The Hong Kong University of Science and Technology
Department of Computer Science and Engineering
COMP4421 (Fall 2014)

Assignment 1

Total = 100 marks
Due: 11:55pm, Oct. 24, 2014
Assignments must be submitted via LMES
Late Policy: 10% reduction; only one day, i.e. 11:55pm, Oct. 25, 2014, late is allowed

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Overview

This assignment consists of two sections: programming section and written section. Both programming and written parts should be submitted via the LMES system. If you would like to finish the written assignment with hand writing, you may scan and upload it.

In programming section, you will use the MATLAB to create one gradient magnitude image, to program an additive (zero mean) Gaussian noise generator, arithmetic mean filter and the Wiener filter. A set of M-files can be obtained from the course website. The routine found in the comp4421_assign1.m file performs a series of image processing and display operations on a pre-defined grayscale image. You are asked to complete the missing implementations in the programming section.

Programming assignment specifics (60%)

Part 1: Create one gradient magnitude image from a grayscale image. (10%)

You need to complete the function in the file "grad_mag_image.m". The function "grad_mag_image" takes a grayscale image of type uint8 as input and returns a gradient magnitude image of the same data type. $mag(\nabla f)$ at z_5 can be calculated with the following equation:

$$mag(\nabla f) \approx |(z_7 + 2z_8 + z_9) - (z_1 + 2z_2 + z_3)| + |(z_3 + 2z_6 + z_9) - (z_1 + 2z_4 + z_7)|$$

z1	z2	z3
z4	z5	z6
z7	z8	z9

<u>Part 2: An additive Gaussian noise generator. (15%)</u>

You need to complete the implementation of an additive Gaussian noise generator in the gen_gauss_noise.m file. The routine gen_gauss_noise takes three numbers as input: size of an image along the X-axis and Y-axis, and the standard deviation of the Gaussian noise. You should generate an image of additive Gaussian noise with the given standard deviation. The data type of the output image should be double.

Hint: You can find a MATLAB internal function to generate random numbers with Normal distribution.

<u>Part 3: Arithmetic mean filter. (15%)</u>

You need to complete the implementation of the routine in the arithmetic_mean_filter.m file. The routine takes a noisy image (in grayscale format of type uint8) as input and attempts to remove the noise with an arithmetic mean filter. A 3×3 window is used to filter the noisy image. The output image type should be uint8.

<u>Part 4: Wiener filtering with the power spectra of noise and un-degraded image. (10%)</u>

You need to complete the Wiener filter, suppose we know the power spectra of the noise S_η and the un-degraded image S_f. You need to complete the implementation in the wiener_filter_1.m file. The data type of the output image should be uint8. Do not use the internal MATLAB function “wiener2” for implementation.

<u>Part 5: Wiener filtering with a constant K. (10%)</u>

You need to complete the Wiener filter, suppose we DO NOT know the power spectra of the noise S_η and the un-degraded image S_f. This routine employs the degradation function H_d (given in the main routine) and a constant $K \approx S_\eta / S_f$ to filter the given noisy image. You need to complete the implementation in the wiener_filter_2.m file. The data type of the output image should be uint8. Do not use the internal MATLAB function “wiener2” for implementation.

Sample run of the programming assignment

sample_run.fig is the output figure from the MATLAB upon all the five parts mentioned in the assignment specifics completed. You should get a similar figure on the screen when you run the following command in the MATLAB environment:

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>> comp4421_assign1;
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Written assignment specifics (40%)

Part 1: Set Operations (10%)

(a) With reference to the following *figure 1*, sketch the set $(A \cup B) \cap (A \cap C)^C$

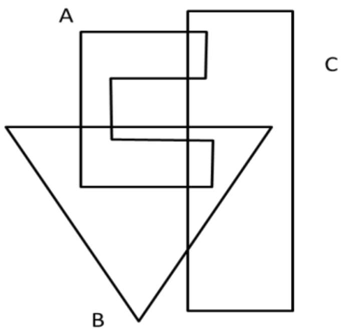

Figure 1

(b) Give expressions for the sets shown shaded in the following figures. The shaded areas in each image constitute one set, so give an expression for each of the three images:

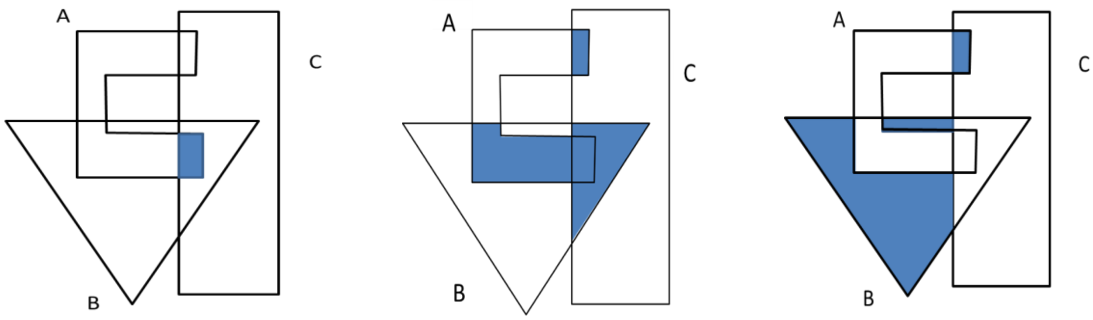

Figure 2

Part 2: Opening and Closing (15%)

Prove the validity of the duality expression of opening and closing.

$$(A \bullet B)^c = \left(A^c \circ \hat{B}\right).$$

Hint: You may use the duality relation of erosion and dilation without proof.

Part 3: Dilation and Erosion (15%)

For the following given image A

0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	0
0	0	0	1	1	1	1	0
0	1	1	1	1	1	1	0
0	1	1	1	1	1	1	0
0	1	1	1	1	0	0	0
0	1	1	1	1	0	0	0
0	0	0	0	0	0	0	0

and structuring elements B:

<1> B=

1	1	1
1	1	1
1	1	1

<2> B=

0	1	0
1	1	1
0	1	0

Calculate the dilation $A \oplus B$ and the erosion $A \Theta B$ using the structuring element <1> and <2> above.