BSc Computer Science
CS1541 Computer Graphics

Module I

Introduction

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Overview

- Transformation and presentation of information in a visual form.
- Creation of pictures with the help of a computer
- Use of computers to create and manipulate pictures on a display device.
- Involves hardware and software
- Interactive computer graphics work using the concept of two-way communication between computer users.
- Pictures have to be DIGITIZED (reduced to lists of numbers) in order to be stored, processed or displayed

Applications

- Education and Training
- Presentation Graphics
- Entertainment
- Computer Art
- Printing Technology
- Computer User Interface
- Visualization
- Image Processing
- Biology and Medicine
- Animation
- Communication
- CAD

Advantages

- **Speed :** Increased Productivity.
- **Accuracy :** More accurate outcomes or products.
- **Compression : Less storage space**
- **Virtualization :** Increases the ability to understand information and interpret patterns significantly
- Superior Quality.
- Lower cost of development.

Basic Terms

- Pixel
- Resolution
- Aspect Ratio
- Bitmap
- Raster Graphics
- Vector Graphics
- Graphics Files
- Image Formats

Pixel(Pel)

- A pixel, dots, or picture element is a physical point in a picture.
- The smallest addressable element of a picture represented on a screen.
- Each pixel has a particular colour and brightness value.
- Though the size of a pixel depends mostly on the size of the electron beam within the CRT, they are too fine and close to each other to be perceptible by the human eye.

Resolution

- The number of horizontal and vertical pixels on a display screen is called Resolution.
- **Types of Resolution:**

  1. Image Resolution
  2. Screen Resolution
- **Image Resolution:** It refers to the pixel spacing the distance from one pixel to the next pixel. In other words, the resolution of an image is the total number of pixels along with the entire height and width of the image.
- **Example:** A full-screen image with resolution 800×600 dpi means that there are 800 columns of dot pixels per inch and each column comprising 600 dot pixels per inch.(dpi)
  A total of **800×600 = 48000** dot pixels in sq. inches image area.
- **Screen Resolution:** Screen resolution is the number of pixels a screen, both horizontally and vertically. So, a screen that has a resolution of 3840 x 2160 it can display 2160 pixels vertically, and 3840 pixels horizontally.

Aspect Ratio

- Ratio of the number of X pixels to the number of Y pixels.
- The standard aspect ratio for PCs is 4:3.
- Some common resolutions, the respective number of pixels and standard aspect ratio are given below:

Resolution	Number of Pixels	Aspect Ratio
320x240	76800	4:3
640x480	307200	4:3
800x600	480000	4:3
1024x768	786432	4:3
1280x720	921600	16:9
1920x1080	2073600	16:9

Bitmap

- A mapping from some domain (for example, a range of integers) to bits, that is, values which are zero or one.
- Also called a bit array or bitmap index.
- The more general term pixmap refers to a map of pixels, where each one may store more than two colors, thus using more than one bit per pixel.
- Often bitmap is used for this as well.
- In some contexts, the term bitmap implies one bit per pixel, while pixmap is used for images with multiple bits per pixel.

Raster Graphics

- Raster images use bit maps to store information.
- This means a large file needs a large bitmap. The larger the image, the more disk space the image file will take up. As an example, a 640 x 480 image requires information to be stored for 307,200 pixels, while a 3072 x 2048 image (from a 6.3 Megapixel digital camera) needs to store information for a whopping 6,291,456 pixels. We use algorithms which compress images to help reduce these file sizes. Image formats like jpeg and gif are common compressed image formats. Scaling down these images is easy but enlarging a bitmap makes it pixelated or simply blurred. Hence for images which need to scaled to different sizes, we use vector graphics.
  File extensions: .BMP, .TIF, .GIF, .JPG

Vector Graphics

- Making use of sequential commands or mathematical statements or programs which place lines or shapes in a 2-D or 3-D environment is referred to as Vector Graphics. Vector graphics are best for printing since it is composed of a series of mathematical curves. As a result vector graphics print crisply even when they are enlarged. In physics: A vector is something which has a magnitude and direction. In vector graphics, the file is created and saved as a sequence of vector statements. Rather than having a bit in the file for each bit of line drawing we use commands which describe series of points to be connected.AS a result a much smaller file is obtained.
- **File extensions :** .SVG, .EPS, .PDF, .AI, .DXF

Raster Graphics vs Vector Graphics

Raster Graphics	Vector Graphics
Raster images are the collection of the pixel.	The Vector images are composed of paths.
Scan conversion is required.	Scan Conversion is not required.
Raster Graphics are less costly.	Vector Graphics are more costly compared to raster graphics.
Raster image takes less space to store.	Vector image takes more space.
Raster graphics can draw mathematical curves, polygons, and boundaries.	Vector graphics can only draw continuous and smooth lines.
File Extension: .BMP, .TIF, .JPG etc.	**File Extension:** .SVG, .PDF, .AI etc.

Graphics Files

- Computer file containing an image or picture in digital format.
- Are often large, so they need to be stored in compressed formats
- Rectangular array of dots called pixels.
- The size of the image is specified in terms of width X height, in numbers of the pixels.
- Resolution is usually measured in DPI (Dots Per Inch).
- The number of the bits per pixel is called the depth of the image.

Image Data Types

- Monochrome and colored images
- **1-bit images**- each pixel is stored as a single bit (0 or 1)
- **8-bit Gray level images**- Each pixel of 8-bit gray level image is represented by a single byte (8 bits). Each pixel of such image can hold 2^8=256 values between 0 and 255
- **8-bit color images** - One byte (8 bits) represents each pixel. The maximum number of colors that can be displayed at once is 256.
- **24-bit color images** -Each pixel is represented by three bytes, usually representing RGB (Red, Green and Blue).

Image File Formats

- Describes how data related to the image will be stored. Data can be stored in compressed, Uncompressed or vector format.
- **JPEG- Joint Photographic Experts Group**
- **GIF - Graphic Interchange Format**
- **PNG- Portable Network Graphics**
- **TIFF- Tagged Image File Format**
- **BMP- Bitmap**
- **EPS- Encapsulated Postscript**
- **PDF- Portable Document Format**
- **EXIF- Exchange Image File**
- **WMF- Windows Meta File**
- **RAW Image Files (.raw, .cr2, .nef, .orf, .sr2, and more)**

Thank You