

Module 1

Computer

Computer is an electronic device that takes raw data as input, process it and returns information as output.

Q 1) Computer Graphics (Define Computer Graphics ?)

Computer graphics is the art of generating images with the help of computer programs. It involves computation, creation and manipulation of data.

Q 3) Application of Computer Graphics

Computer Graphics deal with creation, manipulation & storage of different types of images & objects.

Some of the applications of computer graphics are:

1. Computer Art:

Using computer graphics we can create finite & commercial art which include animation packages, paint packages. These packages provide facilities for designing object shapes and specifying object motion. Cartoon drawing, paintings, logo design can also be done.

2. Computer Aided Drawing:

Designing of buildings, automobile, aircraft is done with the help of computer aided drawing, this helps in providing minute details to the drawing and producing more accurate & sharp drawings with better specifications.

3. Presentation Graphics:

For the preparation of reports or summarising the financial, statistical, mathematical, scientific, economic data for research reports, managerial reports, moreover creation of bar graphs, pie chart, time chart can be done using the tools present in computer graphics.

4. Entertainment

Computer graphics finds a major part of its utility in the movie industry and game industry. Used for creating motion pictures, music video, television shows, cartoon animation films. In the game industry where focus and interactivity are the key players, computer graphics helps in providing such features in the efficient way.

5. Education

Computer generated models are extremely useful for teaching huge number of concepts and fundamentals in an easy to understand and learn manner. Using computer graphics many educational models can be created through which more interest can be generated among the students regarding the subject.

6. Training

Specialised system for training like simulators can be used for training the candidates in a way that can be grasped in a short span of time with better understanding. Creation of training modules using computer graphics is simple and very useful.

7. Visualisation:

Today the need of visualise things have increased drastically, the need of visualisation can be seen in many advance technologies, data visualisation helps in finding insights of the data, to check and study the behaviour of processes around us we need appropriate visualisation which can be achieved through proper usage of computer graphics.

8. Image processing

Various kinds of photographs or images require editing in order to be used in different places. Processing of

existing images & into refined ones for better interpretation is one of the many applications of computer graphics.

9. Machine Drawing

Computer graphics is very frequently used for designing, modifying and creation of various parts of machine and the whole machine itself, the main reason behind using computer graphics for this purpose is the precision and clarity we get from such drawing is ultimately & extremely desired for the safe manufacturing of machine using these drawings.

10. Graphical user Interface:

The use of pictures, images, icons, pop-up menus, graphical objects helps in creating a user friendly environment where working is easy and pleasant, using computer graphics we can create such an atmosphere where every thing can be automated and anyone can get the desired action performed in an easy fashion.

Video Display Devices

The display devices are known as output devices. The most commonly used output device is a graphics video monitor. The operation of most video monitors are based on the standard cathode-ray tube (CRT) design.

Q) → Other examples are: LCD, LED, 3D cells etc

• How the interactive Graphics display works?

The modern graphic display consist of 3 components.

- ① A digital Memory or frame buffer in which the displayed images is stored as a matrix of intensity values
- ② A monitor
- ③ A display controller, which is a simple interface that passes

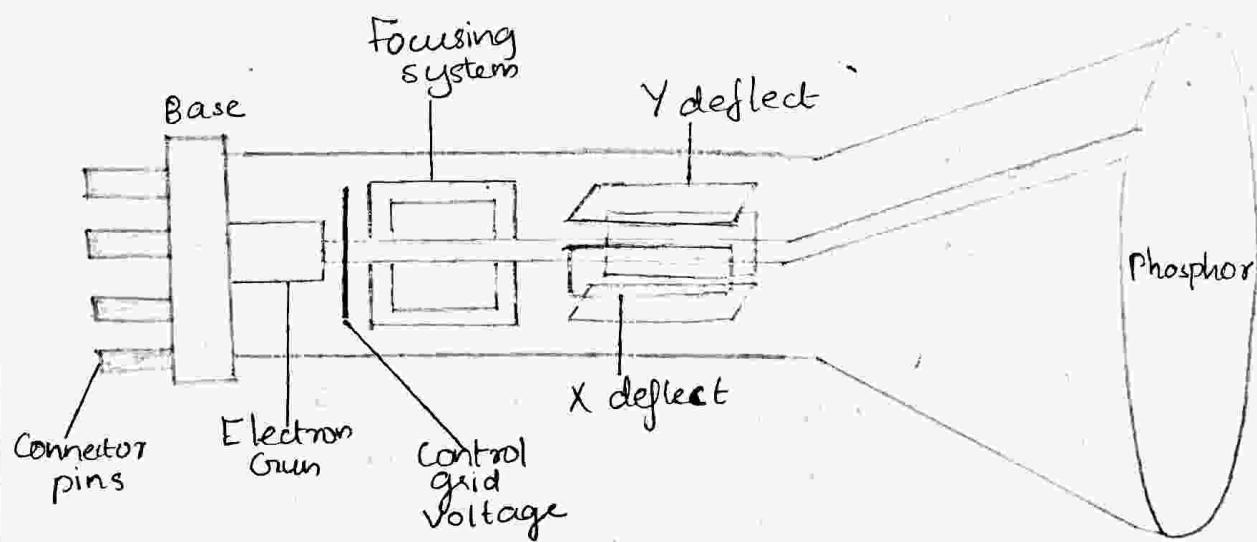
the contents of the frame buffer to the monitor.

Pixels

The pixel is the smallest addressable screen element.

Q 4) Cathode-Ray-Tubes (Explain CRT in detail with the help of a neat diagram?)

A CRT is an evacuated glass tube. An electron gun at the rear of the tube produces a beam of electrons which is directed towards the front of the tube. The inner side of the screen is coated with phosphor substance which gives off light when it is struck by electrons. It is possible to control the point at which the electron beam strikes the screen, and therefore the position of dot upon the screen, by deflecting the electron beams.



The operation of CRT is very simple -

- The electron gun emits a beam of electrons, called cathode rays.
- The electron beam passes through focussing & deflection systems, that direct it towards specified positions on the phosphor-coated screen
- When the beam hits the screen, the phosphor emits a small spot of light at each position contacted by the electron beam.

- It redraws the picture by directing the electron beam back over the same screen points quickly.

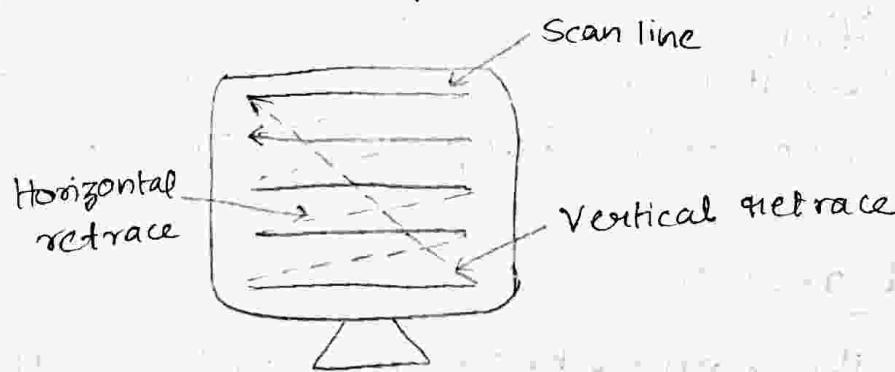
There are two ways Rasterscan and Randomscan by which we can display an object on the screen.

Q9)

Rasterscan (Explain rasterscan displays with the help of a neat diagram)

In a rasterscan system, the electron beam is swept across the screen, one row at a time from top to bottom. It is the most common method of displaying images on the CRT screen. In this method, the horizontal and vertical retrace are generated to move the beam all over the screen in a pattern.

