotation:

- Rotation of an object is repositioning it along a circular path in 2 dimentional plane (xy plane).
- It is specified by an angle θ and a pivot point p (rotating point).



In the above figure, the point P(x,y) located at angle φ with distance r from origin. Suppose if you want to rotate at an angle θ, we get a new location with new point p'(x',y').

Using standard trigonometric measurements,

the representation of the original point $P(x, y)$ is

$$x = r\cos\phi \rightarrow (1)$$
$$y = r\sin\phi \rightarrow (2).$$

Similarly, we can represent the point $P'(x', y')$ as

$$x' = r\cos(\phi + \theta)$$
$$y' = r\sin(\phi + \theta).$$

$$\therefore\ x' = r(\cos\phi\cos\theta - \sin\phi\sin\theta)$$
$$y' = r(\cos\phi\sin\theta + \sin\phi\cos\theta).$$

Substituting the above equations by (1) & (2),

$$x' = r\cos\phi\cos\theta - r\sin\phi\sin\theta$$
$$\boxed{x' = x\cos\theta - y\sin\theta}$$

$$y' = r\cos\phi\sin\theta + \sin\phi\cos\theta.$$
$$\boxed{y' = x\sin\theta + y\cos\theta.}$$

It represents in matrix form,

$$[x' \ y'] = [x \ y]\begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$$

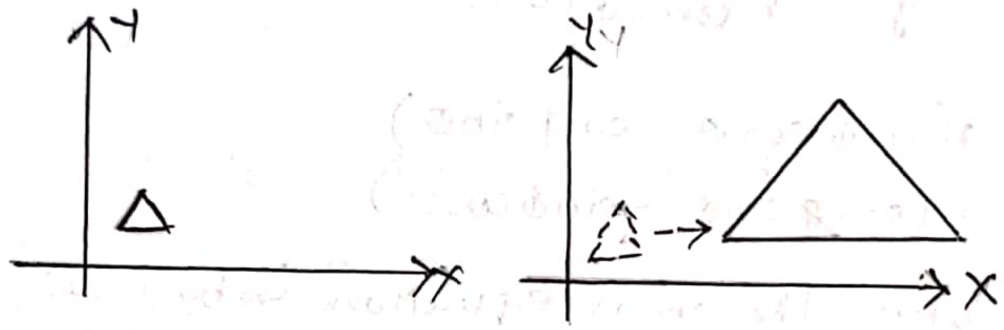
$$\boxed{P' = P \times R}$$

Here $R = \begin{bmatrix}\cos\theta & \sin\theta \\ -\sin\theta & \cos\theta\end{bmatrix}$ is an rotation matrix.

If R is negative, then $R(-\theta) = \begin{bmatrix}\cos\theta & -\sin\theta \\ \sin\theta & \cos\theta\end{bmatrix}$

3. Scaling

- Scaling is one of the transformation that alter or resizes the object.
- The operation is ~~occupied~~ accomplished by multiplying each coordinate value (x, y) of a vertex v by scaling factors S_x and S_y.



Before Scaling After Scaling.

Here, $S_x \rightarrow$ Scaling factor with respect to x.
$S_y \rightarrow$ Scaling factor with respect to y.

Rules:

1. If S_x and S_y lies between 0 and 1,
   - Point is closer to the origin.
   - Size of the object ~~is~~ will decrease.
2. If S_x and S_y are greater than 1,
   - Point is away from the object.
   - Size of the object will increase
3. If S_x and S_y are equal
   - Size of the object will be done uniformly.

From the diagram, let P be the point on object at 'before scaling' graph and P' be the point on object at 'after scaling' graph.

$$\cancel{P(x,y)} \rightarrow P \rightarrow (x,y) \qquad P' \rightarrow (x',y')$$

then,
$$x' = S_x \cdot x.$$
$$y' = S_y \cdot y$$

- Matrix representation so formed is:

$$\begin{pmatrix} x' \\ y' \end{pmatrix} = \begin{pmatrix} S_x & 0 \\ 0 & S_y \end{pmatrix} \begin{pmatrix} x \\ y \end{pmatrix}.$$

OTHER TRANSFORMATIONS:

Some other transformations apart from basic of 2D transformations, includes reflexion and Shearing.

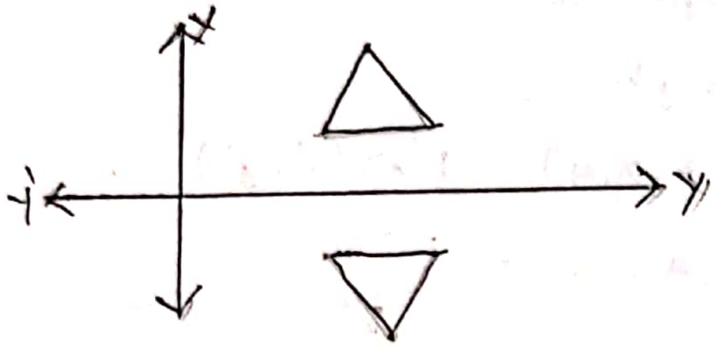
1. Reflection:

- It is a transformation that produces a mirror image of an object.
- It is generated by rotating the object 180° around the axis of reflection.
- In other words, the reflection ~~axis~~ axes are perpendicular to the xy plane.

Possible reflections :-

1. X axis reflection
2. Y axis reflection.
3. Reflection towards origin
4. X=Y equational rotation.

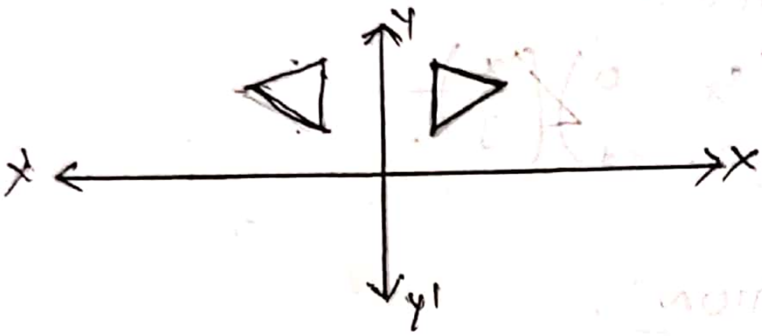
(i) Reflection with respect to X-axis :



Matrix Representation:

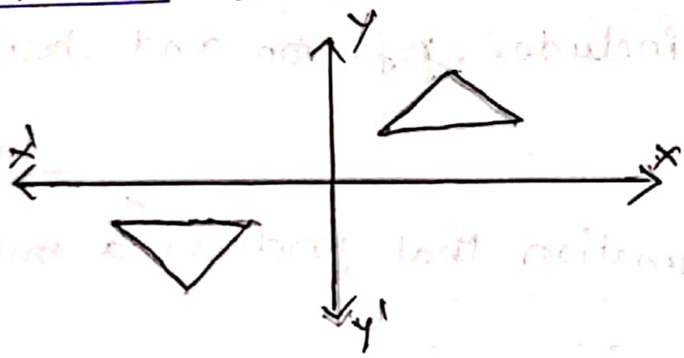
$$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

(ii) Reflection with respect to Y-axis :



$$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

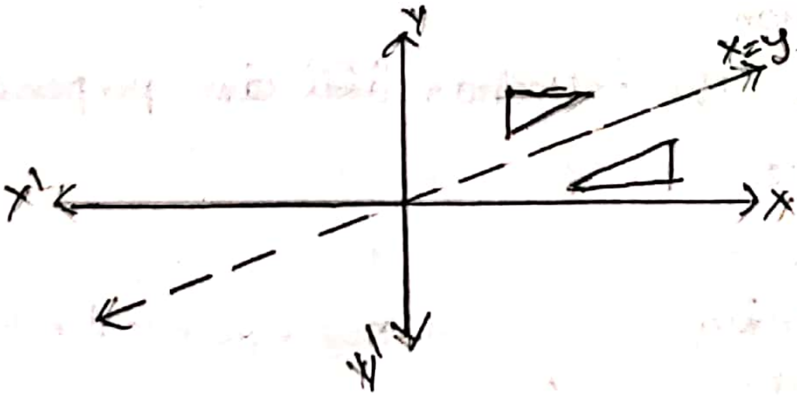
(iii) Reflection towards origin :



Matrix Representation:

$$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

(iv) Reflection about the line $x = y$:

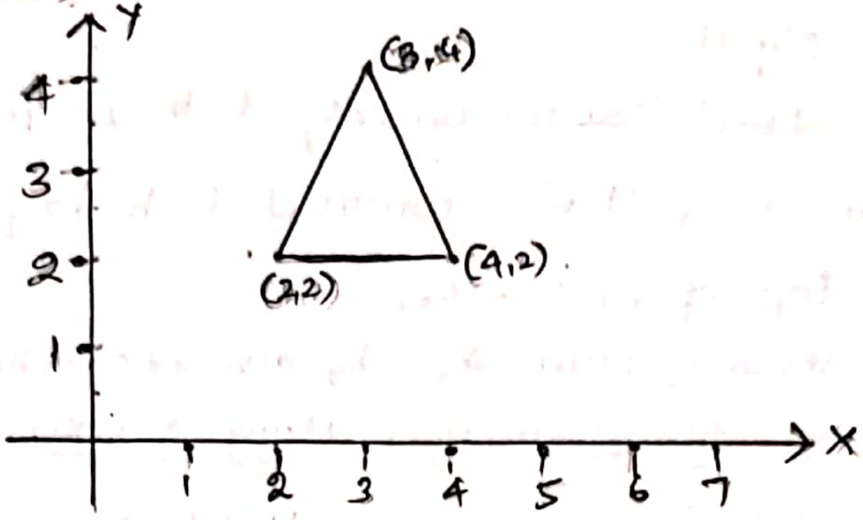


Matrix Representation:

$$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

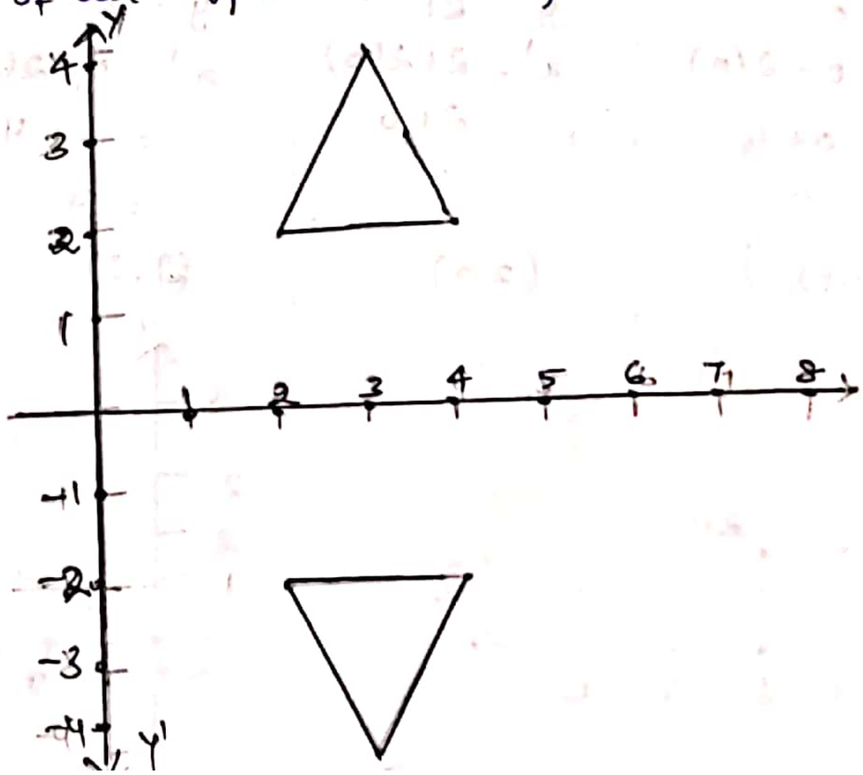
Illustration:

Let us create the reflected object of an original object having points (2,2), (3,4), and (4,2).



Points:	(2,2).	(3,4)	(4,2).
Matrix Representation	$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 2 \\ 2 \\ 1 \end{bmatrix}$	$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 3 \\ 4 \\ 1 \end{bmatrix}$	$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} 4 \\ 2 \\ 1 \end{bmatrix}$
Result.	$x'=2$; $y'=-2$; $h=1$	$x'=3$; $y'=-4$; $h=1$	$x'=4$; $y'=-2$; $h=1$

Plotting the points of x' and y' based on results, we got the reflection of an object with respect to x-axis as,



2. Shearing :

- shear transformation distorts the object shape of the object.
- The effect causes the object to be pushed to ~~the~~ one side as if it was constructed to layers that slides on top of each other.
- The shearing factor sh_x, sh_y also refered to as skewing.

