# MULTIMEDIA SYSTEM

CACS457 BCA - IV/VIII

UNIT 3 – IMAGES AND GRAPHICS

2024

# Chapter Outlines

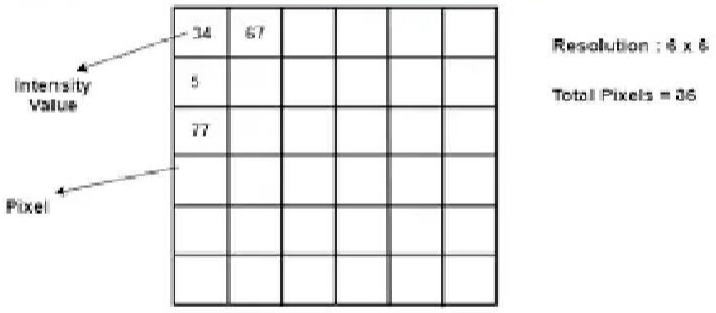
- *Uses of Images and Graphics*
- *Digital Image Representation*
- *Image and graphics Format*
- *Working with image and graphics*
- *Image synthesis, analysis and Transmission*



# Introduction

- *Images and Graphics are an important part of the communication process as well as in multimedia.*
- *An image is a visual representation of an object, scene, or idea. It's a two-dimensional portrayal that captures the essence of something, typically using elements like shapes, colors, and light and shadow.*
- *In the digital world, images are broken down into tiny squares called pixels. Each pixel has a specific color value, and the arrangement of these colored pixels creates the overall image we see.*
- *An image is a spatial representation of an object, a two dimensional or three dimensional scenes or another image.*
- *In multimedia systems, an image is a picture that has been created or copied and stored in electronic format.*
- *An image consists of a rectangular array of data called Pixel.*
- *The physical size of image in inch/cm depends on resolution of device on which the image is displayed.*

# Introduction

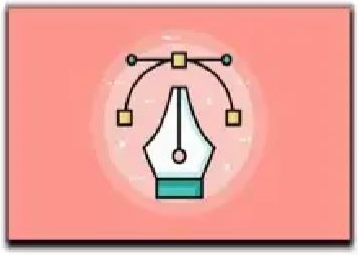



Digital Image

- *Digital Image Representation*
- *For computer representation, function (e.g. intensity) must be sampled at discrete intervals.*
- *Sampling quantizes the intensity values into discrete intervals.*
- *Point at which an image is sampled are called picture elements or pixels.*
- *Resolution specifies the distance between points accuracy.*
- *A digital image is represented by a matrix of numeric values each representing a quantized intensity value.*
- *A digital image is a numeric representation (normal binary) of two dimensional images. When I is a two-dimensional matrix, then I (r, c) is the intensity value at the position corresponding to row r and column c of the matrix.*
- *Intensity value can be represented by bits for black and white images (binary valued images), 8 bits for monochrome imagery to encode color or grayscale levels, 24 bit (RGB).*



- *Types of Images:*
- *Vector Images and Bitmap Images*
- *difference - how they store and represent visual information.*
- *Vector-based Images*
- *defined by mathematical relationship between points, lines, curves, and shapes connecting them to describe an image.*
- *Each object is independent entity with proportion such as color, shape, size, outline and position on the screen.*
- *Smaller file size compared to bitmaps for similar complexity.*
- *Maintain sharp edges and smooth curves even when resized.*
- *Ideal for logos, icons, illustrations, and scalable graphics.*
- *Vector based images are digital images whose representation is compact, scalable and resolution independent means they can Produce highest quality at any scale.*



- *Bitmap Images (Raster Image)*
  - *made up of with individual dots called Pixel that are arranged and colored differently to form a pattern.*
  - *Bitmap images are resolution dependent and must taken into consideration while producing image of different size and quality.*
  - *Resolution is the number of pixels in an image, referred as dpi(dots per inch)*
  - *Larger file size compared to vectors for similar complexity.*