Here, the beam is swept back and forth from the left to the right across the screen. When the beam is moved from left to right, it is ON. The beam is OFF when it is moved from the right to the left. When the beam reaches the bottom of the screen, it is made OFF, and rapidly retraced back to the top left to start again. A display produced in this way is called raster scan display.



Q5)

Explain the term frame buffer?

Picture definition is stored in memory area called the Refresh Buffer or Frame buffer. The memory area holds the set of intensity values for all the screen points. Stored intensity values are then retrieved from the refresh buffer and "painted" on the screen one row scanline at a time as shown in the above figure. Each screen point is referred to as a pixel. At the end of each scanline, the e^- beam returns to the left side of the screen to begin displaying the next scan line.

Q 6. What is a scan line?

- In a raster scan, an image is subdivided into a sequence of strips (usually horizontal) and it is known as Scanline
OR
• Each row of beam horizontal beam is called a scanline.

Q 7. What is mean by picture definition?

- The information regarding the picture to be drawn is called picture definition.

Q 8. What is a pixel?

- Each screen point is referred to as a pixel.

Q 10. Differentiate between horizontal retrace & vertical retrace

Horizontal retrace

In raster scan display, the beam is swept back and forth from left to right across the screen. When the beam is moved from left to the right it is ON. The beam is OFF when it is moved from the right to left. This path of beams are called horizontal retrace.

Vertical retrace

When the bottom beam reaches the bottom of screen in raster scan display, it is made OFF and rapidly moved retraced back to the top left to start again. This path of beams are called vertical retrace.

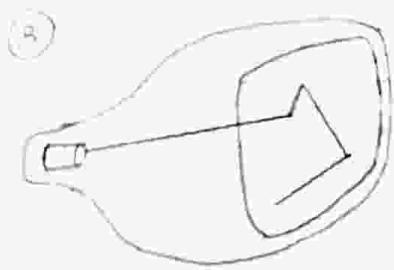
Q 11. Explain the working of random scan display with the help of a neat diagram?

⇒ Random Scan display

In this technique, the electron beam is directed only to the part of the screen where the picture is to be drawn rather than scanning from left to right and top to bottom as in raster scan. It is also called vector display.

Picture definition is stored as a set of line drawing commands in an area of memory referred to as the refresh display file. To display a specified picture, the system cycles through the set of commands in the display file, drawing each component line in turn. After all the line-drawing commands are processed, the system cycles back to the first line command in the list.

Random-scan displays are designed to draw all the component lines of a picture 30 to 60 times each second.



Here, we have to draw a triangle, so first the electron beam moves to the bottom of the screen and draw the straight line and then to the top by drawing a straight line and then back to the bottom by a straight line to complete the figure.

Q.1 What is refresh display file?

→ Picture definition is stored as a set of line-drawing commands in an area of memory referred to as the ~~area~~ refresh display file.

20/05

Q.1 Explain colour CRT Monitors?

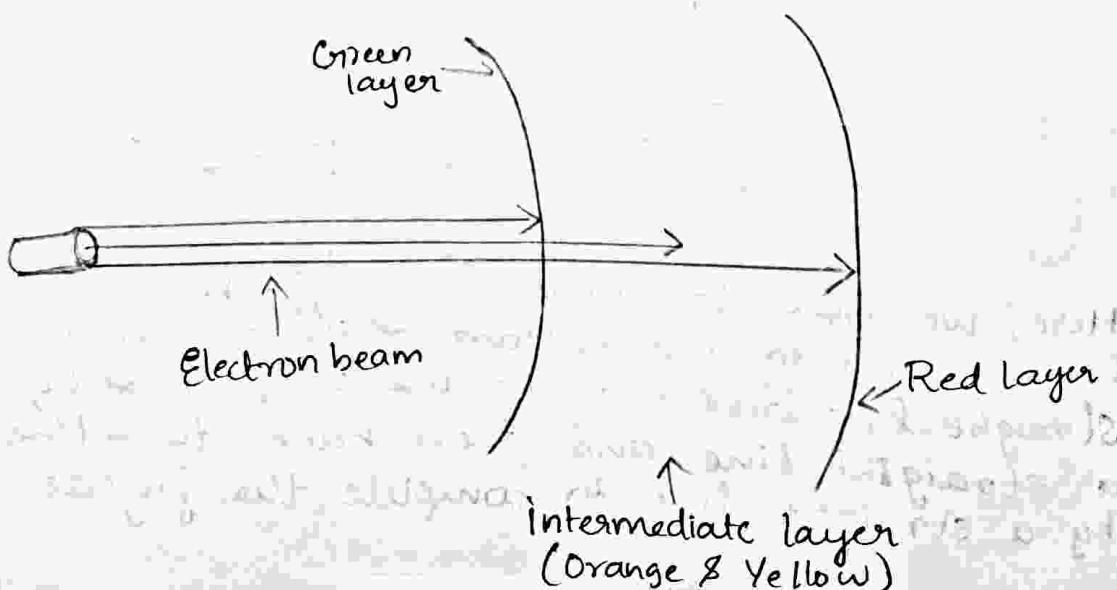
→ A CRT monitor displays color pictures by using a combination of phosphors that emit different-colored light. A range of colours can be used generated by combining the emitted light from the different phosphors.

Two basic techniques for producing color displays with a CRT are:

- beam-penetration method
- shadow-mask method.

Q.2 Explain the working of beam penetration method?

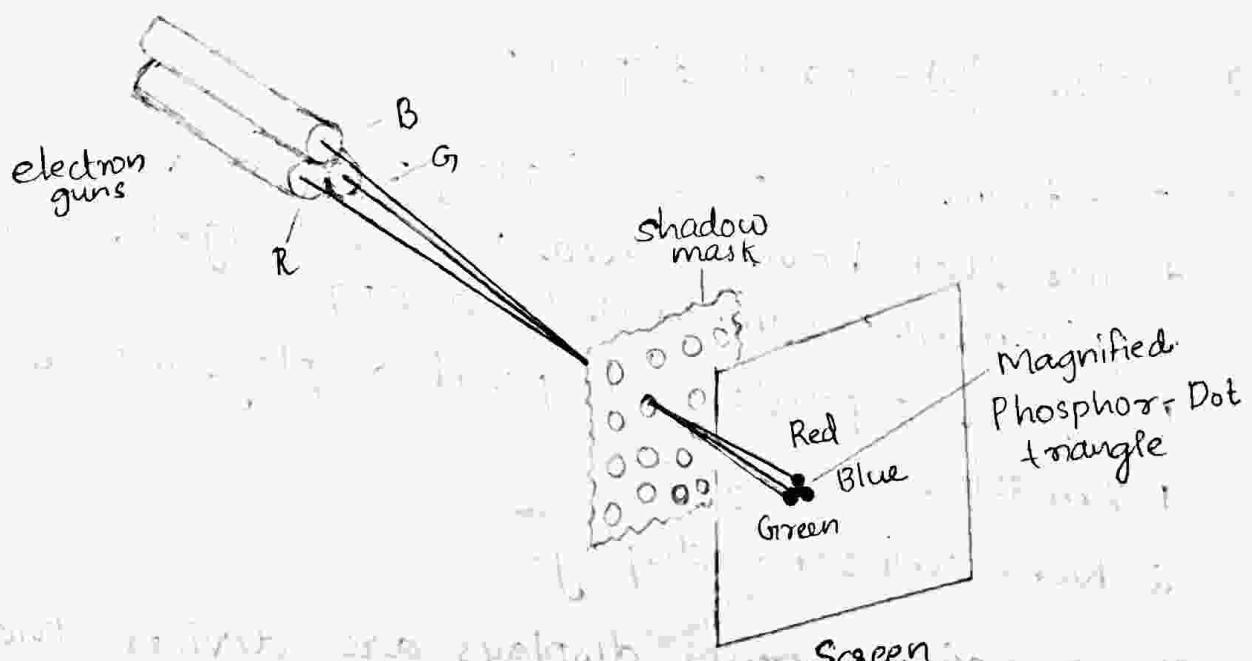
→ Beam-penetration method is used for displaying pictures that has been used with random-scan monitors. Two layers of phosphor, usually red and green are coated onto the inside of the CRT screen, and the displayed color depends on how far the e⁻ beam penetrates into the phosphor layer.