(i) Shearing transformation along x-axis. (x-shearing.) :-

Equation:

$$y' = y.$$

$$x' = x + (sh_x \times y).$$

Matrix representation

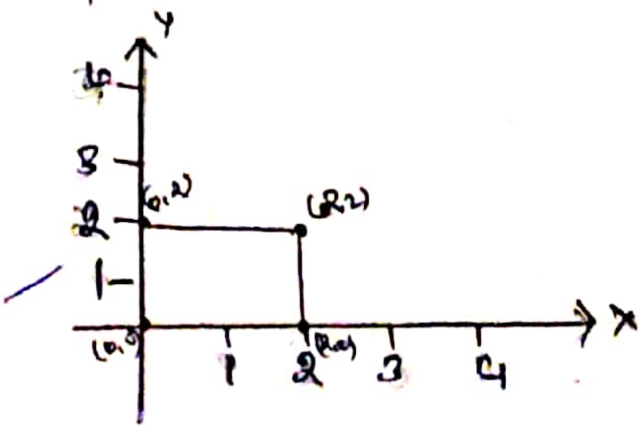
$$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} 1 & sh_x & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

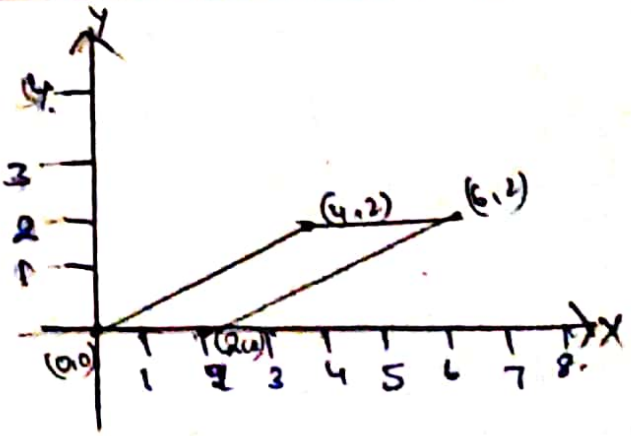
Example

Let the skewing factor sh_x be 2 units.

Let us now shear an object from points (0,0), (2,0), (0,2), (2,2).

(x,y)	(0,0)	(2,0)	(0,2)	(2,2).
Calculation	$y' = 0$ $x' = 0 + 2(0)$ $= 0 + 0$ $= 0$.	$y' = 0$. $x' = 2 + 2(0)$ $= 2 + 0$ $= 2$.	$y' = 2$ $x' = 0 + 2(2)$ $= 0 + 4$ $= 4$.	$y' = 2$ $x' = 2 + 2(2)$ $= 2 + 4$ $= 6$.
(x',y')	(0,0).	(2,0)	(4,2)	(6,2).





(ii) Shearing transformation with respect to y-axis (y-shearing)

Equation

$$y' = y + sh_y \cdot x$$
$$x' = x.$$

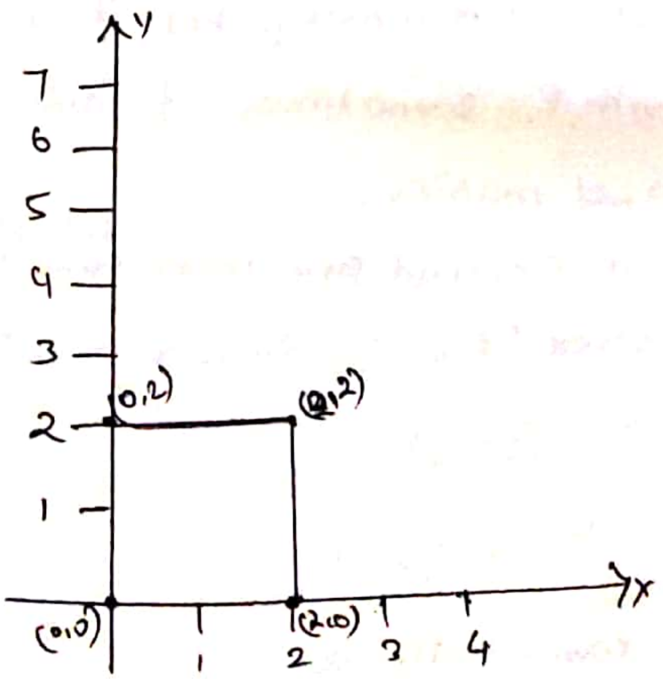
Matrix Representation

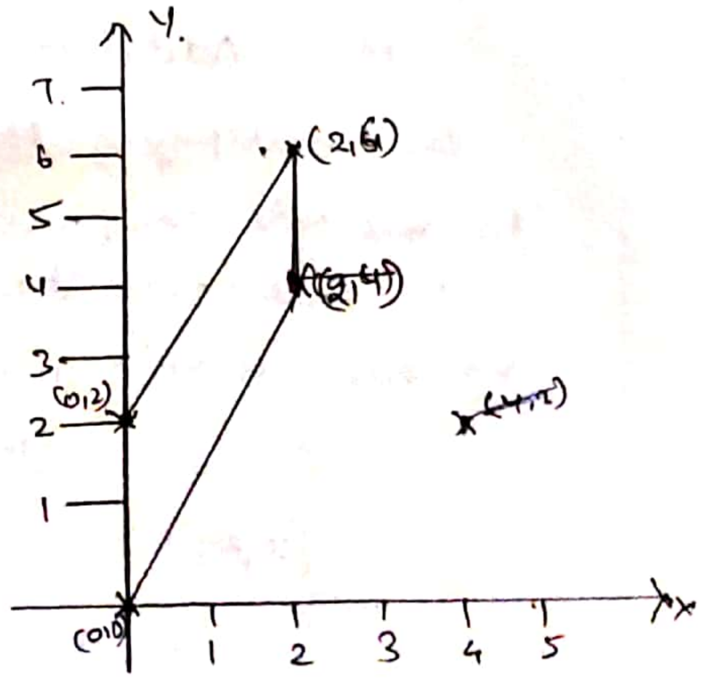
$$\begin{bmatrix} x' \\ y' \\ h \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ sh_y & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ 1 \end{bmatrix}$$

Example

Let us now shear an object from points (0,0), (2,0), (0,2), (2,2) at the shearing factor of 2 units along y axis.

(x,y)	(0,0)	(2,0)	(0,2)	(2,2)
Calculation	$y' = 0 + 2(0)$ $= 0 + 0$ $= 0$ $x' = 0.$	$y = 0 + 2(2)$ $= 0 + 4$ $= 4$ $x' = 2$	$y' = 2 + 2(0)$ $= 2 + 0$ $= 2.$ $x' = 0.$	$y' = 2 + 2(2)$ $= 2 + 4$ $= 6.$ $x' = 2.$
(x',y')	(0,0).	(2,4)	(0,2)	(2,6)





(38)

HOMOGENEOUS COORDINATE :

- In many cases, eg., animation, we need to combin a numerous of basic transformation such as a rotation followed by translation.
- But on combination of these transformations, we cannot simply combine to ~~those~~ single transformation. So homogeneous coordinate ~~is~~ are ~~found~~ used.

If in case of

→ translation : $P' = P + T$. $\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix}$ 2×1

→ Rotation : $P' = R(\theta) * P$ $\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$ 2×1

→ Scaling : $P' = S \times P$ $\begin{bmatrix} x' \\ y' \end{bmatrix} = \begin{bmatrix} S_x & 0 \\ 0 & S_y \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix}$

then the combined transformation formula will be $P' = (M_1 \times P) + M_2$.

M_1 → Multiplicative matrix [it can be either ~~T~~, $R(\theta)$ or S]

M_2 → Additive matrix [it is nothing but T].

On multiplying M_1 with P, sometimes it fails due to ~~mis~~ order comparison ~~of~~ matrices.

To ~~mak~~ reveal them, we expand one more ~~row (column)~~ coordinate in each matrix and called them as homogeneous element.

$(2\times2) \xrightarrow{\text{expands}} (3\times3)$

$(x, y) \longrightarrow (x, y, h)$

h → homogeneous coordinate.

Transforming 2D point into homogeneous 2D point :-

If $x_h = x \times h$.

$h \rightarrow$ any non zero value .

$y_h = y \times h$

then $x = \frac{x_h}{h}$; $y = \frac{y_h}{h}$

Example (To Check) .

(2,3) and $h=2$.

then homogeneous point of (2,3) is $(2\times2, 3\times2, 2)$

$\Rightarrow$ (4, 6, 2).

$\downarrow$ $\downarrow$ $\downarrow$

x_h y_h h.

Now, the 2D point will be $\rightarrow$ $\left(\frac{4}{2}, \frac{6}{2}\right) = (2,3)$.

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II. BASIC TRANSFORMATIONS OF 3D OBJECT :

1. Translation :

It refers to moving an object in a 3 dimentional plane with respect to t_x, t_y, and t_z.

then the equation is,

$x' = x + t_x$.

$y' = y + t_y$.

$z' = z + t_z$.

Matrix representation.

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} x \\ y \\ z \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \\ t_z \end{bmatrix}$$

2. Scaling :

Scaling refers to sizing or shaping of ~~an~~ 3 d object in space with respect to S_x, S_y and S_z.

then the equation and matrix representation will be,.

$x' = S_x \times x$.

$y' = S_y \times y$.

$z' = S_z \times z$.

matrix representation.

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} S_x & 0 & 0 \\ 0 & S_y & 0 \\ 0 & 0 & S_z \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}.$$

3. Rotation ;

Rotation refers to rotating an 3D object at any angle θ in a 3D plane. The 'θ' is axis based, so it can excecutes in three forms.

Suppose if the object is said to rotate, then one of the coordinate will be fixed, so that the value of other two coordinate varies to rotate an object. This indicates that the object rotates along with the fixed axis.

(i) X-roll (x coordinate is fixed):

$x' = x$

$y' = y\cos\theta - z\sin\theta$

$z' = y\sin\theta + z\cos\theta$

$$\boxed{\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & \cos\theta & \sin\theta \\ 0 & -\sin\theta & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}}$$

(ii) Y-roll (Y coordinate is fixed):

$x' = x\cos\theta - z\sin\theta$

$y' = y$

$z' = x\sin\theta + z\cos\theta$

$$\boxed{\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} \cos\theta & 0 & \sin\theta \\ 0 & 1 & 0 \\ -\sin\theta & 0 & \cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}}$$

(iii) Z-roll (z coordinate is fixed)

$x' = x\cos\theta - y\sin\theta$

$y' = x\sin\theta + y\cos\theta$

$z' = z$

$$\boxed{\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} \cos\theta & \sin\theta & 0 \\ -\sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}}$$

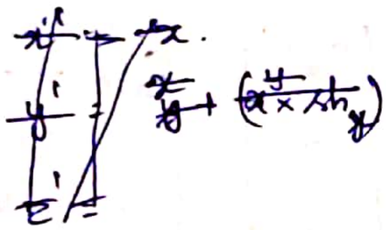
Note: If the rotation to any particular axis is counter clockwise, then the rotation matrix value changes by becoming θ as $-\theta$.

4. Shearing

Shearing refers to tilting or distorting an object. In case of 3 dimentional transformation, it uses sh_x, sh_y, sh_z as a shearing parameter where sh_z is shearing factor along z axis.

It also have a case that one axis is beign a fixed ~~for act~~ as while ~~other~~ other axes were made to shear.

(i) X - shear :



$$x' = x$$
$$y' = (sh_y \times x) + y.$$
$$z' = (sh_z \times x) + z.$$

$$\boxed{\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ sh_y & 1 & 0 \\ sh_z & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}}$$

(ii) Y - shear.

$$x' = (sh_x \times y) + x.$$
$$y' = y$$
$$z' = (sh_z * y) + z$$

$$\boxed{\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & sh_x & 0 \\ 0 & 1 & 0 \\ 0 & sh_z & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}}$$

(iii) Z - shear

$$x' = (sh_x * z) + x.$$
$$y' = (sh_y \times z) + y$$
$$z' = z$$

$$\boxed{\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & sh_x \\ 0 & 1 & sh_y \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}}$$

5. Reflection :

Rotating an 3dimentional object with angle 180° or producing a mirror image of an object with respect to the selected ~~selected~~ reflection plane is refered to as 3D reflection.

The reflection plane takes ~~is based on~~ 2 axes, while the other one acts as a viewing or reflecting axis.

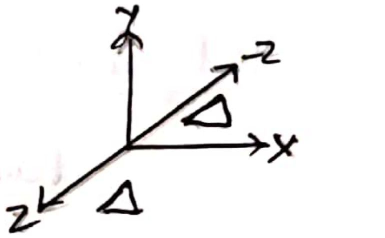
(i) Reflection through xy plane : [reflecting axis -> z]

$x' = x$

$y' = y$

$z' = -z$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & -1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$



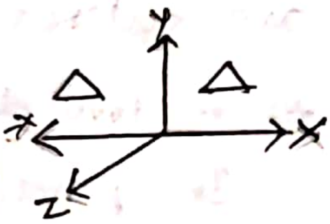
(ii) Reflection through yz plane : [reflection axis -> x]

$x' = -x$

$y' = y$

$z' = z$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} -1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$



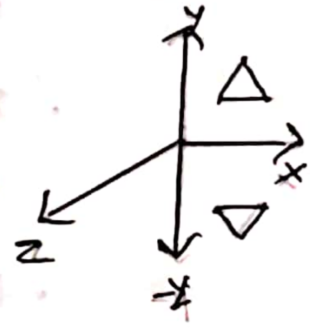
(iii) Reflection through xz plane : [reflection axis -> y]

$x' = x$

$y' = -y$

$z' = z$

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 \\ 0 & -1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix}$$



[Diagram not necessary for examination]

Scanned by CamScanner

III. PROJECTIONS :

Once the world-coordinate descriptions of the object in a scene are converted to viewing coordinates, we can project the 3D objects into twodimentional view plane. Projection refers to projecting a 3D objects to ~~in form of~~ the viewing plane.

