Maharaja Agrasen Institute of Technology
ETCS 211

Computer Graphics & Multimedia
UNIT 1

INTRODUCTION

ETCS-211 Computer Graphics & Multimedia

UNIT I
Introduction, Applications areas, Components of Interactive Computer Graphics System. Overview of Input devices, Output devices, Raster scan CRT displays; random scan CRT displays. DDA and Bresenham's Line Drawing Algorithms, Bresenham's and Mid-Point Circle Drawing Algorithms. Homogeneous Coordinate System for 2D and 3D, Various 2D, 3D Transformations (Translation, Scaling, Rotation, Shear).

UNIT II
Clipping Algorithms, Sutherland-Cohen line Clipping Algorithm Bezier Curves, B-Spline Curves. Parallel Projection, Perspective Projection, Illumination Model for diffused Reflection, Ambient light, Specular Reflection Model, Reflection Vector.

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UNIT III
Shading Models, Flat shading, Gourard Shading, Phong Model. Visible surface detection, Back Face Detection, Depth Buffer (Z-Buffer, A-Buffer) Method. Overview of multimedia: Classification, basic concepts of sound/audio MIDI: devices, messages, software, Authoring tools, Video and Animation: controlling animation, display and transmission of animation

UNIT IV
Data Compression: storage space, coding requirements, Basic compression techniques: run length code, Huffman code, Lempel-Ziv JPEG: Image preparation, Lossy sequential DCT, expanded lossy DCT, Lossless mode, Hierarchical mode. MPEG, Media synchronization, Media Integration, Production Standards.

ETCS-211 Computer Graphics & Multimedia

Text Books:

[T1] Donald Hearn and M.Pauline Baker, "Computer Graphics C version", Second Edition, Pearson Education.
[T2] Ralf Steinmetz & Klara Nahrstedt, "Multimedia Computing Communication & Applications", Pearson Education.

Reference Books:

[R1] C, Foley, VanDam, Feiner and Hughes, "Computer Graphics Principles & practice", 2nd Edition
[R2] R. Plastock and G. Kalley, Schaum's Series, "Theory and Problems of Computer Graphics", McGraw Hill, 2nd edition.
[R3] Fred Halsall, "Multimedia Communications Applications, Networks, Protocols & Standards", Pearson Education.
[R4] David F. Rogers, "Procedural elements for computer graphics", McGraw- Hill.

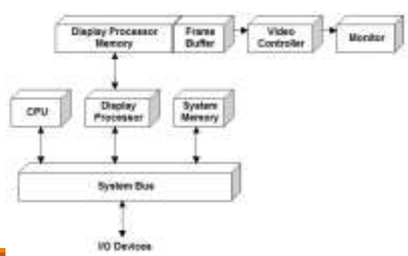
Computer graphics

It is the **creation** and **manipulation** of graphic images by means of a computer.

- Computer graphics started as a technique to **enhance** the display of information generated by a computer.
- This ability to interpret and represent numerical data in pictures has significantly **increased** the **computer's ability** to present information to the user in a clear and understandable form.
- Large amount of data are rapidly converted into bar charts, pie charts, and graphs.

Architecture of a Graphics System

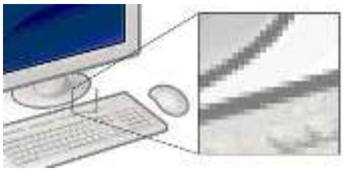
The components of a raster system contains display processor, display-processor memory, frame buffer, video controller, and input/output devices.



Pixel (picture element)

a **pixel** is the smallest piece of information in an image.

- Pixels are normally arranged in a regular **2D grid**, and are often represented using **dots** or **squares**.



Pixel (picture element)

- Each pixel is a **sample** of an original image, where more samples typically provide a more accurate representation of the original.
- The **intensity** of each pixel is variable; in color systems, each pixel has typically three or four components such as red, green, and blue, or cyan, magenta, yellow, and black.

