RGPV Notes Hub

IT601 - Computer Graphics & Multimedia

Unit - I

Knowledge is Power !

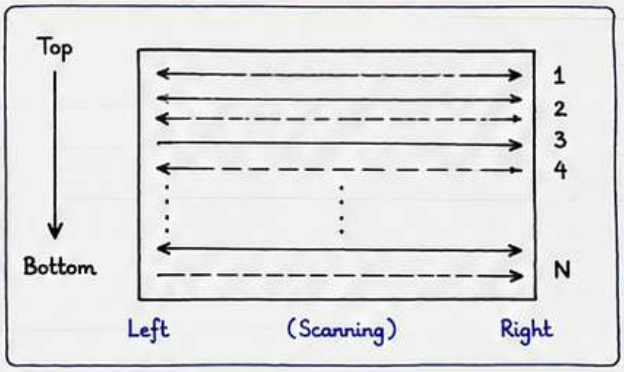
Topic - 1 : Introduction to Raster Scan Displays

1. Introduction

A Raster Scan Display is the most commonly used display device in computer graphics.
It forms an image on the screen by scanning the electron beam (or pixels) row by row from left to right and from top to bottom.

Television, computer monitors, and many other display devices are based on raster scan technology.

Raster Scan Pattern



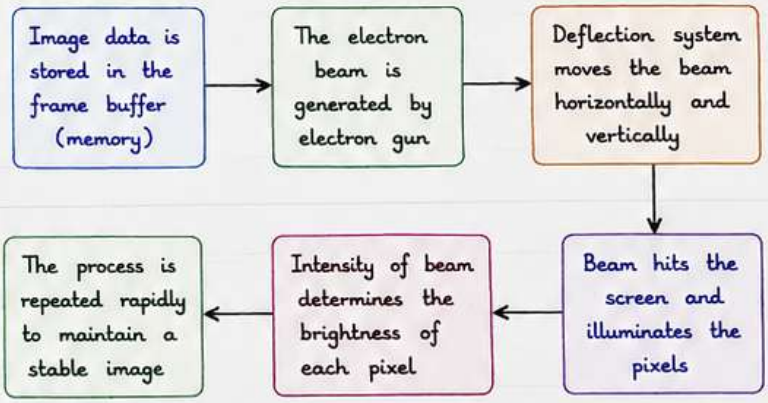
2. Basic Idea

* The screen is divided into a large number of tiny dots called picture elements or pixels.
* The electron beam starts from the top-left corner and moves horizontally to the right.
* After reaching the end of a line, it returns to the beginning of the next line just below.
* This process continues until the entire screen is scanned.

3. Components of Raster Scan Display

* Display Screen - The surface where images are formed.
* Electron Gun - Generates electron beam.
* Deflection System - Controls the movement of beam in horizontal and vertical directions.
* Frame Buffer (Memory) - Stores the image to be displayed.
* Control Circuitry - Synchronizes the scanning and refreshing process.

4. Working Principle



5. Advantages

* Simple and cost effective.
* Can display complex images and colors.
* High refresh rate provides smooth motion.
* Widely used in TVs, monitors and graphics systems.

6. Disadvantages

* High memory requirement for storing image.
* Image quality decreases if resolution is low.
* Flickering may occur at low refresh rate.
* Not suitable for very high resolution without large memory.

7. Applications

* Television and Computer Monitors
* Radar and Defense Systems
* Medical Imaging
* Multimedia and Animation
* Gaming and Simulation.

Important Exam Points

* Raster scan works row by row (left to right, top to bottom).
* Image is made up of pixels.
* Frame buffer stores the image.
* Refresh rate (in Hz) is important to avoid flickering.
* Used in most of the modern display devices.

Summary

Raster Scan Display is a digital display system where the image is formed by scanning the electron beam horizontally across each line and vertically across the screen. It is the foundation of television, computer monitors and other modern display devices.

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Topic - 2 : Raster Scan Displays

Knowledge is Power !

1. Introduction

Raster Scan Displays are the most commonly used display devices in computer graphics and other display systems.

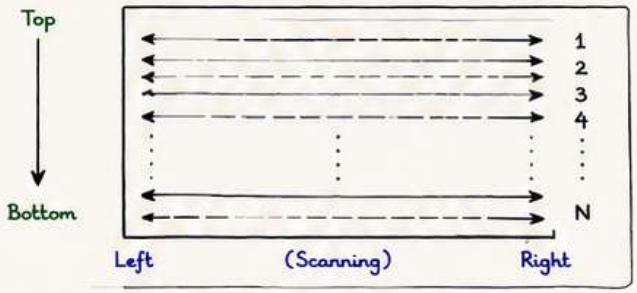
The basic idea is to form an image on the screen by scanning the electron beam (or pixels) row by row from left to right and from top to bottom.

Television, computer monitors and many other display devices use raster scan technology.

2. Working Principle

- The screen is divided into a large number of tiny picture elements called pixels.
- The electron beam starts from the top-left corner.
- It moves horizontally from left to right to form one line (scan line).
- After completing the line, it returns to the beginning of the next line just below.
- This process continues until the entire screen is scanned from top to bottom.

3. Raster Scan Pattern



4. Components of Raster Scan Display

Component	Function
Display Screen	Surface where the image is formed.
Electron Gun	Generates the electron beam.
Deflection System	Controls the movement of the beam in horizontal and vertical directions.
Frame Buffer (Memory)	Stores the image data (pixels).
Control Circuitry	Synchronizes scanning and refreshing.

5. Advantages

- ✓ Simple and cost effective.
- ✓ Can display complex images and colors.
- ✓ High refresh rate gives smooth motion.
- ✓ Widely used in monitors, TVs and graphics systems.

6. Disadvantages

- × High memory requirement.
- × Flickering may occur at low refresh rate.
- × Image quality decreases if resolution is low.
- × Not suitable for very high resolution without large memory.

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Topic - 3 : Storage Tube Displays

Knowledge is Power !

1. Introduction

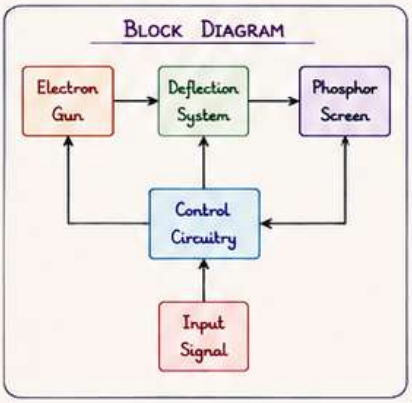
Storage tube displays were among the earliest display devices used in computer systems. They store the image directly on the screen by exciting phosphor dots with an electron beam. The image remains on the screen until it is intentionally erased or until the phosphor naturally fades.

They are also called Cathode Ray Tube (CRT) based display systems.

2. Working Principle

- A storage tube screen is coated with a phosphor material.
- The electron beam from the electron gun strikes the screen at specific points (pixels).
- The struck points become excited and emit light.
- The intensity of light depends on the duration and intensity of the beam.
- The image is stored on the screen as the excited phosphors continue to glow for some time.
- To change the image, the beam erases the previous pattern and writes a new one.

Block Diagram



3. Characteristics

- Direct view storage.
- Vector or random scan type.
- High resolution possible.
- Expensive compared to raster scan displays.
- Low refresh rate.
- Less flicker but slower update.

4. Advantages

- ✓ Good image quality and sharpness.
- ✓ No need for continuous refreshing.
- ✓ Suitable for high resolution.
- ✓ Simple hardware.

5. Disadvantages

- × Low refresh rate.
- × Expensive.
- × Bulky and heavy.
- × Limited color capability.

6. Applications

- → Used in early computer systems (before raster scan monitors).
- → Used in vector display systems.
- → Used in oscilloscopes, radar displays and special purpose systems.
- → Still used in some industrial and scientific instruments.

7. Comparison : Raster vs Storage Tube

Feature	Raster Scan Display	Storage Tube Display
Scan Type	Raster (Row by Row)	Random / Vector
Image Formation	Pixel by pixel	Direct excitation of phosphor
Refresh Rate	High	Low
Cost	Low	High
Complexity	More (needs memory)	Less
Usage	Common in modern systems	Used in older / special systems

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Unit - I

Topic - 4 : Refreshing

Knowledge is Power !

1. Introduction

In Raster Scan Display, the image is not drawn on the screen at once. Instead, the electron beam scans the screen line by line very quickly.
To keep the image visible and steady, the screen must be refreshed continuously.
This process is called **Refreshing**.

2. Meaning

Refreshing is the process of re-drawing the entire image on the screen repeatedly at a very high speed so that the image appears continuous and stable to the human eye.

3. Why Refreshing is Required ?

* The electron beam excites the phosphor dots only for a very short time.
* The phosphor glows for a short duration and then fades.
* If the screen is not refreshed, the image will disappear.
* Refreshing keeps the image bright and steady.

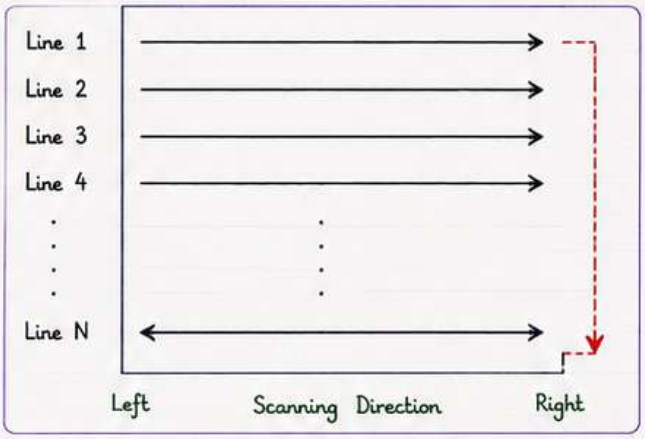
4. How Refreshing Works ?

Display Processor sends image data to the screen memory.
↓
The electron beam scans the screen from left to right (one line).
↓
After completing a line, beam moves to the next line.
↓
After scanning the last line, beam returns to the top and repeats.
↓
This cycle is repeated continuously (refresh cycle).

Important Exam Points

* Refreshing = Re-drawing the entire image repeatedly.
* Required because phosphor glow fades with time.
* Refresh rate is measured in Hertz (Hz).
* Low refresh rate causes flickering.
* High refresh rate gives stable and comfortable viewing.