There are two basic projection methods.

1. Parallel Projection :

Parallel projection discard ~~the~~ z-coordinates and parallel lines from each vertex on the object are entered until they intersect the view plane, which is in two dimentional.

In parallel projection,

- We specify a direction of projection instead of center of projection.
- The distance from the center of projection to project plane is infinite.

~~Here, we connect~~

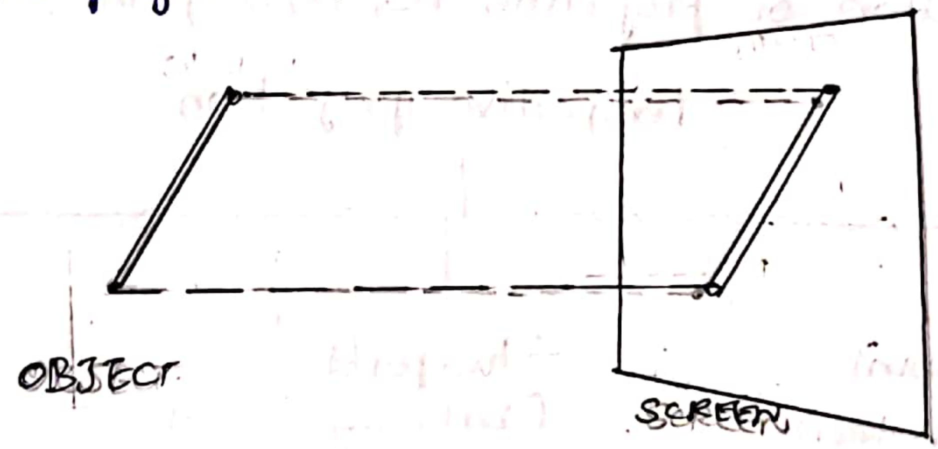
In this type of projection, we connect the projected vertices by line segments which correspond to connections on the original object. They are less realistic but are exact to the measurements of an object.

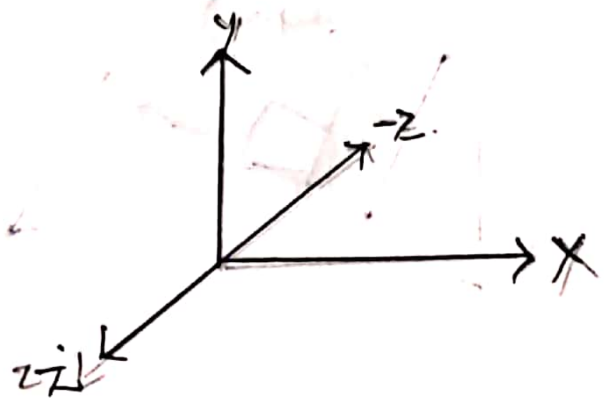
Parallel Projection

- Orthographic
  - Top
  - Front
  - Side
  - Axonometric
- Oblique.
  - Cavalier
  - Cabinet.

* Orthographic projection produces with normal direction to the projection plane.

* In case of oblique projection, the direction of projection is not normal and varies with the types of oblique.
  - Cavaliser makes 45° angle with the projection plane.
  - Cabinet makes equal ~~angle~~ direction (or at angle 63.4°) to the projection plane.





2. Perspective projection :

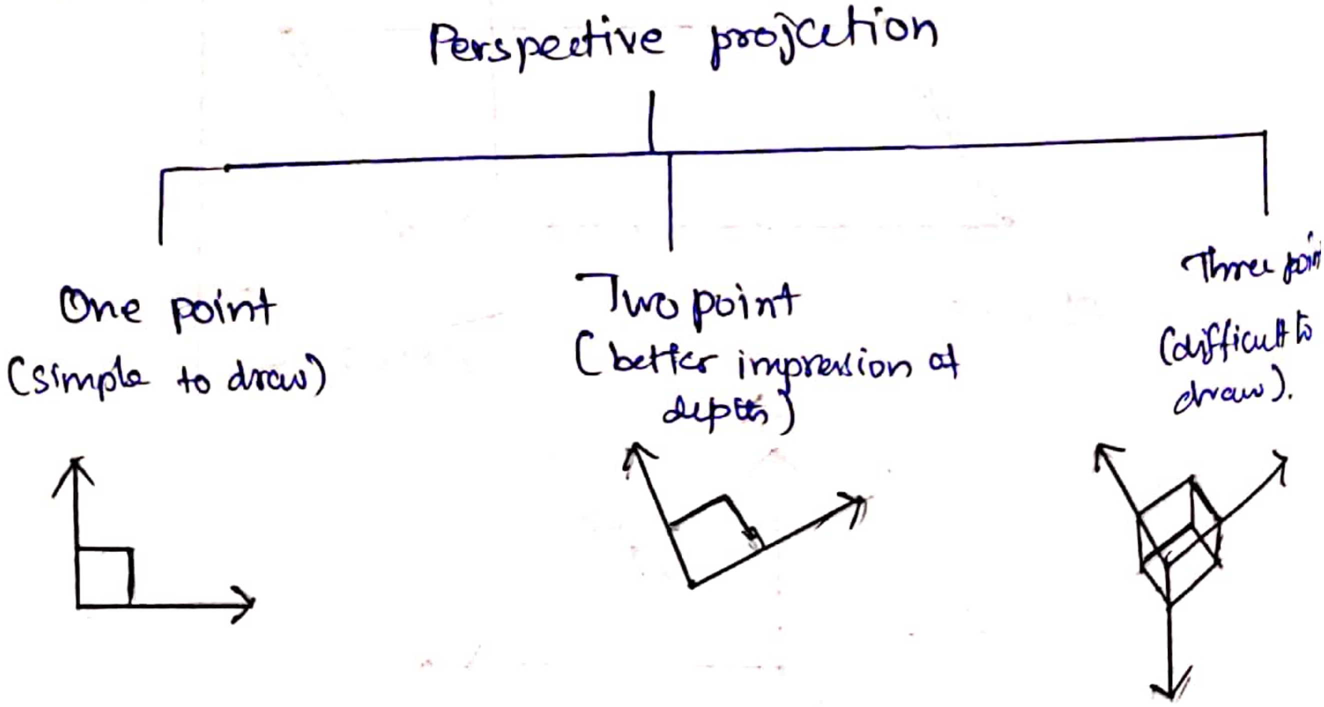
A perspective projection defines the projector lines that converge at the center of projection.

In perspective projection,

- The distance from the center of projection to the projection plane is finite.
- The size of the object varies inversely with the distance.

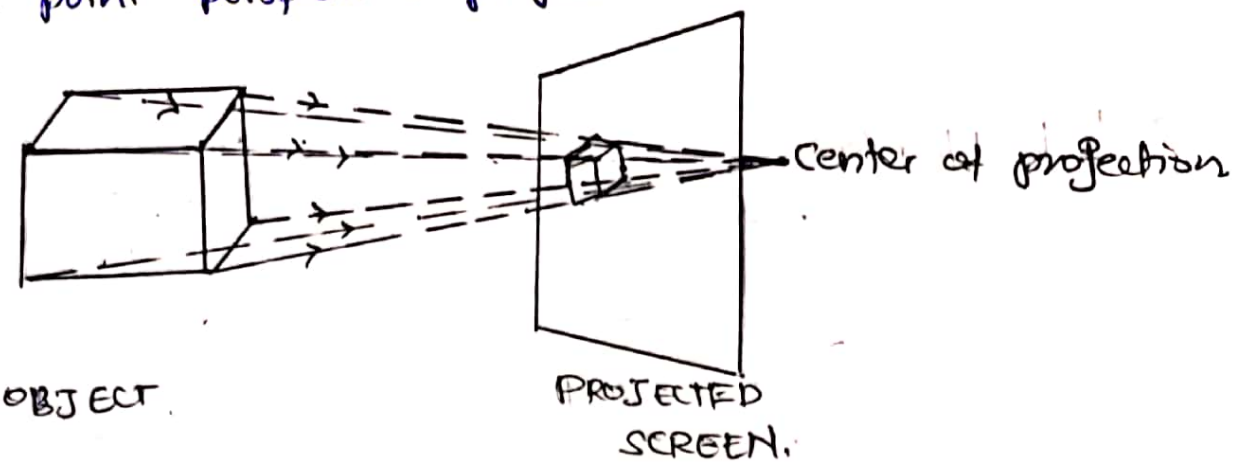
This makes a projected object more realistic.

However, the distance and angles are not preserved and parallel lines do not remain parallel. Instead, they all converge at a single point which is called center of projection or projection reference point.

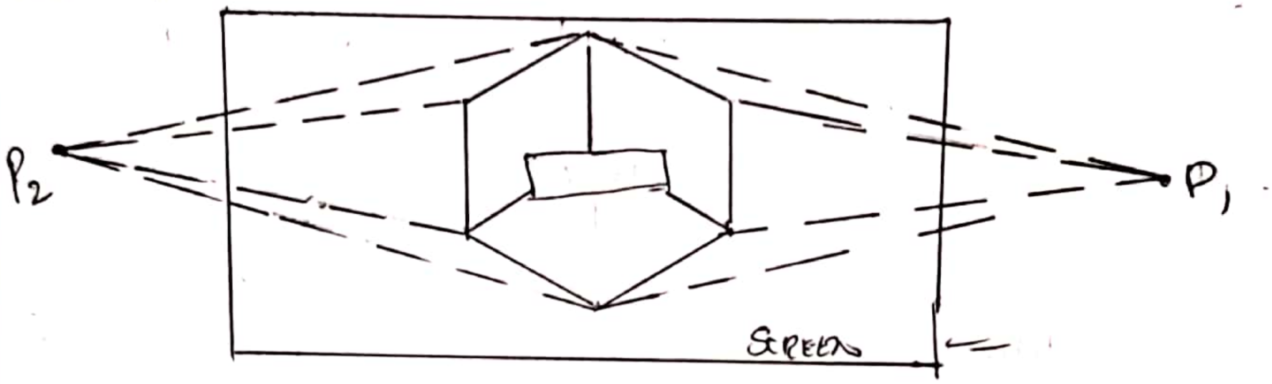


(Not for examination)

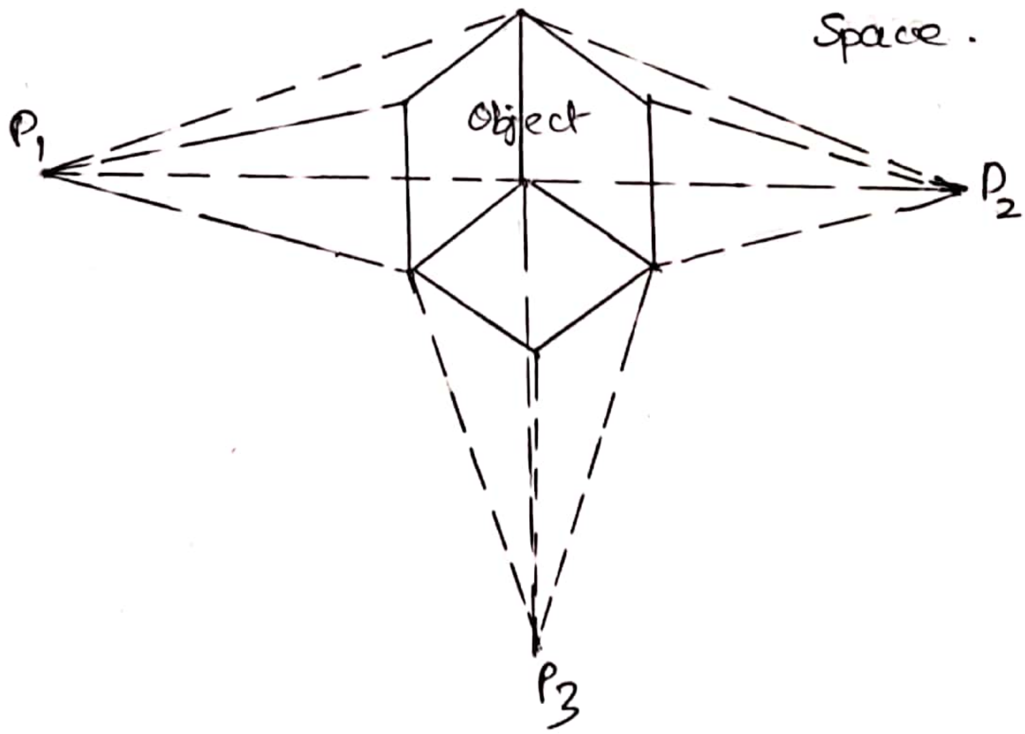
One point perspective projection.



