Chapter 1 (4 Marks)

b

How does a raster display system generate images on a screen? If the total number of intensities achievable out of a single pixel on the screen is 1024 and total resolution is 1024×800, what is will be the required size of frame buffer incase of display purpose? [2+2]

Differentiate between raster scan and random scan display. If we want to resize at 1920×1080 image to one that is 1280 wide with the same aspect ratio, what would be the height of resized image? [4]

b

Define the terms pixel, resolution and pixel density. How much time is spent scanning each row of pixels during screen refresh on a raster system with resolution of 640×480 whose refresh is 24 frames per second? Also calculate the access time per pixel. [3+3]

Consider a raster system with a resolution of 1920 × 1080. How much storage is required if 24 bits per pixel are to be stored in a device with refresh rate of 50 Hz? Find out the aspect ratio. [4]

1. Distinguish between Raster and Vector graphics with suitable example. [6]

b

1. What is computer graphics? Calculate the total memory required to store a 10 minute video in a SVGA system with 24 bit true color and 60 fps refresh rate. [2+4]

1. Compare Raster-scan Display with Random-scan Display. [6]

1. Differentiate between raster and vector graphics. Calculate the frame buffer size (in KB) for a raster system recording a video for 1 min with resolution of 1280×1024, and storing 24 bits per pixel with a refresh rate of 25 fps. [2+4]

Define computer graphics. Illustrate about components for computer graphics. [2+4]

1. Compare random and raster display technology. [6]

1. What do you understand by raster display technology? Suppose a RGB raster system is to be designed using an 8 inch by 10 inch screen with a resolution of 100 pixels per inch in each direction. How long would it take to load this raster system in frame buffer with 24 bits per pixel, if 10^5 bits can be transferred per second? [6]

1. Distinguish between Raster and Vector graphics methods. When do we prefer them? [6]

b

Consider a raster scan system having 12 inch by 10 inch screen with a resolution of 100 pixels per inch in each direction. If the display controller of this system refreshes the screen at the rate of 50 frames per second, how many pixels could be accessed per second and what is the access time per pixel of the system? [4]

How much time is spent scanning across each raw of pixels **during** screen refresh on a raster system with resolution 1024×768 and a refresh rate of 60 **frames** per second? **[4]**

1. What is the size of frame buffer required to store a SVGA with 24 bit true color video of 10 min without compression? [4]

Computer Graphics refers to the creation, manipulation, and representation of images and visual data using computers. It involves generating images, animations, and visual effects using computational techniques. Computer graphics is widely used in fields such as video games, movies, graphic design, and simulations.

Comparison of Raster Graphics and Vector Graphics

Feature	Raster Graphics	Vector Graphics
Definition	Images made up of a grid of individual pixels, each having a specific color.	Images made up of paths defined by mathematical equations, which form shapes like lines, curves, and polygons.
File Size	Typically larger, especially at higher resolutions, because it stores color information for each pixel.	Generally smaller since it stores only mathematical formulas and coordinates.
Scalability	Loses quality when scaled up (can become pixelated or blurry).	Can be scaled up or down without loss of quality because the shapes are redrawn using the mathematical formulas.

Feature	Raster Graphics	Vector Graphics
Resolution	Resolution-dependent; clarity is tied to the image's pixel density.	Resolution-independent; clarity remains consistent at any size.
Common File Formats	JPEG, PNG, GIF, BMP, TIFF	SVG, EPS, PDF, AI
Use Cases	Photographs, digital paintings, web images	Logos, icons, fonts, illustrations
Editing	Pixel-based; editing often involves working on individual pixels or groups of pixels.	Object-based; editing involves manipulating shapes and paths directly.
Rendering	Rendering is typically slower, especially at high resolutions, due to the large number of pixels.	Rendering is typically faster since it only involves calculating the shapes based on equations.
Examples	A photograph taken with a digital camera	A company logo created in Adobe Illustrator

Uses of Computer Graphics

Computer graphics have a wide range of applications, including:

1. **Entertainment**: Used in video games, movies, and animations to create realistic or stylized visual content.
2. **Design and Visualization**: Used in architecture, engineering, and product design to create models, simulations, and visualizations.
3. **Education and Training**: Used in simulations, interactive learning environments, and virtual reality for training purposes.
4. **Medical Imaging**: Helps in visualizing complex data, such as MRI scans or CT images.
5. **Scientific Visualization**: Used to visualize scientific data, such as climate models, molecular structures, and astronomical data.
6. **Art and Digital Media**: Used by artists to create digital paintings, illustrations, and 3D sculptures.
7. **User Interfaces**: Enhances the appearance and usability of software applications and websites.