Display Processor

Purpose: frees the CPU from the graphics routine task.

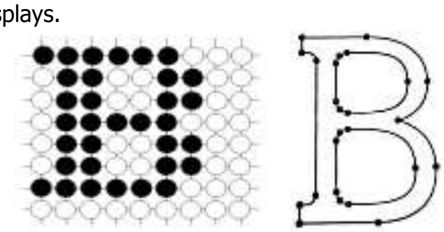
Major task: digitizes a picture definition given in an application program into a set of pixel values for storage in the frame buffer.

This digitization process is called **scan conversion**.

Straight lines and other geometric objects are scan converted into a set of discrete points, corresponding to screen pixel locations.

Display Processor

Characters can be defined with rectangular pixel grids,or they can be defined with outline shapes. The array size for character grids can vary from about 5x7 to 9x12 or more for higher quality displays.



Display Processor

A character grid is displayed by superimposing the rectangular **grid** pattern into the frame buffer at a specified coordinate position.

For characters that are defined as **outlines**, the shapes are scanned converted into the frame buffer by locating the pixels positions closest to the outline

Frame Buffer

Each screen pixel corresponds to a particular entry in a 2D array residing in memory. This memory is called a **frame buffer** or a **bit map**.

The number of **rows** in the frame buffer equals to the number of **raster lines** on the display screen.

The number of **columns** in this array equals to the number of **pixels** on each raster line.

The term pixel is also used to describe the row and the column location in the frame buffer array that corresponds to the screen location. A 512x512 display screen requires 262144 pixel memory locations.

Frame Buffer

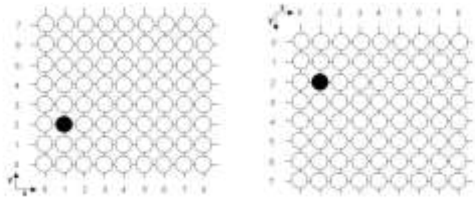
Whenever we wish to display a pixel on the screen, a specific value is placed into the corresponding memory location in the frame buffer array.

Each screen pixel's location and corresponding memory's location in the frame buffer is accessed by nonnegative integer coordinate pair (x, y).

The **x** value refers to the **column**, the **y** value to the **row** position.

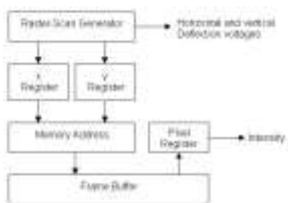
Frame Buffer

The **origin** of this coordinate system is positioned at the **bottom-left corner** of the screen or it is positioned at the **upper-left corner** of the screen.



Video controller

Video controller is used to control the operation of the display device (Monitor/Screen). Video controller accesses the frame buffer to refresh the screen. In figure, the basic refresh operations of the video-controller are shown.



Video controller

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

Initially, the **x register** is set to **0** and the **y register** is set to the value for the top scan line.

The contents of the frame buffer at this pixel position are then retrieved and used to set the **intensity** of the CRT beam.

Then the **x register** is **incremented** by **1**, and the process is repeated for the next pixel on the top scan line.

Video controller

This procedure is continued for each pixel along the top scan line.

After the **last pixel** on the **top** scan line has been processed, the **x register** is **reset** to **0** and the **y register** is set to the value for the **next scan line** down from the top of the screen.

Pixels along this scan line are then processed in turn, and the procedure is repeated for each successive scan line.

Video controller

After cycling through all pixels along the bottom scan line (y=0), the video controller resets the registers to the first pixels position on the top scan line and the refresh process starts over.

The screen must be **refreshed** at a **rate** of at least **60 frames** per **second**.

Input and Output Devices

The user of an interactive graphics system communicates with the graphics program by means of **input devices** such as **keyboard**, **mouse**, **joystick**, **light pen**, graphics tablet (**digitizer**), **touch panels**, **voice systems**, and **scanners**.

