22AIE313 – Computer Vision and Image Processing

Assignment 1

Internal marks considered: 10 marks

Last date for submission 10-03-2025 (Monday)

Objective:

Design a robust image processing pipeline to detect and segment objects in noisy images, using a combination of pixel processing, filtering, and segmentation techniques.

Team Formation & Uniqueness Criteria:

1. Two students per team must collaborate on the assignment.
2. Each team must choose a unique problem statement related to object detection in noisy environments.
3. Even if two teams accidentally select the same dataset, their experiments and reports must be distinct, with different techniques, parameter choices, and evaluations.
4. Additional marks will be awarded for innovative problem selection and creativity in approach.

Task Details & Evaluation:

1. **Problem Selection & Dataset Preparation (10 + 5 = 15 Marks)**
    1. Choose a **real-world problem** where noise impacts object detection (e.g., **medical images, satellite imagery, underwater robotics, night vision surveillance, etc.**).
    2. Justify the choice and challenges of the selected dataset.
    3. Provide details on the dataset, including sample images and noise characteristics.
2. **Noise Reduction (10 Marks)**
    1. Apply and compare **at least two filtering techniques** (one linear and one non-linear) to improve image quality.
    2. Show visual comparisons before and after filtering.
3. **Segmentation and Object Extraction (30 Marks)**
    1. Experiment with **K-Means, Mean Shift, and Graph-based segmentation** to extract objects from noisy backgrounds.
    2. Choose the best method for object extraction based on **accuracy of boundary detection** and justify your decision.

4. **Region-Based Processing (20 Marks)**

    1. Implement **region-growing algorithms** to further refine detected objects.
    2. Use **connected component analysis** to remove small noisy regions and enhance object separation.

5. **Final Evaluation & Report (15 Marks)**

    1. Evaluate segmentation performance with **quantitative metrics** (e.g., IoU, Dice coefficient, pixel accuracy).
    2. Provide **visual comparisons** and discuss the strengths/weaknesses of different approaches.
    3. Ensure that the **experiments are unique**, even if the dataset is similar to another team's.

6. **Innovation in Problem Statement & Approach (10 Marks)**
    - Additional marks will be given for **creative and impactful** problem statements.
    - Implementing **advanced or hybrid approaches** beyond the discussed techniques (e.g., custom filter designs, adaptive segmentation methods) will be rewarded.

Rubrics for Evaluation

Criteria	Excellent (Full Marks)	Good (Partial Marks)	Needs Improvement (Few Marks)	Inadequate (No Marks)
Problem Selection & Dataset Preparation (25 Marks)	Unique and innovative problem, well-explained dataset	Good problem selection but lacks justification	Basic dataset with unclear problem statement	No dataset explanation or problem statement
Noise Reduction (20 Marks)	Clear comparison of filters with justification	Filters applied but lacks detailed analysis	One method applied without explanation	Incorrect or missing noise reduction
Segmentation & Object Extraction (30 Marks)	Multiple techniques tested, best method selected with analysis	Multiple methods used but lacks proper comparison	Only one technique used with minimal justification	Incorrect or ineffective segmentation
Region-Based Processing (20 Marks)	Region-growing & component analysis correctly used	Some regions processed but noisy results	Basic implementation without refinement	No region-based processing

Evaluation & Report (15 Marks)	Clear, well-structured, with metrics and visual analysis	Report is clear but lacks comparison	Basic report with minimal discussion	No report or poorly explained results
Innovation in Problem & Approach (10 Marks)	Unique, creative problem and advanced techniques explored	Some uniqueness but standard approach	Common problem without much novelty	No effort in creativity