UNIT-3

Images and Graphics

An image is a spatial representation of an object, in a two-dimensional or three-dimensional scene. It can be real or virtual.

⊛. Digital Image Representation:

→ A digital image is represented by matrix of numeric values each representing a quantized intensity value. When I is two-dimensional matrix, then I(r, c) is the intensity value at the position corresponding to row(r) and column(c) of the matrix.

→ The point at which an image is sampled are known as picture elements, commonly abbreviated as pixels.

→ If there are just two intensity values for example black and white, they are represented by the numbers 0 & 1; such images are called binary-valued images.

→ When 8-bit integers are used to store each pixel value, the gray levels range from 0 (black) to 255 (white).

→ An image composed of pixels in an electronic/digital system is said to be digital image.

→ Digital image with higher dimension consists of higher no. of pixels and vice-versa which is directly proportional to quality of image.

⊛. Image file format:

1. JPEG (Joint Photographic Experts Group):

→ Common file format with highly supported format.
→ Uses lossy compression
→ Best for web images, email, powerpoint.
→ It's special attribute is that the amount of compression can be allocated.
→ It's file extension is .jpg or .jpeg.

GIF (Graphics Interchangable Format):

→ Widely used for web graphics and supports only 256 colors.
→ Uses lossless compression.
→ Best for web images.
→ It's special attribute is that it can be animated and can add transparency.
→ It's file extension/format is .gif.

PNG (Portable Network Graphics):

→ It is combination of good features of JPEG and gif with bigger file size and supports 16M colors.
→ Uses lossless compression.
→ Best for web images.
→ It's special attribute is it can add transparency.
→ It's file extension is .png.

Image Format:

Image format can be of two types:

1) Captured Image Format: The image format is specified by two main parameters: spatial resolution, which is specified as pixels, and color encoding, which is specified by bits per pixel. Both parameters depend on hardware and software values for input/output images.

Example: VideoPix™/SunVideo™ card:
Spatial resolution: 320 × 240 pixels
Color encoding: 1-bit (binary image), 8-bit (greyscale), 24-bit (color-RGB)

2) Stored Image Format: When we are storing an image, we are storing a two-dimensional array of values, in which each value represents the data associated with pixel in the image. For bitmap the value is binary digit. For color image, three numbers representing intensities of the red, green and blue. Some current file formats for storing image are gif, jpeg, png, bitmap, raw etc.

⊛. Graphics Format:

→ Graphics image formats are specified through graphics primitives and their attributes.

→ Graphics primitives and their attributes represent a higher level of an image representation i.e, either bitmap or pixmap.

→ A bitmap is an array of pixel values that map one by one to pixels on the screen.

→ A pixmap is a more general term describing a multiple bit-per-pixel image.

→ Bitmap formats and Vector formats are some of the examples of graphics format.

Advantages:

→ Reduction of the graphical image data.

→ Easier manipulation of graphical images.

Disadvantage:

→ Additional conversion step from graphical primitives and attributes to it's pixel representation.

Formats:

PHIGS (Programmer's Hierarchical Interactive Graphics Systems).
GIKS (Graphical Kernel System).

Raster Graphics	Vector Graphics.
i) Are composed of pixels.	i) Stores images as mathematical representation such as lines.
ii) Pixel dependent for the quality of an image.	ii) Pixel independent for the quality of an image.
iii) An image looses the quality while it's rescaled.	iii) Rescaled without loss of quality of an image.
iv) Supports compression.	iv) Usually does not support compression.
v) Larger size and less cost	v) Smaller size and higher cost.

Bitmap vs. Vector graphics:

Bitmap	Vector
i) A bitmap contains an exact pixel-by-pixel value of image.	i) A vector graphics contains mathematical description of objects.
ii) A bitmap file is fixed in resolution.	ii) A vector graphics is resolution independent.
iii) The file size of bit-map is completely determined by image resolution and its depths.	iii) The file size of vector graphics depends on the number of graphic elements it contains.
iv) A bitmap image is easier to render.	iv) Displaying a vector graphic usually involves a large amount of processing.

⊛. Image Synthesis, analysis and Transmission:

⊛ Computer Image Processing:-

Computer image processing consists of image synthesis, image analysis and image transmission.

1) Image Synthesis:-

Image synthesis is an integral part of all computer user interfaces and is essential for visualizing 2D, 3D and higher-dimensional objects. Areas like, education, science, engineering, medicine, advertisement, and entertainment all rely on graphics. Following are some representative samples:-

i) User Interfaces → Applications running on personal computers and workstations have user inter-faces that allow users to select menu items, icons and objects on the screen.

ii) Office automation and Electronic Publishing → Office automation and electronic publishing can produce both traditional printed documents and electronic documents that contain text, tables, graphs and other forms of drawn or scanned-in graphics.

iii) Simulation and Animation for Scientific Visualization and Entertainment:

Computer produced animated movies and displays of time-varying behaviour of real and simulated objects are becoming increasingly popular for scientific and engineering visualization. Cartoon characters will increasingly be modeled in computers as 3D shape descriptions.