    *Image size = width in pixels * height in pixels*
  - *A pixel is the smallest display element that makes up the images seen on the television and computer monitors.*

  - *Ideal for photographs, realistic images, and capturing fine details.*
  - *Examples: Digital photographs, scanned documents, web graphics.*
  - *Bit depth refers number of colors which can be stored within each pixel.*

- *Types of colors in images:*
- *1-bit image (monochrome)*
  - *Also referred as binary image*
  - *Each pixel stored as a single bit*
  - *Contains no color*
  - *Mainly used for line art*
  - *0 –black and 1 –white*
  - *Representation, 2^1 = 2 colors or values*
- *8-bit image (grayscale)*
  - *Representation, 2^ 8 = 256 colors or values*
  - *0 for black and 255 for white*
  - *Here, one can find how each pixel is a shade of gray.*



- *Types of colors in images:*
- *24-bit image (3 channels)*
  - *Contains 24 bits per pixel*
  - *Each pixel is represented by three bytes, usually representing RGB.*
  - *Representation, 2^ 24 = 16.7 million colors or values*
  - *256 * 256 * 256*

| Feature | Vector Graphics | Bitmap (Raster) Graphics |
|---|---|---|
| Definition | Graphics made of mathematical paths | Graphics made of pixels |
| Resolution | Resolution-independent (scalable) | Resolution-dependent (fixed resolution) |
| Quality at Scaling | No loss of quality when scaled | Loss of quality and pixelation when scaled |
| File Size | Typically smaller for simple graphics | Typically larger, especially for high-res |
| Editing | Easier to edit individual elements | More difficult to edit specific parts |
| Use Cases | Logos, icons, illustrations, fonts | Photographs, detailed images, textures |
| File Formats | SVG, EPS, AI, PDF | JPEG, PNG, GIF, BMP, TIFF |
| Rendering | Requires rendering to raster for display | Directly displayable |
| Detail and Complexity | Limited by complexity of paths | Can represent very detailed and complex images |
| Software | Adobe Illustrator, CorelDRAW, Inkscape | Adobe Photoshop, GIMP, MS Paint |

# Uses of Images and Graphics

- *Images and graphics are crucial elements in multimedia systems, enhancing the user experience and communication across various platforms.*
- *Enhanced Communication: Images and graphics can represent ideas, concepts, and data visually, making communication more effective.*
- *User Interface Design: Icons and graphical buttons make interfaces more intuitive and easier to navigate.*
- *Information Visualization: Easy data representation such as charts, graphs, and infographics present data in an easily digestible format, helping users understand complex information quickly.*
- *Highlighting Trends: Visual representations can highlight trends, patterns, and correlations in data.*
- *Educational Tools: Educational software uses images and graphics to create interactive learning experiences, such as simulations and virtual labs.*



# Uses of Images and Graphics

- *Entertainment*
- *Gaming: High-quality graphics are essential in video games to create immersive environments and realistic characters.*
- *Animation and Film: Animated movies and special effects in films rely heavily on graphics to tell stories and create visual interest.*
- *Marketing and Advertising : Visual Branding, logos, promotional images, and advertisements use graphics to establish and reinforce brand identity.*
- *Engaging Content: Eye-catching visuals in advertisements and social media posts attract and retain audience attention.*
- *Virtual Reality (VR) and Augmented Reality (AR): High-quality graphics create immersive environments in VR applications, enhancing the sense of presence. AR applications overlay graphical information on the real world, providing additional context and interactivity.*
- *E-commerce Product Visualization: High-resolution images and 360-degree views of products help consumers make informed purchasing decisions.*

- *Image Format*
- *There are different kinds of image formats. We shall consider the image format that comes out of an image frame grabber, i.e., the captured image format, and the format when images are stored.*

*(i) Captured Image Format*

- *The image format is specified by two main parameters: spatial resolution, which is specified as pixels x pixels (e.g. 640x480) and color encoding, which is specified by bits per pixel.*
- *Both parameter values depend on hardware and software for input/output of images.*