- A beam of slow electrons excites only the inner green layer
- A beam of very fast electrons penetrates through the green layer and exits the outer red layer.
- At intermediate beam speeds, combination of red & green light are emitted to show two additional colors, orange and yellow.

Q. Explain the working of shadow mask method?

- ⇒
- It is commonly used in raster scan systems (early TVs) because they produce a much wide range of colors than the beam penetration method.
 - A shadow-mask CRT has three phosphor color dots at each pixel positions.
 - One phosphor dot emits a red light, another emits a green light, and the third emits a blue light.
 - This type of CRT has three electro guns, one for each color dot, and a shadow mask grid just behind the phosphor-coated screen.



Working:

- The three electron beams are deflected and focused as a group onto the shadow mask, which contains a series of holes aligned with the phosphor dot patterns.
- When the 3 beams pass through a hole in the shadow mask, they activate a dot triangle, which appears as a small color spot on the screen.
- We obtain color variations in a shadow mask CRT by varying the intensity levels of the 3 e^- beams.
- By turning off the red and green guns, we get only the color coming from the blue phosphor.
- A white area is the result of activating all 3 dots with equal intensity.
- Yellow is produced with the green and red dots only, magenta is produced with the blue & red dots, and cyan shows up when blue and green are activated equally.

Q. Explain flat-panel display?

The term flat-panel display refers to a class of video devices that have reduced volume, weight, and power requirements compared to a CRT.

We can separate flat-panel display into 2 categories:

1. Emissive display
2. Non-emissive display.

The emissive devices displays are devices that convert electrical energy into light.

eg: Plasma panels, thin-film electroluminescent displays and light-emitting diodes are examples of emissive displays.

The non-emissive displays use optical effects to convert sunlight or light from some other source into graphics patterns.

eg: LCD

Emissive Displays

① Plasma panels

Plasma panels are also called gas-discharge displays, they are constructed by filling the region between two glass plates with a mixture of gasses that usually includes neon. There are series of vertical conducting ribbons placed on one glass panel, and set of horizontal ribbons is built into the other glass panel.

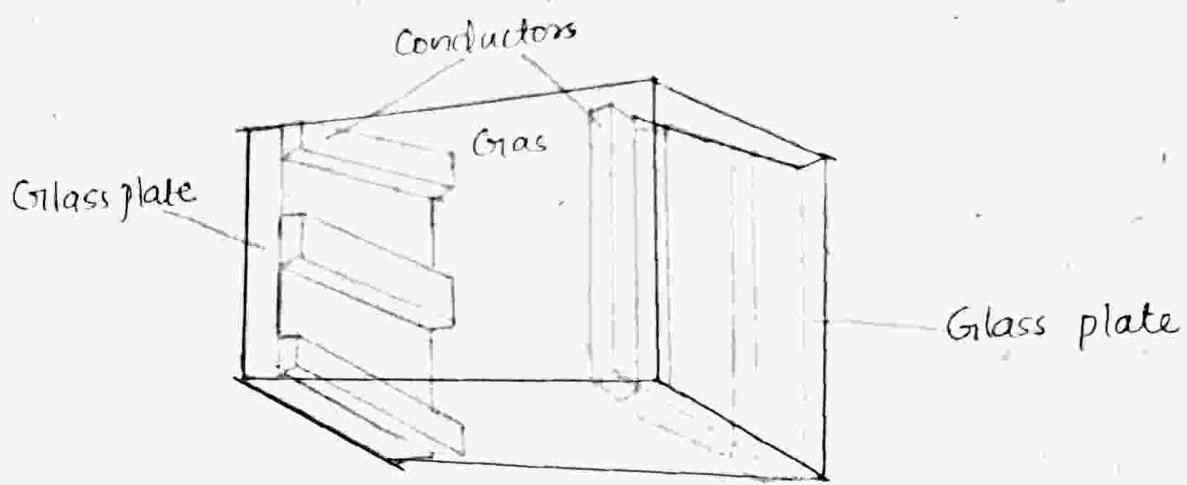
Firing voltages applied to the pair a pair of horizontal and vertical conductors cause the gas as the intersection of the two electrodes conductors to break down into a glowing plasma of electrons & ions.

Advantage:

- High Resolution
- Large screen size is also possible.
- Less volume
- Less weight
- Flicker Free Display.

Disadvantage:

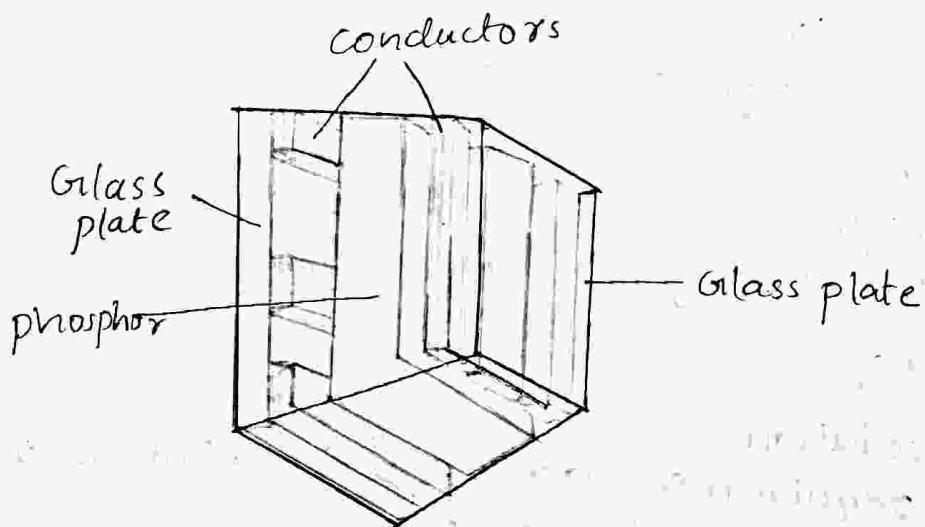
- Poor resolution
- Wiring requirement anode and the cathode is complex.
- Its addressing is also complex
- They are monochromatic devices



② Thin-film electroluminescent displays

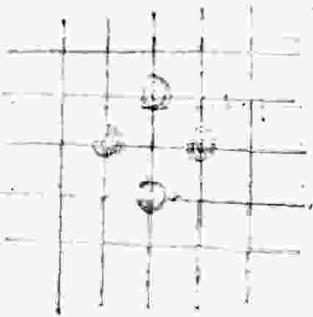
- It is similar in construction to a plasma panel. The difference is that region between the glass plates is filled with a phosphor, such as zinc sulfide doped with manganese, instead of a gas. When a sufficiently high voltage is applied to a pair of crossing electrodes the phosphor becomes a conductor in the area of the intersection of the two electrodes.

Disadvantage: Electroluminescent displays require more power than plasma panels, and good color and gray scale displays are hard to achieve



③ Light-emitting diode

A matrix of diodes is arranged to form the pixel position in the displays, and picture definition is stored in a refresh buffer. Information is read from the refresh buffer and converted to voltage levels that are applied to the diodes to produce the light patterns in the displays.