⊛. Dynamics in Graphics:-

Graphics are not limited to static pictures. Pictures can be dynamically changed; for example, a user can control animation by adjusting speed, portion of the total scene in view, amount of detail shown etc. Hence, dynamics is an integral part of graphics.

Motion Dynamics → With motion dynamics, objects can be moved and enabled with respect to a stationary observer. The objects can also remain stationary and the view around them can move. In many cases, both the objects and the camera are moving.

Update Dynamics → Update dynamics is the actual change of the shape, color or other properties of the objects being viewed. The smoother the change, the more realistic and meaningful the result.

⊛. The Framework of Interactive Graphics System:-

Conceptual framework has the following elements:-

i) Graphics Library → Between application and display hardware there is graphics library / API.

ii) Application Program → An application program maps all application objects to images by invoking graphics.

iii) Graphics System → An interface that interacts between Graphics library and hardware.

iv) Modifications to images are the result of user interaction.

⊛. Graphics Input/Output hardware:

Graphics input hardware are used to transfer input to the computer. The data can be in the form of text, graphics, sound, and text. These devices include keyboard, mouse, trackball, joystick, light pen, image scanner etc.

Graphics output hardware are device to display data from the memory of the computer. Output can be text, numeric data, line, polygon and other objects. These output hardwares accept data from a computer and translates them into form understand by users. Plotters, monitors, Printers are output hardware devices.

⊛. Dithering: Dithering is a image processing algorithm able to simulate the illusion of new colors and shades by varying the pattern of available colors. It is process by which we create illusions of the color that are not present actually. It is done by random arrangement of pixels. Color dithering smoothes out images by creating intermediate shades between two or more extreme colors, called a blend. Dither is applied in the form of noise to prevent quantization error. It is commonly used in the processing of both digital audio and video data.

2) Image Analysis:

Image analysis is concerned with techniques for extracting descriptions from images that are necessary for higher-level scene analysis methods. Image analysis techniques include computation of preceived brightness and color, partial or complete recovery of three-dimensional data in the scene. Image analysis is important in many areas: aerial surveillance photographs, slow-scan television images of the moon or of planets gathered from space, X-ray images. Subareas of image processing include image enhancement, pattern detection and recognition, and scene analysis and Computer vision.

⊛. Image Recognition:

To fully recognize an object in an image means knowing that there is an agreement between the sensory projection and the observed image. How the object appears in the image has to do with the spatial configuration of the pixel values. Agreement between the observed spatial configuration and the expected sensory projection requires the following capabilities:

→ Infer explicitly or implicitly an object's position and orientation from the spatial configuration.
→ Confirm that the inference is correct.

⊛. Image Recognition Steps:

1) **Conditioning:** Conditioning is based on a model that assumes that the observed image is composed of an informative pattern modified by uninteresting variations. It estimates informative pattern based on the basis of observed image. Conditioning can also perform background normalization by suppressing uninteresting systematic or patterned variations. Conditioning is typically applied uniformly and is context-independent.

2) **Labeling:** It is based on a model that assumes that the informative pattern has structure as a spatial arrangement of events. It determines in what kind of spatial events each pixel participates. Labelling operation includes: edge detection, corner detection, thresholding, and identification of pixels that participate in various shape primitives.

3) **Grouping:** Grouping identifies events by collecting or identifying maximal connected sets of pixels, participating in the same kind of event. It determines new sets of entities. It changes the logical data structure. For e.g. Line-fitting is a grouping operation, where edges are grouped in lines.

4) Extracting: The grouping operation determines the new set of entities but they are left naked in the sense that the only thing they posses is their identity. The extracting operation computes for each group of pixels a list of properties, for e.g. centroid, area, orientation etc. It can also measure topological or spatial relationships between two or more groupings.

5). Matching: It determines the interpretation of some related set of image events recognised previously with the extracting step. It associates events with some given 3D objects or 2D shapes. Template matching is a classical example of a wide variety of matching operations, compares examined pattern with known and stored models and chooses the best match.

⊛3). Image Transmission:

→ Image transmission takes into account transmission of digital images through computer networks.

→ There are several requirements on the networks when images are transmitted:

i) The network must accomodate bursty data transport.

ii) Image transmission requires reliable transport.

iii) Time-dependence is not a dominant characteristic of the image in contrast to audio/video transmission.

→ Image size depends on the image representation format used for transmission. There are several possibilities:

i) Raw image data transmission: In this case, image is generated through a video digitizer, and transmitted in its digital format. The size can be computed in following manner:

$$\text{size} = \text{spatial\_resolution} \times \text{pixel\_quantization}.$$

ii) Compressed image data transmission: In this case, image is generated through a video digitizer and compressed before transmission. The reduction of image size depends on the compression method and compression rate.

iii) Symbolic image data transmission: In this case, image is represented through symbolic data representation as image primitives, attributes and other control information. Image size is equal to the structure size, which carries the transmitted symbolic information of the image.