5. Refreshing Process (Conceptual Diagram)



After the last line, the beam returns to the top and the process repeats (refreshes).

6. Refresh Rate (or Refresh Frequency)

Refresh Rate is the number of times per second the entire screen is refreshed.

$$\text{Refresh Rate (in Hz)} = \frac{\text{Number of Refresh Cycles}}{\text{Time (in seconds)}}$$

* Higher refresh rate gives steady and flicker-free image.
* Typical refresh rate is 60 Hz to 120 Hz.
* If refresh rate is too low, flickering will be visible.

7. Effect of Insufficient Refresh Rate

Refresh Rate	Effect
Too Low (< 30 Hz)	Flickering visible, eyes get tired.
Adequate (60 - 80 Hz)	Flicker-free, comfortable viewing.
High (> 100 Hz)	Very smooth and stable image.

8. Factors Affecting Refreshing

* Speed of electron beam
* Screen resolution (more lines = more refresh time)
* Complexity of image
* Processing speed of display processor
* Type of display monitor

9. Importance of Refreshing

* Provides continuous and stable image.
* Avoids flickering and eye strain.
* Ensures smooth motion in animations and videos.
* Essential for all raster scan based display devices.

Summary

Refreshing is the process of re-displaying the entire image on the screen repeatedly at high speed so that the image appears continuous and stable. It is very important for good quality and flicker-free display.

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Unit - I

Topic - 5 : Flickering

Knowledge is Power !

1. Introduction

Flickering is the annoying sensation of seeing brightness variations on a display screen.
It is caused when the screen is not refreshed sufficiently fast.
Human eyes can notice flicker when the refresh rate is low.

2. Meaning

Flickering is the visible fluctuation in brightness of a display screen, i.e., the screen appears to be flickering or blinking.

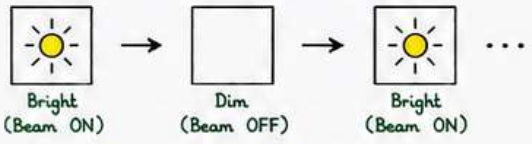
3. Causes of Flickering

- Low refresh rate (in Hz).
- Insufficient refresh cycles per second.
- Interference in power supply.
- Poor quality display hardware.
- Large area with more bright pixels.

4. How Flickering Occurs ?

When the **refresh rate** is low, the phosphor dots (pixels) do not have enough time to glow continuously before they fade.
So, we see brightness variations which are perceived as flicker.

Effect of Low Refresh Rate



Seen as flicker by human eye

5. Human Eye and Flicker Perception

- The human eye retains the image for a short duration (persistence of vision ≈ 1/16 sec).
- If refresh rate is less than 50 - 60 Hz, the eye starts detecting flicker.
- If refresh rate is 60 Hz or more, the image appears steady and flicker is not visible.

6. Refresh Rate vs Flickering

Refresh Rate (Hz)	Effect
Below 30 Hz	Strong flickering, very annoying
30 - 50 Hz	Flickering visible, uncomfortable
50 - 60 Hz	Slight flicker may be visible
60 Hz and above	Flicker-free, comfortable viewing

7. Methods to Reduce or Eliminate Flickering

- Use higher refresh rate (minimum 60 Hz).
- Use high quality display monitors.
- Use proper synchronization between display processor and monitor.
- Ensure stable power supply.
- Use interlacing technique in video displays.

8. Example

Old CRT monitors with 30 Hz refresh rate showed heavy flicker. Modern LCD, LED monitors use 60 Hz, 75 Hz, 120 Hz or more refresh rate which makes the display flicker-free and comfortable.

9. Advantages of High Refresh Rate

- Flicker-free and comfortable viewing.
- Less eye strain and fatigue.
- Better performance in animation and videos.
- More stable and smooth images.

60 Hz or more

10. Disadvantages of Low Refresh Rate

- Flickering visible.
- Causes eye strain and headache.
- Reduces comfort and productivity.
- Not suitable for long working hours.

Low Refresh Rate

Important Exam Points

1. Flickering occurs due to low refresh rate.
2. Minimum 60 Hz refresh rate is recommended.
3. Higher refresh rate gives smooth and stable image.
4. Refresh rate is measured in Hertz (Hz).
5. Raster scan displays are affected by flickering.

Summary

Flickering is the visible variation in brightness of the screen caused by low refresh rate. When the screen is refreshed at a high enough rate (60 Hz or more), the image appears steady and flicker-free. Proper refresh rate is essential for comfortable viewing and good quality display.

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Topic – 6 : Interlacing

Knowledge is Power !

1. Introduction

Interlacing is a video display technique used in raster scan systems to reduce flickering and decrease the bandwidth required for displaying moving images on a screen.

Instead of scanning all the lines of the screen in one pass, the screen is scanned in two (or more) passes using alternate lines.

2. Need for Interlacing

- In non-interlaced (progressive) scan, all lines are drawn in one refresh cycle.
- To avoid flickering, very high refresh rate is required.
- This requires high bandwidth.
- Interlacing reduces bandwidth requirement by refreshing half the lines in each field.
- It also reduces visible flickering.

3. Basic Idea

The entire screen is divided into two fields :

- Odd Field – Consists of all odd numbered lines (1, 3, 5, ...).
- Even Field – Consists of all even numbered lines (2, 4, 6, ...).
- First the odd field is scanned, then the even field is scanned.
- Both fields together form one complete frame.

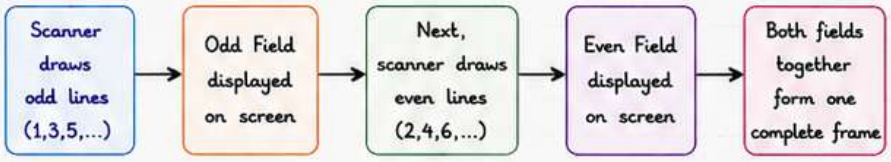
7. Types of Interlacing

- (i) Two-Field Interlacing
  Most commonly used.
  Consists of two fields – odd and even.
- (ii) Four-Field Interlacing
  Screen is divided into four fields.
  Used in high quality video systems.

8. Advantages

- ✓ Reduces flickering.
- ✓ Requires less bandwidth.
- ✓ Allows display of motion with lower refresh rate.
- ✓ Useful in television and video systems.
- ✓ More economical in terms of hardware.

4. How Interlacing Works ?

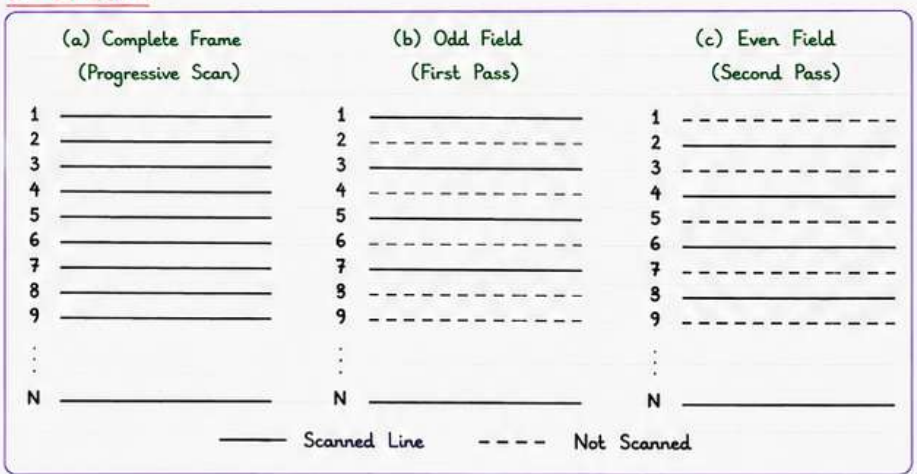


This cycle repeats continuously.

5. Interlaced vs Non-Interlaced (Progressive) Scan

Feature	Interlaced Scan	Non-Interlaced (Progressive) Scan
Scanning	Two fields (odd & even lines)	All lines in one pass
Refresh Rate	Lower refresh rate sufficient	Higher refresh rate required
Bandwidth	Less bandwidth required	More bandwidth required
Flickering	Less flicker	More flicker at low refresh rate
Motion Smoothness	Slightly less smooth	Very smooth
Use	TV systems, Interlaced monitors	Computer monitors, modern displays

6. Diagram



9. Applications

- Television (TV) broadcasting (NTSC, PAL systems).
- Video recording and playback systems.
- Older CRT monitors.
- Surveillance and security camera systems.
- Video conferencing systems.

Important Exam Points

1. Interlacing reduces flickering by scanning alternate lines.
2. Odd field consists of odd numbered lines.
3. Even field consists of even numbered lines.
4. Both fields together form one complete frame.
5. Interlacing reduces bandwidth requirement.

Summary

Interlacing is a raster scan technique in which the screen is scanned in two passes (odd and even fields). It reduces flickering and bandwidth requirement by refreshing alternate lines in each pass. Both fields together form one complete frame.

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Topic - 7 : Colour Monitors

Knowledge is Power !

1. Introduction

A Colour Monitor is a display device which is capable of producing colours by using the combination of three primary colours. Colour monitors are widely used in computers, TVs, mobiles, laptops and various multimedia applications to display images, videos and animations in colour.

2. Basic Idea

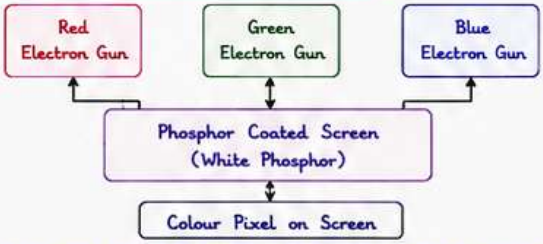
- Any colour can be obtained by mixing three primary colours : Red, Green and Blue.
- These three colours are called additive primary colours.
- By controlling the intensity of each primary colour, a wide range of colours can be produced.

3. Additive Colour Model (RGB)

In colour monitors, the RGB (Red, Green, Blue) model is used. In this model, colours are created by adding the intensities of Red, Green and Blue lights.