Two point perspective projection:



Three point perspective projection:



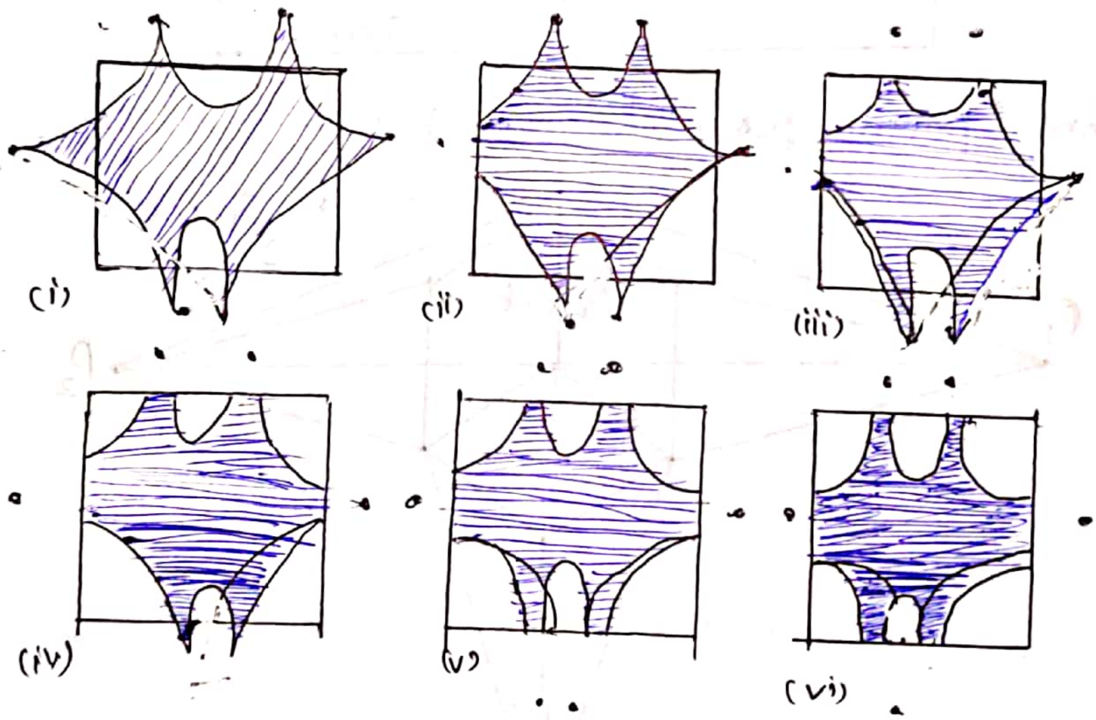
UNIT 3.

PREMISES AND ALGORITHMS OF 2D AND 3 DIMENTIONAL VIEWING AND REPRESENTATION

Sutherland Hodgeman Clipping :
(Polygon clipping algorithm).

→ This type of algorithm uses a rectangular frame to clipp the vertices of a polygon.

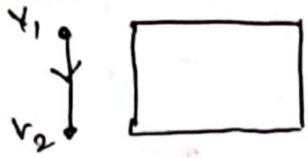
→ This algorithms clips the polygon ~~aginst~~ against the rectangular frame with respect to top, bottom, left and right.



(i) Normal polygon with frame.
(ii) left clipping.
(iii) Top clipping
(iv) Right clipping.
(v) Bottom clipping.
(vi) New object.

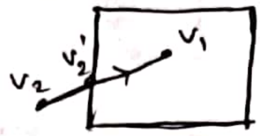
There are four cases to clip the polygon through its vertices on the perimeter.

CASE 1 :



$V_1 \rightarrow$ out
$V_2 \rightarrow$ out
Save none

CASE 2 :

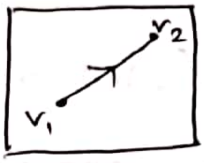


$V_1 \rightarrow$ In
$V_2 \rightarrow$ out.
Save V_2'.

CASE 3

$V_1 \rightarrow$ in
$V_2 \rightarrow$ out
save V_1'

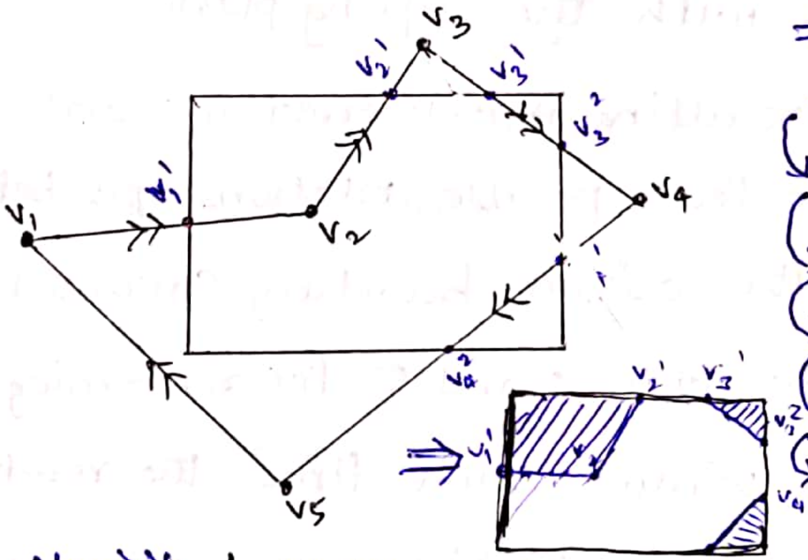
CASE 4 :



$V_1 \rightarrow$ in.
$V_2 \rightarrow$ in
save both vertices.

ILLUSTRATION

Consider a following object and we are asked to clip the given object as follows,



From this diagram,

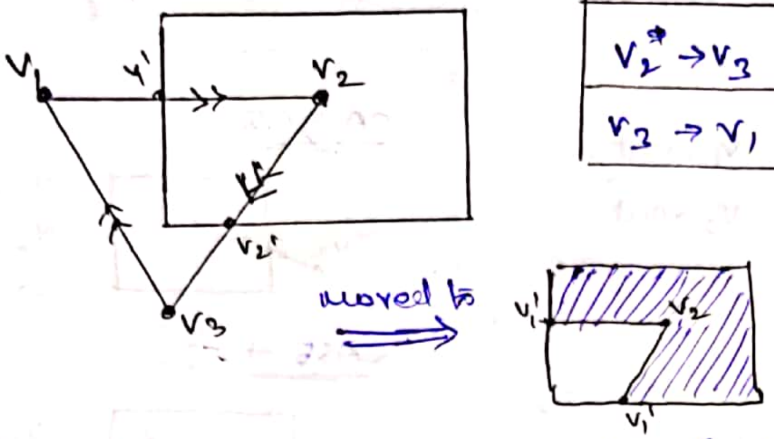
$V_1 \rightarrow$ Out
$V_2 \rightarrow$ In (Save V_1')
$V_3 \rightarrow$ out (Save V_2')
$V_4 \rightarrow$ Out (Save V_3', V_3^2)
$V_5 \rightarrow$ Out (Save V_4', V_4^2)
$V_1 \rightarrow$ Out (Save none.)

Proof:

$V_1 \rightarrow V_2$	$V_2 \rightarrow V_3$	$V_3 \rightarrow V_4$	$V_4 \rightarrow V_5$	$V_5 \rightarrow V_1$
$V_1 \rightarrow$ outside.	$V_2 \rightarrow$ In	$V_3 \rightarrow$ Out	$V_4 \rightarrow$ Out	$V_5 \rightarrow$ Out
$V_2 \rightarrow$ Inside.	$V_3 \rightarrow$ Out	$V_4 \rightarrow$ Out.	$V_5 \rightarrow$ Out	$V_1 \rightarrow$ Out
Save V_1'	Save V_2'	Save V_3' V_3^2	Save V_4' $\cdot V_4^2$	Save none

18

ILLUSTRATION 2:



	Vertex 1	Vertex 2	Save
$v_1 \to v_2$:	Out	In	$\vec{v_1'}$
$v_2 \to v_3$	In	Out	$\vec{v_2'}$
$v_3 \to v_1$	Out	Out	None
	—	—	—

negleted shades
required object.

Algorithm: (What actually done here in illustrations) (NOT FOR EXAM)

1. Read the coordinates of all vertices of the polygon
2. Read the coordinates of the clipping window.
3. Consider the left edge of the window.
4. Compare the vertices of each edge of the polygon, Individually with the clipping plane.
5. Save the resulting ~~inter~~ intersections and vertices according to four possible relationships between the edge and the clipping boundary (discussed earlier)
6. Repeat the steps 4 and 5 for remaining edges of the clipping window. Each time the resultant vertices is successively passed the next edge of the clipping window
7. Stop.

Scanned by CamScanner

Visible Surface detection Method (VSD)

A major consideration in the generation of realistic graphics display is identifying the parts of a scene that can be visible from the chosen viewing position. Many approaches and algorithms are made for the effective identification of visible objects.

Some methods may include,

→ More memory

→ More processing time.

→ Can apply to the special type of objects.

Deciding a method is based on factors as,

- Complexity of the screen.
- Type of an object
- Available equiptment
- Whether static or animated graphical object has to be generated.

Visibility of surface is classified into two important approaches.,

1. Object space method
2. Image space method.

Object Space Method	Image Space Method
Visibility is decided by comparing the parts of the object given in the screen.	Visibility is decided by point-to-point at each pixel position on the screen.
Used in vector graphic system	Used in raster scan system
Provides accuracy.	Provides consumption of time.
Continuous operation	Discreate operations.
Example: Back face detection method	Example: Depth buffer method

I. BACKFACE Detection Method:

This method is used to identify the back face of the given polygonal object. It has two ways of approach,

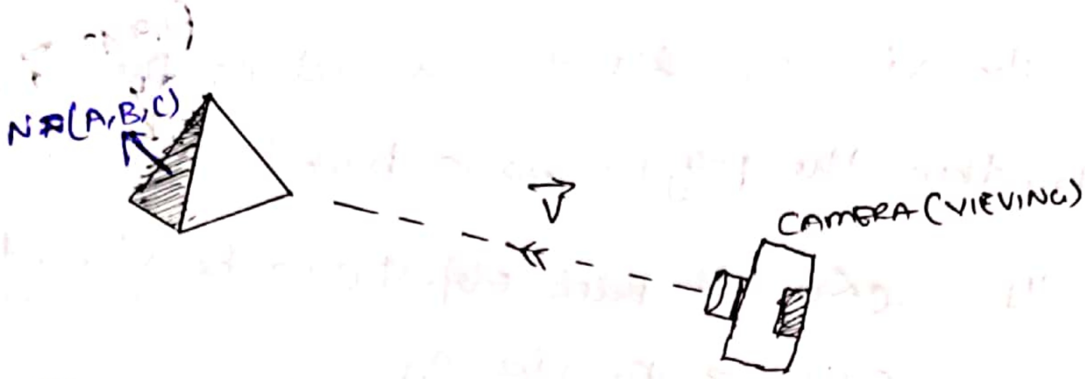
(i) Inside. (ii) Outside.

This test helps us to find whether the point on the polygon is inside or outside.

Let us consider a plane equation,

$$Ax + By + Cz = 0$$

where, x, y, z are the coordinates and A, B, C are the arbitrary constants or spacial arguments.



~~In a d~~

As per above diagram, let the point $P(x,y,z)$ be in the polygon. If $\vec{V}$ is the viewing ~~vector~~ direction and $\vec{N}$ is the normal vector.,

$$\boxed{\vec{V} \cdot N > 0.}$$

And the plane equation will be

$$\boxed{Ax + By + Cz > 0}$$

If the object description have been converted into the viewing coordinates and the viewing direction is parallel to z-axis, then

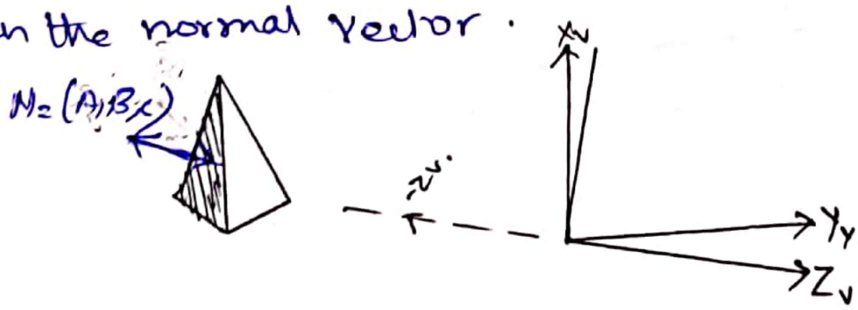
$$V = (0, 0, V_z)$$

$$\boxed{V \cdot \vec{N} = V_z \cdot C.}$$

$0\vec{i} + 0\vec{j} + V_z\vec{k} \cdot (A\vec{i} + B\vec{j} + C\vec{k})$

~~$V_z\vec{k} \cdot C\vec{k}$~~ $= V_z C$ ~~$\vec{k}\cdot\vec{k}$~~

We consider only the sign of C, the z component on the normal vector.



The viewing direction is along the negative z-axis, then the polygon is in back face.

If $C < 0$ → Back object can be viewed.

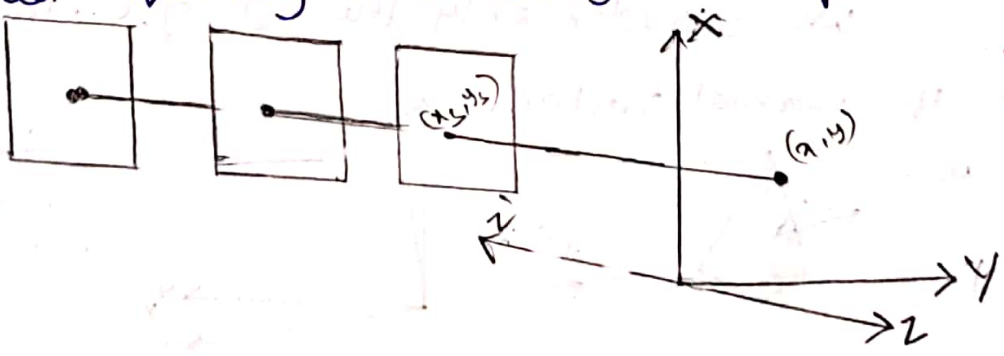
$C = 0$ → no viewing.