Non-emissive displays

① Liquid Crystal Display (LCD)

LCDs are commonly used in small systems such as calculators and portable, laptop computers. It produces a picture by passing polarized light from the surroundings or from an internal light source through a liquid crystal material layer that can be aligned to either block or transmit the light.

The term liquid crystal refers to the fact that these compounds have a crystalline arrangement of molecules, yet they flow like a liquid. Here, two glass plates, each containing a light polarizer at right angles to the other plate, sandwich the liquid-crystal material. Rows of horizontal transparent conductors are built into one glass plate, and columns of vertical conductors are put into the other plate. The intersection of two conductors defines a pixel position. There are two states; ON state - light will transmit and OFF state - light will not transmit.

Advantage:-

- Low power consumption
- Small size
- Low cost.

Disadvantage:-

- LCD's are temperature-dependent ($0-70^{\circ}\text{C}$)
- LCDs do not emit light; as a result, the image has very little contrast.
- LCDs have no color capability
- The resolution is not good as that of a CRT

Q. Explain emissive displays ? (15)

Q. Explain the working of non-emissive display with the help of an example ? (15)

Q. What are direct view storage tubes (DVST) ? (5)

⇒ DVST terminals also use the random scan approach to generate the image on the CRT screen. The term storage tube refers to the ability of the screen to retain the image which has been projected against it, thus avoiding the need to rewrite the image constantly.

Function of guns: Two guns are used in DVST.

1. Primary gun:- It is used to store the picture pattern.
2. Flood gun or Secondary gun:- It is used to maintain picture display.

Advantages:-

No refreshing is needed

High resolution

Cost is very less

Disadvantages:-

- It is not possible to erase the selected part of a picture.
- It is not suitable for dynamic graphics applications.
- If a part of picture is to modify, the time is consumed.

Raster Scan Display System with video controller

Q. Explain Raster scan system?

Raster Scan System

- In addition to the central processing unit (CPU), a special processor, called the video controller or display controller, is used to control the operation of the display device.

- A fixed area of the system memory is reserved for the frame buffer, and the video controller is given direct access to the frame buffer memory.

• Operation performed:-

① Refreshing operation

② Transformation (Area ~~area~~ of the screen can be enlarged, reduced, or moved during the refresh cycle).

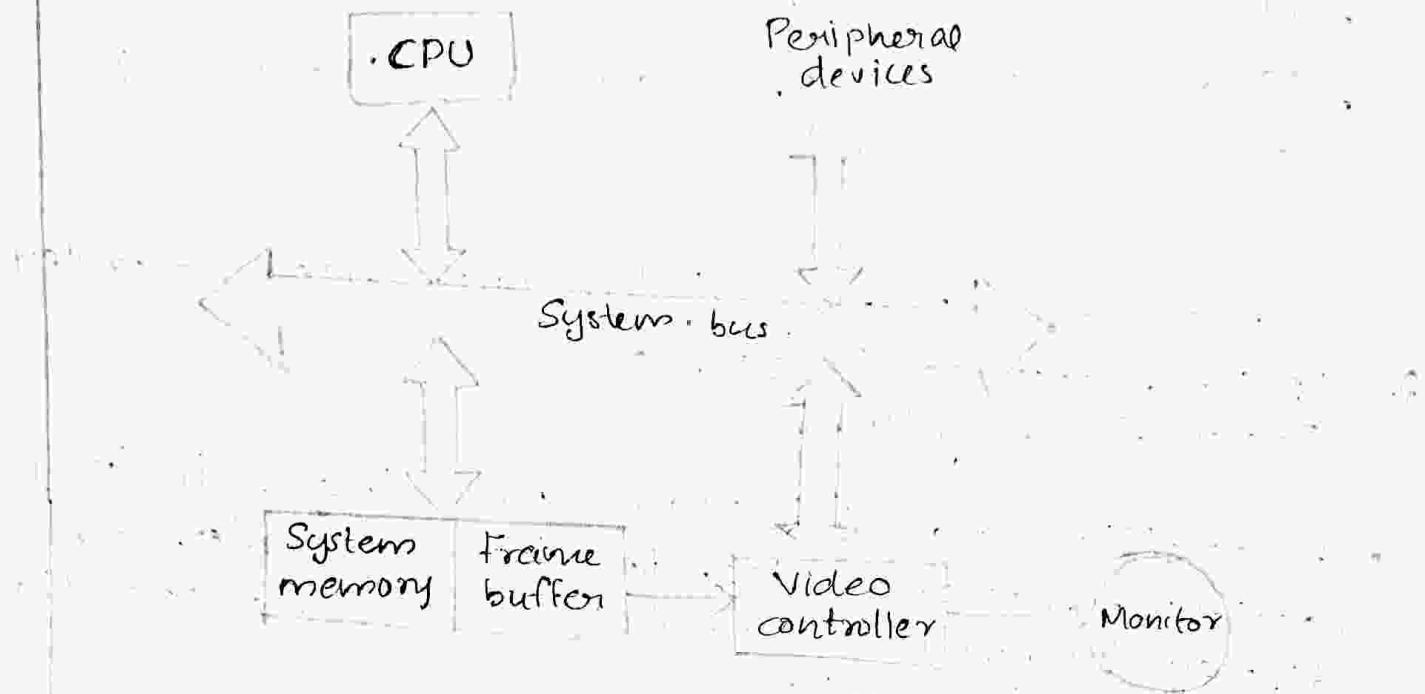
- In raster scan displays a special area of memory is dedicated to graphics only. This memory area is called frame buffer.

- It holds the set of intensity values for all the screen points

- The video controller retrieves the stored intensity values from frame buffer and displays them on the screen one row (scan line) at a time, typically

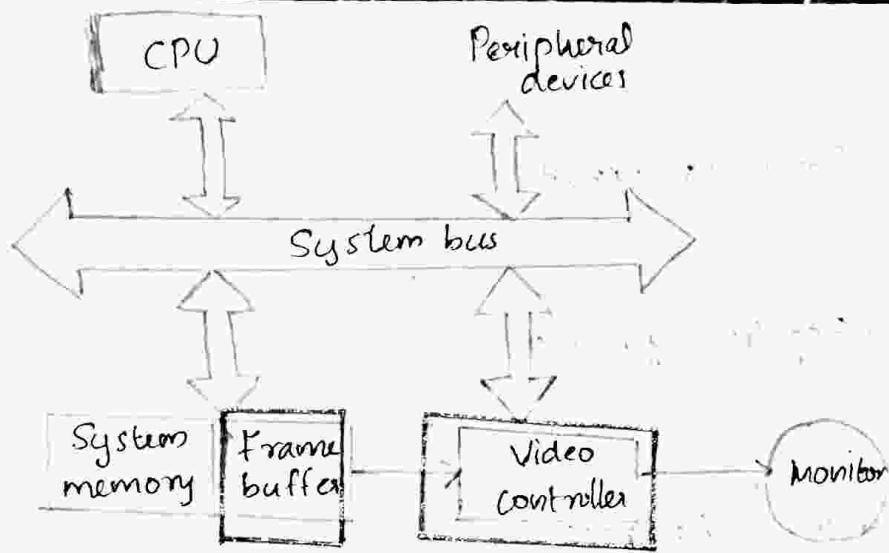
50 times per second.

