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Engineering, Built Environment and IT
Department of Computer Science

COS791

Image Analysis and Understanding

Assignment One

Due: 5 September 2025

Instructions

1. This is an individual assignment / Plagiarism is not allowed.
2. The use of libraries is permitted, you may use any programming language of your choice.
3. The assignment consists of one question to be answered as follows. The code, input-output image files, and a readme file specifying how to run your code should be placed in a folder labelled Ass1 zipped and uploaded. Additionally, a report (PDF) detailing the configuration of the experimental setup and the results should be submitted as provided in the template.
4. A zipped data file containing training, and test images and a report template (IEEE Conf template). There are 10 (distorted and ground truth) Training images and 5 (distorted and ground truth) Test images.
5. This assignment is worth 25 Marks (Report is 10 Marks). The report is not to exceed 6 pages, you can include sample output images for qualitative (visual) analysis.

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The goal of this assignment is to apply metaheuristic optimisation to automatically enhance the quality of a greyscale image by optimising contrast and brightness parameters. We will explore how metaheuristic optimisation can be used in image processing tasks without relying on traditional filters.

1 Background

Image enhancement improves the visual quality of an image for human viewers or for further processing (e.g., segmentation, object detection). Common methods include histogram equalisation, gamma correction, and contrast stretching. However, selecting optimal enhancement parameters manually is time-consuming and suboptimal.
In this assignment, you will

- Use a genetic algorithm[1] and variable neighbourhood search[2] to create an image enhancement pipeline.
- Evaluate the enhanced image using an objective fitness function.
- Compare results.

The following image enhancement techniques are to be considered.

a) Gamma Correction

b) Gaussian Blur

c) Unsharp Masking

d) Histogram Equalisation

e) Contrast Stretching

2 Evaluation Metrics

Since you have a distorted image and its ground truth, the objective function should measure how close the processed image is to the ground truth. The following options are available

1. Mean Squared Error (MSE).
2. Peak Signal-to-Noise Ratio (PSNR).
3. Structural Similarity Index (SSIM).

3 Specification

Your algorithm(GA or VNS) should randomly create a pipeline (with a variable length or fixed length, but a minimum length of 4) of enhancement techniques. The pipeline should be trained on the training images and then applied to individual test images.
The report template main headings should be followed strictly but the following detail may be considered:

1. Details of the parameters of the enhancement techniques used, if any.
2. Configuration details of both the GA and VNS, including fitness (objective) function. (Hint: can be a specific evaluation metric or a weighted approach)
3. Overall experimental design

	Objective function	Best Individual	Seed value
GA			
VNS			

Training results table

ImageTest	MSE		PSNR		SSIM	
	GA	VNS	GA	VNS	GA	VNS
Image 1 (seed)						
Image 2 (seed)						
Image 3 (seed)						
Image 4 (seed)						
Image 5 (seed)						

Training results table

References

1. Holland, J. H. (1992). Genetic algorithms. Scientific american, 267(1), 66-73.
2. Mladenović, N., & Hansen, P. (1997). Variable neighbourhood search. Computers & operations research, 24(11), 1097-1100.