$C > 0$ → Front object can be viewed.

In general, we can lable any polygon as a backface, if it is normal vector has a z-component value. That is, $\boxed{C \le 0}$.

II. Depth Buffer Method : (Z-buffer).

It compares the depth at each pixel position in the projector plane. It is also refered to as z-buffer. The object depth is measured from the view plane. This method is usually applied to scenes containing only polygon surfaces because depth value can be computed quickly and easily to implement.



With object descriptions converted to projection coordinates, each (x,y,z) position on a polygon surfaces, ~~coordinate~~ corresponds to the orthographic projection point (x,y) on the view plane. Therefore, for each pixel position (x,y) on the view plane, object depths can be compared by comparing z values.

From the given picture above, s_1 is closest at this position, so the surface (s_1) intensity value at (x,y) is saved as (x_s, y_s).

Depth value for a surface position (x,y) are calculated from the plane equation for each surface.

$$\boxed{z = \frac{-Ax - By - D}{C}} \longrightarrow (1).$$

For scan line, the following pointing criteria is applied

Case 1: Adjacent horizontal position across the line differs by 1.

∴ The new position will be $p'((x+1), y)$.

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

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

$$\boxed{z' = z - A/C}$$

54

case 2: Adjacent vertical position across the line differs by 1.

Then the new position will be $p'(x, (y-1))$.

$$\therefore z' = \frac{-Ax - B(y-1) - D}{C}$$

$$= \frac{-Ax - By - D}{C} + \frac{B}{C}.$$

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

Algorithm for Depth Buffer Method:

- Initialise $depth_{(x,y)} = 0$; $I_{background}$ & refresh $= I_{background}$;

- for each point on each polygon surface do
  {
  → compare the depth value to previously stored in depth buffer.
  → Calculate the z values for each (depth) xy position on surface,
  → if (z > depth (x,y)) then
  { depth(x,y) = z;
  refresh $= I_{surface}$; }
  }

end Algorithm.

Drawbacks :

* The depth buffer method can ~~only~~ ~~find~~ only find ~~the~~ one visible surface at each pixel position.
* If any surface is transparent, the viewing of that is neglected and opague the surface through surface intensity contribution.

This overcomes by A-buffer method for visibility detection.

~~A-BA~~

II. A-Buffer Method :

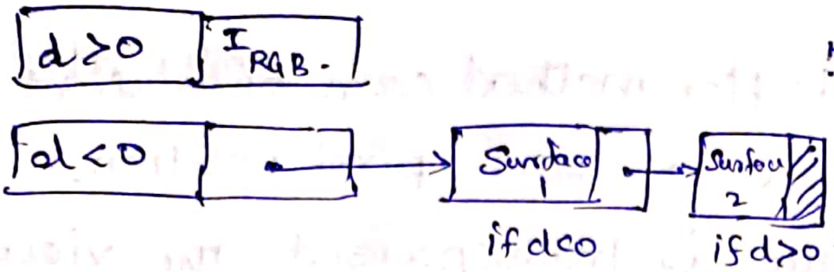
- It represents an antialiated, area-averaged, accumelation ~~method~~ buffer method used for the implementation of surface rending system.
- It follows ~~REA~~ REYES approach, in case of rending a surface (i.e., Rends Everything You Ever Saw).
- For each pixel position, A buffer method implements the linked list data structure where they ~~dat thay~~ uses 2 fields.

← data → ← link →

Depth	Intensity

-

	DEPTH	INTENSITY.
d > 0	depth of the surface overlaping the pixel value will be stored	Intensity stores the RGB component of the surface colour.
d < 0	Contributes to next intensity as multiple surface contribution	Stores as a pointer to points to the next node.



Linked list structure for A buffer method. (if d<0 & d>0).

- Data for each surface is the linked list includes
  - * RGB intensity component.
  - * Opacity parameters.
  - * Depth
  - * percentage of area coverage.
  - * Surface identifyer.
  - * other surface rending parameters.
  - * Pointer to next surface.

Object Representation: (NOT FOR EXAM)

Object is usually represented as a collection of surface. It is divided into two categories. One is boundry Representation and the other is space partitioning representation.

→ Boundry representation describes 3D object as a ~~bou~~ set of surfaces that seperates the object interior from the environment.

→ Space partitioning environment describes interior properties, by partitioning the special region containing the ~~special~~ set of ~~region~~ small, non-overloading contagious solids.

Polygon Surfaces :

The most commonly used boundry representation for a three dimentional object is the set of polygon surface that encloses the interior. A polygon surface can be thought as a surface composed of polygonal surface.

Polygon tables :

Representation of vertex coordinates, edges and other property of polygon into table form is called polygon table. Polygon table are classified into two categories.

Polygon tables.

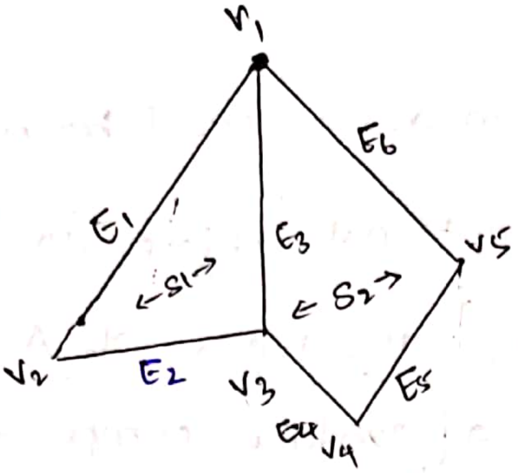
Geometric table

Attribute table

→ Geometric table contains vertex coordinate and the other parameter which specify geometry of polygon.

→ Attribute table stores other information like colour, transparancy, etc.,

The convindent way to respresent polygonal table is to represent geometric table into three different tables namely vertex table, edge table and polygon surface table.



From the figure, there are 5 vertices, 6 edges and so forms polygon of 2 surfaces.

* Each vertex stores x, y and z coordinates information which represents in the vertex table v : x, y, z. .
* The edge table is used to store the edge information of polygon. It is done by storing the endpoints of ~~vertices~~ edges.
* Polygon surface table stores the number of surface present in the polygon.

The table is formed based on this information.

VERTEX TABLE	EDGE TABLE	SURFACE POLYGON TABLE
$V_1 : x_1, y_1, z_1$	$E_1 : V_1, V_2$. (S_1)	$S1 : E_1, E_2, E_3$
$V_2 : x_2, y_2, z_2$	$E_2 : V_2, V_3$ (S_1)	$\Rightarrow V_1, V_2, V_3$.
$V_3 : x_3, y_3, z_3$	$E_3 : V_1, V_3$. $(S1 \& S2)$	$S_2 : E_3, E_4, E_5, E_6$
$V_4 : x_4, y_4, z_4$	$E_4 : V_3, V_4$ (S_2)	$\Rightarrow V_1, V_3, V_4, V_5$.
$V_5 : x_5, y_5, z_5$	$E_5 : V_4, V_5$ (S_2)	
	$E_6 : V_5, V_1$ (S_2)	

Plane Equation :

For producing display of 3D objects we must proceed the input data representation for the object through several procedures. For this processing, we need to find orientation and it can be obtained by vertex coordinate values and the equation of polygon plane.

The equation of polygon plane is generally be expressed as -

$$\boxed{Ax + By + Cz + D = 0.}$$

where A, B, C, D is constant describing the speial properties of plane and (x, y, z) is the specified position of the plane.

To ensure the properties of plane, consider the points (x_1, y_1, z_1), (x_2, y_2, z_2) and (x_3, y_3, z_3) on the plane. The plane equation for different positions are,

$$Ax_1 + By_1 + Cz_1 + D = 0 \Rightarrow \frac{Ax_1 + By_1 + Cz_1}{D} = -1 \quad -(1).$$

$$Ax_2 + By_2 + Cz_2 + D = 0 \Rightarrow \frac{Ax_2 + By_2 + Cz_2}{D} = -1 \quad -(2)$$

$$Ax_3 + By_3 + Cz_3 + D = 0 \Rightarrow \frac{Ax_3 + By_3 + Cz_3}{D} = -1 \quad -(3)$$

By using concept of ~~determinant~~ determinant, the solution value for A, B, C, D is given below.

$$A = \begin{vmatrix} 1 & y_1 & z_1 \\ 1 & y_2 & z_2 \\ 1 & y_3 & z_3 \end{vmatrix} \qquad B \Rightarrow \begin{vmatrix} x_1 & 1 & z_1 \\ x_2 & 1 & z_2 \\ x_3 & 1 & z_3 \end{vmatrix}$$

$$C = \begin{vmatrix} x_1 & y_1 & 1 \\ x_2 & y_2 & 1 \\ x_3 & y_3 & 1 \end{vmatrix} \qquad D = (-1) \times \begin{vmatrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \\ x_3 & y_3 & z_3 \end{vmatrix}$$

The normal vector is used to determine the orientation of 3D object on plane.

Using plane equation in vector form, we obtain D value as

$$\boxed{D = (-1)\, N \cdot P}$$

The plane equation is also used ~~to~~ to find the position of any point compare to plane surface as follows.,

If $Ax + By + Cz + D$,

- Is equal to 0, then the point is not on the plane.
- Is positive, then the point is outside the surface.
- Is negative, then the point is inside the surface.

Polygon Meshes:

~~Representations~~

The Three Dimentional solids and surfaces can be approximated by the set of polygons and line elements. Such surfaces is called polygon meshes.

In Polygon meshes, every edges are shared by atleast two polygons. The set of polygons and their faces, together forms the skin of the object.

This method is used to represent the broad class of solid surface in graphics. A polygon can be rended by using hidden face removal algorithm,

Advantages:

1. Can be used to make models of any objects.
2. Easy to represent as a set of variables.
3. Easy to transform.
4. Easy to ~~transform~~ draw on computer system.

Disadvantages:

1. Curved surfaces can only be approximately represented.
2. It is difficult to obtain meshes for some types of object like hair and, liquid, etc.,

(62)

Representation of polygon meshes:

Polygon mesh can be represented in three ways.

1. Explicit Representation:

In explicit representation, each polygon stores all the vertices in order in the memory as,

$$P = \{((x_1, y_1, z_1), (x_2, y_2, z_2)), \ldots, (x_m, y_m, z_m), (x_n, y_n, z_n))\}$$

It processes fast but requires more memory.

2. Pointer to Vertex list:

In this method, each vertex stores in vertex list and then polygon contains pointer to the required vertex.

$$V = \{(x_1, y_1, z_1), (x_2, y_2, z_2), \ldots, (x_m, y_m, z_m), (x_n, y_n, z_n)\}$$

$$P = \{(V_1, V_2), (V_2, V_3) \ldots, (V_m, V_1)\}.$$

Eg. Polygon of 3,4,5 is represented as $P = \{(V_3, V_4), (V_4, V_5), (V_5, V_3)\}$.

It is considerabily save in space but common edge is difficult to find.

3. Pointer to Edge list :

In this ~~po~~method, polygon have pointers to the edge list and edge list have pointers to vertex list for each edge & vertex pointer is required which points to the ~~next~~ ~~vertex~~ vertex list.

$$V = \{(x_1, y_1, z_1), (x_2, y_2, z_2), \ldots, (x_n, y_n, z_n)\}.$$

$$E = \{(v_1, v_2), (v_2, v_3), (v_3, v_4) \ldots (v_n, v_{n+1})\}.$$

$$P = \{E_1, E_2, \ldots, E_n\}.$$

This approach is more memory efficient and easy to find common edges.

Types of Polygon meshes :

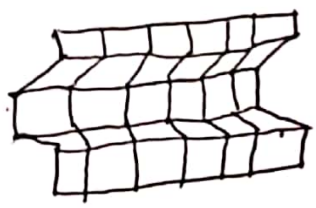
1. Triangle strip :

This function produces $(n-2)$ connective triangles for n vertices of given coordinates.

2. Quadrilateral mesh :

This function generates a mesh of $(n-1)$ by $(m-1)$ quadrilaterals for a given coordinates of n by m array of vertices.

Triangle strip



Quadrilateral mesh.

~~Fitted~~ Area Premises:

When polygon is simplified with more than ~~one~~ three vertices, it is possible that the vertices may not lie on the plane. This may be due to numerical errors in selecting coordinate position of vertices.

1. One way is to divide the given polygon into triangles.
2. Another way is done when approximate A, B, C and D values is to be taken. We can do by projecting the polygon onto the coordinates planes.

Using this method, we take

A ∝ Area (polygon projection of yz plane)

B ∝ Area (polygon projection of xz plane)

C ∝ Area (polygon projection of xy plane)

Filled Area Premises

Polygon is an ordered list of vertices which is more easier to process over other output premises since they have linear boundryes.

For filling polygons (or area) with particular colors, you need to determine the pixels falling on the border of the polygon and those which fall inside the polygon.

Boundary Fill Algorithm:

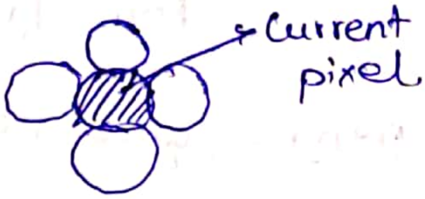
This algorithm picks the point on the object and starts to fill until it hits the boundary of the object. The color of the boundry is different from the color of the object we fill, that should be for this algorithm to work.