Key Terms in Computer Graphics

1. **Pixel**:
   - The smallest unit of a digital image or display, representing a single point in the image. Pixels are the building blocks of digital images, and each pixel can display a color based on its bit depth.
2. **Bit Depth**:
   - Refers to the number of bits used to represent the color of a single pixel. Higher bit depth allows for more colors to be displayed. For example, an 8-bit image can display 256 colors, while a 24-bit image can display over 16 million colors.
3. **Refresh Rate**:
   - The number of times per second that a display updates its image, measured in Hertz (Hz). A higher refresh rate results in smoother motion on the screen, important for gaming and video playback.
4. **Resolution**:
   - The number of pixels displayed on the screen, typically described as width x height (e.g., 1920×1080). Higher resolution results in sharper and more detailed images.
5. **Aspect Ratio**:
   - The ratio of the width to the height of the display or image. Common aspect ratios include 4:3, 16:9, and 21:9. It determines the shape and how the content fits on the screen.
6. **Refresh Buffer (Frame Buffer)**:
   - A portion of video memory containing the current image displayed on the screen. The refresh buffer stores pixel data, and the display reads from it to update the screen.
7. **Pixel Density**:
   - Measured in pixels per inch (PPI), it refers to the number of pixels within a certain area of the screen. Higher pixel density results in a sharper image, as more pixels are packed into the same area.

Components for Computer Graphics

1. **Graphics Processing Unit (GPU)**:
    - A specialized processor designed to accelerate the rendering of images, animations, and video. It handles complex mathematical calculations needed for creating graphics.
2. **Monitor/Display**:
    - The hardware that displays the output from the computer. Monitors vary in resolution, refresh rate, aspect ratio, and pixel density.
3. **Video Memory (VRAM)**:
    - Memory dedicated to storing image data that the GPU processes. VRAM is crucial for handling high-resolution textures and complex scenes in games and 3D applications.
4. **Graphics Software**:
    - Applications and tools used for creating and manipulating graphics, such as Adobe Photoshop, Blender, and AutoCAD.
5. **Input Devices**:
    - Devices like a mouse, keyboard, graphics tablet, or stylus used to interact with and create graphics.
6. **Display Interface**:
    - The connection between the computer and the display, such as HDMI, DisplayPort, or VGA, which transmits video signals to the monitor.

These components work together to create, process, and display graphical content on a computer.

Feature	Raster Scan Display	Random (Vector) Scan Display
Drawing Technique	Uses a grid of pixels to draw images, scanning line by line from top to bottom.	Draws images using lines or curves directly by controlling the electron beam.
Image Representation	Represented as a matrix of pixels (bitmap).	Represented as mathematical equations of lines and curves.
Refresh Rate	Generally has a fixed refresh rate (e.g., 60 Hz), independent of image complexity.	Refresh rate depends on the complexity of the image. Simple images refresh faster.

Feature	Raster Scan Display	Random (Vector) Scan Display
Memory Requirement	Requires a frame buffer to store pixel data; memory size depends on screen resolution.	Requires less memory as it only needs to store the endpoints and equations of lines and curves.
Image Quality	Can display detailed and complex images with a lot of colors, but may suffer from aliasing (jagged edges).	Produces high-quality images with smooth lines, but can only handle simple line-based images.
Application	Commonly used in TVs, monitors, and general-purpose graphics (e.g., photos, videos).	Used in specialized applications like oscilloscopes, radar displays, and certain types of CAD systems.
Complexity of Images	Handles complex images well, including detailed textures and filled regions.	Best suited for simple images like line drawings and wireframe models; struggles with filled or highly detailed images.
Color Handling	Can display millions of colors simultaneously.	Typically supports fewer colors due to the limitations of drawing lines and curves directly.
Aliasing	More prone to aliasing effects due to the pixel grid structure.	Less prone to aliasing, as images are drawn using continuous lines.
Speed	Slower for drawing images because it requires updating every pixel in the grid.	Faster for simple line-based images but can slow down with increased complexity.
Hardware Cost	Generally lower cost due to widespread use and mass production.	Higher cost, often due to the specialized hardware required.
Flexibility	More flexible for a wide range of applications, including multimedia.	Less flexible, mainly suited for technical and scientific applications.
Refresh Complexity	Independent of the image complexity; refreshes all pixels regardless of the image.	Refreshes only the lines or curves that make up the image, so complexity impacts refresh time.

1. Flat Panel Display:

- **Definition:** Flat panel displays are thin, lightweight display devices that are commonly used in TVs, monitors, and mobile devices. Unlike traditional cathode-ray tube (CRT) displays, flat panel displays do not require bulky vacuum tubes.
- **Types:** The main types include Liquid Crystal Display (LCD), Light Emitting Diode (LED), and Organic Light Emitting Diode (OLED).
- **Advantages:** They are energy-efficient, space-saving, and offer high resolution and brightness.

