UNIVERSITY OF CALGARY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
ENEL697 DIGITAL IMAGE PROCESSING
TEST NO. 2
WINTER 2005 SESSION
13 April 2005

Instructions:

1. This is a closed-book, closed-notes test.
2. The use of only a nonprogrammable calculator with no text storage facilities is permitted.
3. Answer all five questions.
4. Show all steps in your answers.
5. Total marks = 20.
6. Time permitted = 90 minutes.

Question 1: Explain the differences between
(i) local and global image processing operations, and
(ii) fixed and adaptive image processing operations.
Give one example for each case.
(3 marks)

Question 2: In deriving the Wiener filter, it is assumed that the processes generating the image $\mathbf{f}$ and noise $\boldsymbol{\eta}$ are statistically independent of each other, that the mean of the noise process is zero, and that both the processes are second-order stationary. A degraded image is observed as $\mathbf{g} = \mathbf{f} + \boldsymbol{\eta}$. The following expression is encountered for the mean-squared error (MSE) between the Wiener estimate $\tilde{\mathbf{f}} = \mathbf{L}\mathbf{g}$ and the original image $\mathbf{f}$:

$$\varepsilon^2 = E\left[Tr\left\{(\mathbf{f} - \tilde{\mathbf{f}})(\mathbf{f} - \tilde{\mathbf{f}})^T\right\}\right]. \tag{1}$$

Reduce the expression above to one containing $\mathbf{L}$ and autocorrelation matrices only. Give reasons for each step of your derivation.
(6 marks)

Question 3: Explain the differences between the Laplacian and subtracting Laplacian operators. Give the corresponding convolution masks and explain their effects on an input image.
(4 marks)

Question 4: Give a step-by-step algorithmic (procedural) representation of the method to map linearly a selected range of gray-level values $[x_1, x_2]$ to the range $[y_1, y_2]$ in an image of size $M \times N$. Values below x_1 are to be mapped to y_1, and values above x_2 mapped to y_2.
(3 marks)

Question 5: Give a step-by-step algorithmic (procedural) description of histogram equalization. List the strengths and weaknesses of the method.
(4 marks)

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