CHAPTER – 3

Images and Graphics

Image representation
The Nature of Digital Image:

- An image is a spatial representation of an object, a two-dimensional or three-dimensional scene or another image.
- The images often reflect the intensity of lights.
- Most photographs are called continuous tone images because the method used to develop the photograph creates the illusion of perfect continuous tone throughout the image.
- Images stored and processed by computers, displayed on computer screens are called digital images although they often look like continuous tone. This is because they are represented by a matrix of numeric values each represents a quantized intensity values.

Basic concept:

The smallest element on digital image is known as a pixel- a picture element. A digital image consists of a (usually rectangular) matrix of pixels.

Digital Image Representation:

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

The points at which an image is sampled are known as picture elements, commonly known as pixels. The pixels values of intensity images are called Gray scale levels. The intensity at each pixel is represented by an integer and is determined from the continuous image by averaging over a small neighbourhood around the pixel location.

- If there are just two intensity values, for example, black and white, they are represented by the numbers 0 and 1, such images are called binary-valued images.
- When 8-bit integers are used to store each pixel value, the Gray levels range 0 (black) to 255 (white).
- Digital pictures are often very large. For example, suppose we want to sample and quantize an ordinary (525-line) television picture with a VGA video controller, so that it can be redisplayed without noticeable degradation. We must use a matrix of 640x480 pixels, where each pixel is represented by an 8-bit integer.

Image and Graphic Format
Image Format:

There are different kinds of image formats: captured image format and stored image format.

(i) Captured Image Format:

The image format is specified by two main properties spatial resolution, which is specified as Pixel x Pixel and colour encoding, which is specified by bits/pixel. Both parameter values depend on hardware and software for input/output images.

Sun video offers capture and compression of video at resolution (320x240) pixels in several formats.
cellB – 30 fps (frames per second)
JPEG – 30 fps
MPEG1 I frames – 30 fps
MPEG1 IP frames – 17 fps
Capture YUV – 30 fps
Capture RGB – 30 fps
Capture RGB-24 – 12 fps

(ii) Stored Image Format:

When we store an image, we are storing a two-dimensional array of values, in which each value represents the data associated with a pixel in the image. For a bitmap, this value is a binary digit. For a color image, the value may be a collection of:

- Three numbers representing the intensities of red, green and blue components of the colour at that pixel.
- Three numbers that are indices to tables of red, green and blue intensities.
- A single number that is an index to a table of colour triples.
- An index to any number of other data structures that can represent a colour including XYZ colour systems.
- Four or five samples for each colour.

In addition, each pixel may have other information associated with it.

Graphics Format:

- Graphics image formats are specified through graphics primitives and their attributes.
- To the category of graphics primitives belong lines, rectangles, circles and ellipses, text strings specifying two-dimensional objects (2D) in graphical image or example, polyhedron, specifying three-dimensional objects (3D).
- A graphics package determines which primitives are supported. Attributes such as line style, line width and color affect the outcome of the graphical image.
- Graphics primitives and their attributes represent a higher level of an image representation i.e. the graphical images are not represented by a pixel matrix. This higher level of representation needs to be converted at some point of the image processing into the lower level of the image representation.
  For Example, When an image is to be displayed. The advantage of the higher level primitives is the reduction of data to be stored per one graphical image and easier manipulation of the graphical image. The disadvantage is the additional conversion step from the graphical primitives and attributes and generates either bitmap or pixmap.

Computer Image Processing:

Computer graphics concern the pictorial synthesis of real or imaginary object form their computer based models. The related field of image processing treats the converse process, the analysis of scene or the reconstruction of models from pictures of 2D and 3D objects.

Image Synthesis:

Image synthesis is an integral part of all computer user interfaces and is indispensable for visualizing 2D, 3D and higher level dimensional objects. Areas as diverse as education, science, engineering, medicine, advertising and entertainment all rely on graphics. Some representative samples of Image synthesis.

(i) User Interface: Applications running on personal computers and workstations have user interfaces that rely on desktop window systems to manage multiple simultaneous activities and on point and click facilities to allow users to select menu items, icon 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. Example, Hypermedia Systems that allow browsing network of interlinked multimedia documents.

- 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 scientific and engineering visualization.

Image Analysis:

- Image Analysis is concerned with techniques for extracting descriptions from images. By itself, knowledge of the position and value of any particular pixel almost conveys no information related to recognition of an object, the description of an objects shape, its position and orientation, the measurement of any distance on the object or whether the object is defective.
- Hence, image analysis techniques include computation of perceived brightness and color, partial or complete recovery of three-dimensional data in the scene, location of discontinuous corresponding to objects in the scene and characterization of the properties of uniform regions in the image.
- Image analysis is important in many areas:
    - Aerial Surveillance photographs
    - Slow scan television images of the moon or planets gathered from space probes.
    - Television images taken from an industrial robot's visual sensor.
    - X-ray images and computerized axial tomography (CAT) scans.
- Sub-areas of image processing include:
    - Image enhancement
    - Pattern detection and recognition
    - Scene analysis and computer vision

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 accommodate busty data transport because image transmission in busty.

ii. Image transmission requires reliable transport.

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

Images 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 the following manner.

size=spatial-resolution x pixel-quantization
if image resolution=640x480 pixels
pixel quantization=8 bits per pixel
Transmission size=307200 bytes

(ii) Compressed Image data transmission:

In this case, the image is generated through a video digitizer and compressed before transmission. Methods such as JPEG or MPEG are used to downsize (compress) the image. The reduction of image size depends on the compression method and compression rate.

(iii) Symbolic image data representation:

In this case, the image is represented through symbolic data representation as image primitives (example, 2D or 3D geometric representation), attributes and other control information. This image representation method is used in computer graphics.