Here, we assume that color of the boundary is same for the entire object.

Boundary fill algorithm can be implemented by 4 ~~collect~~ connected pixels and 8 connected pixels.

1. Four Connected Boundary Fill :

In this, we connect the current vertex with the above, below left and right pixels and fills those pixels until they ~~are~~ hits the boundary.



Algorithm:

① Initialise the values seedx, seedy, dcol, fcol = 0;

② Define the boundary value of the polygon.

③ Check if the current seed value (seedx, seedy) is of default colour.

If ~~dcol(x, y~~ getpixel (x, y) = dcol, then
repeat step ④ and ⑤.

④ Change the default colour with the fill color at the seed point.

setpixel (seedx, seedy, fcol)

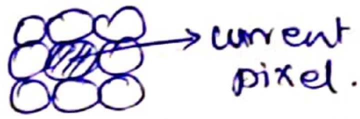
⑤ Follow the functions below recursively,

Flood fill (seed x-1, seed y, fcol, dcol)
Flood fill (seed x+1, seedy, fcol, dcol)
Flood fill (seed x, seed y-1, fcol, dcol)
Flood fill (seed x, seed y+1, fcol, dcol)

⑥ exit algorithm.

2. Eight connected Boundary fill

Here, we connect the current vertex with 8 other pixels which are at left above, left below, left, right above, right below, right, above and below directions ~~with~~ to the current pixel. This overcomes the disadvantage of 4 connected pixels.



Algorithm:

① Initialise the values seedx, seedy, dcol, fcol

② Define the boundary value of the polygon.

③ Check if the current seed value (seedx, seedy) is of dcol (default color)

③ If get pixel(x,y) = dcol then repeat Ⓐ and ⑤.

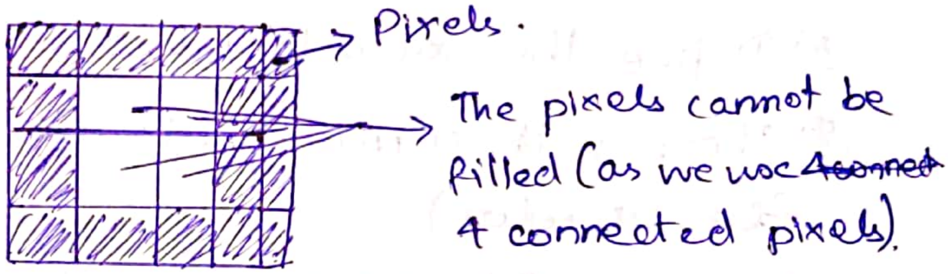
Ⓐ. setpixel (seedx, seedy, fcol)

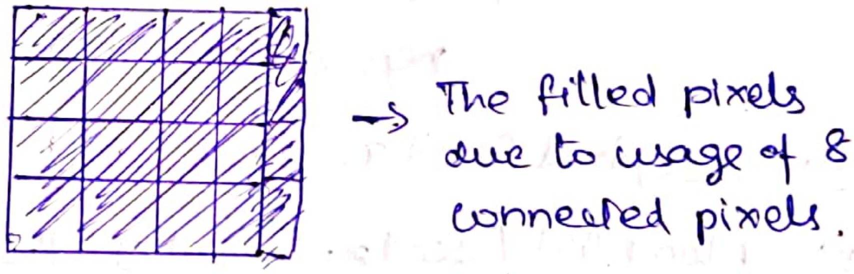
⑤ Flood fill (seedx−1, seed y, fcol, dcol)
Flood fill (seedx+1, seed y, fcol, dcol)
Flood fill (seed x, seedy−1, fcol, dcol)
Flood fill (seed x, seed y+1, fcol, dcol)
Flood fill (seed x−1, seed y−1, fcol, dcol)
Flood fill (seed x−1, seed y+1, fcol, dcol)
Flood fill (seed x+1, seed y−1, fcol, dcol)
Flood fill (seed x−1, seed y−1, fcol, dcol)

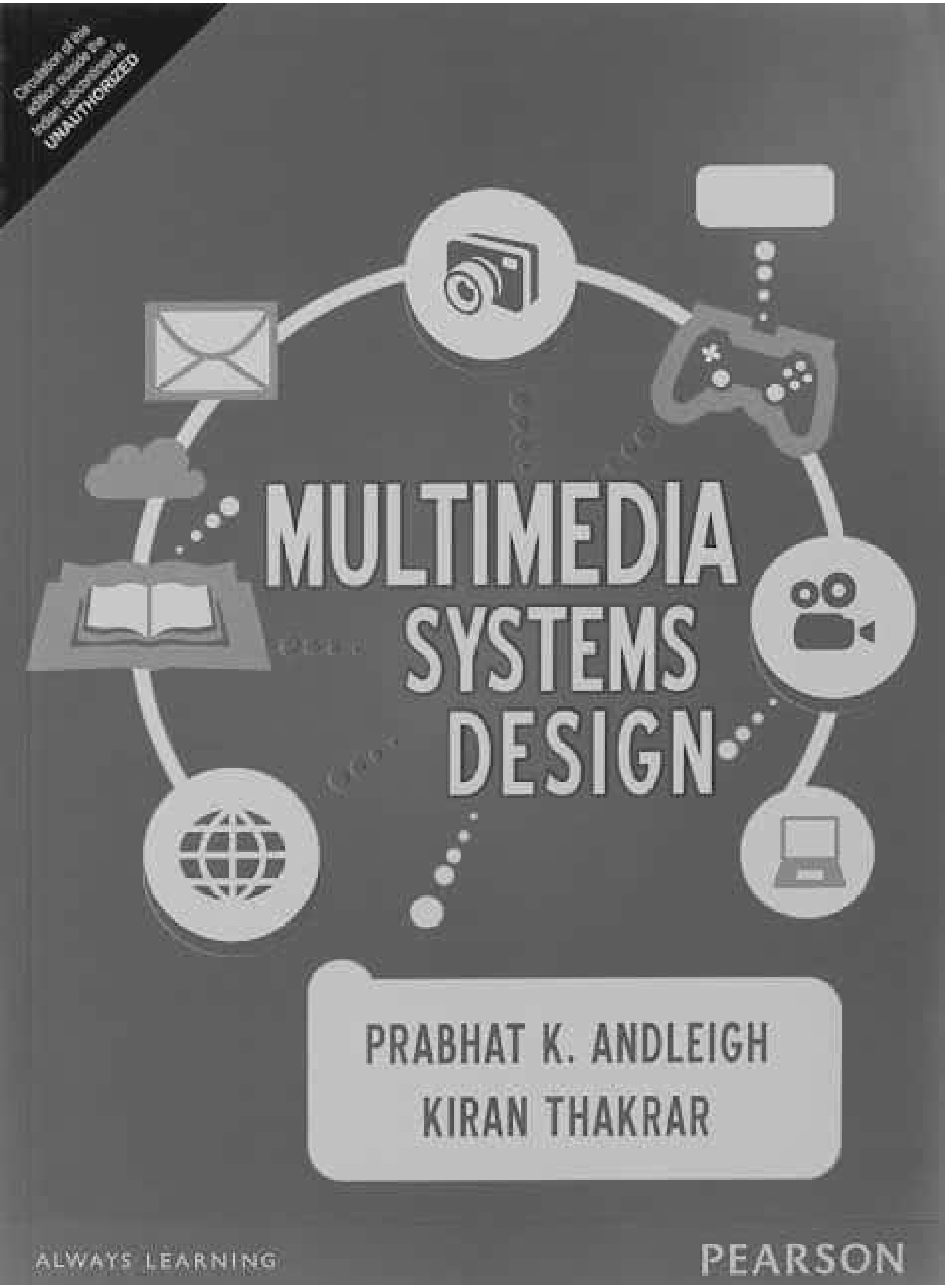
⑥ Exit algorithm.

(68) Why 4 ~~collect~~ connected pixel fails over 8 ~~pix~~ connected pixel ?

As 4 connected pixels fills the colour of only left, right, above, below pixels of current pixels. There occurs the inference that we cannot fill some region which we try to fill. But 8 connected does at it ~~fails~~ ~~as~~ fills all the other adjacent pixel of current pixel.



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PEARSON

CORE PAPER XVII

COMPUTER GRAPHICS AND MULTIMEDIA

PART II - MULTIMEDIA

— SYLLABUS —

UNIT IV : Multimedia System Design :

Multimedia basics - Multimedia applications - Multimedia system architecture - Evolving technologies of multimedia - Defining objects for multimedia system - Multimedia data interface standards - Multimedia Databases.

UNIT V : Hypermedia :

- Multimedia authorising user interface.
- Hypermedia messages.
- Mobile messages.
- Hypermedia message components
- Creating hypermedia messages.
- Integerated multimedia message standards.
- Distributed multimedia systems.

PART 2 : MULTIMEDIA.

UNIT 4

Multimedia System Design.

Multimedia is a computer based presentation techniques that incorporates text, graphics, sound, animation and video elements. A combination of these elements grabs the viewer's attention and retain it. The multi sensory input addresses the different learning needs and styles of different users and enhance the entire experience for the user.

Multimedia Basics :

(i) **Facsimile :**

Fascimile transmissions were first practical means of transmitting document images over a telephone line. The basic technology, now widely used, has evolved to higher ~~~~ scanning density for better quality fax.

(ii) Document Images :

- Document images are used for storing business documents that must be retained for long period of time or may needed to be accessed by a large number of people.

②

(iv) Photographic images :

Photographic images are used for a wide range of applications such as employee records for instant identification at the ~~sec~~ security desk, real estate system with photographs of houses in the database containing the description of houses, medical cases and so on.

(v) Geometrical Information System maps :

Maps used in GIS (geometrical Information System) are being widely used for natural resources and wildlife management as well as urban planning. These system stores the graphical information of the map along with a database.

(vi) Voice Commands and Voice synthesis :

Voice commands and voice synthesis are used for hand free operations of a computer system. Voice commands allows the users to direct computer operation by ~~operation~~ spoken commands. Voice synthesis is used for presenting the results of an action to the user in the synthasised voice.

(vii) Audio messages :

Annotated audio mail already uses audio or voice messages as attachments to memos and documents such as maintainance manuals.

(viii) Video message :

Video messages are beign used in the manner similar to annocated voice mails.

(ix) Full motion stored and live video :

It is very useful for online trainings and maintaining manuals.

The capacity to use full-motion stored video for e-mail or live video for presentations and video conferencing are important evolutionary steps. 3D video technologies are beign adapted to create virtual reality.

(x) Holographic Images :

Holographic images extends the concept of virtual reality by allowing the user to get inside a part, such as engines and view ~~inside~~ its operation from the inside.

④

Common Components of multimedia: (Defining objects for MM).

The following are the major components of multimedia.

(i) Text :

It contains alphabetic and some other special characters. Keyboard is usually used for input of text ; however, there are some internal features to include such texts.

(ii) Graphics :

It is technology to generate, represent, process, manipulate and display pictures. It is one of the most important components of multimedia application. The developements of graphics is supported by different software.

(iii) Animation :

Computer animations is the modern technology, which helps in creating, processing, developing, sequencing and displaying a set of images. It gives ~~virtual~~ visual effects or motion capture.

(iv) Audio :

This technology synthesises and plays audio (sound). There are many Instruction that can delivered through medium.

(v) Video :

This technology records, synthesises and displays sequential and continual images. In order to watch a video without any interuption, the device must display 25-30 fr/sec.

Applications of Multimedia:

Let us now see the different fields were mm is applied. The fields are described below.,

(i) Presentation:

With the help of multimedia, presentations can be made made effective to represent the ideas effectively and visually.

(ii) E-books:

Today, books are available on internet easily and also they are digitalised.

(iii) Digital Library:

The need to be physically present at a point library is no more necessary. Libraries can be accessed from the internet also. Digitalization has helped libraries to come to its level of development.

(iv) E-learning:

Most of the institutions are using such technology to educate people, in the motive to make students understand and learn the concepts easier.

(v) Movies making:

Most of the special effects that we see in any movie, is only because of multimedia technology. ~~It~~ supports

(b)

some special feature and operation that can manipulate with motion capture, [illegible]

(v) Video Games :

Video games are one of the most interactive and interesting creation of multimedia technology. Video games fascinate not only the children but also adults too.

(vi) Animated films :

Along with video games, animated films is another great source of entertainment for children. In recent times, high end graphics were used in animation such that the films are made related to realistic visual display.

(vii) Multimedia conferencing :

People can arrange personal as well as business meetings online with the help of multimedia conference technology. conferencing has an applications in a variety of field including collaborative learning and groupware. But in MM conferencing, multipoint facility, personalization, unification facilities with office automation facilities and userfriendly interface are required.

(viii) E-shopping :

Multimedia technology has created a different arena for the e-commerce.