*Example: VideoPix / SunVideo card: spatial resolution : 320 * 240 Pixels*

*Color Encoding: 1-bit (binary Image), 8-bit (grayscale), 24-bit (color - RGB)*

*(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 and for color image, 3 numbers representing intensities of RGB.*
- *Some of the file formats for image storing are gif, jpeg, png, tif, bitmap etc.*

- *Graphics Format*
- *Graphic image formats are specified through graphics primitives and their attributes.*
- *Graphic primitive – line, rectangle, circle, ellipses, specification 2D and 3D objects.*
- *Graphic attribute – line style, line width, color. Graphics formats represent a higher level of image representation, i.e., either bitmap or pixmap.*
- *Bitmap – array of pixel values that map one-by-one pixels on the screen.*
- *Pixmap – Describes multiple bit-per-pixel image.*
- *Formats:*
  - *PHIGS (Pfogfᵃmmef's Hierarchical Interactive Graphics)*
  - *GKS (Graphical Kernel System)*



- *Image and Graphics Format*
- *There are many file formats used to store bitmaps and vectored drawing. Following is a list of few image file formats.*

| Format | Extension |
|---|---|
| Microsoft Windows DIB | .bmp .dib .rle |
| Microsoft Palette | .pal |
| Autocad format 2D | .dxf |
| JPEG | .jpg |
| Windows Meta file | .wmf |
| Portable network graphic | .png |
| Compuserve gif | .gif |
| Apple Macintosh | .pict .pic .pct |

- *Image and Graphics Format*
- *JPEG (Joint Photographic Experts Groups)*
  - *commonly used file format for digital images, particularly photographs.*
  - *It employs lossy compression to reduce file size, which can result in some loss of image quality.*
  - *PEG files are widely supported across various platforms and devices.*
  - *best suited for complex images with gradients and color variations, though not ideal for images with text or sharp edges due to potential artifacts.*
  - *File extensions include .jpg and .jpeg.*
  - *Best for web images, email, PowerPoints*

- *GIF (Graphics Interchangeable Format)*
- *It is a bitmap image format widely used for simple graphics and animations.*
- *It supports up to 256 colors, using lossless compression to maintain image quality without data loss.*
- *GIFs can include multiple frames, making them ideal for short, looping animations and memes.*
- *They support transparency but lack the color depth needed for high-quality photographs.*
- *Common file extension is .gif.*

- *PNG (Portable Network Graphics)*
- *Raster graphics file format known for its lossless compression, preserving image quality without data loss.*
- *It supports a wide range of colors, including 24-bit RGB and 32-bit RGBA, allowing for high-quality images and transparency.*
- *PNG is ideal for images requiring sharp detail and clear text, such as logos, icons, and web graphics.*
- *The format is widely supported across various platforms and applications.*
- *Common file extension is .png.*
- *PNG can be used for editing photographs without losing quality through repeated savings like JPEG.*

- *TIFF (Tagged Image File Format)*
- *high-quality raster graphics format known for its ability to store detailed images without loss of quality, using either lossless compression or uncompressed formats.*
- *It supports multiple color spaces, including grayscale, RGB, and CMYK, and can handle high bit depths for greater color precision.*
- *TIFF files can contain multiple pages in a single file, making them ideal for document storage and professional printing.*
- *This format is widely used in photography, publishing, and archiving due to its versatility and extensive metadata support.*
- *Common file extensions are .tif and .tiff.*

- *Image File Size*
- *Depends on total number of pixels & number of bits per pixel (quantization).*
- *Image file size = W*L*n bits*

*where, W - Width (Pixels), L – Length (Pixels), n – number of bits per pixel*



- ~~Dynamics in Graphics:~~
- *Graphics aren't limited to static pictures. Pictures can be dynamically varied, for instance, a user can control animation by adjusting speed, portion of total scene in view, amount of details shown etc. Hence, dynamics is an integral part of graphics.*
- *Motion Dynamics:*
- *Here, Objects can be moved and enabled with respect to stationary observer. The objects can also remains stationary and the view around them can move. In many cases, both the objects and the camera/observer are moving.*
- *Update Dynamics:*
- *Here, the actual change of shape, color, or other properties of the objects being viewed.*
- *The smoother the change, the more realistic and meaningful the image/result.*

