School of Computer Science and Applied Mathematics
UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

APPM4058A & COMS7238A: Digital Image Processing
Assignment 1

Hand-out date: March 31, 10:00
Hand-in date: April 14, 23:59

Instructions

- This is an individual assignment.
- Before the final hand in, submit your solution PDF file to Turnitin to produce a similarity check report (assuming Turnitin is available in Ulwazi).
- Hand in the electronic files and source code on Ulwazi. See more instructions in Section **Hand-Ins**.
- You may use built in image processing functions, unless otherwise specified where image processing algorithms must be coded from scratch.
- The total marks available for this assignment is 30.

Objectives

- Implement and apply various image contrast enhancement techniques.
- Understand and apply lowpass, highpass, bandreject, and bandpass filtering in spatial and frequency domain.

Problems

1 - Low light image contrast enhancement [10]

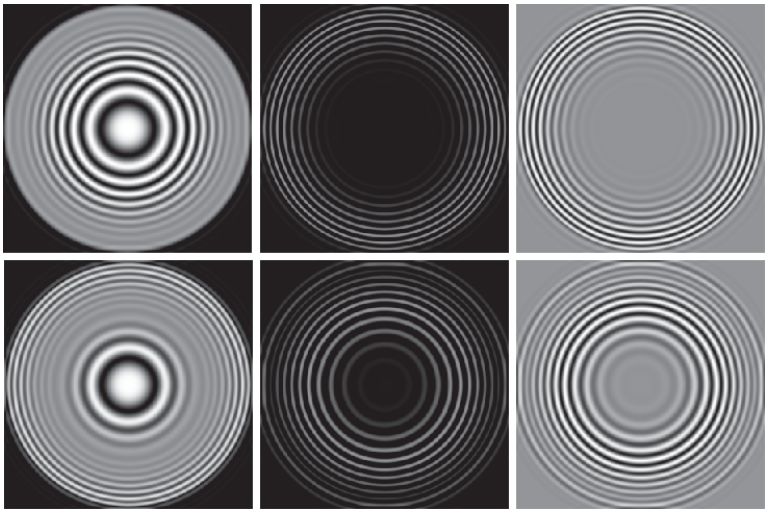
The visibility of objects and their surroundings is significantly reduced in poor lighting conditions or at nighttime. Images taken under these conditions can be processed using contrast enhancement techniques to improve the overall appearance. In this problem, you are required to perform contrast enhancement for low light images using

1. Contrast stretching [3]
2. Histogram equalization [4]

For these techniques, you are expected to implement your own functions, i.e., built-in contrast stretching and histogram equalization functions are not to be used. Test your implementations using images **road_low_1.jpg**, **road_low_2.jpg**, and **sports_low.png**. In your solution, display the original image and modified images alongside their respective histograms. Compare and comment on the subjective quality of modified images. [3]

2 - Spatial and frequency domain filtering [20]

2.1 Filtering in frequency domain [12]



a b c
d e f

Figure 1: a. lowpass filtering result; b. highpass result; c. Image b with intensities scaled; d. bandreject result; e. bandpass result; f. Image e with intensities scaled.

Spatial and frequency domain linear filters can be classified into lowpass, highpass, bandpass, and bandreject filters. Given a low-pass filter, the other three filters can be constructed from it. In this problem, you are required to implement the following:

1. Lowpass filter **zoneplate.tif** to generate an image similar to Fig. 1a. [3]
2. Highpass filter **zoneplate.tif** without intensity scaling the result. Your image should be similar to Fig. 1b. [2]
3. Perform bandreject filtering on **zoneplate.tif** to generate an image close in appearance to Fig. 1d. [3]
4. Perform bandpass filtering on **zoneplate.tif** to generate an image close in appearance to Fig. 1e. [2]
5. Scale your results from 2 and 4 to generate images similar to Figs. 1c and 1f. [2]

Hint: To separate frequency bands requires filters with sharp cutoffs, so use Butterworth filters with $n = 3$.

2.2 Filtering in spatial domain [8]

Repeat Questions 1–4 in Question 2.1 using spatial filtering.

Hand-Ins

Before your final hand-in, submit your solution PDF file in Turnitin to produce a similarity report. This report will be viewed by the lecturer only.

A compressed file (.tar.gz) named by your student number is to be submitted on Ulwazi. This file when extracted must include:

- Your solution PDF file, named as follows: "assignment_1_<student_no>.pdf" (For example: "assignment_1_0000000.pdf"). In your solution, for each question (clearly marked by the question number) include the following:
  1. display the input images, output images and plots with suitable sizes for view.
  2. discussions and comments on the techniques and results.
- Your source code folder "src" containing separate python or matlab files for each problem. All code must be clearly commented, and should generate the resulting images and graphs included in your report when run.
- An output folder, containing output images for each problem which must be saved as "q<question_number>.png" (For example: "q1.1.png")