Q. Explain the architecture of raster scan systems?

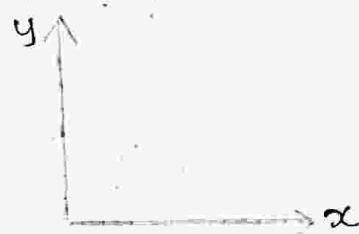


Raster Scan Systems (architecture)

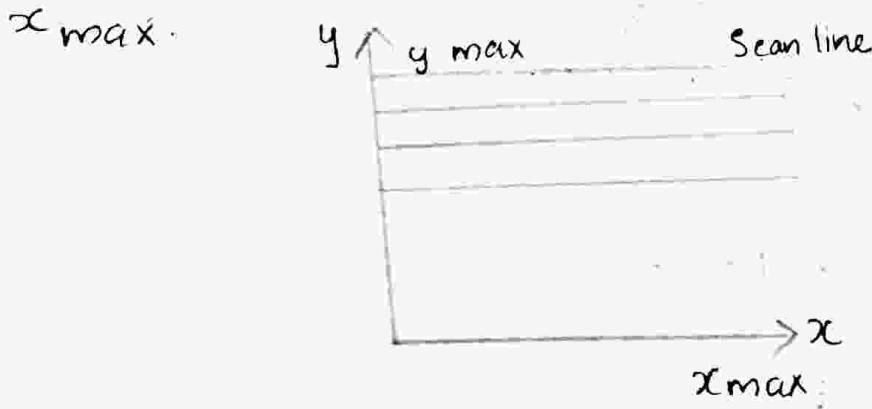
- In addition to the central processing unit (CPU), a special processor, called the video controller or display controller, is used to control the operation of the display device.
- Q. Explain the working of video controller with suitable diagrams.
- A fixed area of the system memory is reserved for the frame buffer, and the video controller is given direct access to the frame buffer.



- Frame buffer location and the corresponding screen positions, are referenced in cartesian coordinates.



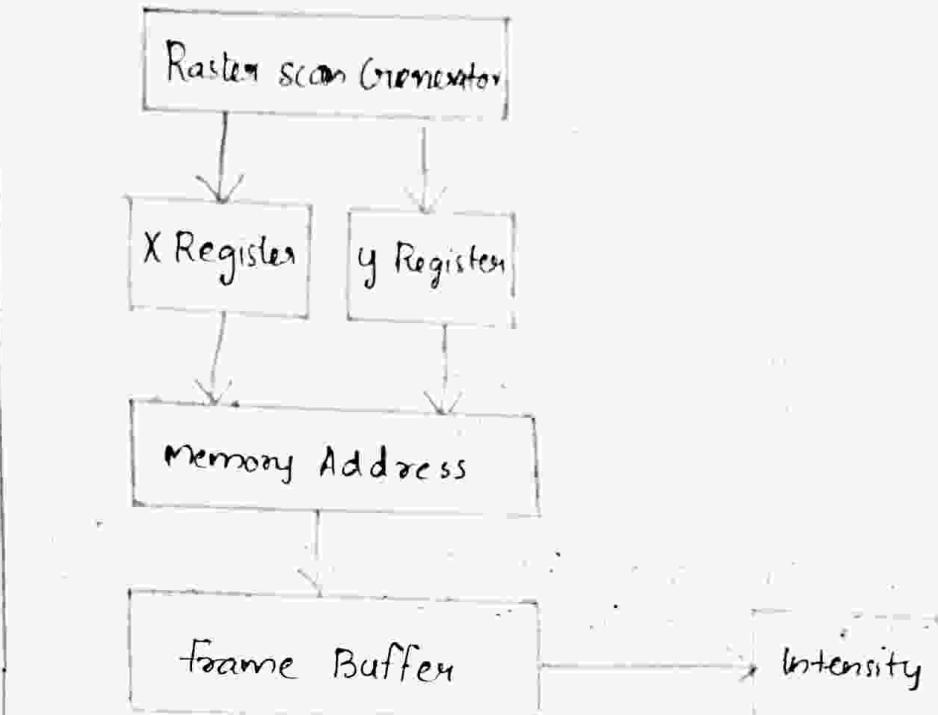
- Scan line are then labeled from y_{max} at the top of the screen to 0 at the bottom. Along each scan line, screen pixel positions are labeled from 0 to x_{max} .



Simple Organization of the video Controller

- Two registers are used to store the coordinates of the screen pixels.

The basic refresh operation of the video controller:-



To speed up pixel processing video controllers can retrieve multiple pixel values from the refresh buffer on each pass. The multiple pixel intensities are then stored in a separate register and used to control the CRT beam intensity for a group of adjacent pixels. When this group of pixels has been processed the next block of pixel values is retrieved from the frame buffer.

Colour Map look up table

- In color displays, 24 bits per pixel are commonly used, where 8 bits represent 256 levels for each colour. It is necessary to read 24-bits ~~as~~ for each pixel from frame buffer. This is very time consuming
- To avoid this, video controller uses Look UP tables (LUT) to store many entries of pixel values in RGB format

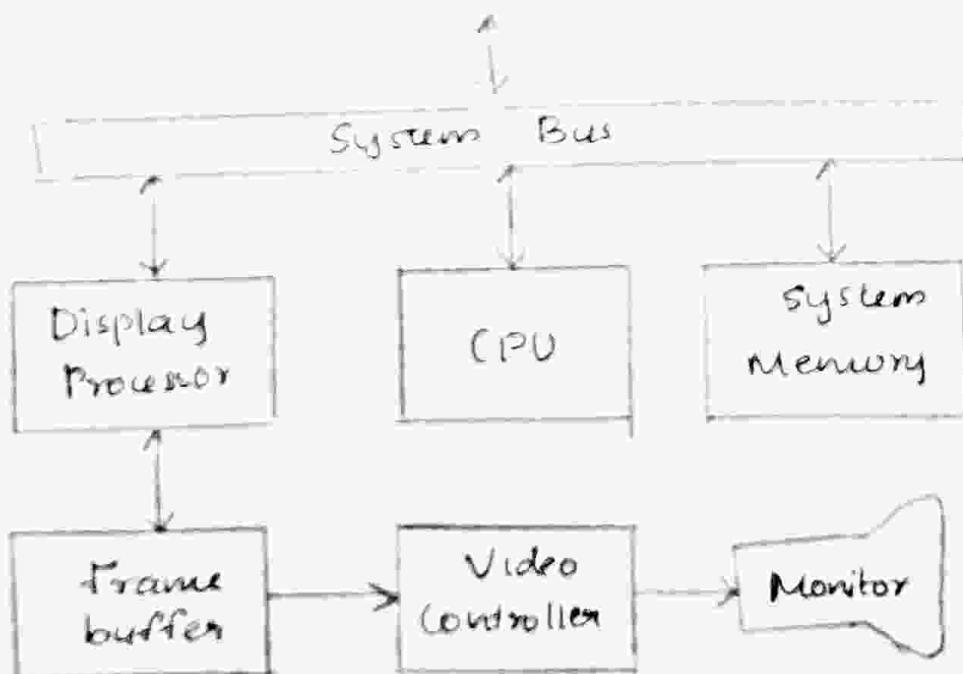
- With this facility, now it is necessary to only read index to the Look Up Table from the frame buffer for each pixel.
- The specified entry in the Look Up Table is then used to control the intensity or color of the CRT.

