CSC566 – Digital Image Processing

Lab: Image Representation & Description (MATLAB)

Objective:
This lab introduces students to image representation and description techniques using MATLAB. Students will learn how to extract boundary-based and region-based representations, compute shape, topological and texture descriptors, and understand how these features describe image objects.

Learning Outcomes

- Extract boundary-based representations from segmented images
- Compute region-based descriptors such as area, perimeter, eccentricity, and compactness
- Compute topological descriptors including connected components and Euler number
- Implement basic chain coding for boundary representation
- Apply Fourier descriptors for shape description
- Extract texture descriptors using Gray-Level Co-occurrence Matrix (GLCM)

Software & Tools

- MATLAB (with Image Processing Toolbox)
- Sample images (coins.png, cameraman.tif or provided by lecturer)

Part A: Image Segmentation

1. Load an image and convert it to grayscale if necessary.
2. Apply noise reduction and convert the image into a binary image using thresholding.
3. Fill holes and remove small unwanted objects.

Deliverable: Display the original grayscale image and the final binary image.

Part B: Boundary-Based Representation

1. Extract object boundaries from the binary image.
2. Overlay the detected boundaries on the binary image.

Deliverable: Screenshot showing boundaries superimposed on the object image.

Part C: Region-Based Descriptors

For each detected object:
- Compute area
- Compute perimeter
- Compute eccentricity
- Compute compactness

Deliverable: A table summarising the computed descriptors for each object.

Part D: Topological Descriptors

1. Compute the number of connected components in the image.
2. Compute the Euler number.
3. Estimate the number of holes using Euler number.

Deliverable: Values of C, H, and Euler number with a brief explanation.

Part E: Chain Code Representation

1. Select one object boundary.
2. Generate an 8-direction chain code from the boundary.
3. Display the first 30 chain code values.

Deliverable: Chain code output and short explanation of its meaning.

Part F: Fourier Descriptors

1. Convert the selected boundary into a complex signal.
2. Apply Fourier Transform to obtain Fourier descriptors.
3. Reconstruct the boundary using a limited number of coefficients (e.g., P = 10, 30, 80).

Deliverable: Plots showing original and reconstructed boundaries with discussion.

Part G: Texture Description (GLCM)

1. Select a region of interest (ROI) from a texture image.
2. Compute the Gray-Level Co-occurrence Matrix (GLCM).
3. Extract texture features such as contrast, energy, homogeneity, and correlation.

Deliverable: Extracted texture feature values with brief interpretation.

Submission Requirements

- Lab report (2–3 pages)
- Include screenshots, tables, and short explanations
- MATLAB codes may be included in the appendix
- Submit according to lecturer's instructions

Assessment Rubric (20 Marks)

- Segmentation correctness: 3 marks
- Boundary representation: 3 marks
- Region descriptors: 4 marks
- Topological descriptors: 3 marks
- Chain code implementation: 3 marks
- Fourier descriptors: 3 marks
- Texture analysis: 1 mark