

Chapter 1 – Introduction

Objective: Understand basic image types, display, and simple manipulations.

1. Load and Display Images

- Load one grayscale image and one color image using MATLAB/Python.
- Display both images side by side.
- Observe and describe the difference between grayscale and color images in terms of channels, pixel intensity, and appearance.

2. Negative of an Image

- Generate the negative of a grayscale image by subtracting each pixel intensity from the maximum (255 for 8-bit images).
- Display the original and negative image side by side.
- Explain how the negative image affects visual perception.

3. Image Subsampling

- Downsample a grayscale image by factors of 2, 4, and 8.
- Display the subsampled images alongside the original.
- Discuss how image resolution and details change with subsampling.

Chapter 2 – Digital Image Fundamentals

Objective: Explore pixel operations, quantization, and bit-plane manipulation.

1. Gray-Level Quantization

- Reduce a grayscale image to 2, 4, 8, 16, and 256 gray levels.
- Display all versions.
- Discuss how quantization affects image quality and visibility of details.

2. Bit-Plane Slicing

- Extract all 8 bit-planes of an 8-bit grayscale image.
- Display them in order from the most significant bit (MSB) to the least significant bit (LSB).
- Explain which bit-planes contain most of the image information.

3. Pixel Neighborhood Analysis

- Choose a pixel from a grayscale image.
- List its 4-neighbors (top, bottom, left, right) and 8-neighbors (including diagonals).
- Explain the concept of pixel neighborhoods and their importance in filtering and edge detection.

Chapter 3 – Intensity Transformations & Spatial Filtering

Objective: Enhance images using intensity transformations and spatial filters.

1. Histogram and Histogram Equalization

- Plot the histogram of a grayscale image.
- Apply histogram equalization to enhance contrast.
- Display the original and equalized images and compare their histograms.
- Discuss how histogram equalization improves image visibility.

2. Contrast Stretching

- Perform linear contrast stretching on a low-contrast image.
- Display the original and stretched images.
- Explain the effect of stretching on pixel intensities and image appearance.

3. Smoothing with Spatial Filters

- Apply an averaging filter (3×3 and 5×5 kernel) to smooth a grayscale image.
- Display all smoothed images and compare the effect of kernel size on blurring.
- Explain how smoothing affects noise and details.

4. Sharpening with Laplacian Filter

- Apply a Laplacian filter to a grayscale image to enhance edges.
- Display the original and sharpened images.
- Describe how sharpening affects image features.

Chapter 4 – Filtering in the Frequency Domain

Objective: Learn to process images using frequency domain techniques.

1. Fourier Transform and Spectrum Visualization

- Compute the 2D Fourier Transform of a grayscale image.
- Display the magnitude spectrum using logarithmic scaling.
- Explain the significance of low and high-frequency components in the image.

2. Low-Pass Filtering in Frequency Domain

- Design and apply an Ideal Low-Pass Filter (ILPF) to blur an image.
- Display the filtered image alongside the original.
- Discuss how low-pass filtering removes high-frequency components.

3. High-Pass Filtering in Frequency Domain

- Design and apply an Ideal High-Pass Filter (IHPF) to enhance edges.
- Display the filtered image and compare it with the original.
- Explain how high-pass filtering highlights fine details.

4. Notch Filtering for Periodic Noise Removal

- Add synthetic periodic noise to a grayscale image (e.g., sinusoidal pattern).
- Design and apply a notch filter in the frequency domain to remove the noise.
- Display the noisy and filtered images.
- Explain how notch filtering isolates and removes specific frequency components.