Final Project Guidelines

Advanced Computer Image Processing

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Overview

The final project for the *Advanced Computer Image Processing* course is completed in groups of **two students**. Each project must demonstrate practical understanding of topics covered in class, including:

- image segmentation and thresholding,
- edge-based and region-based segmentation,
- K-means clustering in intensity or colour space,
- interpolation and basic image transformations,
- histogram equalization and contrast enhancement,
- optionally: a simple neural network for segmentation.

Each group submits:

- a written report (6–10 pages),
- a **20-minute presentation**,
- code and figures demonstrating the implemented methods.

Project Topic Options

1. Segmentation Using Thresholding and K-Means

Develop a segmentation pipeline using classical methods from the course. Possible components include:

- global thresholding based on histogram analysis,
- local (adaptive) thresholding,
- multi-level thresholding (e.g., Otsu),
- K-means clustering on intensity or colour features,
- edge detectors (Sobel, Prewitt, Canny) to refine boundaries,
- preprocessing with histogram equalization or contrast stretching.

Projects should compare at least two segmentation approaches and evaluate how preprocessing affects the results.

2. Image Super-Resolution With Interpolation and a Simple CNN

Investigate reconstruction quality using:

- nearest-neighbour, bilinear, and bicubic interpolation,
- a small learned model (e.g., SRCNN-style network),
- metrics such as MSE, PSNR, SSIM,
- optional geometric transformations for data augmentation.

The focus is understanding the differences between classical interpolation and learned upsampling.

3. Edge-Based Segmentation Using Gradient Operators

Construct a segmentation method based on edge information:

- apply Sobel, Prewitt, or Canny detectors,
- optionally apply histogram equalization before edge detection,
- extract object regions from edge maps.

Discuss the influence of smoothing, noise, and image transformations on edge stability.

4. Threshold-Based Segmentation of Medical or Natural Scene Images

Choose MRI, CT, ultrasound, X-ray, or microscopy images. Apply:

- global and adaptive thresholding,
- histogram equalization or contrast enhancement,
- analysis of intensity distributions,
- simple region splitting and merging (no morphological ops).

Discuss challenges such as noise, low contrast, or overlapping intensities.

5. Simple Neural Network for Image Segmentation (Optional)

Implement a small encoder–decoder or CNN-based segmentation model. The project should include:

- dataset selection or creation,
- preprocessing (normalization, histogram equalization, transformations),
- comparison with classical segmentation (thresholding, K-means),

Grading Criteria

Written Report (80%)

- correct use of course methods (segmentation, thresholding, clustering),
- quality of experiments and analysis,
- clarity of figures and interpretation,
- organization, writing quality, and completeness.

Oral Presentation (20%)

- clear explanation of methods,
- logical structure within 20 minutes,
- quality of visual materials,
- ability to answer questions.

Submission Requirements

- PDF report (6–10 pages),
- code (GitHub link or zipped folder),
- presentation slides,
- all figures must be clearly labelled (before/after processing).