CSE463 Lab Assignment 2

Deadline: March 8, 2025, 11:59PM

Submission instructions:

You will require a total of 7 different images in this assignment. The numbers are mentioned in square brackets.

- Open a folder in Google Drive and name it as- ID_Name_Lab2
    a. Upload the images you used (number them the way [..] is numbered, eg. Image 1, Image 2, etc.)
    b. Ensure that you submit an ipynb file containing all the outputs of your results.
- Share the link of the folder in the submission form. (Make sure the folder is accessible(**Anyone with the link**)
- Submission Link: https://forms.gle/g4LeVJo1xo9UExBS6

Step 1: Exploring Basic Convolution and Custom Kernels

1. **Apply Convolution with a Simple Kernel**
    - **Task:** Given a **grayscale** image[1], apply a basic 3x3 **identity kernel** to the image using a 2D convolution function (e.g., cv2.filter2D). Observe and describe the output in 1-2 sentences.
2. **Custom Kernel Design**
    - **Task:** Design a 3x3 custom kernel to create a **sharpening** effect on an image[2]. Apply the kernel to the image and describe how this kernel affects the overall clarity and contrast of the image. [Opposite of blurring]

Step 2: Understanding Padding and Its Effects on Convolution

3. **Experiment with Different Padding Techniques**
    - **Task:** Apply the sharpening kernel created in Step 1 to an image[3] with three different padding types: **constant (zero-padding)**, **reflect padding**, and **same padding**.

Step 3: Filtering for Noise Reduction and Smoothing

4. Adding Noise and Applying an Average Filter

- **Task:** Add **Gaussian noise** to an image[4]. Apply a 5x5 average filter using cv2.blur and observe the changes in noise level and overall appearance of the image. Explain in 1-2 sentences.

5. Gaussian Blur for Smoothing

- **Task:** Apply a Gaussian blur to the noisy image created in Part 4 using a 5x5 Gaussian kernel (cv2.GaussianBlur). Experiment with different standard deviations (sigma values) and observe how the level of smoothing changes. Explain in 1-2 sentences.

Step 4: Edge Detection and Gradient Calculation

6. Applying Laplacian Filter for Edge Detection

Task: Use the Laplacian filter to detect edges in a clear image[5]. Apply the Laplacian filter on the grayscale image, then visualize the result.

7. Estimating Horizontal and Vertical Gradients

Task: To estimate the edges in horizontal and vertical directions, apply two simple gradient kernels:

- For vertical edges, use:

$$\begin{bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{bmatrix}$$

- For horizontal edges, use:

$$\begin{bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{bmatrix}$$

Apply each kernel separately to an image[6] and visualize the results to observe the types of edges each captures. Explain in 1-2 sentences. (Just one more 😐)

Step 5: Image Enhancement through Histogram Equalization

8. Histogram Equalization for Contrast Enhancement

- **Task 1:** Load a low-contrast grayscale image[7] and apply histogram equalization. Observe and describe in 1-2 sentences how the contrast improves.
- **Task 2:** Apply histogram equalization three times on the original image[7] and describe any diminishing effects or artifacts that appear. Explain in 1-2 sentences (One last time 🙂)