UNIVERSITY OF CALGARY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
ENEL697 DIGITAL IMAGE PROCESSING
TEST NO. 1
WINTER 2004 SESSION
1 March 2004

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. Total marks = 20.
5. Time permitted = 90 minutes.

Question 1: Explain the differences between spatial resolution and gray-scale resolution in a digitized image.
(2 marks)

Question 2: Using the continuous Fourier transform, derive the relationship between the Fourier transforms of an image $f(x, y)$ and its modified version given as $f_1(x, y) = f(x - x_1, y - y_1)$.
Explain the differences between the two images in the spatial and frequency domains.
(4 marks)

Question 3: The image

$$\begin{bmatrix} 1 & 2 & 1 \\ 2 & 3 & 2 \\ 1 & 2 & 1 \end{bmatrix}$$

is processed (separately) by systems having the following impulse responses:
(a) $h(m, n) = [-1, 1]$;
(b) $h(m, n) = [-1, 1]^T$; and
(c) a 3×3 matrix with all elements equal to $\frac{1}{9}$.
Compute the output image in each case over a 3×3 array, assuming that the input is zero outside the array given.
(6 marks)

Question 4: The Laplacian operator is given by the mask

$$\begin{bmatrix} 0 & 1 & 0 \\ 1 & -4 & 1 \\ 0 & 1 & 0 \end{bmatrix}.$$

Derive the MTF of the operator.

Explain the effect of the operator on an image in (a) the space domain, and (b) the frequency domain.
(6 marks)

Question 5: A 3×3 window of a noisy image contains the following pixel values:

$$\begin{bmatrix} 52 & 59 & 41 \\ 62 & 74 & 66 \\ 56 & 57 & 59 \end{bmatrix}.$$

Compute the outputs of the 3×3 mean and median filters for the pixel at the center of the window. Show all steps in your computation.
(2 marks)

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