Raster Scan Display System with Display Controller

Raster scan Display Controller/ Processor (DP)

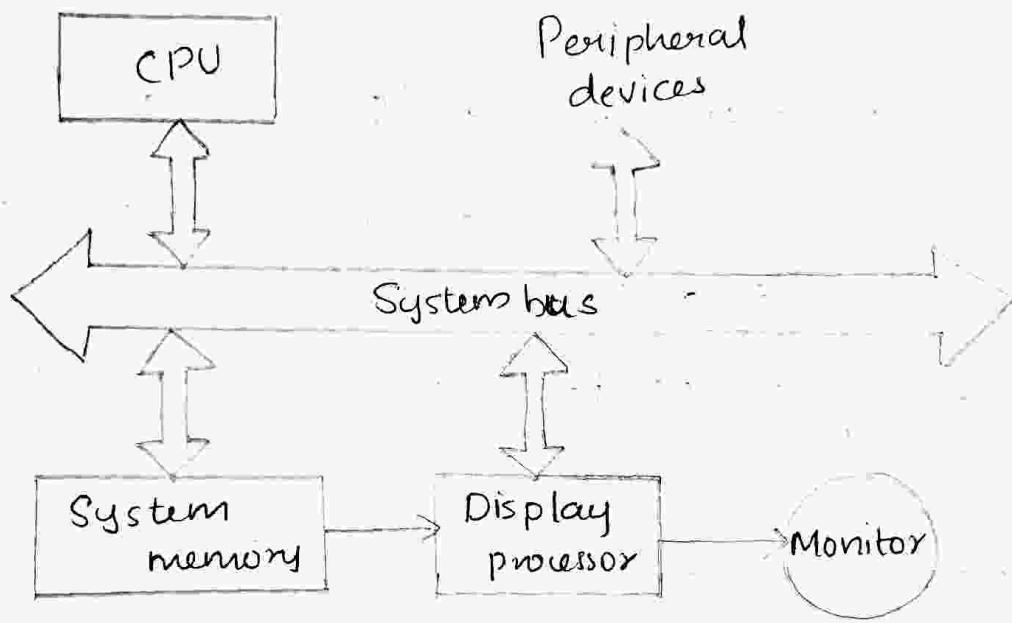
- A raster system containing a separate display processor (graphics controller, display controller).
- The purpose of the DP is to free the CPU from the graphic cores.
- It generates various line styles (dashed, dotted or solid)
- Display Processor displays color areas and performs certain transformation and manipulation on display objects.

J/I Devices



Random Scan Systems

- Graphic commands are translated by the graphics package into a display file stored in the system memory.
- This file is then accessed by the display processor unit (DPU) (graphic controller) to refresh the screen.



Input device

An input device is a piece of hardware used to provide data to a computer used for interacting and control. It allows input of raw data to the computer for processing.

Input devices are:

1. Keyboard
2. Mouse
3. Trackball and spaceball
4. Joystick
5. Data glove
6. Digitizers
7. Image scanners
8. Touch panels
9. Light pens
10. Voice systems

Keyboard

Alphanumeric keyboard is used as a device for entering text strings. Most English language keyboards use the QWERTY layout.

Cursor control keys and function keys are common features of keyboard. Function keys allows users to enter frequently used operations in a single keystroke, and cursor keys can be used to select displayed objects.

It has function keys, control keys, arrow keys, keypad and the keyboard itself with the letters, numbers and commands.

- Keyboards are connected to the computer through USB or Bluetooth.
- A laptop keyboard is more compact than a desktop keyboard to make the laptop smaller & lighter
- Smartphones and tablets use on-screen keyboard to input messages & select commands.

2. Mouse

An input device used to control the cursor and coordinate. It can be wired or wireless. It allows the user to do the following:-

- Move the mouse cursor
- Select
- Scroll
- Open or execute a program
- Drag-and-drop
- Perform other functions with the use of additional buttons.

A laptop uses a touchpad as the mouse. A ~~so~~ smartphone and tablet uses a touchscreen as primary input device & the user's finger is used as the mouse.

A mouse is a small hand held device used to position the screen cursor. Wheels or rollers on the bottom of the mouse can be used to record the amount and direction of movement.

Optical mouse

An optical mouse uses an optical sensor to detect the mouse motion. An optical mouse is moved over as a special mouse pad that has a grid of

horizontal and vertical lines. The optical sensors detects the movement across the lines in the grid.

Z Mouse

Z mouse includes three buttons, a thumbwheel on the side, a trackball on the top and a standard mouse ball underneath. This design provides a six degree of freedom to select positions, rotations & other parameters. Application of z mouse in CAD, animation etc.

3. Trackball and Spaceball

Trackball

A trackball is a pointing input device. It consists of a ball held by a socket containing sensors to detect a rotation of the ball about two axes. It is like an upside-down mouse with a ball that sticks out. The user rolls the ball with the thumb, fingers or the palms of the hand to produce screen cursor movement. Potentiometers attached to the ball measures the amount and direction of rotation. Trackballs are often mounted on keyboards.

Spaceball

A graphical input device that is based on a fixed spherical ball. It allows complex objects to be positioned and rotated in three-dimensional space using single input device. Internally a spaceball is made from a set of strain-gauges. It provides six degree of freedom (movement of a rigid body in a 3-dimensional space) and does not actually move.

Strain gauges measures the amount of pressure applied to the spaceball to provide input for spatial processing and orientation as the ball is pushed or pulled in various directions. It is used for 3-D positioning & selection operations in virtual reality systems, modeling animations, CAD etc.

4. Joystick.

A joystick consists of a small, vertical lever mounted on a base that is used to steer the screen cursor.

Most joysticks, select screen positions with actual stick movement; others, respond to pressure on the stick. The distance that the stick is moved in any direction from its center position corresponds to screen cursor movement in that direction. Potentiometers mounted at the base of the joystick measure the amount of movement and springs return the stick on the center position, when it is released.

One or more buttons can be programmed to act as input switches to signal certain actions once a screen position has been selected.

Movable Joystick

It has eight switches which are arranged in a circle, so that the stick can select any one of eight directions for cursor movement.

Isometric joystick

It is a pressure sensitive joystick with a nonmovable stick. Pressure on the stick is measured with strain gauge and converted to movement of the cursor in the direction specified.

5. Data Glove

It can be used to grasp a virtual object. The glove is constructed with a series of sensors that detect hand and finger motions.

Electromagnetic coupling between transmitting antennas and receiving antennas is used to provide information about the position and orientation of the hand. Input from the glove can be used for position or manipulate in a virtual screen.

Digitizers

A common device for drawing, painting or interactively selecting coordinate positions on an object is a digitizer. These devices can be used to input coordinate value in either a two-dimensional or a 3 dimensional space.

One type of digitizer is graphics tablet, which is used to input two-dimensional coordinates by activating a hand cursor or stylus at selected positions on a flat surface. A hand cursor contains cross hairs for sighting positions, while a stylus is a pencil-shaped device that is pointed at positions on the tablet. The three-dimensional artist's digitizing system uses electromagnetic resonance to detect the three-dimensional position of the stylus. Graphics tablets provide a highly accurate method for selecting coordinate positions. Electro-magnetic pulses are generated in sequence along the wires, and an electric signal is induced in a wire coil in an activated stylus or hand cursor to record a tablet position. Acoustic tablets use sound waves to detect a stylus position.

Three-dimensional digitizers use sonic or electromagnetic transmissions to record positions. Resolution of this system is from ~~around~~ 0.8 mm to 0.08 mm, depending on the model.

Image scanners

Drawings, graphs, color and black-and-white photo or text can be stored for computer processing with an image scanner by passing an optical scanning mechanism over the information to be ~~sort~~ stored.

Touch panels

Touch panels allow displayed objects or screen position to be selected with the touch of a finger. A typical application of touch panels is for the selection of processing options that are represented with graphical icons. Other systems can be adapted for touch input by fitting a transparent device with a touch-sensing mechanism over the video monitoring screen. Touch input can be recorded using optical, electrical, or acoustical method.

Optical touch panels employ a line of infrared light emitting diodes (LEDs) along one vertical edge and along one horizontal edge of the frame. The opposite vertical & horizontal edge contain light detectors. These detectors are used to record which beams are interrupted when the panel is touched. The two crossing beams that are interrupted identify the horizontal and vertical coordinates of the screen position selected.