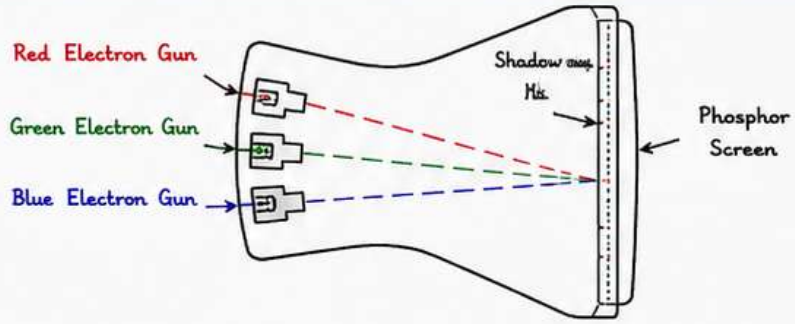
- R + G = Yellow
- R + B = Magenta
- G + B = Cyan
- R + G + B = White
- (No Light) = Black

4. How Colour is Produced ?



Each pixel on the screen is made up of three coloured sub-pixels (Red, Green, Blue). By varying the intensity of each gun, different colours are produced.

5. Colour Monitor Architecture (CRT Based)



- Three electron guns (R, G, B) are placed at the back of the CRT.
- A Shadow Mask (perforated metal sheet) ensures that each gun hits only its respective phosphor dots (R, G or B).
- The phosphor screen contains tiny dots (triads) of Red, Green and Blue.
- By controlling the intensity of each gun, desired colour is produced.

6. Colour Depth

Colour depth is the number of bits used to represent the colour of a pixel.

Colour Depth (bits)	Colours Possible	Example
8 bits	256 colours	Older systems
16 bits	65,536 colours	High colour
24 bits	16.7 Million colours	True colour
32 bits	16.7 Million+ (with transparency)	Advanced systems

7. Types of Colour Monitors

- CRT (Cathode Ray Tube) Monitors - use electron guns and phosphor screen.
- LCD (Liquid Crystal Display) - use backlight, filter and liquid crystal technology.
- LED Monitors - advanced LCD with LED backlighting.
- OLED Monitors - self emitting pixels, provide better colour and contrast.

8. Advantages

- ✓ Displays a wide range of colours.
- ✓ Improves visual quality and realism.
- ✓ Useful in graphics, multimedia, animation and gaming.
- ✓ Better user experience in computers and TVs.

9. Disadvantages

- × Colour monitors are more expensive.
- × More power consumption.
- × Older CRT monitors are bulky and heavy.
- × Eye fatigue may occur if settings are poor.

10. Applications

- Television and video systems.
- Multimedia and animation.
- Graphic design and CAD/CAM.
- Gaming and simulation.
- Medical imaging and scientific visualization.

Important Exam Points

- Three primary colours used in monitors : Red, Green, Blue.
- Any colour is obtained by additive mixing of RGB.
- Colour depth decides the number of colours that can be displayed.
- Shadow mask in CRT ensures correct colour formation.
- Higher colour depth gives better image quality.

Summary

Colour Monitors use additive colour model (RGB) to produce a wide range of colours. By controlling the intensity of Red, Green and Blue beams, any colour can be created. Different types of monitors and higher colour depth provide better and realistic display for multimedia and real-world applications.

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Unit - I

Topic - 8 : Display Processors

Knowledge is Power !

1. Introduction

A Display Processor is a special type of hardware device that generates the signals required to display graphics on the screen. It takes image data (from memory) and converts it into pixel intensity values and controls the display device (monitor). It handles operations like scanning, refreshing, intensity control and timing.

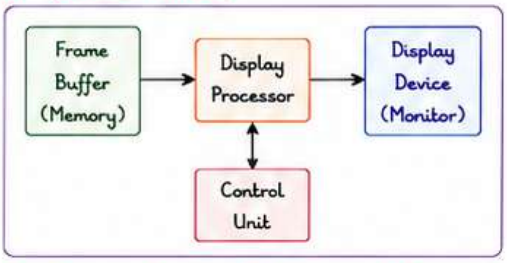
2. Need for Display Processor

* Reduces the load on the CPU.
* Generates timing and control signals.
* Handles high speed data transfer.
* Allows continuous refresh of the screen.
* Improves display performance.

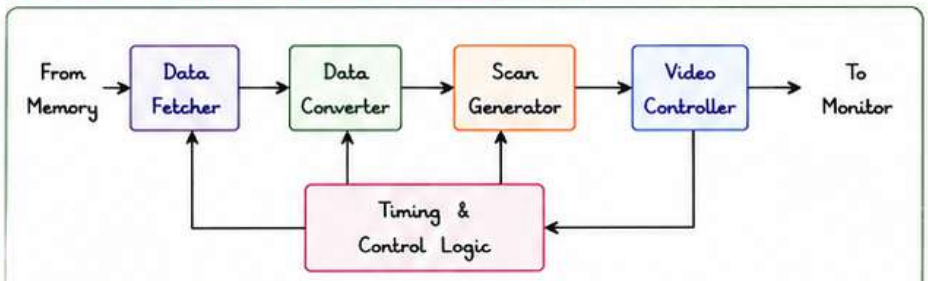
3. Functions of Display Processor

* Fetches image data from frame buffer (memory).
* Converts data into pixel intensity values.
* Generates synchronized scanning signals.
* Controls intensity, brightness and colour.
* Refreshes the display screen.
* Provides video signal to the monitor.

4. Block Diagram



5. Internal Structure of Display Processor



* Data Fetcher : Fetches image data (pixels) from frame buffer.
* Data Converter : Converts digital data to pixel intensity values.
* Scan Generator : Generates horizontal and vertical scanning signals.
* Video Controller : Generates video signal and controls output.
* Timing & Control Logic : Synchronizes all operations.

6. How Display Processor Works ?

* The display processor reads pixel data from the frame buffer.
* It converts the data into required intensity (brightness/colour).
* Then it generates horizontal and vertical scan signals.
* These signals control the beam movement on the screen.
* The video signal is sent to the monitor to light the pixels.
* The process repeats continuously for a smooth display.

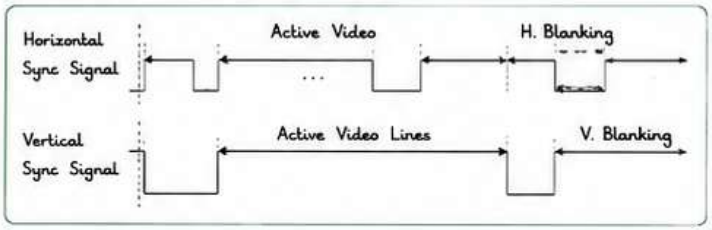
7. Types of Display Processors

Type	Description
Random Scan Display Processor	Used in vector or random scan systems.
Raster Scan Display Processor	Used in raster scan systems (TV, monitors).
Colour Display Processor	Handles colour models (RGB, CMY, etc.).
Refresh Display Processor	Specialized in high speed refreshing.

8. Raster Display Processor (Overview)

* In raster displays (TV, monitors), the screen is divided into pixels arranged in rows and columns.
* The display processor scans the screen row by row.
* It fetches pixel data from memory and sends it to the monitor.
* This process is repeated for all rows (top to bottom) to form a complete image.

9. Display Processor Timing (Typical)



Where,
Active Video : Actual display area.
Blanking : Non-display time (for beam retrace).
Sync Signals : For synchronization.

10. Advantages

- ✓ Offloads work from CPU.
- ✓ High speed data handling.
- ✓ Provides smooth and flicker-free display.
- ✓ Supports different display devices.
- ✓ Better control over timing and intensity.

11. Disadvantages

- × Additional hardware increases cost.
- × Complex design and implementation.
- × Needs high speed memory (frame buffer).
- × Power consumption may be high.

12. Applications

* Computer monitors and laptops.
* Television and video display systems.
* Multimedia systems and projectors.
* Medical imaging and scientific visualization.
* CAD/CAM and animation systems.

Important Exam Points

1. Display processor generates the video signal.
2. It uses frame buffer as memory.
3. It controls scanning, timing and intensity.
4. It is essential for raster scan display.

Summary

A Display Processor is a dedicated hardware device that fetches image data from memory, processes it, generates scanning and timing signals, and sends video signal to the monitor for smooth display.

Key Terms

- → Frame Buffer : Memory that stores image data.
- → Raster Scan : Scanning row by row.
- → Sync Signal : Synchronization signals.
- → Blanking : Non-display time.

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Unit - I

Topic - 9 : Resolution

Knowledge is Power !

1. Introduction

Resolution is the measure of the sharpness and clarity of an image on the screen. It refers to the number of distinct pixels that can be displayed in a given area.
Higher the resolution, better will be the image quality.

2. Need for High Resolution

- Makes images sharp and clear.
- Improves detail and realism.
- Better for graphics, animation and videos.
- Essential for CAD/CAM, medical imaging, and scientific visualization.

3. Basic Concept

A raster screen is made up of tiny dots called pixels arranged in rows and columns.
Resolution is represented as :

Horizontal Resolution (pixels) × Vertical Resolution (pixels)
Example : 1920 × 1080

4. Types of Resolution

- Spatial Resolution (Display Resolution)
  Number of pixels on the screen (e.g., 1920 × 1080).
- Image Resolution
  Number of pixels in an image or picture (e.g., 3000 × 2000).
- Colour Resolution (Bit Depth)
  Number of bits used to represent the colour of a pixel (e.g., 8-bit, 16-bit, 24-bit, 32-bit).

5. Measuring Resolution

- PPI (Pixels Per Inch)
  Number of pixels in one inch of an image or display.
  Higher PPI = Sharper image.
- DPI (Dots Per Inch)
  Used in printers. Number of dots printed in one inch.
  Higher DPI = Better print quality.

Important Exam Points

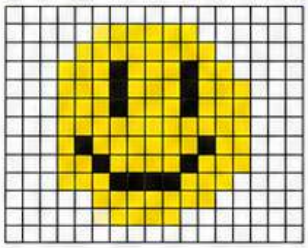
- Resolution = Number of pixels that can be displayed.
- Higher resolution → Better clarity and detail.
- Resolution is represented as (Horizontal × Vertical).
- PPI is used for displays and images.
- DPI is used for printers.
- More resolution requires more memory and processing.