- The Framework of Interactive Graphics System:
- *Image can be generated by video digitizer cards that capture NTSC (PAL) analog signals and create a digital image. Graphical images are generated using interactive graphics systems. Conceptual framework has following software components:*

1) *Application Model:*

- *The application model represents the data or objects to be picture on the screen; it is stored in an application database.*
- *The model is an application-specific and is created independency of any particular display system Between application and display hardware there is graphics library/API.*

2) *Application Program:*

- *The application program handles user input. It produces views by sending to the third component, the graphics system, a series of graphics output commands that contain both a detailed geometric description of what is to be viewed and the attributes describing how the objects should appear.*

3) *Graphics System:*

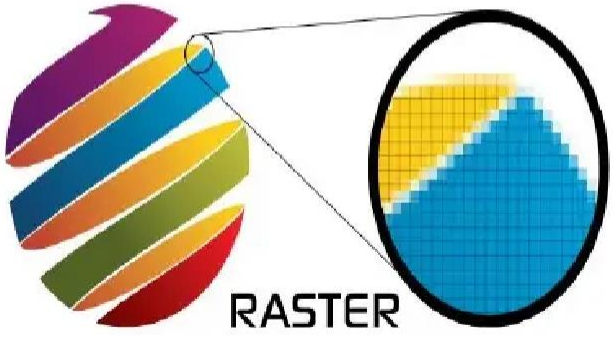
- *It is responsible for producing the picture from the detailed descriptions and for passing the usef's input to the application program for processing.*
- *It is an intermediary component between the application program and the display hardware.*

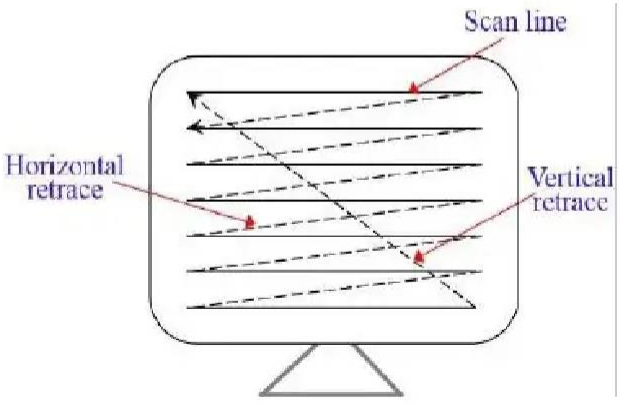
- Graphics Harware:
- At the hardware level, a computer receives input from interaction devices and output images to display devices.
- Graphics Input hardware *are used to transfer input to the computer.*
- *The data can be in the form of texts, graphics, sound and images. These devices includes keyboard, mouse, trackball, joystick, image scanner etc.*
- *Track-ball can be made to sense rotation about the vertical axis in addition to the about two horizontal axes.*
- *A space-ball is a rigid sphere containing strain gauges. User pushes/pulls the sphere in any direction, providing 3D translation and orientation.*
- *Graphics output hardware are the devices to display data from the memory of the computer.*
  *Output can be text, numeric data, line, polygon, images and other objects.*
- *It accepts data from computer and translates into form understood by users.*
- *Plotters, monitors, printers are the output hardware devices.*



- Output: Raster Display
- *An image is subdivided into various horizontal lines which are referred to as scan lines which are then further divided into different pixels which helps in the processing of an image.*
- *In this system, a beam of an electron is moved across the screen. It moves from top to bottom considering one row at a time.*
- *When each scan of the line is refreshed it returns to the left side of the screen. This motion is known as Horizontal retrace.*
- *As a particular frame ends, the beam of electron moves to the left top corner of the screen to move to another frame. This motion is referred to as Vertical retrace.*
- *The picture is then stored in an area of memory which is referred to as the frame buffer or refresh buffer.*
- *The buffer in a raster scan is that area that is responsible for containing intensity of the various points on the screen.*
- *The values stored in the buffer are then fetched and traced over scan lines one by one on the screen*

