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

APPM4058A & COMS7238A: Digital Image Processing
Assignment 1

Hand-out date: April 20, 10:00
Hand-in date: May 4, 23:59

Instructions

- This is an individual assignment, adhere to the academic integrity. Plagiarism will result in 0%.
- The due date is strictly applied. Extension is possible in cases where they fall in the criteria the university specified.
- Before the final hand in, submit your solution PDF file to Turnitin to produce a similarity check report. This report will be viewed by the lecturer only.
- Hand in the electronic files and source code on Sakai. 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 25 (or 30 including the bonus question).

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]

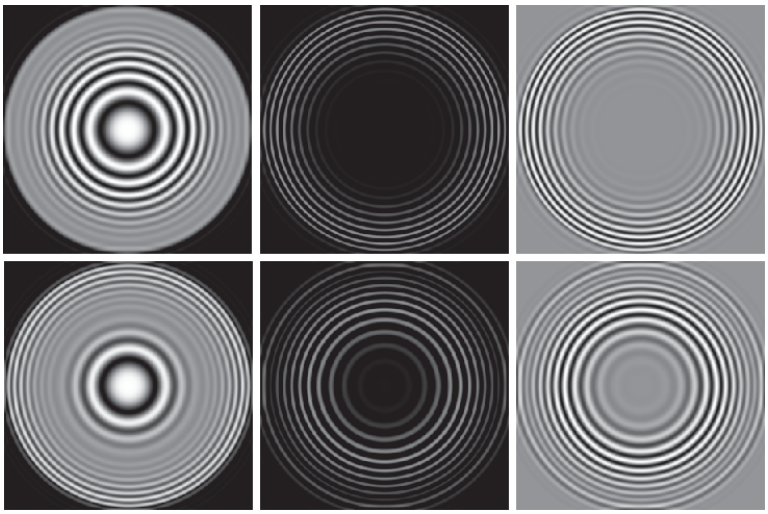
The visibility of objects and their surroundings is significantly reduced in poor lighting conditions or at nighttime. Images taken under these conditions can be processed using contrast enhancement techniques to improve the overall appearance. In this problem, you are required to perform contrast enhancement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

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

For these techniques, you are expected to implement your own functions, i.e., you are not allowed to use built-in functions. 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 [15]

2.1



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. [5]
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. [4]
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 Bonus question [5]

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 Sakai. 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.
  3. source code list following your discussions.
- Your source code folder "src" containing separate python or matlab files for each problem. All code must be clearly commented on top of generating appropriate 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")