6. Example of Resolutions

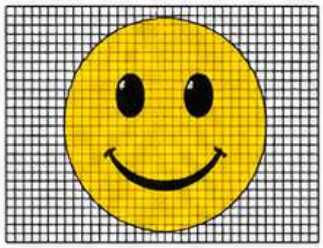
Resolution	Name / Type	Use
640 × 480	VGA	Old monitors, basic use
800 × 600	SVGA	Standard monitors
1024 × 768	XGA	Older laptops, projectors
1366 × 768	HD	Common in laptops
1920 × 1080	Full HD	Most monitors, TVs
2560 × 1440	QHD (2K)	High quality monitors
3840 × 2160	4K UHD	Ultra HD displays, TVs

7. Illustration

Low Resolution (e.g., 640 × 480)



High Resolution (e.g., 1920 × 1080)



More pixels → More detail → Sharper image

8. Factors Affecting Resolution

- Screen size - Larger screen needs higher resolution.
- Pixel density - More pixels per inch gives better resolution.
- Graphics hardware - Better GPU supports higher resolution.
- Memory - Higher resolution requires more video memory.
- Refresh rate - Higher resolution with low refresh rate may cause flickering.

9. Effect of Resolution

Resolution	Effect on Display
Low Resolution	Images look blurry, jagged and unclear.
Medium Resolution	Better clarity, acceptable quality.
High Resolution	Sharp, clear, smooth images with more detail.

10. Advantages and Disadvantages

Advantages	Disadvantages
✓ Sharp and clear images.	× Requires more memory.
✓ More detail and realism.	× Needs powerful hardware.
✓ Better user experience.	× Higher cost of devices.
✓ Useful for multimedia and graphics.	× More processing time.

Summary

Resolution plays a very important role in the quality of display. It is the total number of pixels that can be displayed on the screen. Higher resolution gives better image quality but also requires more memory and processing power.

IT601 - Computer Graphics & Multimedia

Unit - I

Topic - 10 : Working Principle of Dot Matrix Printer

Knowledge is Power !

1. Introduction

A Dot Matrix Printer is an impact printer that prints characters by striking an inked ribbon against the paper through a matrix of tiny pins (dots). It is capable of producing both text and graphics. It is widely used where low cost and multi-part printing are required.

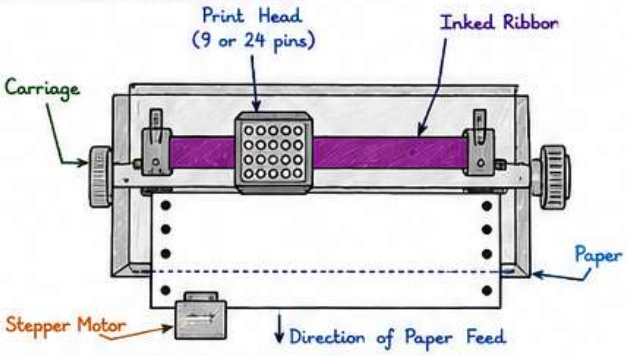
2. Basic Idea

- Characters or images are formed by a pattern of dots (matrix).
- A print head containing pins moves horizontally and vertically.
- Pins strike the ribbon, which in turn presses ink on the paper.
- The result is a pattern of dots that forms characters or graphics.

3. Main Components

1. Print Head (with Pins)
2. Inked Ribbon
3. Paper
4. Carriage (Horizontal Movement)
5. Stepper Motor
6. Control Circuit / Interface

4. Construction Diagram



5. Working Principle (Step by Step)

1. The data to be printed is sent from the computer to the printer.
2. The control circuit interprets the data and decides which pins need to be activated.
3. The print head moves horizontally to the starting position.
4. Selected pins are driven forward and strike the inked ribbon.
5. The ribbon presses against the paper and ink is transferred, forming a pattern of dots.
6. After printing one line, the paper is advanced up (vertically) by the stepper motor.
7. The process repeats for the next line until printing is complete.

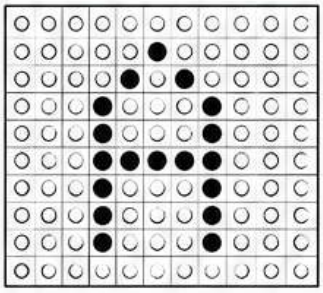
6. Print Head (Pin Matrix)

- The print head contains a matrix of pins arranged in rows and columns.
- Common configurations:

Pin Configuration	Use
9 Pins	Draft quality text
18 Pins	Better quality text and graphics
24 Pins	High quality text and graphics

Higher the number of pins, better is the print quality but the cost also increases.

7. Dot Matrix Formation



Example : 5 x 7 Dot Matrix (A character)

● = Pin ON (dot printed)

○ = Pin OFF (no dot)

This pattern of dots forms the character 'A'.

8. Types of Dot Matrix Printers

- Character Printer - Prints only characters.
- Line Printer - Prints one line at a time.
- Page Printer - Prints one page at a time.

9. Advantages

- ✓ Low cost.
- ✓ Can print on multi-part stationery (carbon copies).
- ✓ Reliable and durable.
- ✓ Can print text and graphics.
- ✓ Low cost of maintenance.

10. Disadvantages

- × Noisy operation.
- × Print quality is lower compared to modern printers.
- × Slower printing speed.
- × Larger in size.

11. Applications

- Printing invoices, bills, and receipts.
- Bank passbooks and continuous forms.
- Ticket printing in buses, railways, airlines.
- Where low cost and durability are important.

Important Exam Points

- Dot matrix printer is an impact printer.
- Uses a matrix of pins to print characters.
- Pins strike the inked ribbon and print on paper.
- Can produce both text and graphics.
- Used for multi-part printing.

Summary

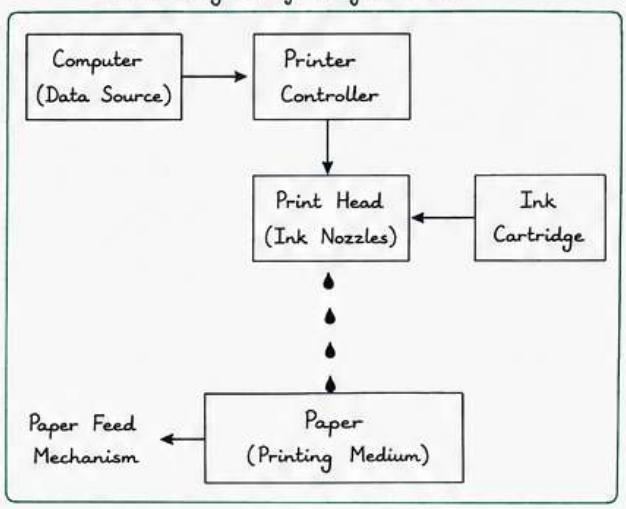
Dot Matrix Printer works by striking an inked ribbon with a matrix of pins to create characters or graphics as a pattern of dots on paper. It is a low cost, reliable and widely used printer for text and moderate quality graphics.

Working Principle of Inkjet Printer

1. Introduction

An Inkjet printer is a non-impact printer that produces high quality text and graphics. It works by spraying tiny droplets of ink onto the paper to form characters and images. It is quiet, fast and capable of producing colour output.

Block Diagram of Inkjet Printer



2. Basic Principle

* The printer stores ink in cartridges.
* Ink droplets are ejected through tiny nozzles.
* These droplets are placed on the paper in a controlled manner to form text or graphics.
* The process is similar to point plotting on the screen but in physical form on paper.

3. Construction

⇒ Ink Cartridge / Reservoir : Stores the ink. Separate cartridges are used for different colours (Cyan, Magenta, Yellow, Black).

⇒ Print Head : Contains a large number of microscopic nozzles through which ink droplets are ejected.

⇒ Paper Feed Mechanism : Moves the paper in precise steps after each line is printed.

⇒ Controller : Receives data from computer and controls the movement of paper and print head as well as ink ejection.

4. Working Principle (Step by Step)

1. The computer sends the data (text or image) to the printer.
2. The controller processes this data and converts it into a format suitable for printing.
3. The paper is fed into the printer by the paper feed mechanism.
4. The print head moves horizontally across the page.
5. The controller activates the nozzles and tiny ink droplets are ejected onto the paper at specific positions to form a line.
6. After one line is completed, the paper is moved down slightly (by the feed mechanism).
7. The print head again moves across and prints the next line.
8. This process continues until the entire page is printed.

5. Types of Ink Droplet Ejection

(a) Thermal Inkjet

* A small heater is used to rapidly heat the ink.
* The ink boils and a bubble is formed.
* The bubble expands and forces a droplet of ink out of the nozzle.
* When the bubble collapses, fresh ink is drawn in.

(b) Piezoelectric Inkjet

* A piezoelectric crystal is used.
* When voltage is applied, the crystal changes shape.
* This change in shape creates pressure on the ink.
* The pressure forces a droplet out of the nozzle.
* When voltage is removed, the crystal returns to its original shape and ink is drawn in.

6. Advantages

* High quality output.
* Capable of printing in colour.
* Quiet operation.
* Low cost compared to other printers.
* Can print on variety of paper types.

7. Disadvantages

* Printing speed is lower than laser printers.
* Ink cartridges need to be replaced frequently.
* Ink may dry if printer is not used regularly.

8. Applications

* Printing documents, reports, letters.
* Printing photographs and images.
* Used in homes, offices, schools and small businesses.
* Useful for high quality colour printing.

Important Points

* Non-impact printer.
* Uses ink droplets.
* Works by point plotting on paper.
* Produces high quality colour output.

Topic – 12 : Working Principle of Laser Printer

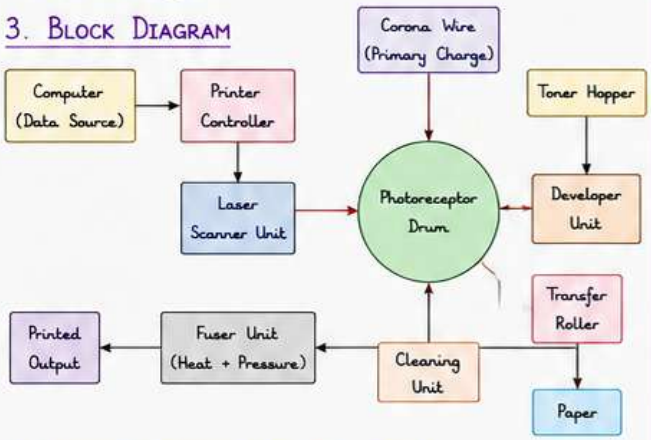
1. Introduction

A laser printer is a high speed, high quality printer. It produces text and graphics by using the electrostatic process and laser technology. It is quiet, efficient and suitable for large volume printing.