- Output: Raster Display



- Output: Raster Display
- *Most common type of graphic monitors using raster scan display type CRT*
- *Point plotting device, Based on TV technology*
- *Electron beam is swept across the screen, one row at a time from top to bottom, starting at the upper left corner of the display*
- *Process is repeated until the entire screen is covered, and the beam is then returned to the upper left corner to start a new scan*
- *Beam intensity is turned on and off to create a pattern of illuminated spots*
- *Pictures are dynamically stored in a piece of memory known as frame buffer or refresh buffer.*
- *This buffer holds the set of intensity values all the screen points (pixels). Quality is determined by no. of pixels i.e resolution of the image.*
- *Requirement to control the intensity of the screen positions:*
  - *Simple black and white system - 1 bit per pixel (bitmap)*
  - *Color system - 24 bits/pixel (maximum no. of color representation, pixmap)*
- *Frame buffer or refresh buffer (storage) requirements:*
- *Large storage, e.g. 24 bits, screen resolution of 1024x1024 requires 3mb of RAM*
- *Refresh rate: 60 to 80 frames per second*

- *Advantages of Raster Scan Display:*
- *Capable of presenting bright pictures*
- *Unaffected by picture complexity*
- *Suitable for showing dynamic motion*
- *Lower cost*
- *Ability to display areas filled with solid colors or patterns*
- *Disadvantages of Raster Scan Display:*
- *Requires large amount of memory (RAM)*
- *Pfoduced "stªif stepped" ªppeªfª1ce of diªgo1ªl li1es o1 the imªge (k1ow1 ªs aliasing effect)*
- *True line cannot be represented exactly due to the discretization of the display surface (discrete nature of pixel representation)*

- *Dithering : Image Processing Technique*
- *Dithering is a technique used to simulate colors or shading.*
- *It's ª imªge pfocessi1g ªlgofithm ªble to simulªte the illusio1 of 1ew colofs ª1d shªdes by varying the pattern of available colors.*
- *It is the process which concerns on creating illusion of colors that are not present actually.*
- *And is done by random arrangement of pixels.*
- *Color dithering smoothens 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. And is commonly used in digital audio, image and video data.*
- *Example: Dithering in Photoshop*

- *Programs like Photoshop allow photographers and graphic artists to add exciting nuances to their images. A typical application is to change a black-and-white photo into one that is aged with dithering is as shown below.*
- *By adding some textures and color fills, Photoshop can render this image into an artistically dithered image as seen below.*



# *Image Synthesis, analysis and Transmission*

## *~~Computer image processing~~:*

- *Consists of image synthesis, image analysis and image transmission*
- *Computer graphics deal with the graphical synthesis of real or imaginary images from computer-based models. In contrast to this technique, image processing involves the opposite process, that is, the analysis of scenes, or the reconstruction of models from images representing 2D or 3D objects.*
- *Image synthesis is the process of generating digital images from scratch or by manipulating existing images using algorithms and computational techniques.*
- *Concept and Goals:*
- *The goal of image synthesis is to produce realistic or creative images that can be used for various purposes. This can involve:*
- *Generating entirely new images: Like creating a photorealistic landscape that doesn't exist in the real world.*
- *Modifying existing images: This could involve editing an image to add or remove objects, changing the background, or creating different variations of the same scene.*

# Image Synthesis, analysis and Transmission

## ~~Image synthesis Tech~~niques

- Image synthesis relies on various techniques, with advancements driven by artificial intelligence (AI) and machine learning (ML). Some common approaches are:
- Generative Adversarial Networks (GANs): This is a popular technique where two neural networks compete with each other. One network (generator) generates images, while the other network (discriminator) tries to distinguish the generated images from real ones. This competition helps the generating network create increasingly realistic images.
- Autoencoders: These are neural networks trained to compress an image into a smaller representation and then reconstruct it back to its original form. This process can learn the underlying patterns in images and be used to generate new variations based on those patterns.
- Template-based methods: These techniques use existing images as templates and manipulate them to create new variations. This could involve swapping objects, applying different textures, or changing the lighting.
- https://www.youtube.com/watch?v=J1aG12dLo4I