2. Resolution and Aspect Ratios of Monitors:

- **Resolution:**
  - The resolution of a monitor refers to the number of pixels that can be displayed on the screen, typically expressed as width × height (e.g., 1920 × 1080).
  - Higher resolution means more pixels, leading to sharper and more detailed images.
- **Aspect Ratio:**
  - The aspect ratio is the ratio of the width to the height of the screen.
  - Common aspect ratios include 4:3 (standard), 16:9 (widescreen), and 21:9 (ultrawide).
  - The aspect ratio affects how content is displayed, with different ratios offering different viewing experiences.

3. Raster and Vector Display:

- **Raster Display:**
  - Raster graphics are composed of a grid of individual pixels, where each pixel has a specific color value.
  - Commonly used in TV screens, computer monitors, and digital images.
  - Advantages include ease of representation for complex images but may become pixelated when enlarged.
- **Vector Display:**
  - Vector graphics use mathematical equations to represent images as shapes, lines, and curves.

- Commonly used in graphic design, CAD software, and fonts.
- Advantages include scalability without loss of quality, making them ideal for resizing.

4. Plasma Display:

- **Definition:** Plasma displays are a type of flat panel display that use small cells containing electrically charged ionized gases (plasma) to produce images.
- **Characteristics:** Known for high contrast ratios, deep blacks, wide viewing angles, and vibrant colors.
- **Disadvantages:** Heavier, less energy-efficient, and prone to screen burn-in compared to modern displays like LCDs and OLEDs.

---

1. *If pixels are accessed from the frame buffer with an average access the 300ns. Then will this rate produce the flickering effects? (screen resolution = 640×480)*

2. *If the total intensity available for a pixel is 256 and the screen resolution is 640×480. What will be the size of the frame buffer?*

3. *Consider 256 pixel $\times$ 256 scan lines image with 24-bit true color. If 10 minutes video is required to capture, calculate the total memory required?*

If we want to resize at 1024×768 image to one that is 640
[illegible] *same* [illegible]

width

5. ***How much time is spent scanning across each row of pixels during screen refresh on a raster system with resolution 1024×768 and refresh rate 60 frames per second?*** *[2070 Chaitra]*

Solution:

6. ***Consider a raster scan system having 12 inch by 10 inch screen with a resolution of 100 pixels per inch in each direction. If the display controller of this system refreshes the screen at the rate of 50 frames per second, how many pixels could be accessed per second and what is the access time per pixel of the system?*** *[2071 Shrawan]*

① Soln:-

Access time for 1 pixel = 300ns

Access time for 640x480 pixel = 640x480x300

$$f = \frac{1}{t} = \frac{1}{640 \times 480 \times 300 \times 10^{-9} s} = 10.85 fps$$

This value is less than 50 fps so flickering occurs.

②

Soln:-

Total intensity available for a pixel = 256
(which mean 8 bits per pixel , 2^8 = 256)

size in frame buffer for 1 pixel = 8bit

For 640 x 480 , size in frame buffer =
640 x 480 x 8
= 2457600 bits

1 byte = 8 bits

Size of frame buffer in bytes = 2457600 / 8
= 307200 bytes
= 300kB

Date ____
Page ____

(3)

Soln ÷

Resolution = 256 × 256 pixels

Color depth = 24 bit per pixel (8 for Red, 8 for Green, 8 for blue channel)

Duration = 10 minutes

no of pixel per frame = 256 × 256 = 65536.

24 bit = 3 byte

Each pixel requires 3 bytes for 24 bit true color

size of single frame = 65536 × 3 bytes
= 192 kB

assume for video

Now
no of frames in 10 min = 10 × 60 × 30 fps
= 18,000 frames

Size of video = size of single frame × no. of frames in 10 min
= 192 kB × 18,000
= 3.375 GB

Date
Page

(4)

→ Even after image resize, aspect ratio is same

$$\frac{W1}{H_1} = \frac{W2}{H_2}$$

or $\frac{\cancel{768}\ 1024}{768} = \frac{640}{H_2}$

∴ $H_2 = 480$

(8)

soln ÷

Resolution = 1024 × 768

refresh rate = 60 fps

60 frame takes 1 s to scan

1 frame takes $\frac{1}{60}$ s to scan

1 frame = 1024 × 768 pixels

For 1024 × 768 pixel take $\frac{1}{60}$ s to scan

For 1 pixel it take $\frac{1}{60 \times 1024 \times 768}$ s to scan

To scan 1 row of pixel i.e 1024 pixels

it take = $\frac{\cancel{1024}}{60 \times \cancel{1024} \times 768}$ s $= 2.17 \times 10^{-5}$ s

(8)

Soln ÷

Total pixels = $12 \times 100 \times 10 \times 100$

$= 1200000$ pixels

refresh rate = 50 fps

50 frames are accessed per second

1 frame = 1200000 pixels

50 frames = $1200000 \times 50 = 60000000$ pixels

Access time per pixel = $\frac{1}{60000000} = 1.667 \times 10^{-8}$ s