2. Basic Principle

* The image to be printed is formed on a photosensitive drum by a laser.
* The charged areas on the drum attract toner particles.
* The toner is transferred to the paper.
* The toner is then fused (fixed) on the paper using heat and pressure.
* The drum is cleaned and discharged for the next cycle.

3. Block Diagram



4. Working Principle (Step by Step)

1. The computer sends the print data to the printer.
2. The controller converts the data into a bitmap and sends it to the laser scanner.
3. The corona wire gives a uniform negative charge to the surface of the photoreceptor drum.
4. The laser beam scans the drum and discharges the areas where printing is required. (Image is formed)
5. The developer unit supplies toner. The toner sticks to the charged (dark) areas on the drum.
6. The transfer roller gives a positive charge to the back of the paper. Toner is transferred from drum to paper.
7. The paper passes through the fuser unit where heat and pressure melt and fix the toner on paper.
8. The paper comes out as printed output.
9. The drum surface is cleaned and discharged by the cleaning unit. It is ready for the next cycle.

5. Main Components and their Functions

Component	Function
Laser Scanner Unit	Creates the image on the drum by scanning the laser beam.
Photoreceptor Drum	A light sensitive drum which holds the image.
Corona Wire	Gives a uniform charge to the drum.
Developer Unit	Applies toner to the charged areas on the drum.
Toner Hopper	Stores and supplies toner.
Transfer Roller	Transfers toner from the drum to the paper.
Fuser Unit	Fuses (melts) the toner on the paper using heat and pressure.
Cleaning Unit	Removes remaining toner and discharges the drum.
Printer Controller	Controls the entire printing process.

6. Advantages

* High speed printing.
* High quality output.
* Low noise operation.
* Suitable for high volume printing.
* Clear and sharp text and graphics.

7. Disadvantages

* Cost is high.
* Large size compared to other printers.
* Requires more power.
* Colour laser printers are expensive.

Important Points

* Works on the principle of electrostatic photography.
* Uses laser to create image on drum.
* Toner is used instead of ink.
* Heat and pressure fix the toner on paper.

8. Applications

* Used in offices, companies and organizations.
* Used for printing documents, reports, charts, figures etc.
* Used in publishing, banks, schools, and industries.

Typical Exam Points

* Draw and explain the block diagram of laser printer.
* Write the working principle of laser printer.
* List the main components and their functions.
* Differentiate between dot matrix, inkjet and laser printers.

Key Terms

* Laser Scanner
* Photoreceptor Drum
* Corona Wire
* Developer Unit
* Transfer Roller
* Fuser Unit
* Toner
* Electrostatic Process

Working Principle of Keyboard

1. Introduction

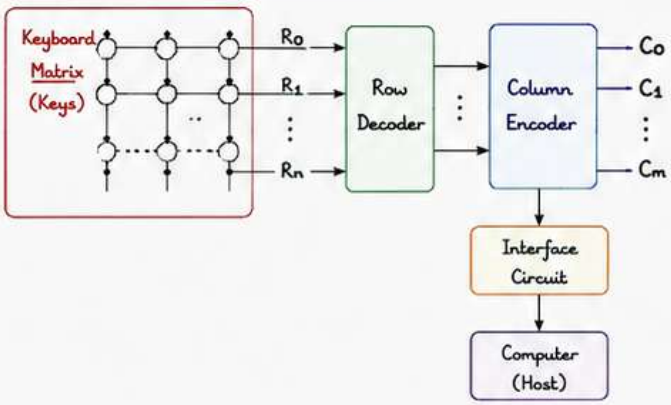
A keyboard is an input device that allows the user to enter data, commands and control signals into the computer. It consists of a set of keys, each representing a character, number, symbol or function.

2. Keyboard Layout

A standard keyboard contains :

* Alphanumeric keys (A-Z, 0-9)
* Function keys (F1 – F12)
* Control keys (Ctrl, Alt, Shift, Enter, Esc etc.)
* Navigation keys (Arrow keys, Home, End etc.)
* Numeric keypad

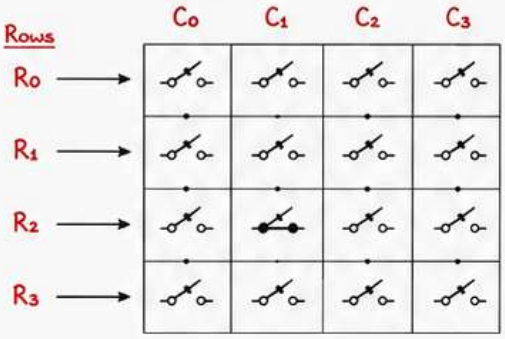
3. Basic Structure of Keyboard



4. Working Principle (Step by Step)

1. The keyboard consists of a matrix of keys arranged in rows and columns.
2. Each key is connected at the intersection of a particular row and column.
3. The keyboard controller scans the rows one by one.
4. It activates one row at a time and checks all columns to see which key is pressed.
5. When a key is pressed, the row and column lines corresponding to that key become active.
6. The controller identifies the row and column number.
7. This row-column information is converted into a scan code (binary code).
8. The scan code is sent to the computer through the interface.
9. The computer interprets the scan code and performs the required action (displaying character, command etc.).

5. Keyboard Matrix Example (4 × 4)



If the key at Row R_2 and Column C_1 is pressed, the controller detects it and generates the scan code for that key.

6. Scan Code Generation

* A unique binary code is assigned to every key.
* When a key is pressed, its scan code is generated.
* Example : 'A' key → 1C (Hex)
* The break code (key released) may also be generated in some systems.

7. Interface Between Keyboard and Computer

* Modern keyboards use interface circuits to communicate with CPU.
* Types of interfaces used :
  - ⇒ AT Interface (5-pin DIN connector)
  - ⇒ PS/2 Interface (6-pin mini DIN)
  - ⇒ USB Interface (Universal Serial Bus)
  - ⇒ Wireless (Bluetooth / RF)

8. Advantages

- ✓ Easy to use.
- ✓ Fast data entry.
- ✓ Provides wide range of characters and functions.
- ✓ Reliable and durable.
- ✓ Low power consumption.

9. Disadvantages

- × Physical keys can wear out due to heavy use.
- × Dust and dirt can affect performance.
- × Limited to fixed set of keys.

10. Applications

* Data entry in computers.
* Typing documents, programs, and commands.
* Controlling software and system operations.
* Used in gaming and special function operations.

Important Points

- Keyboard works on row-column scanning method.
- Pressed key is identified by its row and column position.
- Scan code is generated and sent to the computer.
- It acts as the primary input device for data entry.

Typical Exam Questions

1. Draw and explain the block diagram of keyboard.
2. Explain the working principle of keyboard.
3. What is scan code? How is it generated?
4. List the types of keyboard interfaces.

Key Terms

- Keyboard Matrix
- Row Decoder
- Column Encoder
- Scan Code
- Interface Circuit
- Row Scanning
- Column Encoding

IT601 – Computer Graphics & Multimedia

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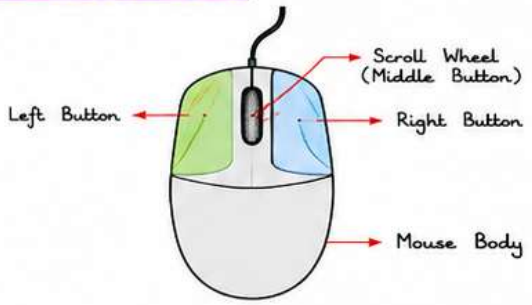
Unit – I

Working Principle of Mouse

1. Introduction

A mouse is a popular pointing device used to interact with a graphical user interface (GUI). It controls the movement of the pointer (cursor) on the screen.

2. Parts of a Mouse



3. Types of Mouse

- Mechanical Mouse (Ball Mouse)
- Optical Mouse
- Laser Mouse
- Wireless Mouse

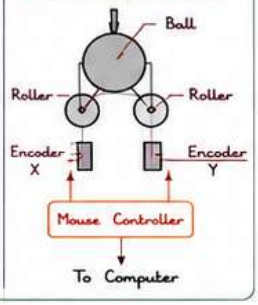
4. Working Principle (Step by Step)

1. The mouse is moved on a flat surface.
2. The movement of the mouse is detected by an internal sensor.
3. This movement is converted into electrical signals.
4. The signals are processed by the mouse controller (IC).
5. The processed data (displacement and direction) is sent to the computer through the cable or wireless receiver.
6. The computer interprets this data and moves the pointer (cursor) on the screen accordingly.

5. Mechanical (Ball) Mouse

- A rubber ball at the bottom of the mouse rolls in all directions.
- The movement of the ball is transferred to two rollers placed at right angles.
- These rollers are connected to rotary encoders.
- The encoders generate electrical pulses proportional to the movement.
- These pulses are sent to the computer to move the cursor.

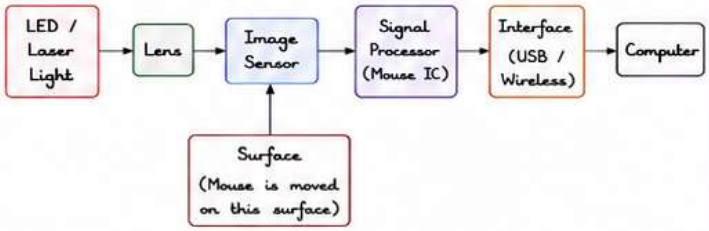
Inside View of Ball Mouse



6. Optical / Laser Mouse (Modern Mouse)

- An LED (optical mouse) or laser (laser mouse) is used to illuminate the surface.
- A small sensor (image sensor) continuously captures images of the surface.
- The mouse controller compares consecutive images to detect movement and direction.
- The movement is calculated in X and Y directions.
- This data is sent to the computer to move the cursor.

Block Diagram of Optical / Laser Mouse



7. Movement Detection

- When the mouse is moved, the pattern of the surface under the mouse changes.
- The sensor detects this change.
- By comparing the old and new images, the controller calculates how much the mouse has moved in X and Y directions.
- It also detects the direction of movement.