# Image Synthesis, analysis and Transmission

## Image synthesis Applications

- Image synthesis has a wide range of applications across various fields:
- Entertainment: Producing concept art for animation or design, as well as special effects for movies and video games.
- Medicine: Drug discovery or training objectives using the simulation of medical images.
- Engineering: Here, it is used for designing and building virtual environments or prototypes for product testing.
- Art and design: Developing original artistic styles and investigating creative potential.
- Science and research: Visualizing scientific data or creating simulations of complex phenomena.



# Image Synthesis, analysis and Transmission

## Image Analysis

- Image analysis is concerned with techniques for extracting descriptions from images that are necessary for high-level scene analysis methods.
- This includes computation of perceived brightness and color, partial or complete recovery of three- dimensional data in the scene, location of discontinuities corresponding to objects in the scene and characterization of the properties of uniform regions in the image.
- Image processing includes image enhancement, pattern detection and recognition and scene analysis and computer vision.
- Image enhancement deals with improving image quality by eliminating noise or by enhancing contrast.
- Pattern detection and recognition deal with detecting and clarifying standard patterns and finding distortions from these patterns.
- Scene analysis and computer vision deal with recognizing and reconstructing 3D models of a scene from several 2D images.
- It may deal with calculating the intensity, hue, saturation of the image, the centroid, and identification of noise, detection of patterns or recognition of the image itself.

# Image Synthesis, analysis and Transmission

## Image Analysis Applications

- Numerous fields find image analysis to be highly significant, including criminology, biometrics, aerial surveillance photography, medicine, slow scan television images of the moon, and space probe plates, as well as machine vision.
- Image analysis is used in areas such as
  - Aerial surveillance photographs
  - Slow scan images of the moon or of planets gathered from space probes
  - Television images taken from an industrial robot's visual sensor
  - X-ray images and computerized axial tomography (CAT) scans, etc.
- Sub-areas of image analysis includes,
- Image Enhancement : deals with improving image quality by eliminating noise (extraneous or missing pixels) or by enhancing contrast.
- Pattern Detection and Recognition :deals with detecting and clarifying standard patterns and finding distortions from these patterns.
- Scene Analysis and Computer Vision : deals with recognizing and reconstructing 3D models of a scene from several 2D images.
- An example is an industrial root sensing the relative sizes, shapes, positions and colors of objects.

