UNIVERSITY OF CALGARY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
SCHULICH SCHOOL OF ENGINEERING
ENEL697 DIGITAL IMAGE PROCESSING
TEST NO. 1
WINTER 2007 SESSION
7 March 2007

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: Draw sketches of two images to illustrate the notion of frequency in images in terms of (a) line pairs per millimeter and (b) cycles per millimeter. Explain the differences between the two notions.

(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: Using mathematical expressions and operations as required, explain how a degraded image of an line may be used to derive the modulation transfer function (MTF) of an imaging system.

(5 marks)

Question 4: Write the expressions for the convolution and correlation of two images.
Explain the similarities and/or differences between the two.
State the equivalent relationships in the Fourier domain.
Explain the effects of the operations in the spatial and frequency domains.

(4 marks)

Question 5: Give the numerical mask representation of the two-dimensional Laplacian operator.

A 5×5 image is given as

$$f(m,n) = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 5 & 5 & 5 & 0 \\ 0 & 5 & 5 & 5 & 0 \\ 0 & 5 & 5 & 5 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}. \tag{1}$$

Compute the Laplacian of the image and interpret the result.

List the important characteristics of the Laplacian operator.

Describe an application of the Laplacian operator.

(5 marks)

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