Multimedia System Architecture :

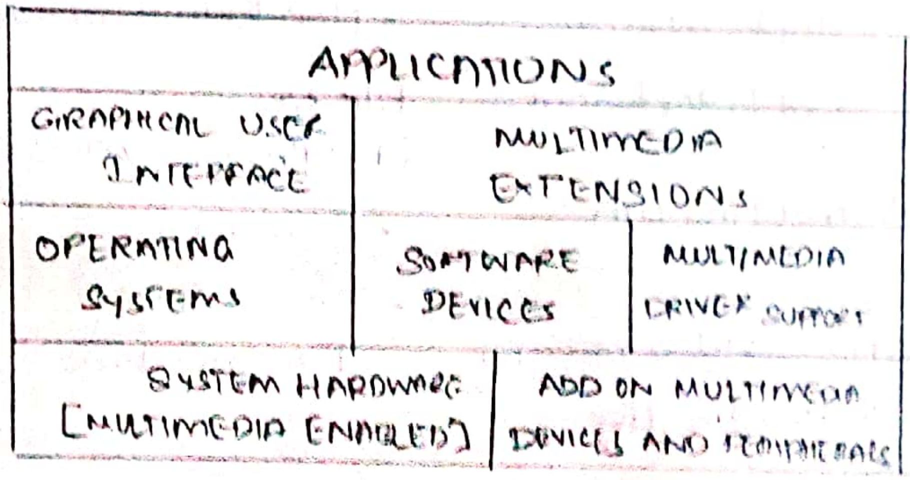
Typical Application

DOCUMENT IMAGING	IMAGE PROCESSING AND RECOGNITION
• Document image hardware requirements.	• Image enhancement • Image animation. • Image annotation. • Optical character recognition • Hand writting recognition • Non Textual image recognition
FULL MOTION DIGITAL VIDEO APPLICATIONS	ELECTRONIC MESSAGING
• Training and Manuals. • Business Applications. • Games and Entertainment	• E-mail. • SMS /MMS. • Fax machine.
UNIVERSAL MULTIMEDIA APPLICATION	
• Full motion video messages. • Viewer Interactive Live Video. • Audio and Video Indexing.	

Multimedia System Architecture

- Multimedia encompasses large variety of technologies and integeration of multiple architectures.
- ~~Pri~~ Unlike most other systems, multimedia encompasses a large variety of technologies and integeration of multiple architectures interacting in time. Another
- Another important aspect is that, all these multimedia capabilities must integrate ~~integerat~~ with the standard user interfaces such as MS windows, X windows or presentation manager.

Multimedia workstation environment:



The above diagram describes the architecture of multimedia workstation environment. The right side shows the new architectural entities required for supporting multimedia applications.

For each special devices such as scanner, video canvas cameras, VCRs and sound equipment, a software device driver is need to provide interface from an application to the device. The GUI require control extensions to support application such as full motion video.

High Resolution Graphics Display:

The various graphics standards such as MCA, GCA and XGA have demonstrated the increasing demands for higher resolutions for GUIs.

Combined graphics and imaging applications require functionality at three levels. They are provided by three classes of single-monitor architecture.

(i) VGA mixing: The image acquisition memory serves as the display source memory, thereby fixing its position and size on screen.

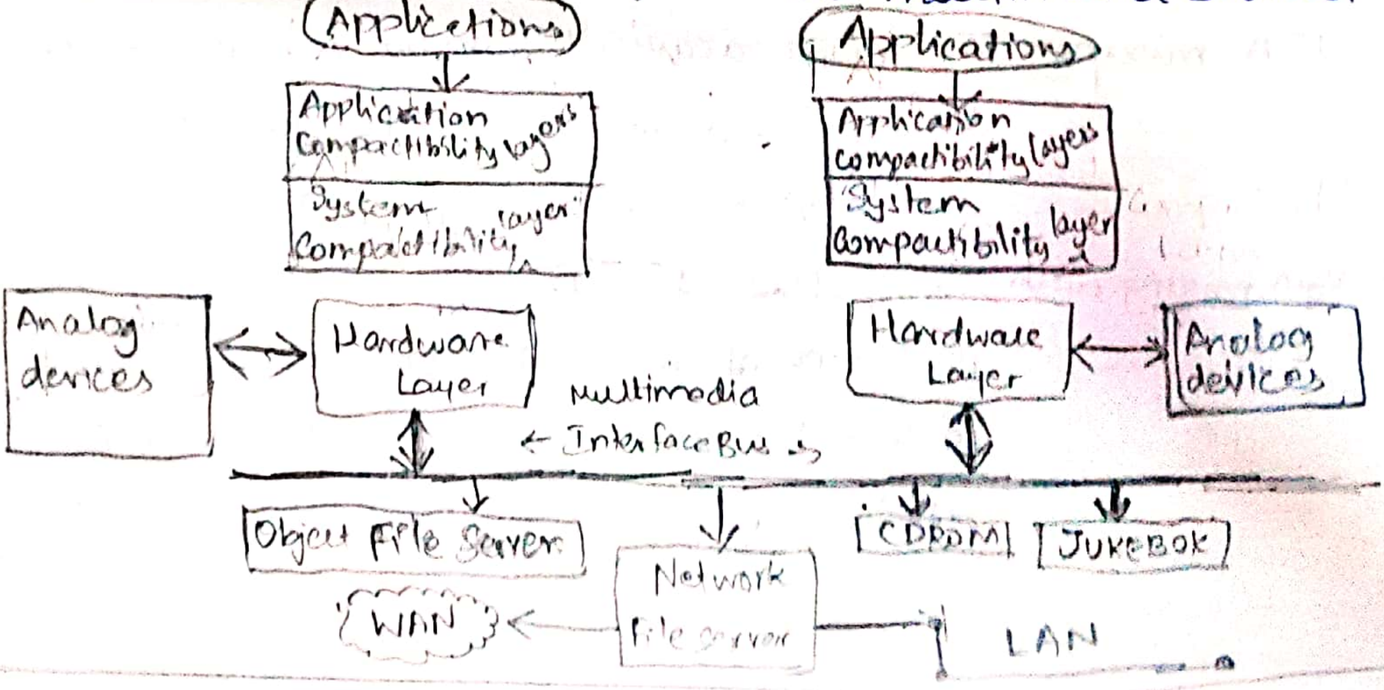
(ii) VGA mixing with scaling: Use of scalar ICs allows sizing and positioning of images in pre-defined windows. Resizing the window causes the things to be retreived again.

(iii) Dual-buffered VGA/Mixing/Scaling : Double buffer schemes maintain the original images in a decompression buffer and the resized image in a display buffer.

The IMA Architectural Framework :

The interactive Multimedia ~~Architect~~ Association has a task group to define the architectural framework of Multimedia to provide interoperability. The task group has concenterated on the desktops and the servers. Desktop formats is to define the interchange formats. This format allows multimedia objects to be displayed on any work stations.

- The architecture approach taken by IMA is based on defining interfaces to a multimedia interface bus. This bus would be interface between systems and multimedia sources.



Network Architecture for Multimedia System:

Multimedia systems need special networks. Because large volumes of images and video messages are beign trans-mitted.

Asynchronous Transfer Mode technology (ATM) simplifies transfers across LANs and WANs.

Task based Multilevel networking

Higher classes of services requires more expensive components ~~like~~ in the workstations as well as in the servers supporting the workstations applications.

Rather than impose this cost on all the workstations, an alternative method is to adjust the class of service to the specific requirments for the user. This approach is to adjust the class of services according to the type of data beign handled at a time also.

High speed server to server Links

- Duplication : It is the process of duplicating an object that the user can manipulate. There is no requirment for duplicated object to remain synchronized with the source object.

- Replication: Replication is defined as the process of maintaining two or more object of the same object in a network that periodically re-synchronizes to provide the user faster and more reliable access to the data replication in a complex process.

NETWORK STANDARDS:

The two ~~we~~ well known networking standards are ethernet and token ring. ATM and FDDI are the two technologies which we are going to discuss in detail.

ATM : (Asynchronous Transfer Mode): It's topology was originally designed for broadband applications in public networks.

ATM is a method of multiplexing and relaying (cell-switching) 53 byte cells.

48 → user information.

5 → header information.

- Cell switching: It is a form of fast packet switching based on the use of cells.
- Cell: Short, fixed length packets are called cells.

FDDI (Fiber Distributed Data Interface) : This network ~~FDDI~~ is an excellent candidate to act as the hub in a network configuration, or a backbone that interconnects different types of LANs.

It presents a potential for standardization for high speed networks.

Evolving technologies of multimedia :-

Multimedia applications uses a number of technologies generated for both commercial business application as well as the video games industry. Here are some technologies:

1. Hypermedia documents :

Hypermedia documents are documents which have text, embedded or linked media objects such as image, audio, hologram or full-motion video.

2. Hypertext

Hypertext allows authors to link information together, create information paths through a large volume of related text in documents. It allows fast and easy searching and reading of selected experts.

3. Hypermedia

- It is an extension of hyper text.
- In that, we can include texts, any kind of information that can be stored in electronic storage, such as audio ~~video~~, animated video, graphics or full-motion video.

4. Hyper speech:

Multimedia stimulated the document of general purpose speech interfaces. Speech synthesis and speech recognition are fundamental requirments for hyperspeech system. Speech recognition is converting the analog speech into ASCII text.

5. HDTV

A broad casting standards such as NTSC, PAL, SECAM, NHK have an idea of bringing the world together on a single HD television. A comparing standards in the US Changed direction from analog to digital technology: A 1125 line digital HDTV has been developed and beign commertialized

6. 3D technology and holography

Three dimentional technologies are concerned ~~connected~~ with two areas: pointing devices and displays. 3D pointing devices are essential to manipulate object in a 3D display system. 3D displays are ~~con~~ acheived using holographic technologies.

7. Digital Signal Processing :

Digital Signal Processing are used in applications such as digital servos in hard disk devices, and fax/ modems. DSP technology is used in digital wireless communications such as personal communication networks, wireless LAN, and digital cordless phones.

~~8. Interlock synchronisation~~

Multimedia Data Interface Standard :

File formats for MM system :

(i) Device - independant Bitmap (DIB) :

This file contains bit, map, color, and color paleate information.

(ii) RIFF device Independent Bitmap (RDIB) :

Resource Interface File format (RIFF) is the std. ~~standard~~ file format defined for microsoft, windows and other OS. It allows more complex set of bits maps than can be handled by DIB.

(iii) Musical Instrument Digital Interface (MIDI)

This is the interface standard for file transfer between a computer and a musical instrument such as a digital piano. It is also used for full motion video and voice - mail messaging system. It has the advantage of ready availability of MIDI fordevice controller boards for pc.

(iv) RIFF Musical Instrument Bitmap (RMIB)

MIDI format within a RIFF envelope provides a more complex interface.

(v) Pallatte File Format (PAL) :

An interface that allows defining pallatte of 1 to 256 colors in a representation as RGB values.

(vi) Rich Text Format (RTF) :

This file format allows embedding graphics and other file formats within a document.

(vii) Waveform Audio File Format (WAVE)

A digital file representation of digital audio.

(viii) Window metafile Format (WMF)

This is a vector graphics format used by MS windows as an interchange format.

(ix) Multimedia movie Format (MMF) :

This is a format used for digital video animation. For apple's, it is a standard for file exchange by Quick time enabled system.

(x) Digital video Command set (DVCS) :

This is the set of digital video commands stimulating VCR controlls.

(xi) Video Media Control Interface (VMCI)

MS's high level control ~~trans for~~ interface for VCR controls, including play, rewind, record and so on.

(xiii) Spatial Data Transfer Standard :

It is designed to provide a common storage format for geographics and cartographic data.

Multimedia Data Bases :

Multimedia Databases is a collection of inter-related multimedia data that includes text, graphics, and multisources.

The frame work that manages different types of multimedia data which can be stored, delivered and utilized in different ways is known as Multimedia Database Management Systems.

There are three classes of multimedia databases, they include static, dynamic and dimentional data.

Contents of Multimedia Database :

(i) Media Data - The actual data representing an object.

(ii) Media Format Data - Informations about the format of the data after it goes through the acquistation, processing and encoding phase.

(iii) Media Keyword data - Keyboard description relating to generation of data. (a.k.a content description data) ex, date, time.

(iv) Media Feature data - Content dependant data.
ex, colours, textures and shapes etc,

Applications of Multimedia Database Management System:

1. Repositary application:

A large amount of multimedia data as well as meta-data that is stored for retrival purposes. For Example, repositary satilite images, engineering drawings, radiology scanned pictures.

2. Presentation application:

They involve delivary of multimedia data. Here data is processed as it is delivered. For example, annotating of video and audio data, real time editing analysis.

3. Collaborative work using multimedia Information:

It involves executing a complex task by merging drawings, changing notifications. For example, intellegence healthcare network.

Challanges of multimedia data:

1. Modelling : Can improve DB versus information techniques.
2. Design : The design has not been addressed fully
3. Storage : It presents a problem of representation, compression to device during I/O operations.

4. Performances : The use of parrellel processing may allenate some problems but such are not developed.

5. Queries and retrivals : For MM data through queries opens up many issues like efficient query formalation, queue execution and optimisation which need to be work upon.

Uses of multimedia Data Base Management Systems :

1. Documents and record management : ~~Industries and~~
Industries and businesses that kept detailed records and variety of documents. Example, insurance claim record.

2. Knownledge dissemination :
It is been an effective tool by multimedia database in terms of several sources. Example, e-books.

3. Education and Training :
Computer aided learning materials can be designed using multimedia sources which are now a days more popular. Example, Digital Libraries.

4. Real time control and monitoring :
Multimedia presentation of information, as coupled with active DB technology, can be more effective means for monitoring and ~~comp~~ controlling complex task. Example, manufacturing operation ~~ex~~ controlls.