In acoustical touch panels, high frequency sound waves are generated in the horizontal and vertical directions across a glass plate. Touching the screen causes part of each wave to be reflected from the figure to the emitters. The screen position at the point of contact is calculated from a measurement of the time interval b/w the transmission of each wave and its reflection to the emitted

Light Pen

This pencil-shaped pen devices are used to select screen positions by detecting the light coming from points on the CRT screen. They are sensitive to the short burst of light emitted from the phosphor ~~coating~~ coating at the instant the electron beam strikes a particular point. Other light sources, such as the background light in the room, are usually not detected by a light pen. An activated light pen, pointed at a spot on the screen as the electron beam lights up that spot, generates an electrical pulse that cause the coordinate position of the electron beam to be recorded. As with cursor-positioning devices, recorded light-pen coordinates can be used to position an object or to select a processing option.

Voice system

Speech recognition are used in some graphics workstation as input devices to accept voice commands. The voice-system input can be used to initiate graphics operations or to enter data. The system operate by matching an input against a pre-defined dictionary of words and phrases.

Output Device

An output device is a piece of computer hardware that receives data from a computer and then translates that data into another form.

The key distinction between an input device and an output device is that an input device sends data to the computer, whereas an output device receives data from the computer.

- | | |
|----------------------|-------------------------------|
| 1. Monitor | 6. GPS |
| 2. Printer | 7. Sound Card |
| 3. Headphones | 8. Video Card |
| 4. Computer Speakers | 9. Braille Reader |
| 5. Projector | 10. Speech-Generating Device. |

Monitor

Mode: Visual

Function:- A monitor consists of a screen, circuitry, a power supply, buttons to adjust screen settings and a casing that contains all of these components.

A monitor displays data from a computer onto a screen so the user can interact with the data via a digital interface.

Printer

Mode: Print

Function:- The function of a printer is to create a copy of whatever is sent from the computer to the printer. Printer take electronic data sent from a computer & generate a hard copy.

Headphones

Mode : Sound

Function : Headphones output audio from a computer through two individual headphones for a single listener.

Also known as earphones, headphones allow you to ~~listen~~ listen to audio without disrupting other people in the vicinity.

Computer Speakers

Mode : Sound

Function : Computer Speakers are hardware devices that transform the signal from the computer's sound card into audio.

Speakers create sound using internal amplifiers that vibrate at different frequencies according to data from the computer. This produces sound.

Projector

Mode : Visual

Function : This output device "projects" computer images or video onto a wall or screen. Projectors are typically used for presentations, watching movies, or as a teaching aid, as they enable an entire roomful of people to see images generated by a single computer.

Modern projectors usually connect to the computer via an HDMI cable or VGA.

GPS (Global Positioning System)

Mode : Data

Function : GPS is a radio-based navigation system that's composed of a sender computer and a receiver. The sender broadcasts signals to satellites.

that ping to the sender the exact location of the sender computer in the form of latitude and longitude coordinates. The satellites use microwave signals to talk to the GPS, giving information on location, vehicle speed, and a number of other pieces of data.

Sound Card

Mode: Sound

Function: The sound card controls the output of sound signals, enabling devices like speakers and headphones to work. The sound card is known as an expansion which means it can be added to the motherboard.

Although a sound card is not essential to a computer's basic functionality, you need one if you wish to play games, watch movies, listen to music, and use audio & video conferencing.

Video Card

Mode: Visual

Function: Video card is an expansion card that slots into the motherboard. The video card processes images and video, enabling visuals to be seen on a display. Most computers have basic video & graphics capabilities built into the computer's motherboard, but for faster, more detailed graphics, a video card is required.

Braille Reader

Mode: Print

Function: A braille reader is a peripheral device that enables a blind person to read text displayed on a computer monitor. The text is sent by the computer to the device, where it is translated into a braille format and made readable by pushing rounded pins up through a flat surface. Braille readers are also called braille displays and come in various sizes.

Speech- Generating Device (SGID)

Mode: Sound

Function: SGIDs, also known as voice output communication aids, generate text to speech. A user types something and when the command is sent, the SGID reads the sentence out loud.

Hardcopy devices

[Different types of Printers] (Plotters)

The quality of the pictures obtained from a device depends on dot size and the number of dots per inch, or lines per inch, that can be displayed. To produce smooth characters in printed text strings, higher quality printers shift dot positions so that adjacent dots overlap.

Printers produce output by either impact or non-impact

Impact printers press formed character faces against an inked ribbon onto the paper. A line printer is an example of an impact ~~po~~ device, with the typefaces mounted on bands, chains, drums or wheels.

Non impact printers and plotters use laser techniques, ink-jet sprays, xerographic processes, electrostatic methods, and electrothermal methods to get images onto paper.

In a laser device, a laser beam creates a charge distribution on a rotating drum ~~created~~ coated with a photoelectric material, such as selenium. Toner is applied to the drum and then transferred to paper.

Ink-jet methods produce output by squirting ink in horizontal rows across a roll of paper wrapped on a drum. The electrically charged ink streams is deflected by an electric field to produce dot-matrix patterns. A desktop ink-jet plotter with a resolution of 360 dots per inch.

An electrostatic device places a negative charge on the paper, one complete row at a time along the length of the paper. Then the paper is exposed to a toner areas, where it adheres to produce the specified out. Ancolor electrostatic powder/plotter prints colour. Electrothermal method use heat in a dot-matrix print head to output patterns on heat-sensitive paper.

We can get limited color output on an impact printer by using different coloured ribbons. Non impact devices use various techniques to combine three color pigments (cyan, magenta & yellow) to produce a range of color patterns. Laser and xerographic devices deposit the 3 pigments on separate passes. Ink-jet methods shoot the 3 colors simultaneously on a single pass along each print line on the paper.

Drafting layouts and other drawings are typically generated with ink-jet or pen plotters. A pen plotter has one or more pens mounted on a carriage, or crossbar, that spans a sheet of paper. Pens with varying colors and widths are used to produce a variety of shadings and line styles. Wet-ink, ball-point and felt tip pens ~~can~~ can be used with a pen plotter. Plotter paper can lie flat or be rolled onto a drum or belt. Crossbars can be either moveable or stationary, while the pen moves back and forth along the bar. Either clamps, a vacuum, or an electrostatic charge hold the paper in position.

Graphics Software

There are two general classification for graphics software general programming packages and special-purpose application packages.

A general graphics programming package provides an extensive set of graphics functions that can be used in a high-level programming language. Basic functions in a general package include those for generating purpose picture components (straight lines, circles, polygons and other figures), setting color and intensity values, selecting views, and applying transformations.

Application graphics packages are designed for non-programmers, so that user can generate displays without worrying about how graphics operations work. The interface to the graphics routines in such package allow users to communicate with the programs in their own terms. Example for that application packages are the artist's painting programs and various business, medical and CAD systems.

Coordinate Representation

General graphics packages are designed to be used with cartesian coordinate specifications. If coordinate values for a picture are specified in some other reference frame they must be converted to cartesian coordinates before they can be input to

the graphics package.

We can construct the shape of individual objects, such as trees or furniture, in a scene within separate coordinate reference frames called modelling coordinates, or local coordinates or master coordinates. Once individual object shapes have been specified, we can place the objects into appropriate positions within the scene using a reference frame called modelling coordinates or sometimes local coordinates or master coordinates.

Once individual object shapes have been specified, we can place the objects into appropriate positions within the scene using a reference frame called world coordinates.

The display coordinate systems are referred to as device coordinates or screen coordinates in the case of a video monitor.

A graphics system first converts world-coordinate positions to normalized device coordinates, in the range from 0 to 1, before final conversion to specific coordinates. This makes the system independent of the various devices that might be used at a particular workstation.

