UNIVERSITY OF CALGARY
DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
SCHULICH SCHOOL OF ENGINEERING
ENEL697 DIGITAL IMAGE PROCESSING
TEST NO. 1
WINTER 2010 SESSION
8 March 2010

Instructions:

1. This is a closed-book, closed-notes test.
2. Calculators and other electronic devices are not permitted.
3. Answer all five questions.
4. Total marks = 20.
5. Time permitted = 90 minutes.

Question 1: Explain the notion of simultaneous contrast with a figure and an equation.
Explain the notion of just-noticeable difference.

(3 marks)

Question 2: Write detailed mathematical expressions to represent (a) the linear convolution and (b) the correlation of a digital image, $f(m, n)$, of size $M \times N$ pixels, with another digital image, $g(m, n)$, of size $P \times Q$ pixels.
What is the size of the result in each case?
Explain the similarities and differences between the two operations.

(5 marks)

Question 3: Give the definitions of the normalized mean squared error (NMSE) and the perceptual mean squared error (PMSE) to compare two images, $f(m, n)$ and $g(m, n)$, each of size $M \times N$ pixels.
Explain the differences between NMSE and PMSE, and indicate their relative advantages or disadvantages.

(3 marks)

Question 4: You are given a digital image of size 2×2 pixels,

$$f(m,n) = \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}. \tag{1}$$

Convert the image into a vector $\mathbf{f}$ by row or column ordering.

Write the equations or formulas to calculate the total energy of the image using (a) the array format, $f(m,n)$, (b) the dot or inner product of the vector $\mathbf{f}$ with itself, and (c) the outer product of the vector $\mathbf{f}$ with itself.

Calculate the energy of the image using each of the three methods.

(4 marks)

Question 5: Give a step-by-step algorithm for the application of the ideal lowpass filter to a digital image in the Fourier domain.

Discuss the applications, advantages, and disadvantages of the method.

(5 marks)

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