UNIT 5

Multimedia authoring and User Interface Multimedia Authoring Systems and Hypermedia

Multimedia authoring and User Interface Multimedia Authoring Systems

Multimedia authoring systems are designed with two primary target users: They are

(i) Professionals who prepare documents, audio or sound tracks, and full motion video clips for wide distribution.

(ii) Average business users preparing documents, audio recordings, or full motion video clips for stored messages' or presentations.

The authoring system covers user interface. The authoring system spans issues such as data access, storage structures for individual components embedded in a document, the user's ability to browse through stored objects, and so on.

Design Issues for Multimedia Authoring

Enterprise wide standards should be set up to ensure that the user requirements are fulfilled with good quality and made the objects transferable from one system to another.

So standards must be set for a number of design issues

1. Display resolution
2. Data formula for capturing data
3. Compression algorithms
4. Network interfaces
5. Storage formats.

Display resolution

A number of design issues must be considered for handling different display outputs. They are:

(a) Level of standardization on display resolutions.

(b) Display protocol standardization.

(c) Corporate norms for service degradations

(d) Corporate norms for network traffic degradations as they relate to resolution issues Setting norms will be easy if the number of different work station types, window managers, and monitor resolutions are limited in number. But if they are more in number, setting norms will be difficult .Another consideration is selecting protocols to use. Because a number of protocols have emerged, including AVI, Indio, Quick Time and so on. So, there should be some level of convergence that allows these three display protocols to exchange data and allow viewing files in other formats.

File Format issues

There are varieties of data formats available for image, audio and full motion video objects.

Since the varieties are so large, controlling them becomes difficult. So we should not standardize on a single format. Instead, we should select a set for which reliable conversion application tools are available.

Data Compression Issues

Another key design Issue is to standardize on one or two compression formula for each type of data object. For example for facsimile machines, CCITT Group 3 and 4 should be included in the selected standard. Similarly, for full motion video, the selected standard should include MPEG and its derivatives such as MPEG 2.

While doing storage, it is useful to have some information (attribute information) about the object itself available outside the object to allow a user to decide if they need to access the object data. One of such attribute information are:

(i) Compression type
(ii) Size of the object
(iii) Object orientation
(iv) Data and time of creation
(v) Source file name
(vi) Version number (if any)
(vii) Required software application to display or playback the object.

Designing User Interfaces

User interface involves number of time interactions with the users.

User Interface should be designed by structured following design guidelines as follows:

1. Planning the overall structure of the application
2. Planning the content of the application
3. Planning the interactive behavior
4. Planning the look and feel of the application.

Hypermedia

Hyper media messaging

Messaging is one of the major multimedia applications. Messaging started out as a simple text-based electronic mail application. Multimedia components have made messaging much more complex.

However, Hypermedia messaging is not restricted to the desktops; it is increasingly being used on the road through mobile communications in metaphors very different from the traditional desktop metaphors.

Mobile Messaging

It represents major new dimensions in the user interactions with messaging system. It also remote access from users using PDAs, notebook computers, etc.,.

Hypermedia Message Components

1. The user may have watched some video presentation on the material and may want to attach a part of that clip in the message. While watching it, the user marks possible quotes and saves an annotated copy.
2. Some pages of the book are scanned as images. The images provide an illustration or a clearer analysis of the topic.
3. The user writes the text of the message using a word processor. The text summarizes the highlights of the analysis and presents conclusions.

Creating Hypermedia Messages

Hypermedia message is a complex collection of a variety of objects.

It is an integrated message consisting of text, rich text, binary files, images, and bitmaps voice and sound, and full motion video. Creating of a hypermedia message requires some preparation. A hypermedia report is more complex. It requires the following steps:

1. Planning
2. Creating each component
3. Integrating components

The planning phase for preparing the hypermedia message consists of determining the various sources of input. These can include any of the following:

1. A text report prepared in a word-processing system.
2. A spreadsheet in a spreadsheet program.
3. Some diagrams from a graphics program.
4. Images of documents.
4. Sound dips.
5. Video clips.

Integrated Multimedia Message Standards

Let us review some of the Integrated Multimedia Message Standards in detail.

Vendor Independent Messaging (VIM)

VIM interface is designed to facilitate messaging between VIM. Enabled electronic mail systems as well as other applications. The VIM interface makes mail and messages services available through a well-defined interface.

A messaging service enables its clients to communicate with each other in a store-and-forward manner. VIM-aware applications may also use one-or-more address books.

Address books are used to store information about users, groups, applica tions, and so on.

VIM Messages:

VIM defines messaging as a stored-and-forward method of application-to-application all program-to-program data exchange. The objects transported by a messaging system are called messages.

Message Definition:

Each message has a message type. The message type defines the syntax of the message and the type of information that can be contained in the message.

- **Mail Message:** It is a message of a well-defined type that must include a message header and may include note parts, attachments, and other application-defined components. End users can see their mail messages through their mail programs.

Message Delivery: If message is delivered successfully, a delivery report is generated and sends to the sender of the message if the sender requested the delivery report. If a message is not delivered, a non-delivered report is sent to the sender.

- A message that delivered will be in a message container will be marked as 'unread', until the recipient open and read it.

Message Container:

Multiple users or applications can access one message container. Each message in a message container has a reference number associated with it for as long as the message remains stored in the message container.

VIM Services:

The VIM interface provides a number of services for creating and mailing a message. Some of them are:

.:. Electronic message composition and submission.

.:. Electronic message sending and receiving.

.:. Message extraction from mail system.

.:. Address book services.

Integrated Document Management

It is for managing integrated documents.

Integrated document Management for Messaging Specialized messaging system such as Lotus Notes provide integrated document management for messaging. The user can attach embed or link a variety of multimedia objects.

When document is forwarded to other users, all associated multimedia objects are also forwarded and available to the new receivers of the forward message.

Multimedia Object Server and Mail Server Interactions:

The mail server is used to store I’ll e-mail messages. It consists of a file server with mail files for each user recipient. This file server act as a mail box.

All received mail is dropped in the user's mail file. The user can review or delete these mails. When mail messages include references to multimedia objects, mail file contains only link information.

DISTRIBUTED MULTIMEDIA SYSTEMS

If the multimedia systems are supported by multiuser system, then we call those multimedia systems as distributed multimedia systems.

A multi user system designed to support multimedia applications for a large number of users consists of a number of system components. A typical multimedia application environment consists of the following components:

1. Application software.
2. Container object store.
3. Image and still video store.
4. Audio and video component store.
5. Object directory service agent.
6. Component service agent.
7. User interface and service agent.
8. Networks (LAN and WAN).

APPENDIX

(NOT FOR EXAMINATION)

COMPONENTS OF DISTRUBUTE MULTIMEDIA SYSTEM

Application Software

The application software perfom1s a number of tasks related to a specific business process. A business process consists of a series of actions that may be performed by one or more users.

The basic tasks combined to form an application include the following:

(1) Object Selection - The user selects a database record or a hypermedia document from a file system, database management system, or document server.

(**2) Object Retrieval**- The application retrieves the base object.

(**3) Object Component Display** - Some document components are displayed automatically when the user moves the pointer to the field or button associated with the multimedia object.

(4) User Initiated Display - Some document components require user action before playback/display.

(5) Object Display Management and Editing: Component selection may invoke a component control sub application which allows a user to control playback or edit the component object.

Document store

A document store is necessary for application that requires storage of large volume of documents. The following describes some characteristics of document stores.

1. **Primary Document Storage**: A file systems or database that contains primary document objects (container objects). Other attached or embedded documents and multimedia objects may be stored in the document server along with the container object.

2. **Linked Object Storage**: Embedded components, such as text and formatting information, and linked information, and linked components, such as pointers to image, audio, and video. Components contained in a document, may be stored on separate servers.

3. **Linked Object Management**: Link information contains the name of the component, service class or type, general attributes such as size, duration of play for isochronous objects and hardware, and software requirements for rendering.

Image and still video store

An image and still video is a database system optimized for storage of images. Most systems employ optical disk libraries. Optical disk libraries consist of multiple optical disk platters that are played back by automatically loading the appropriate platter in the drive under device driver control.

The characteristics of image and still video stores are as follows:

(i) Compressed information
(ii) Multi-image documents
(iii) Related annotations
(iv) Large volumes
(v) Migration between high-volume such as an optical disk library and high-speed media such as magnetic cache storages
(vi) Shared access: The server software managing the server has to be able to manage the different requirements.

Audio and video Full motion video store

Audio and Video objects are isochronous. The following lists some characteristics of audio and full-motion video object stores:

(i) Large-capacity file system: A compressed video object can be as large as six to ten M bytes for one minute of video playback. Temporary or permanent Storage: Video objects may be stored temporarily on client workstations, servers Providing disk caches, and multiple audio or video object servers. Migration to high volume/lower-cost media.

(ii) Playback iso-chronocity: Playing back a video object requires consistent speed without breaks. Multiple shared access objects being played back in a stream mode must be accessible by other users.

Component Service Agent

A service is provided to the multimedia used workstation by each multimedia component. This service consists of retrieving objects, managing playback of objects, storing objects, and so on. The characteristics of services provided by each multimedia component are object creating service, playback service, component object service agent, service agents on servers and multifaceted services means (multifaceted services component objects may exist in several forms, such as compressed or uncompressed).

User Interface Service Agent

It resides on each user workstation. It provides direct services to the application software for the management of the multimedia object display windows, creation and storage of multimedia objects, and scaling and frame shedding for rendering of multimedia objects.

The services provided by user interface service agents are windows management, object creation and capture, object display and playback, services on workstations and using display software. The user interface service agent is the client side of the service agents. The user interface agent manages all redirection since objects are located by a look-up mechanism in the directory service agent

Data base processing servers are traditional database servers that contain alphanumeric data. In a relational database, data fields are stored in columns in a table. In an object-oriented database these fields become attributes of the object. The database serves the purpose of organizing the data and providing rapid indexed access to it. The DBMS can interpret the contents of any column or attribute for performing a search.

Network Topologies for Multimedia Object Servers

A number of network topologies are available Network topology is the geometric arrangement of nodes and cable links in a network. We still study three different approaches to setting up multimedia servers.

(i) **Centralized Multimedia Server**: A centralized multimedia object server performs as a central store for multimedia objects. All user requests for multimedia objects are forwarded by the applications to the centralized server and are played back from this server. The centralized server may serve a particular site of the corporation or the entire enterprise. Every multimedia object has a unique identity across the enterprise and can be accessed from any workstation. The multimedia object identifier is referenced in every data that embeds or links to it.

Dedicated Multimedia Servers: This is the approach where a video server is on a separate dedicated segmenting this approach, when a workstation dumps a large video, the other servers on the networks are not affected. Provides high performance for all local operations. The iso-chronocity of the objects is handled quite well in a dedicated mode.

Disadvantage of this approach is that the level of duplication of objects.

Distributed multimedia servers:

In this approach multimedia object servers are distributed in such a manner that they are placed in strategic locations on different LANs. They are replicated on a programmed basis to provide balanced service to all users.

Multi-server Network Topologies

To distribute the full functionality of multimedia network wide there are variety of network topologies available. The primary topologies are Traditional LANs (Ethernet or Token Ring Extended LANs (Using network switching hubs bridges and routers). High speed LANs (ATM and FDDI II). WANs (Including LANs, dial-up links-including ISDN T1 and T_3 lines-etc.).

Traditional LANS (Ethernet or Token Ring) Ethernet:

- **Ethernet**: It is Local Area Network hardware, communication, and cabling standard originally developed by Xerox Corporation that link up to 1024 nodes in a bus network. It is high speed standard using a baseband (single-channel) communication technique. It provides for a raw data transfer rate of 10 Mbps, with actual throughput in the range of 2-3 Mbps. It supports a number of sessions in a mix of live video, audio electronic mail and so on.
- **Token Ring**: It is a Local Area Network architecture that combines token passing with a hybrid star/ring topology. It was developed by IBM. Token Ring Network uses a multi-station Access unit at its hub.

ATM (Asynchronous Transfer Mode)

It is a network architecture that divides messages into fixed size units (called cells) of small size and that establishes a switched connection between the originating and receiving stations.

A TM appears to be a potential technology for multimedia systems for connecting object servers and user workstations. ATM is actually a good candidate for two reasons: as a hub and spoke teleology, it adapts very well to the wiring closest paradigm; and it allows workstations to operate at speeds defined by the workstation. Figure 5.12 below illustrates LAN topology using an A TM Switching System.

FDDI II (Fibre Distributed Data Interface II)

- It is a standard for creating high-speed computer networks that employ fiber-optic cable. FDDI II operates exactly like token ring,. With one difference: FDDI employs two wires through all the hosts in a network.

- FDDI II is a single media LAN and its full bandwidth supports all users. FDDI II appears to be a very useful high-speed technology for connecting servers on an additional separate network and providing the dedicated high bandwidth necessary for rapid transfer and replication of information objects. Figure 5.13 shows a multilevel network based

WANS (Wide Area Network)

This includes LANs, dial up ISDN, T1 (1.544 Mbits/sec) and T3 (45.3 Mbits/sec) lines and regular telephone dial-up lines. The two big issues here are:

:.W ANs may have a mix of networking and communication protocols.

:. WAN has a variety of speeds at which various parts of it where it communicates. Protocol Layering: Layering helps to isolate the network from the application. Layering of protocols started with the release of the ISO model.