8. Advantages

- ✓ Easy to use.
- ✓ High accuracy.
- ✓ Fast response.
- ✓ Requires less desk space.
- ✓ Optical / Laser mouse needs no cleaning.
- ✓ Works on variety of surfaces (in optical / laser).

9. Disadvantages

- × Mechanical mouse needs regular cleaning.
- × Does not work on glass or highly reflective surfaces (in some optical mouse).
- × Can be affected by dust in ball mouse.

10. Applications

- Used in almost all computers and laptops.
- Used in CAD/CAM, gaming, graphic designing.
- Used in all GUI based software.

Important Points

- Mouse is a pointing device.
- It converts physical movement into electrical signals.
- Optical and laser mouse are more reliable than mechanical mouse.
- It helps in selecting, dragging and positioning objects on the screen.

Typical Exam Questions

- Draw and explain the working principle of mouse.
- Differentiate between mechanical and optical mouse.
- List the applications of mouse.
- What are the parts of a mouse?

Key Terms

- Cursor : Pointer on the screen.
- Sensor : Detects movement.
- Encoder : Converts movement to pulses.
- Interface : Connects mouse to computer.

Working Principle of Scanner

1. Introduction

A scanner is an input device that converts text, images or graphics from paper or photographs into digital form so that it can be stored, edited and processed by a computer.

2. Basic Principle

- The scanner captures the image from the document.
- It converts the captured light into electrical signals.
- These signals are then converted into digital data by ADC.
- The digital data is sent to the computer where it is stored as an image file.

3. Main Components of Scanner

① Light Source : Provides light to illuminate the document.

② Mirrors : Direct the light onto the document and then to the sensor.

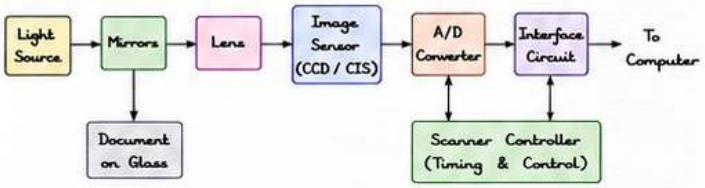
③ Lens : Focuses the reflected light on the image sensor.

④ Image Sensor (CCD / CIS) : Converts light into electrical signals.

⑤ A/D Converter : Converts analog signals from the sensor into digital data.

⑥ Interface Circuit : Sends digital data to the computer.

4. Block Diagram of Scanner



5. Working Principle (Step by Step)

1. The document is placed face down on the glass surface.
2. The light source (lamp / LED) illuminates the document.
3. The reflected light from the document is directed by mirrors towards the lens.
4. The lens focuses the light on the image sensor (CCD/CIS).
5. The image sensor converts the light intensity into analog electrical signals.
6. The A/D converter converts these analog signals into digital data.
7. The interface circuit sends the digital data to the computer.
8. The computer reconstructs the image and displays it on the screen.

6. Types of Scanner

- **Flatbed Scanner** : Document is placed on a flat glass surface and the scanning head moves under the glass.
- **Sheet-fed Scanner** : Paper is fed through the scanner automatically.
- **Handheld Scanner** : The user moves the scanner by hand over the document.
- **Drum Scanner** : Used in professional printing and high quality image processing.

7. Inside View (Typical Flatbed Scanner)

8. Advantages

- ✓ Converts documents and photos into digital form.
- ✓ High accuracy and quality.
- ✓ Easy to use.
- ✓ Saves space (digital storage).
- ✓ Image editing and sharing becomes easy.
- ✓ Long term preservation of documents.

9. Disadvantages

- × High quality scanners are expensive.
- × Large size scanners take more space.
- × Speed is slower compared to some other devices.
- × Requires proper cleaning and maintenance.

10. Applications

- Used in offices for digitizing documents, reports, forms.
- Used in graphic designing and DTP work.
- Used in libraries and archives for storing books and historical records.
- Used in medical field (scanning X-ray, MRI, reports).
- Used for educational purposes and research.

Important Points

- Scanner is an input device.
- It works on the principle of reflection of light.
- Light is converted into electrical signals and then into digital data.
- CCD and CIS are the most commonly used sensors.

Typical Exam Questions

1. Draw and explain the block diagram of scanner.
2. Explain the working principle of flatbed scanner.
3. Write short notes on CCD and CIS.
4. List the applications of scanner.

Key Terms

- Scanner : An input device for capturing images.
- CCD : Charge Coupled Device.
- CIS : Contact Image Sensor.
- A/D Converter : Analog to Digital Converter.
- Resolution : Clarity and detail of the image.

Working Principle of Digitizing Camera

1. Introduction

A Digitizing Camera (Digital Camera) is an electronic device that captures real-world images and converts them directly into digital form. It is widely used in computer graphics, multimedia, image processing and computer vision.

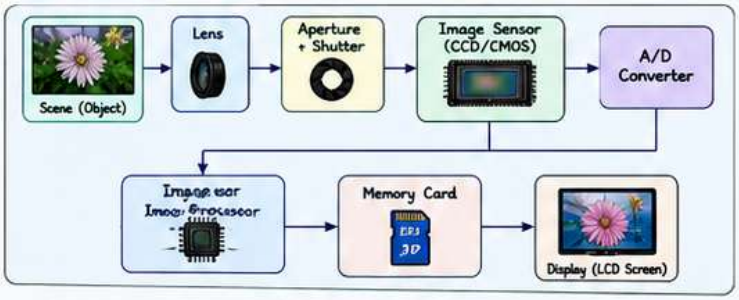
2. What is Digitizing Camera ?

A camera that captures light from the scene and converts it into digital image data (binary form) using an image sensor and stores it in memory as an image file.

3. Main Components

Component		Function
	Lens	Focuses the incoming light on the sensor.
	Aperture	Controls the amount of light entering.
	Shutter	Controls exposure time.
	Image Sensor	Converts light into electrical signals.
A/D	A/D Converter	Converts analog signals into digital data.
	Image Processor	Processes, corrects and compresses image.
	Memory Card	Stores the image as digital file (JPEG/RAW).
	Display (LCD)	Shows the captured image on screen.

4. Block Diagram



5. Working Principle (Step by Step)

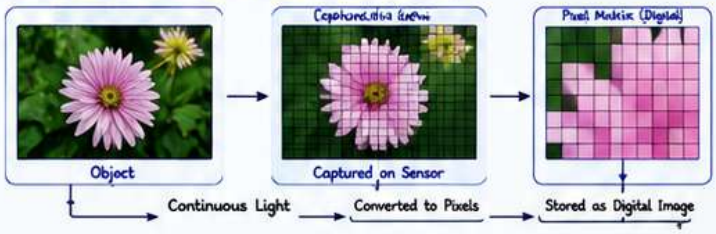
1. Light from the object enters the lens.
2. Lens focuses the light on the image sensor.
3. Aperture and shutter control the amount and duration of light.
4. Image sensor (CCD/CMOS) converts light into analog electrical signals.
5. A/D converter converts analog signals into digital (binary) data.
6. Image processor applies processing like white balance, colour correction and compression.
7. The final digital image is stored in memory card.
8. Image can be viewed on LCD screen or transferred to computer.

6. Image Sensor Technologies

Feature	CCD Sensor	CMOS Sensor
Full Form	Charge Coupled Device	Complementary MOS
Quality	Very High	High
Power Consumption	More	Less
Speed	Slower	Faster
Cost	Expensive	Cheaper
Usage	Professional cameras	Mobile, DSLR, webcam

7. Inside View of Digital Camera

8. Example : Image Formation Process



9. Advantages

- ✓ Stores images directly in digital form.
- ✓ High quality images.
- ✓ Easy to edit and share.
- ✓ No film required.
- ✓ Instant preview.
- ✓ Used in wide range of devices.
- ✓ High resolution and colour accuracy.

10. Disadvantages

- × More expensive than normal analog cameras.
- × Image sensor may create noise in low light.
- × Requires battery power.
- × Memory card storage can fill quickly.

11. Applications

- Digital photography
- Multimedia and computer graphics
- Medical imaging
- Satellite and earial imaging
- Surveillance and security
- Industrial inspection
- Scientific research
- Film and video production
- Mobile phone cameras
- Document digitization

Important Points

- Digitizing camera converts real-world image into digital form using an image sensor.
- CCD and CMOS are the most commonly used sensors.
- Output image is stored as JPEG or RAW format.

Typical Exam Questions

1. Draw and explain the block diagram of digitizing camera.
2. Write the working principle of digital camera.
3. Differentiate between CCD and CMOS sensor.
4. What are the applications of digitizing camera?

Key Terms

- Image Sensor
- CCD
- CMOS
- A/D Converter
- Image Processor
- Aperture
- Shutter
- Resolution

IT601 - Computer Graphics & Multimedia

Topic - 17
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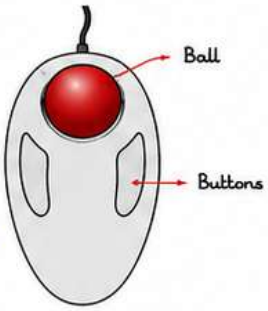
Unit - I

Track Ball

1. Introduction

A track ball is an input pointing device used to control the movement of the cursor on the screen. It is similar to a mouse but instead of moving the whole device, the user rotates a ball with fingers or thumb to move the cursor.

2. Parts of Track Ball

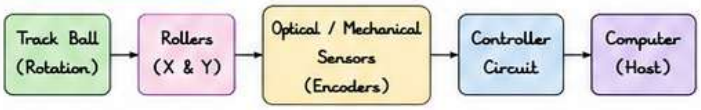


1. Ball
2. Rollers (X-axis & Y-axis)
3. Optical / Mechanical Sensors
4. Controller Circuit
5. Buttons (Left, Right, Middle - optional)
6. Cable / Wireless Module

3. Working Principle

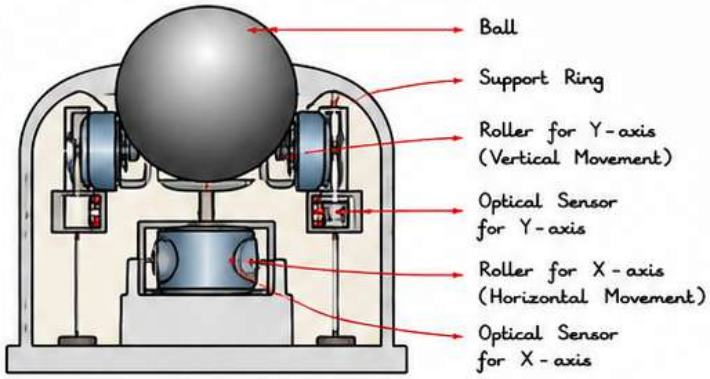
- The ball is free to rotate in any direction.
- When the user rotates the ball with fingers or thumb, it rolls on the support.
- The rotation of the ball turns the rollers placed perpendicular to each other (one for X-axis and other for Y-axis).
- These rollers are connected to encoders or sensors.
- When a roller rotates, the encoder generates electrical pulses.
- The pulses are proportional to the movement and direction of the ball.
- The controller processes these signals and sends corresponding movement data (ΔX, ΔY) to the computer.
- The computer updates the cursor position on the screen accordingly.