An initial modeling-coordinate position (x_{mc}, y_{mc}) in this illustration is transferred to a device coordinate position (x_{dc}, y_{dc}) with the sequence:

$$(x_{mc}, y_{mc}) \rightarrow (x_{wc}, y_{wc}) \rightarrow (x_n, y_n) \rightarrow (x_{dc}, y_{dc})$$

The modelling and world-coordinate positions in this transformation can be any floating-point values; normalized coordinates satisfy the inequalities $0 \leq x_{mc} \leq 1$, $0 \leq y_{mc} \leq 1$; and the device coordinates

x_{dc} and y_{dc} are integers within the range $(0,0)$ to (x_{max}, y_{max}) for a particular output device.

Graphics Functions

A general-purpose graphics package provides users with a variety of functions for creating and manipulating pictures.

The basic building blocks for pictures are referred to as output primitives. They include character strings and geometric entities, such as points, straight lines, curved lines, filled areas (polygon) and shapes defined with arrays of color points.

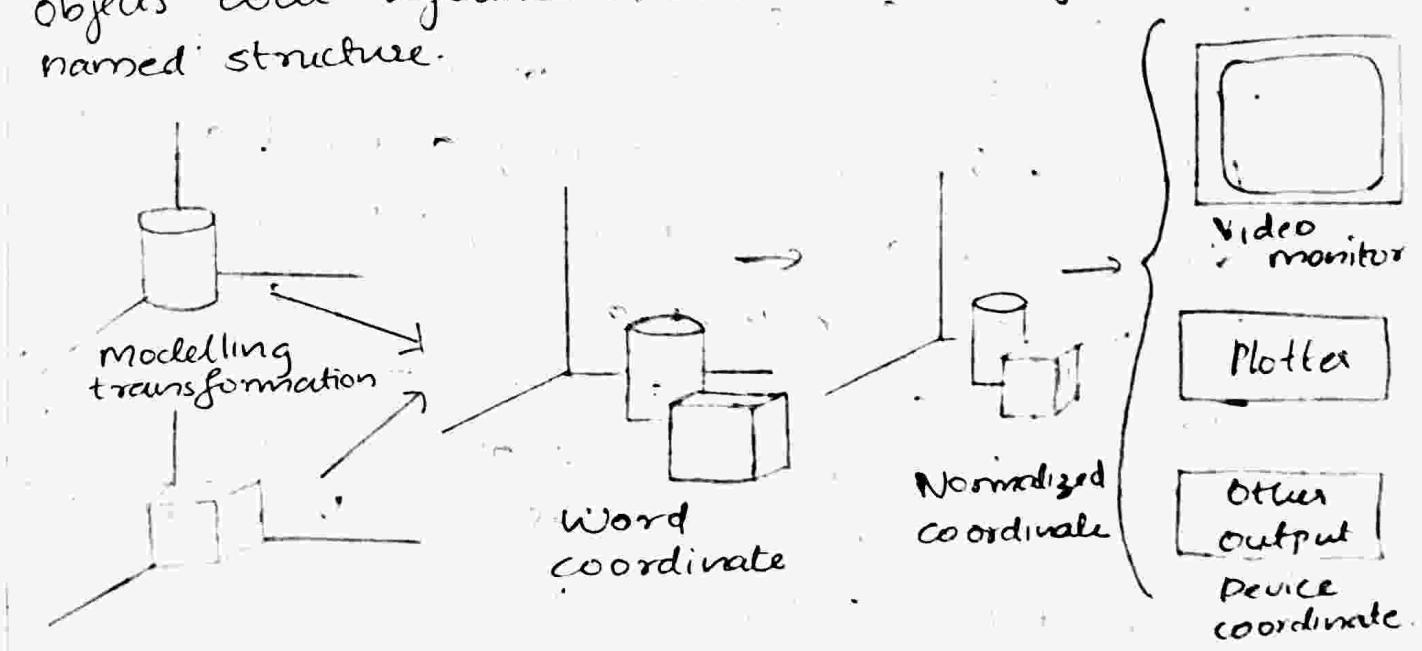
Attributes are the properties of the output primitives, an attribute describes how a particular primitive is to be displayed. They include intensity and color specifications, line styles, text styles and area-filling patterns. Functions within this category can be used to set attributes for an individual primitive class for or for groups of output primitives.

We can change the size, position, or orientation of an object within a scene using geometric transformations. Similarly Modelling transformation are used to construct a scene using object descriptions given in modelling coordinates.

Viewing transformation are used to specify the view that is to be presented and the portion

of the output display area that is to be used.

Pictures can be subdivided into component parts, called structures or segments or objects, depending on the software package in use. Each structure defines one logical unit of the picture. A scene with several objects can reference each individual object in a separate named structure.



Interactive graphics application use various kinds of input devices, such as a mouse, a tablet, a joystick. Input functions are used to control and process the data flow from these interactive devices.

A graphic package contains a no. of housekeeping tasks, such as cleaning a display screen and initializing parameters. It is done under the heading control headings.

Software Standards

The primary goal of standardized graphics software is portability. When packages are designed with standardized graphics functions, software can be moved easily from one hardware system to another and used in different implementations and applications.

International and national standards planning

organizations in many countries have cooperated in an effort to develop a generally accepted standard for computer graphics.

Graphical Kernel System (GKS) system was adopted as the first graphics software standard by the International Standards Organization (ISO) and by various national standards organizations including ANSI. Although GKS was originally designed as a two-dimensional graphics package, a three dimensional GKS extension was subsequently developed.

The second software standard to be developed and approved by the standards organizations was PHIGIS, which is an extension of GKS. Increased capabilities for object modeling, color specifications, surface rendering, and picture manipulations are provided in PHIGIS. Subsequently, an extension of PHIGIS called PHIGIS+, was developed to provide 3-D surface-shading capabilities not available in PHIGIS. A language binding is then defined for a particular high-level programming language. The binding gives the syntax for accessing the various standard graphics function from this language. For example, the general form of the PHIGIS (and GKS) function for specifying a sequence of $n-1$ connected two-dimensional straight line segments is,

polyline(n , x , y)

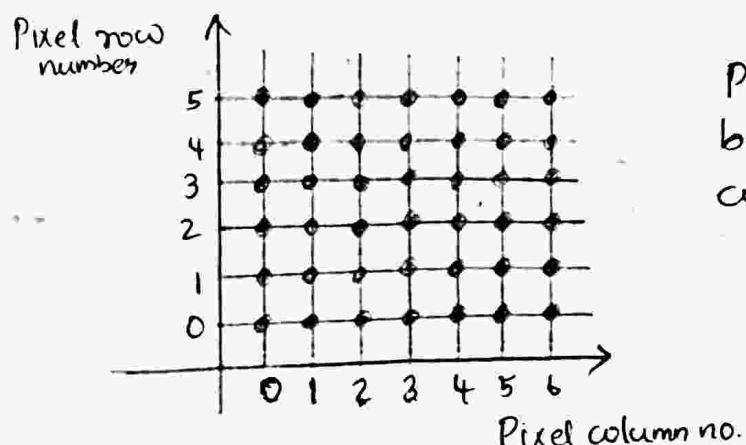
PHIGS Workstations

In PHIGS and GKS, however the term workstation is used to identify various combinations of graphics hardware and software. A PHIGS workstation can be a single output device, single input device, a combination of input and output devices, a file or even a window displayed on a ~~various~~ video monitor.

General structure of a PHIGS program:-

```
openPhigs (errorfile, memorySize)
openWorkstation (ws, connection, type)
    (create and display picture)
closeWorkstation (ws)
closePhigs
```

where parameter errorfile is to contain any error messages that are generated and parameter memorySize specifies the size of an internal storage area. The workstation identifier is given in parameter ws, and parameter connection states the access mechanism for the workstation, such as an input device, an output device, a combination outin device, or an input or output metafile.



Pixel positions referenced by scanline number and column number.