# Image Synthesis, analysis and Transmission

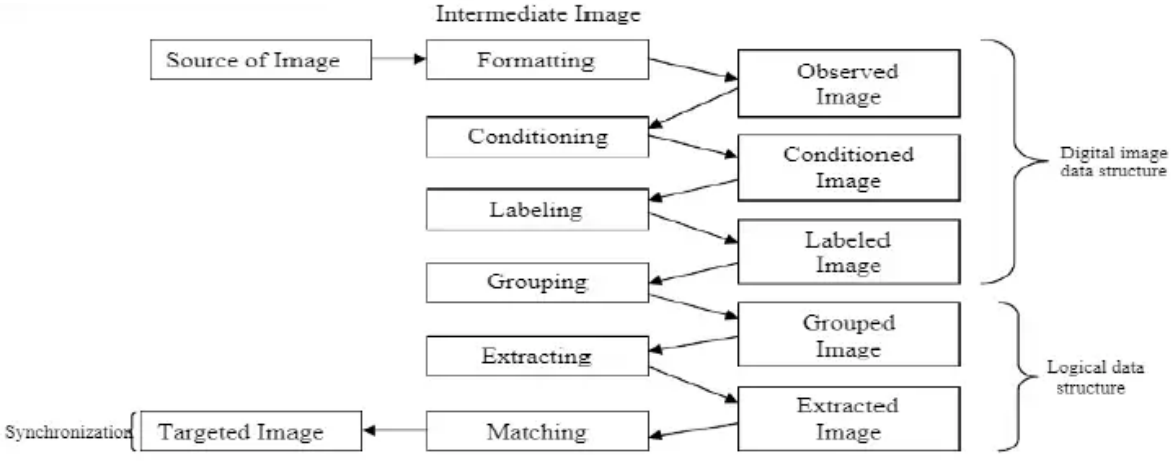
~~Image Recognit~~ion

- Recognition of an object means knowing that there is an match between the sensorial projection (eg. By a camera) and the observed image.
- How an object appears in an image depends on the spatial co1figufªtio1 of the pixel values.
- Spatial configuration refers arrangement, layout, and relationships between objects, features and elements within an image or scene.
- The following conditions have to be met for the observed spatial co1figufªtio1 and the expected projection to match:
  - position and orientation of an object can be explicitly or implicitly derived from the spatial co1figufªtio1,
  - verify that the derivation is correct.
- To derive the position, orientation, and category of an object (e.g., a cup) from the spatial co1figufªtio1 of gray levels, we need a way to determine the pixels that are part of an object.
- we need a way to distinguish various observed object characteristics from the pixels that are part of an object, for e.g., special markings, lines, curves, surfaces, or object boundaries (e.g.,the rim of a cup).



# Image Synthesis, analysis and Transmission

Image Recognition Steps:



## Image Recognition Steps:

- Formatting of an Image
- The formatting step shoots image by using camera and bringing it into a digital form, It means that we will have a digital representation of an image in the form of pixels.
- The five steps of image recognitions are:

1. Conditioning

- It is based on a model that assumes an image that can be observed is composed of information patterns, which are disturbed by irrelevant variations. In image, there is usually uninteresting object introduced during digitize as noise.
- While conditioning, interesting objects are highlighted by suppressing or analyzing uninteresting in systematic or patterned variations.
- Also, conditioning can normalize the background by ignoring irrelevant systematic or patterned variations.
- The typical conditioning process is independent from the context.

# Image Synthesis, analysis and Transmission

## Image Recognition Steps:

2. Labeling or Marking

- The informative pattern has structure as a spatial arrangement of events, each spatial event being a set of connected pixels.
- Labeling determines in what kinds of spatial events each pixel participates.
- E.g. edge detection technique, determines continuous adjacent pairs which differ in intensity or color.
- Another labeling operation must occur after edge detection, namely thresholding.
- It specifies which edges should be accepted and which should not; the thresholding operation filters only the significant edges from the image and labels them.

3. Grouping

- It can turn edges into line by determining edges belongs to same spatial event.
- A grouping operation, where edges are grouped into lines, is called line filtering.
- The grouping operation involves a change of logical data structure.



# Image Synthesis, analysis and Transmission

## Image Recognition Steps:

4. Extracting

- Generating list of properties from set of pixel in spatial event.
- The extracting operation computes for each group of pixels a list of properties. eg., Centroid, area, orientation
- Extraction can also measure topological or spatial relationship between two or more grouping.

5. Matching

- It is the matching operation that determines the interpretation of some related set of image events, recognized previously in extracting step.
- It associating these events with some given three dimensional object or two-dimensional shape.
- The classic example is template matching, which compares the examined pattern with stored models (templates) of known patterns and chooses the best match.

# Image Synthesis, analysis and Transmission

## 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:
  - The network must accommodate bursty data transport because image transmission is bursty (The burst is caused by the large size of the image).
  - Image transmission requires reliable transport.
  - 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:

1. Raw image data transmission:

- Image is generated from a video digitizer, and transmitted in digital format.
- Size computed as:
  - Size = spatial resolution * Pixel Quantization

# Image Synthesis, analysis and Transmission

*Image Transmission*

2. *Compressed image data transmission:*

- *Image is generated through a video digitizer, and compressed before transmission.*
- *Size reduction depends upon the compression rate and compression method.*

3. *Symbolic image data transmission:*

- *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.*