4. Block Diagram



Movement of Ball → Rotation of Rollers → Generation of Pulses → Processing by Controller → Cursor Movement on Screen

5. Inside View of Track Ball



6. Types of Track Ball

- **Mechanical Track Ball** : Uses mechanical rollers and encoders.
- **Optical Track Ball** : Uses optical sensors and does not require physical contact between ball and sensors.
- **Wireless Track Ball** : Connects to computer without cables using Bluetooth / RF.

7. Advantages

- ✓ Does not require much desk space.
- ✓ More accurate than touch pads.
- ✓ Cursor control is smooth.
- ✓ Can be used in places where moving the whole device is not possible.
- ✓ Durable and reliable.
- ✓ Less physical movement of hand.

8. Disadvantages

- × Rolling the ball may require cleaning.
- × Not suitable for drawing or precise graphic work compared to mouse.
- × Initial cost is higher than basic mouse.

9. Applications

- Used in desktop computers, laptops and kiosks.
- Used in embedded systems and control panels.
- Common in laptops (in place of mouse).
- Used in industrial and medical equipment.
- Useful in environments with limited space.

Important Points

- Track ball controls cursor by rotating the ball.
- Rollers convert ball movement into electrical pulses.
- Pulses are processed and sent to computer.
- It is a stationary device; only ball is moved.
- Track ball is more compact than mouse.

Typical Exam Questions

1. Draw and explain the block diagram of track ball.
2. Explain the working principle of track ball.
3. Write short notes on track ball.
4. What are the advantages and disadvantages of track ball?

Key Terms

- Track Ball
- Rollers
- Encoder
- Optical Sensor
- Controller
- Pulses
- ΔX, ΔY
- Cursor

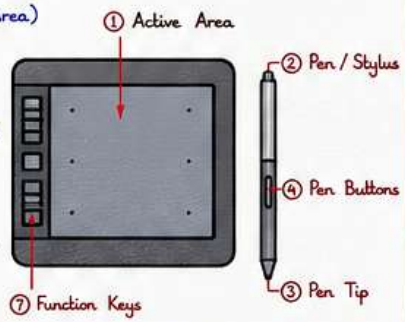
Tablets (Graphics Tablet)

1. Introduction

A graphics tablet is a pointing input device that allows the user to draw images, select objects or write handwritten text by moving a pen (stylus) over a flat surface. It is widely used in computer graphics, CAD/CAM, animation, digital arts and design.

2. Parts of Graphics Tablet

① Tablet Surface (Active Area)
② Pen / Stylus
③ Pen Tip
④ Pen Buttons (Side Switch)
⑤ Tablet Controller / Interface
⑥ USB / Wireless Receiver
⑦ Function Keys / Express Keys (optional)



Graphics Tablet

3. Working Principle

* The tablet surface contains a grid of tiny sensors or electromagnetic coils.
* A special pen (stylus) is used. The pen usually does not need batteries (in electromagnetic tablets).
* When the pen tip is brought near the tablet surface, it disturbs the electromagnetic field.
* The tablet controller detects this disturbance and calculates the position (X, Y) of the pen on the active area.
* If the pen is pressed on the surface, the controller sends a 'pen down' signal (like mouse click).
* The pressure applied by the pen is measured and sent as additional data.
* These position, pressure and button status signals are sent to the computer via USB or wireless.
* The computer interprets this data and moves the cursor or draws on the screen accordingly.

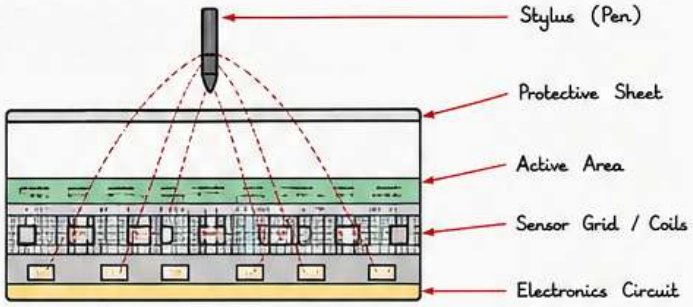
4. Block Diagram

Working Flow :
Pen Movement → Disturbance in Field → Detection by Sensors → Controller Calculates (X, Y, Pressure) → Data Sent to Computer → Cursor / Drawing on Screen

5. Types of Graphics Tablet

* Electromagnetic Tablet : Uses electromagnetic field to detect pen position. (Most common)
* Resistive Tablet : Detects pen pressure by resistive layer. (Less accurate)
* Capacitive Tablet : Uses capacitive sensing technology. (High accuracy and multi-touch support)

6. Inside View (Electromagnetic Tablet)



7. Advantages

✓ High accuracy and precision.
✓ Natural drawing experience like paper.
✓ Sensitive to pressure and tilt (in advanced tablets).
✓ No need to move whole hand like mouse.
✓ Useful for drawing, sketching, CAD, animation.
✓ Reduces fatigue during long work.

8. Disadvantages

× More expensive than mouse.
× Requires practice for beginners.
× Needs flat surface to work properly.
× Pen may get lost or damaged.

9. Applications

* Digital drawing and painting.
* CAD/CAM and engineering design.
* Image editing and photo retouching.
* Animation and multimedia production.
* Online signature and handwriting recognition.
* Education and e-learning.

Important Points

* Graphics tablet works like a mouse but offers more precision.
* It converts pen movement and pressure into digital data.
* Commonly used by designers, engineers, animators and artists.
* Pen is more accurate than mouse for drawing tasks.

Typical Exam Questions

1. Draw and explain the block diagram of graphics tablet.
2. Explain the working principle of graphics tablet.
3. What are the parts of graphics tablet? Explain.
4. Differentiate between graphics tablet and mouse.
5. List the applications of graphics tablet.

Key Terms

* Graphics Tablet
* Stylus (Pen)
* Active Area
* Sensor Grid / Coils
* Controller
* Interface
* X, Y Coordinates
* Pressure Sensitivity
* Electromagnetic Field

Joysticks

1. Introduction

A joystick is a pointing input device used to control the movement of a cursor or an object on the screen. It is widely used in computer games, CAD systems, simulators, robot control and virtual reality.

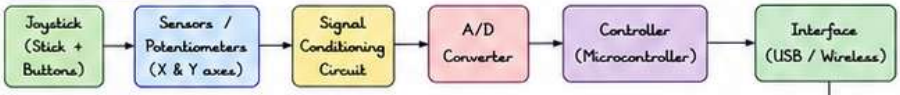
2. Parts of Joystick

1. Stick (Handle) : Moved by the user in any direction.
2. Buttons : Used for additional commands (fire, select, etc.).
3. Sensors / Potentiometers : Detect the tilt and direction of the stick.
4. Controller Circuit : Converts movement into electrical signals.
5. Interface (USB/Wireless) : Sends data to computer.

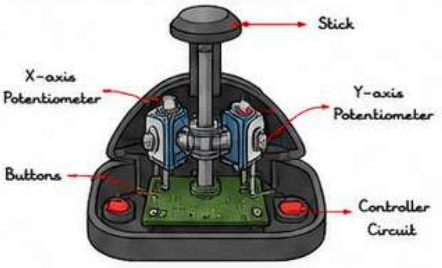
3. Working Principle

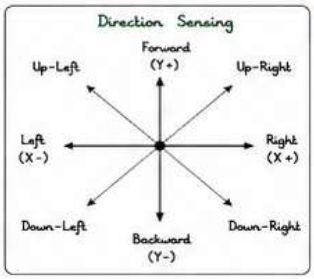
- The user moves the stick in any direction.
- The stick is connected to two potentiometers (for X and Y axes) or to Hall effect sensors.
- When the stick is tilted, the values of the potentiometers change according to the direction and amount of tilt.
- These analog values are converted into digital data by an A/D converter.
- The controller circuit processes this data and sends it to the computer through USB or wireless interface.
- The computer interprets the data and moves the cursor or controls the object on the screen.

4. Block Diagram



5. Inside View of Joystick





6. Types of Joysticks

- **Analog Joystick** : Provides continuous output based on position.
- **Digital Joystick** : Provides output in fixed directions (up/down/left/right).
- **2-Axis Joystick** : Controls movement in X and Y directions.
- **Multi-Axis Joystick** : Provides control in 3 or more axes (X, Y, Z and rotation).
- **Flight Joystick** : Used in flight simulators and aircraft control.
- **Game Joystick** : Used in video games.

7. Advantages

- ✓ Provides smooth and natural control.
- ✓ More accurate than keyboard for movement.
- ✓ Easy to use and comfortable.
- ✓ Useful in games, CAD, simulation and robotics.
- ✓ Can provide multi-direction control.

8. Disadvantages

- × Occupies more space on desk.
- × May require calibration.
- × Good quality joysticks are expensive.
- × Mechanical parts may wear out with use.

9. Applications

- Video games and entertainment.
- CAD/CAM systems for 3D object manipulation.
- Flight, space and vehicle simulators.
- Robot arm and industrial machine control.
- Virtual reality and training systems.
- Remote control of machinery and cranes.

Important Points

- Joystick is a 2D or multi-axis pointing device.
- Tilting the stick changes the values of sensors.
- Analog values are converted to digital data.
- More natural and efficient for movement control than keyboard.
- Commonly used in games and simulators.

Typical Exam Questions

1. Draw and explain the block diagram of joystick.
2. Explain the working principle of joystick.
3. What are the parts of a joystick?
4. Differentiate between analog and digital joystick.
5. List the applications of joystick.

