

# Digital Image Processing- Assignment 4

14 November 2024

## Instructions

This assignment is designed to test your understanding and practical skills in image processing, focusing on segmentation, Hough Transform, and Harris Corner Detection. Use Python and OpenCV for all coding tasks, and provide comments to explain each step in your code. Submit your code files and a brief report summarizing your observations and findings for each task.

## Task 1: Image Segmentation Using Thresholding (20 Marks)

- (a) Load a grayscale image and implement the following thresholding methods to segment the image:

- **Binary Thresholding**
- **Adaptive Thresholding**
- **Otsu's Thresholding**

*(10 Marks)*

- (b) Display the original and segmented images side by side for comparison, ensuring each method is clearly labeled. *(5 Marks)*
- (c) In 2-3 sentences, discuss which method provided the best segmentation for your image and why. Consider factors like clarity of object boundaries and noise levels. *(5 Marks)*

## Task 2: Line Detection Using Hough Transform (20 Marks)

- (a) Write a function to detect and highlight straight lines in an image using the **Hough Line Transform**. Make sure to use the Canny edge detector to preprocess the image before applying the Hough Transform. *(10 Marks)*
- (b) Test your function on an image with clear straight lines, such as a road, building, or grid structure. Display the original image and the processed image with highlighted lines. *(5 Marks)*
- (c) Experiment with different threshold parameters in the Hough Transform to optimize line detection. In 2-3 sentences, describe the parameter changes and how they affected the results. *(5 Marks)*

## Task 3: Circle Detection Using Hough Circle Transform (20 Marks)

- (a) Implement a function to detect circles in an image using the **Hough Circle Transform**. Use suitable preprocessing steps (e.g., smoothing) to improve detection accuracy. *(10 Marks)*
- (b) Apply your function to an image with circular objects (e.g., coins, wheels, or round signs). Display the original image and the processed image with detected circles overlaid. *(5 Marks)*
- (c) Experiment with different radius ranges and accumulator thresholds. Display the results with and without these adjustments, and briefly explain any improvements observed. *(5 Marks)*

## Task 4: Harris Corner Detection (20 Marks)

- (a) Create a function to detect and mark corners in an image using the **Harris Corner Detection** method. Use an appropriate method to mark the detected corners on the original image. *(10 Marks)*

- (b) Apply your function to an image with distinct corners, such as a chessboard or a building with strong edges and corners. Display the original and processed images with corners marked. *(5 Marks)*
- (c) Vary the sensitivity parameter (typically called  $k$ ) in the Harris Corner Detection function. Observe how it affects corner detection, showing both original and altered results. Briefly explain your findings in 2-3 sentences. *(5 Marks)*

## Task 5: Short Theory (10 Marks)

In 100-150 words, explain how the **Hough Transform** differs when detecting lines versus circles in an image. Discuss how parameter space and computational complexity vary between these applications. *(10 Marks)*

## Submission Requirements

- Submit a single ZIP file containing:
  - Your Python code files with comments explaining each step.
  - Images used for each task (both original and processed).
  - A brief report (PDF format) summarizing your observations and findings for each task.
- Name your submission file as: `YourName_ImageProcessingAssignment.zip`

**Total Marks: 100**