CSCI 39534 - Digital Image Processing
Project Description: Part 2
Thresholding Techniques and Preprocessing

Project Overview

In this part of the project, students will apply various thresholding techniques introduced in class (e.g., Histogram Thresholding, Adaptive Thresholding, and Otsu's Method) to extract meaningful segments from project images. However, prior to applying any segmentation technique, students are required to preprocess the image to enhance the visual quality and remove noise and artifacts.

Each student will be assigned one of the parts. For the assigned section, students are expected to:

- Apply a minimum of **three preprocessing techniques** from earlier lessons such as:
  - Median filtering, Gaussian filtering, or Alpha-trimmed Mean filtering (for noise removal)
  - Histogram equalization or contrast stretching (for contrast enhancement)
  - Sobel or Canny edge detection (for edge enhancement and preservation)
- Follow with one or more thresholding techniques depending on the image:
  - Global Thresholding (Iterative or Histogram-based)
  - Adaptive Local Thresholding
  - Sauvola's Adaptive Thresholding
  - Otsu's Thresholding
- Compare results visually and analytically using PSNR and/or qualitative discussion.

Student Assignments

1. **Otsu Thresholding (Student 1)**
   Implement the Otsu thresholding technique on a grayscale image. Otsu's method automatically determines the optimal threshold based on the image histogram. Apply at

least three preprocessing steps prior to thresholding. Show the effect of Otsu thresholding on the project images (10) and compare it with results from adaptive thresholding methods.

2. **Adaptive Local Thresholding (Student 2)**
   Use the thresholding formula:

$$T[n,m] = k\left[\mu[n,m] + \frac{I_{\max}[n,m] - I_{\min}[n,m]}{M}\right]$$

   where M is the maximum pixel intensity, and k is a tunable constant. Apply 3 or more preprocessing steps (e.g., denoising, contrast enhancement, or edge detections) before thresholding. Try different values of k and visualize the binarized output for each case.

3. **Sauvola's Adaptive Thresholding (Student 3)**
   Use the Sauvola formula:

$$T[n,m] = \mu[n,m]\left(1 + k\left(\frac{\sigma[n,m]}{R} - 1\right)\right)$$

   Tune the parameters k, R, and window size. Apply 3 or more preprocessing steps to clean the image before thresholding. Experiment with different values of k and analyze the segmentation quality.

Deliverables

- Description and justification of preprocessing steps used
- Final thresholded images for each technique
- Comparison of results (visual and quantitative)
- Summary of parameter impact and segmentation effectiveness