Key Terms

- Joystick : Input pointing device.
- Axis : Direction of movement (X, Y, Z).
- Potentiometer : Variable resistor.
- A/D Converter : Analog to Digital Converter.
- Controller : Processes input signals.

IT601 – Computer Graphics & Multimedia

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Unit – I

Graphical Input Techniques

1. Introduction

Graphical input techniques allow the user to input pictures, drawings, shapes or any graphical information into the computer. These techniques are widely used in computer graphics, CAD/CAM, multimedia, image processing and animation.

2. Need of Graphical Input

- ✓ To input drawings, sketches and images.
- ✓ To create interactive systems.
- ✓ More natural and easy compared to keyboard input.
- ✓ Essential for CAD, digital art, gaming, simulation and education.

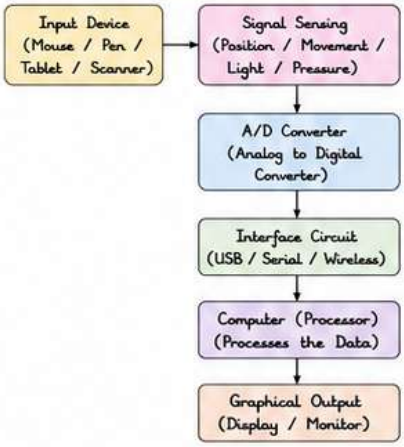
3. Common Graphical Input Devices / Techniques

Sr.	Technique / Device	Description
1.	Keyboard 	Used to input commands, values and text which control graphical objects.
2.	Mouse 	Used for selecting, pointing, dragging and drawing simple graphics.
3.	Trackball 	A ball is rotated by hand to move the cursor. Useful in compact spaces.
4.	Joystick 	Used to specify direction and position in 2D or 3D environments.
5.	Graphics Tablet (Digitizer Tablet) 	Pen is used on the tablet surface to draw or select. Very useful for designers and artists.
6.	Light Pen 	A pen-shaped device that can detect the position on the screen and select or draw.
7.	Scanner 	Converts drawings, photos, sketches or documents into digital form.
8.	Digitizing Camera 	Captures images of objects or scenes and converts them into digital data.
9.	Touch Screen 	User inputs by touching the screen. Used in kiosks, mobiles, tablets.
10.	3D Input Devices 	Devices that allow 3D manipulation of objects (e.g., 3D mouse, spaceball).

4. Working Principle (General)

- ✱ User interacts with the input device.
- ✱ The device senses the movement, position or action.
- ✱ The analog signals produced by the device are converted into digital data using A/D converter.
- ✱ The digital data is sent to the computer.
- ✱ The computer interprets the data and updates the graphical output on the screen.

5. Block Diagram (General)



Example – Graphics Tablet

1. Pen moves on the tablet surface.
2. Tablet senses the X, Y position and pressure.
3. Signals are converted to digital values.
4. Data is sent to the computer.
5. Computer draws the lines or shape on the screen.

6. Advantages

- ✓ Easy and natural interaction.
- ✓ High accuracy and precision.
- ✓ Useful for drawing and design.
- ✓ Supports complex graphical data.
- ✓ Saves time and increases productivity.
- ✓ Widely used in many applications.

7. Limitations

- × Some devices are expensive.
- × Requires proper training.
- × Sensitive devices need care and maintenance.
- × May require calibration.

8. Applications

- ✱ CAD/CAM and engineering design.
- ✱ Digital painting, animation and illustration.
- ✱ Image editing and photo retouching.
- ✱ Medical imaging and diagnosis.
- ✱ Simulation and training systems.
- ✱ Gaming and virtual reality.
- ✱ GIS (Geographic Information Systems).
- ✱ Education and e-learning tools.

9. Comparison of Some Graphical Input Devices

Device	Input Type	Dimensions	Accuracy	Common Use
Mouse	Movement + Clicks	2D	Medium	General purpose
Graphics Tablet	Pen Position + Pressure	2D	High	Drawing, Design
Joystick	Direction + Buttons	2D / 3D	Medium	Games, Simulation
Scanner	Optical Scan	2D (Image)	High	Image Input
Digitizing Camera	Image Capture	2D / 3D (Scene)	High	Multimedia, Vision
Touch Screen	Touch Position	2D	Medium	Kiosks, Mobile

Important Points

- ✱ Graphical input techniques convert human actions into digital data.
- ✱ A/D conversion is used to convert analog signals from input devices.
- ✱ These techniques make systems more interactive and user-friendly.

Typical Exam Questions

1. Explain various graphical input techniques.
2. Draw and explain the block diagram of a graphics tablet.
3. Explain the working principle of joystick.
4. Compare mouse and graphics tablet.
5. List the applications of graphical input techniques.

Key Terms

- A/D Converter
- Digitizer
- Graphics Tablet
- Light Pen
- Joystick
- Scanner
- Trackball
- Touch Screen
- Input Device
- Resolution

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Unit – I

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Positioning Techniques

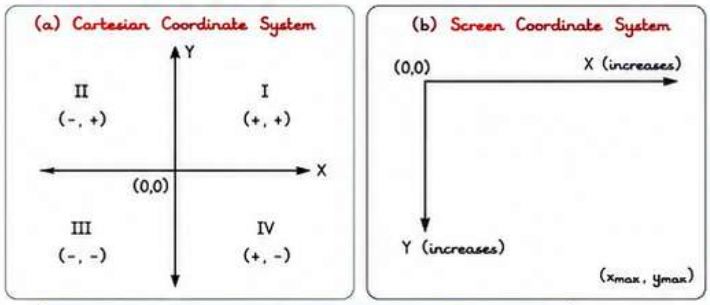
1. Introduction

Positioning techniques specify the location of graphical objects on the display screen. These techniques convert real world coordinates into device coordinates so that the objects appear at correct positions on the screen.

2. Need of Positioning Techniques

- ✓ To display objects at desired locations.
- ✓ To create and manipulate shapes accurately.
- ✓ To support interactive applications.
- ✓ Essential in CAD, animation, gaming and simulation.

3. Coordinate Systems



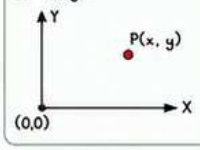
Note : In screen coordinates, origin is at top-left corner. X increases to the right and Y increases downward.

4. Positioning Techniques

(a) Absolute Positioning

Position of an object is specified directly using its coordinates.

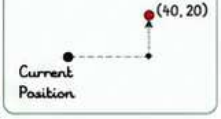
Example : Plot pixel at (x, y).



(b) Relative Positioning

Position is specified with respect to the current position.

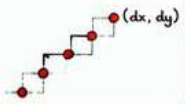
Example : Move 40 units right and 20 units up.



(c) Incremental (Step) Positioning

Object position is updated by small increments.

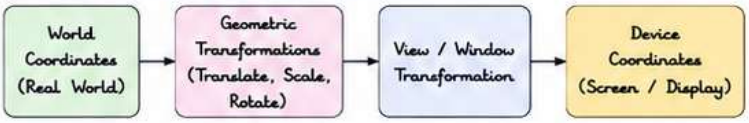
Example : Move in steps (dx, dy).



5. Positioning Methods

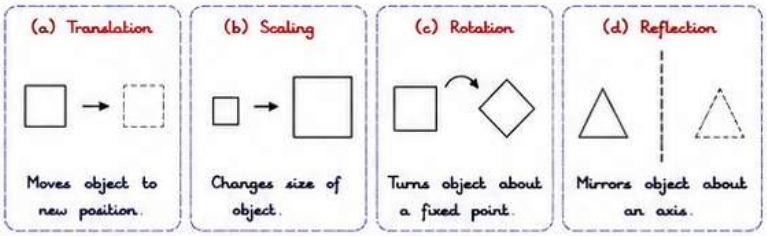
Method	Description
Direct (Absolute)	Specify exact coordinates (x, y) for plotting.
Relative (Vector)	Specify position using displacement (dx, dy).
Incremental (Step)	Specify position using small increments.
Polar Coordinates	Specify position using (r, θ) where r = distance, θ = angle.
Device (Screen)	Specify position in screen coordinates (pixels).
World Coordinates	Specify position in real world coordinates.

6. World to Device Coordinate Transformation



This process maps objects from real world to screen.

7. Common Geometric Transformations



8. Advantages

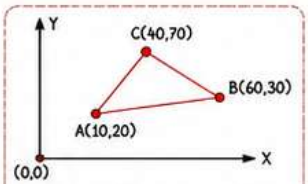
- ✓ Accurate placement of objects.
- ✓ Supports complex graphical operations.
- ✓ Essential for realistic animation and simulations.
- ✓ Improves interactivity and user control.
- ✓ Basis for all graphical transformations.

9. Limitations

- × Complex transformations require more computations.
- × Rounding errors may occur.
- × High accuracy needs more processing power.
- × Different devices may have different resolutions.

10. Applications

- CAD/CAM for designing and modeling.
- Robot and machine control systems.
- Flight and vehicle simulators.
- Video games and animations.
- GIS and mapping applications.
- Medical imaging and virtual reality.
- Scientific data visualization.



Example : Object positioned using coordinates.

11. Example (Step by Step)

Step	Operation	Description	Example
1	Specify Position	Choose coordinates	(x = 100, y = 150)
2	Transform	Apply translation	(x' = x + dx, y' = y + dy)
3	Scale	Resize object	(x'' = x' * s, y'' = y' * s)
4	Map to Screen	Convert to screen coords	(X, Y) in pixels
5	Display	Plot the object	Object appears on screen

Important Points

- Positioning techniques decide where objects appear.
- Screen coordinates have origin at top-left.
- World coordinates are converted to device coordinates.
- Transformations help in moving, scaling and rotating.
- Basis for all interactive graphics.

Typical Exam Questions

1. Explain positioning techniques in computer graphics.
2. Differentiate between world coordinates and device coordinates.
3. Explain absolute, relative and incremental positioning.
4. Explain world to device coordinate transformation.
5. What are the applications of positioning techniques?

Key Terms

- Absolute Positioning
- Relative Positioning
- Incremental Positioning
- World Coordinates
- Device Coordinates
- Translation
- Scaling
- Rotation
- Transformation
- Screen Coordinates