Typically, the primary output device in a graphics system is a video monitor such as **C**athode **R**ay **T**ube (CRT) and **L**iquid **C**rystal **D**isplay (LCD). We can obtain hard-copy output for our images in several formats for presentations or archiving. Hard copy devices include **slides film**, **printers**, and **plotters**.

Computer display standard

Various computer display standards or **display modes** have been used in the history of the personal computer.

They are often a combination of

Display resolution: specified as the width and height in pixels,

Color depth: measured in bits, and

Refresh rate: expressed in hertz.

Computer display standard

A computer image is usually represented as a discrete grid of pixels.

The number of pixels determines the resolution of the image. Typical **resolutions range** from 320x200 to 2000x1500

The color depth: is the number of distinct colors that can be represented by a pixel depends on the number of bits per pixel (bpp).

A **1 bpp** image uses 1 bit for each pixel, so each pixel can be either on or off.

Computer display standard

Each additional bit doubles the number of colors available, so a 2 bpp image can have 4 colors, and a 3 bpp image can have 8 colors:

- 1 bpp, 2^1 = 2 colors (monochrome)
- 2 bpp, 2^2 = 4 colors
- 3 bpp, 2^3 = 8 colors
- **…**
- 8 bpp, 2^8 = 256 colors
- 16 bpp, 2^{16} = 65,536 colors (**Highcolor**)
- 24 bpp, $2^{24} \approx$ 16.7 million colors (**Truecolor**)

Computer display standard

For **color depths of 15** or **more** bits per pixel, the depth is normally the sum of the bits allocated to each of the red, green, and blue components(**RGB**).

Highcolor, usually meaning 16 bpp, normally has **five bits** for **red** and **blue**, and **six bits** for **green**, as the human eye is more sensitive to errors in green than in the other two primary colors.

Computer display standard

For applications involving **transparency**, the **16 bits** may be divided into five bits each of red, green, and blue, with one bit left for transparency.

A **24-bit** depth allows 8 bits per component.

On some systems, **32-bit** depth is available: this means that each 24-bit pixel has an extra 8 bits to describe its **opacity** (for purposes of combining with another image).

Applications of Computer Graphics

- ✓ Computer Aided Design (CAD)
- ✓ Computer Aided Geometric Design (CAGD)
- ✓ Entertainment (animation, games, etc.)
- ✓ Computer Art
- ✓ Presentation Graphics
- ✓ Education and Training
- ✓ Geographic Information Systems (GIS)
- ✓ Visualization (Scientific Vis., Inform. Vis.)
- ✓ Medical Visualization
- ✓ Image Processing
- ✓ Graphical User Interfaces

Types of Computer Graphics

Two Types of Computer Graphics:
1. Interactive Graphics
2. Non-Interactive/ Passive Graphics

Interactive Computer Graphics

- It involves two way communication between computer and user.
- User is given control over the image by providing an input device that takes the user request to the computer.
- Example: Flight simulator used to train pilots.

Advantages: Fuel saving, safety.

Another example is video game controller.

2. Non-Interactive Graphics / Passive Graphics

- In this type of computer graphics, user has no control over the images.
- Images are displayed with the help of a static stored program and according to the instructions that are written in the program.
- Example: screensavers.

Q-1. Raster Graphics Are Composed Of

a) Paths
b) Palette
c) Pixels
d) None Of These
Ans-pixels

Q-2. Raster Images Are More Commonly Called

a) Pix Map
b) Bitmap
c) Both A & B
d) None Of These
Ans-bitmap

Q-7. Types Of Computer Graphics Are

Scalar And Raster
Vector And Raster
Vector And Scalar
None Of These
Ans- Vector And Raster

Q-4. The Brightness Of Each Pixel Is

a) Compatible
b) Incompatible
c) Both A & B
d) None Of These
Ans- Incompatible

Q-5. Each Pixel Has ________ basic Color Components

a) Two Or Three
b) One Or Two
c) Three Or Four
d) None Of These
ANS- Three Or Four